The Infrastructural Linkages of Transport Policy:
A Study of the Wagon Economics of Indian Railway Freight Operations

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by

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Preface

Restructuring of the railways is currently an important area in international economic debate. Through most of their history, the world's railways have operated either under direct control or close regulation by government. These operational modes relate as much to the history of railway construction as to the economics of public utilities and limited transport competition. Sinking of large amounts of capital on railway projects with long gestation required the active agency of the state. The state also served as the guarantor of economic rates of interest and also as the preserver of 'natural monopolies' in transportation. Railway construction was also the source of considerable technological and engineering innovation during the 19th century, which laid the foundations of the modern industrial state. However, while the colonial objectives that guided railway construction in India placed the state mainly in the role of a financial arbiter, the Planning era placed the railways on the infrastructural pedastal on which the national development objectives were bestowed. The primary consideration that has kept the Indian Railways under the Government's wing was that, in addition to providing investment support, the state would participate directly in railway equity.

Indian Railways (IR), now entering the 150th year of service to the nation, is among the largest surface transportation networks in the world today. Its role as the provider of efficient transportation infrastructure that connects and develops regions and boosts industrial and agricultural development, has been the backbone for the development planning effort. The capital which has been sunk into the IR infrastructure has had far-reaching effect on the growth of the Indian economy in the post-Independence period. As a giant departmental organisation with a vast route-network of broad gauge, metre gauge and narrow gauge tracks that span the entire country, IR has transported people and commodities with almost equal fervour, touching the daily lives of all Indians. However, it is also apparent to one and all that this monolithic organisation is in the process of decay. What has led to this state of affairs? Many Committees such as the National Transport Policy Committee, the Railway Reforms Committee, the Railway Fare and Freight Committee, and very recently, the Rakesh Mohan Committee have tried to identify the malaise that ails IR. The White Paper on Indian Railways Projects and the Status Papers on Indian Railways have sought to do so from IR's own perspectives and have sought appropriate redressal.

Although it has been said that an enormous amount of research has been done on the railways in India, no study has actually sought to understand the process of decay. The availability of a longterm statistical database on the operations of IR is one of the principal attractions for any researcher. But to deal with the whole IR organisation would be an impossible task for a single researcher. Thus what the present study has attempted is to feel the pulse of the railways and to provide a bird's eye view of the problems which have brought IR to its present state. After painstakingly assembling an immense amount of data, the study has taken a tour of freight operations on IR, which is the basic lifeline of the railways. It is from these operations that any railway system earns adequate revenues to ensure its own survival. Any weakness that enters the railway freight system can thus have magnified future consequences, with shocks that may be felt years later. Study of the recent history of the Indian railway system, which takes us from the time of its nationalisation as a unified national carrier through 50 years of the Indian planning effort, has revealed that a single chain of fateful decisions - i.e. whether to initially invest in the railways, or to modernise them later, or to transport selected bulk-commodities on them, or to deny them budgetary support, or to go in for gauge conversion - in the course of the 150-year history of IR is taking its toll now. And the moot question at this hour, is whether to reorganise the Indian railways or to abort their operation. Whatever decision the policymakers take today will have consequences to be felt in the future, with or without the railways.

The study hopes to find some place in transportation research in India. The empirical findings and the database that has been assembled should provide scope for further research and a solid foundation to studies on the Indian railways. It is hoped that both policymakers, researchers and railway administrators, as well as ordinary IR enthusiasts will benefit from reading the study, and will join in arriving at the best collective solution to the problems that currently confront IR.

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ABBREVIATIONS USED IN THE STUDY

ACSPF	=	Accident Compensation, Safety & Passenger Amenities Fund
AG	=	all gauges
AMTRAK	=	American Class I passenger railways, USA
BBUNL	=	Bharat Bhari Udyog Nigam Ltd.
BF	=	blast furnace
BG	=	broad gauge
BICP	=	Bureau of Industrial Costs and Prices
BOLT	=	'Build, Own, Lease, Transfer
BOT	=	'Build, Own, Transfer'
B-P	=	Breusch-Pagan econometric test for heteroscedasticity in data
BR plc	=	British Rail
CaC	=	railway Capital-at-Charge
CCA	=	Central Controlling Authority, Indian Railways
CIL	=	Coal India Limited
CIMMCO	=	Central India Machinery Manufacturing Company
CLW	=	Chittaranjan Locomotive Works, Asansol, West Bengal
CNC	=	Compagnie Nationale des Cadres, SNCF
CO	=	incremental railway capital outlay
C-O	=	Cochrane-Orcutt econometric adjustment procedure for autocorrelation
coeff	=	coefficient
comp	=	computed
CONCOR	=	Container Corporation of India
CONRAIL	=	Consolidated Rail Corporation, USA
CR	=	*(i)* return on railway capital-at-charge
CR	=	*(ii)* Central Railway
CR	=	*(iii)* China Railways
CSO	=	*(i)* Central Statistical Organisation
CSO	=	*(ii)* Central Standards Office of the Indian railways, merged into RDSO
CTPC	=	Committee on Transport Policy and Coordination
CV	=	commercial vehicle
DB	=	Deutsche Bahn, or German National Railways
df	=	degrees of freedom
DF	=	Development Fund
DMU	=	diesel multiple units
DRF	=	Depreciation Reserve Fund of the Indian Railways
DSP	=	Durgapur Steel Plant, Durgapur, West Bengal
DVC	=	Damodar Valley Corporation
DW	=	Durbin-Watson econometric test for autocorrelation
EAF	=	electric arc furnace
EC	=	European Community
EEC	=	European Economic Community
EIC	=	East India Company
EMU	=	electric multiple units
ER	=	Eastern Railway
ESS	=	explained sum of squares
ETNA	=	Etude Technologique pour un Nouvel Acheminement, SNCF
FCI	=	Food Corporation of India
FWU	=	4-wheeler unit
FYP	=	Five-Year Plan
GDP	=	Gross Domestic Product
GLS	=	Generalised Least Squares
GMF	=	Gares Multifonctions, SNCF
GOI	=	Government of India
GWR	=	Great Western Railway, Great Britain
HDC	=	high-density corridor, India
HDN	=	high-density network, India
HIC	=	high-income country
HMSO	=	Her / His Majesty's Standards Office, Britain
ICC	=	Interstate Commerce Commission, USA
IISCO	=	Indian Iron & Steel Company, Burnpur, West Bengal
ICF	=	Integral Coach Factory, Perambur, Chennai, Tamilnadu

IR = Indian Railways
IRC = Indian Railway Committee, or Acworth Committee
IRCON = Indian Railway Construction Corporation
IREC = Indian Railway Enquiry Committee, or Kunzru Committee
IRFC = Indian Railway Finance Corporation
IRYB = Indian Railway Yearbook
ISP = Integrated Steel Plant
JNR = Japanese Nationalised Railways
JR = Japanese Railways
km = kilometre
kmph = kilometre per hour
LDC = less developed country
LIC = low-income country
LMSR = London Midland & Scottish Railway, Great Britain
LNER = London & North Eastern Railway, Great Britain
LOC = letter of credit
LSE = London School of Economics
m = metre
MG = metre gauge
MIT = Massachusetts Institute of Technology
MMTC = Mines & Minerals Trading Corporation, India
MOP = Ministry of Planning
MRTS = mass rapid-transit system
MSP = mini-steel plant
MT = million metric tonnes
NCR = National Capital Region, *i.e.* Delhi
NIDC = National Industrial Development Corporation
NE = net railway revenue earnings
NEFR = North-East Frontier Railway
NER = North-East Railway
NR = Northern Railway
NTKm = net tonne-kilometres
NTPC = *(i)* National Thermal Power Corporation
NTPC = *(ii)* National Transport Policy Committee
NTPC = National Thermal Power Corporation
OHS = open high-sided
OLS = *(i)* open low-sided
OLS = *(ii)* Ordinary Least Squares
OYW = 'Own Your Wagon' scheme
PCC = partial correlation coefficient
PDS = Public Distribution System
POL = petroleum, oil and lubricants, i.e. mineral oils
PSO = *(i)* public-sector undertaking
PSU = *(ii)* public service obligation
PWD = Public Works Department
p.a. = per annum
R^2 = multiple regression coefficient
R^2 = R^2 coefficient adjusted for degrees of freedom *[coefficient of determination]*
R&D = research and development
RDSO = Research Design & Standards Organisation, Lucknow, Uttar Pradesh
REC = Railway Executive Committee, Great Britain
RCF = Rail Coach Factory, Kapurthala, Punjab
RFFC = Railway Fare & Freight Committee, or Nanjundappa Committee
RFSEC = Railway Freight Structure Enquiry Committee, or Mudaliar Committee
RITES = Rail India Technical Services
RRC = Railway Reforms Committee, India
RRF = Revenue Reserve Fund
RRT = Railway Rates Tribunal
Rs = rupees
RTEC = Railway Tariff Enquiry Committee, or Paranjape Committee
RTRC = Railway Testing & Research Centre, merged into RDSO

SAIL	=	Steel Authority of India Limited
SCR	=	South-Central Railway
SEB	=	State Electricity Board
SER	=	South-Eastern Railway
SNCF	=	Société Nationale de Chemin de Fer, or French National Railways
SOC	=	social opportunity cost
SR	=	*(i)* Southern Railway, India
SR	=	*(ii)* Southern Railway, Great Britain
SRMC	=	short-run marginal cost
STP	=	social time-preference
s.e.	=	standard error
T	=	metric tonnes
TAT	=	turnaround time
TGV	=	Train à Grande Vitesse, SNCF
TELCO	=	Tata Engineering & Locomotive Company, Jamshedpur, Bihar
TISCO	=	Tata Iron & Steel Company, Sakchi, Jamshedpur, Bihar
TRES	=	Train rapide èconomique et sûr, SNCF
TRO	=	Tarification Routière Obligatoire, SNCF
UNIGAUGE	=	unified railway gauge project, India
UNO	=	United Nations Organisation
USD	=	US dollars
VAT	=	value-added tax
WAP	=	Wheel and Axle Plant, Yelahanka, Bangalore, Karnataka
WBSEB	=	West Bengal State Electricity Board
WCTR	=	World Conference on Transport Research
WDR	=	World Development Report
WIL	=	Wagon India Limited
WPU	=	wagon-producing units
WR	=	Western Railway
WWI	=	World War I
WWII	=	World War II

Organisations & Publishers

GOI	=	Government of India
GOWB	=	Government of West Bengal
MIT	=	Massachusetts Institute of Technology
OUP	=	Oxford University Press

Chapter 1

INFRASTRUCTURE & THE RAILWAYS

1.1 The Economics of Infrastructure

Infrastructure development and the extended linkages this has with economic growth and development has come into close scrutiny in the post-recessionary world situation of the 1990s. Two major reasons contributing to a lack of soft alternatives in this regard, are the tail-off of high achievable LDC growth rates in capital goods with the incursion of consumer-oriented living standards and consequently increased production costs, and exhaustion of scale economies within the existing spatial distribution of resources. Although country-experience of infrastructure development has been wide and diverse, with impacts varying with size of the country involved, the importance of new thrusts in this direction derives from potential increases in market-size and productive capacities which would ensue. The rationale behind this, drawn diversely from the literature on Schumpeterian innovation cycles, Kondratieff long waves and Kuznets swings[1] postulates that long sustained expansionary waves leading to economic development would arise from concentrated focal investment in those economic sectors having vertical interdependency-linkages with the widest spectrum of economic activity. Development of infrastructure is also important from the point of view of 'closing the development gap' and 'catching-up', so as to leave the LDCs advantageously placed with respect to the new World Trade Order and its anticipated spin-offs.

The first question that has however to be confronted here relates to the origins and the modes of generation of infrastructure. The vast development canvas afforded by economic history has generally shown the generation of infrastructure to have been an act of governance, raising obvious conflicts with the *laissez faire* concepts of the state. Infrastructure therefore exists generally as the result of design rather than of chance, or of the `invisible hand', since the scale of coordination and promotion required for putting infrastructure into place is usually well beyond the capacity of disaggregated economic enterprise. Moreover in most cases, the large investments required for the development of infrastructure have either been directly sourced or else supported from government coffers.

The second question that confronts the issue relates to the impact of infrastructural bottlenecks in constraining the growth of the economy, or conversely to the multiplier impact of infrastructural investment in achieving the acceleration of development. Infrastructure is directly a *development* variable rather than a *growth* variable, since the qualitative levels of economic activity undergo a sea-change once infrastructure has been instituted. Thus the development options that governments face relate to the relative location of development investments *i.e.* whether the investment to be made will be at the economic base, or at downstream positions. Rules of complementarity between infrastructural and other investments dictate a sequencing of these investment flows so that capacities created by investment of one type are fully exhausted before the next expansion in capacity occurs.

The present study will look into the character and role of infrastructure in development through the medium of one of its most important historical constituents, namely transportation. Within the different modes of transport, the greater part of two centuries of economic development has borne close association with the development of railways. Although the degree of dependence of economic activity upon railways varies according to country and according to the point of time from which the development of transportation commenced, most advanced economies today can attribute their state of advancement to critical periods in the past, when the advent of railways improved communication linkages adding new muscle to their industrial sectors. India, in this respect, was one of the fortunate few where the railways were introduced around the same time as they were in the advanced countries. However the course of subsequent economic development differed significantly, the historical reasons for which have usually been identified in colonialism. The coming of national independence and the institution of planned economic development made a marked change in the placement of the Indian economy vis-a-vis the railway infrastructure that was already in position, and nearly five decades of development experience are now available to assess the impact that transport development has had on the economy in its character of an infrastructural variable. The various facets of this impact will now be outlined and assessed.

1.1.1 Types of Infrastructure

Under the older name of *social overhead capital* [Rosenstein Rodan, Nurkse, Hirschman], infrastructure encompasses a gamut of *public utilities*, like power, telecom, water supply, sanitation, etc., and *public works* like roads, dams, irrigation-canals, and the entire range of transportation services. Since the process of economic development involves complex interplays between different constituent sectors of the economy, the provision of infrastructure, which defines the social envelope of this interdependence, determines the ultimate pace of and locational balances within the process. The extent of such provision depends on *infrastructural investment*, which may then alternately be represented as a capital variable within economic space, that determines the ultimate efficacy of capital outlays made on other technical inputs in raising output and productivity.

A first distinction might be made between public works and public utilities as components of infrastructure. The word-prefix 'public' attached to each indicates a commonality between them arising from their common characteristics as *public goods*, and on account of their collective or social provision. Beyond this, the two categories become dissimilar because while the former boosts the scope for the economics of value, production and distribution, the latter improves welfare. Thus despite their inclusion within the common genre of *infrastructure*, not all its constituents are common in physical character or in the location of their ultimate impact on the economy. Instead, each constituent is a separate entity, capable of exercising its influence on production and distribution processes either singly, or conjointly with other infrastructural constituents. Because of this ambivalence, the crucial factor deciding the efficacy of infrastructural outlays is the order of their precedence. Thus the provision of power without roadways would limit the infrastructural impact on production, because it remains delinked from the markets, and the provision of water supply without sanitation would not necessarily improve welfare, because of the absence of basic hygiene. In a long-term analysis of development, perhaps the most crucial infrastructural input would be transportation, because of its capacity to unify fragmented markets and consolidate production and the allocation of resources.

The present study is focused on this particular aspect of transportation as a part of development infrastructure. Although the overall infrastructural impact of transport services on the economy may be similar, distinctions are often drawn between alternative transportation modes in terminology such as *surface transport*; *land-based* and *water-based* transportation; *inland* and *international* waterways; global *seaways*; *air transport*; etc. The endowment of transportation facilities that any country is provided with at a given point of time is a joint-product of geographical location and economic history, with the chronology of development exercising a deterministic role. For instance, while inland waterways had once held an all-important position in transport scenarios of the past, their actual presence was restricted to countries which had adequate systems of navigable rivers. Later, with a revolution in other modes of transport, while the domestic importance of waterways declined considerably, the seaways still hold on to that importance by virtue of their primacy in international freight movements. Even within *surface* transport, the two important constituents i.e. the roadways and railways are not necessarily perfect alternates, since while the former have developed mainly to serve the need for moving low-volume freight over shorter distances, the latter have over time become increasingly specialised towards the movement of bulk freight. The newer development of airways in more recent times has centred around the need for unprecedented speed in the delivery of special freight over vast distances, but still remains little more than a fringe choice for the LDCs because of the huge amounts of capital investments required. Thus surface transport is still the first investment choice while developing the infrastructure for transportation in such countries, and the railways hold special importance to countries of larger size with vast internal distances.

1.1.2 Transportation & the Mobility of Resources

Economic development devolves upon the integration of isolated growth trends in economic activity into nationwide economic acceleration. One factor crucial to such consolidation is mobility of men and materials over the economy, since such mobility widens the ambit of markets for inputs and finished products and demand and supply linkages therein. Infrastructure plays a role auxiliary to the development process. While infrastructural variables often have the character of public goods supplied by public utilities, they are critical to the determination of the overall productive capacity of the economy. There are, however, important distinctions between the different components in infrastructure. Infrastructural sectors such as energy or power produce direct outputs. The transport infrastructure on the other hand produces services that indirectly bear on gross output through their influence on factor and product mobility and hence on resource allocations. The transportation network serving the economy by interlinking its sectors and regions is an infrastructural variable. Commodity flows over this network and their growth indicate infrastructural demands and their realisation. The supply variable is the carrying capacity of the transportation network which determines the extent to which such flows can take place, and thus the future course of development.

The present study will examine transport infrastructure in the Indian economy as a determinant in economic and industrial development processes. However the exact nature and direction of causation in this respect is not universally established. Contemporary opinion on the role of infrastructure in economic development thus falls broadly into two divergent schools of thought. One school maintains that development of social overheads should be made with anticipatory demand in mind, the rationale being that creation of social overheads generates cost-reducing external economies. The other protagonist school argues that transport and other infrastructural facilities should be created in response to capacity shortages within the economy, since long-term investment carries risks and uncertainty when made in anticipation of long-term demand that might not even materialise. Whether the two sets of opinions are so absolute as to be mutually exclusive, or whether each individual opinion is a product of the economic circumstances and the times in which it arose will also need to be examined by reference to the long history of railway development across the world.

1.2 Global Availability of Transport Infrastructure

The growth of global transport infrastructure has been mainly concentrated over the period of 200 years since the closing years of the 18th century. It has thus kept pace with and is probably causally linked to phenomena such as the growth of world trade, colonialism and industry over the same period; however, where the 19th century might be called the 'Railway century' because of the assimilation of steam power in transportation, the present century is appropriately the 'Road century' because of the advent of the internal combustion engine. A difference would therefore be noticeable between the country-transport networks developed over the previous century as compared to those developed more recently. Most industrialised countries, especially in Europe, have extensive railway networks in addition to highways and superhighways, raising spatial incidence of transport infrastructure to very high levels. Countries in the LDC group generally have much lower incidence, and also show pronounced absence of railways relative to roads. However an obvious exception might exist in respect of the decolonised countries, especially those in South Asia. The development of railways in these countries proceeded almost alongside railway development in the colonial nation - and as will be seen, with capital being solely sourced from the latter. That the colonial power in this respect was almost invariably Great Britain is not merely coincidental, since the economic might that the British Empire acquired was largely the product of its colonial enterprise, including provision of transport as infrastructure for this. Other European colonial powers *e.g.* France, had much less to show by way of transport development in their colonies such as Algeria. Although the same colonised countries did, along with others, acquire an overlay of roads in the 20th century, the fact remains that the penetration of railways that already existed meant that fewer roads were constructed till their eventual independence. It also stands to reason that since foreign (British) capital in large amounts had been sunk into railway construction and operation, there was obvious reluctance to open the tranportation sector to competition from roadways.

Hence a cross-comparison of transport infrastructure across the countries of the world shows wide variability both in the relative extent of road and rail networks, and in terms of their spatial incidence. Cross-comparison nevertheless proves illuminating and establishes uniform principles for evaluating the incidence of transport infrastructure across alternative modes.

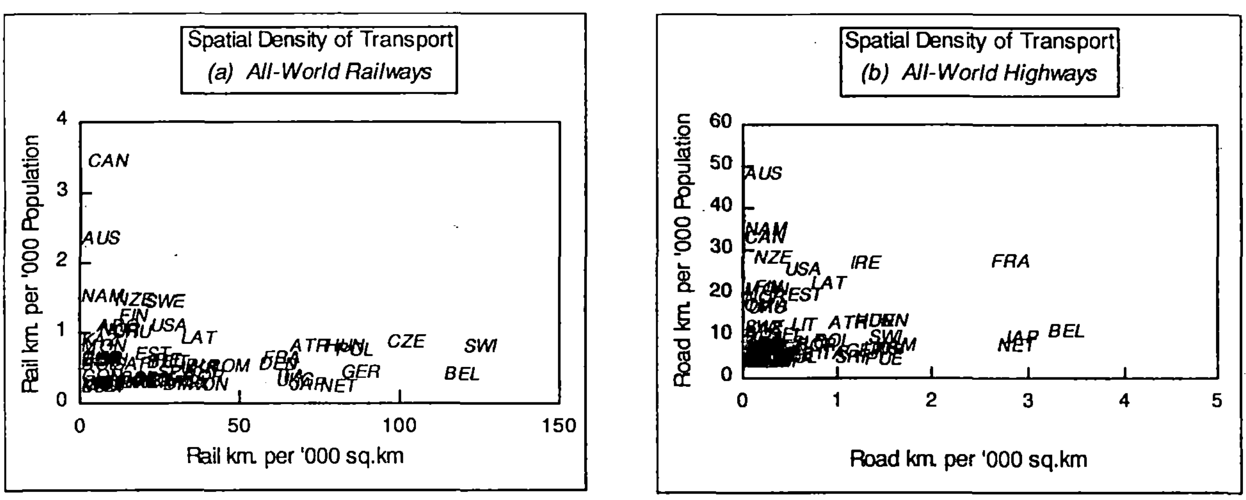
Geometric cross-comparisons of the mode-wise extent of transport infrastructure across 130 low, medium and high income countries in 1992-93 are presented in the figures. The two important incidence indicators that form the horizontal and vertical axes of *Fig.*1(*a & b*) and 2(a & *b*), are respectively, ***availability of*** *transport across space,* and *availability of transport across settlement,* denoted in the figures as ratios for modal route-kilometres per thousand sq.km area and modal route-kilometres per thousand population. The ratios are computed separately for railways, highways - the two principal modes of surface transport. The former ratio indicates the spatial density of the modal network, while the latter reflects the relative access the population has to it.

The formulation of the indicators used here might be briefly explained. As such, the necessity for transportation arises both because of the distances that have to be traversed within a country, and because of the size of the population that needs to be provided transport services. In practice, either principle - or both, in exceptional circumstances - have been responsible for the peculiarities in evolution of modal networks in different countries. Since as background to the incidence concept, the idea of population density determines this choice, cross-comparison can be made on the incidence features of railway, highway and all-mode transport in the countries under reference, against foreknowledge of their spatial and demographic dimensions.

1.2.1 The Country Analysis

Comparing the relative position of railway and highway networks in all 130 countries, as presented in Fig 1.1*a* and 1.1*b*, pronounced differences are noticed between the general incidence characteristics of railways and highways. While railway incidence seems particularly influenced by the settlement density of a country, the incidence of highways is determined more by its spatial size. In Figure 1*a* for instance, countries with highest spatial densities for railways are all European and include densely-populated Switzerland, Belgium and Germany, among others. In contrast, and inspite of high spatial density of railways, the correspondingly high density of population ensures that relative access of the population to railway transport remains much smaller than in Canada and Australia, and even in Sweden, implying that countries with the highest spatial density of railway coverage are also countries with the highest settlement density of population. Railways are therefore *settlement*-oriented. Bearing in mind that Canada and Australia are rather exceptional in terms of their phenomenal size and nominal population, therefore acting as geometric outliers in the *space*-oriented cluster, the dominance of settlement density in determining the incidence of railways is even more apparent.

***Figure* 1.1: Spatial Density of Modal Transport by World Countries**

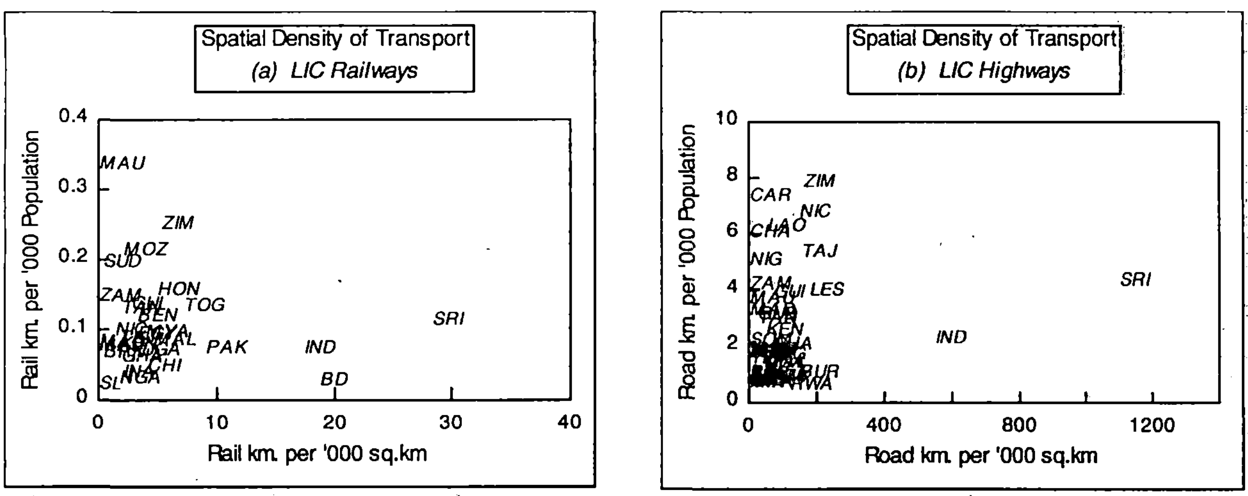


Sources: Plotted Inter-Country Data using standard 3-letter country identifiers, from *World Factbook 1993,* CD-ROM Database incorporating US State Department Data, Wayzata Technologies, 1993

The incidence of highways, on the other hand, seems largely complementary to the incidence of railways in the countries considered, implying that the development of their highway networks is *space*-oriented, and supplements rather than duplicates rail networks in most countries. However, a few countries maintain their relative cluster positioning in *Fig* 1.1*a* and 1.1*b* Thus the vast territories of Australia and Canada have low spatial coverage by both highways and railways, and are therefore *under*-served by transport even though their sparse populations may also not warrant higher density of coverage. In contrast, countries like France, Netherlands and Belgium in Europe, and Japan show high spatial densities for both railways and highways, indicating that while the high density of settlement in these countries has necessitated parallel development of both transport modes, the development may well have been competitive, especially over periods when the total traffic generated by their economies proves insufficient for full utilisation of total transport capacity. Although the UK and the US lie closer to the general cluster of countries in the figures, and are therefore not individually distinguishable among them, they too show competitive development between railways and highways. However, where the order of this competitiveness in the UK is similar to that in France and shows settlement-orientedness, it acquires space-orientation in the US, which is a large country with a relatively sparse population.

Fig 1.2*a* and 1.2*b* confine country analysis solely to economies with lower income, including India and China. Although as would be expected, the transport coverage provided by rail and highways is lower than in the high income countries which are more visible in the earlier figure-set, it is seen however that railway development has been settlement-oriented only in India, Bangladesh and Sri Lanka, and to a lesser extent in Pakistan, and is otherwise well below 10 route-km/1000 sq.km in the 42 low-income countries [LIC] being considered. India, Pakistan, Bangladesh and Sri Lanka thus all act as outliers to the general pattern of railway development established by the LICs, and it is curious to note that they also have a shared history of railway development under the British, with the present railway systems of the first three countries having once been part of a common pre-Partition railway system. As will be seen presently, much of the early development of railways across the world drew finance from British capital markets and it is only natural that the former British colonies should have benefited by acquiring more extended railway systems than other LICs.

***Figure* 1.2: Spatial Density of Modal Transport in Low-Income Countries**



Sources: Plotted Inter-Country Data using standard 3-letter country identifiers, from *World Factbook 1993,* CD-ROM Database incorporating US State Department Data, Wayzata Technologies, 1993

However comparing the incidence of railways with that of highways, only two of the former four countries remain outliers - namely, India and Sri Lanka. Sri Lanka, because of its compact island nature, is better endowed in spatial terms by transport facilities. India, because of the strong thrust towards the building of road infrastructure in its Five-Year Plans, has expanded its spatial access to highways, although to some extent, this thrust has also arrested the further expansion of railways over the same period. Most LICs on the other hand form a dense cluster along the vertical axes, implying uniformly low coverage by transport infrastructure in general, and accessibility of transport services to the population being arrayed in terms of the ratio of country-population to country-size.

The first overview of global transport infrastructure that has been gained through the foregoing country analysis enables general principles to be laid for evaluation. On the strength of these principles, it is observed that the LICs are under-served by transportation in both spatial and population terms, and that a greater degree of complementarity characterises the development of railway and highway infrastructure in the high income countries [HIC] than in the LICs. Inspite of these broad features, relative similarity is noted between the development of transport modes in India vis-a-vis the Western European countries indicating that fruitful study might be made of the parallel development experience.

1.2.2 *Per Capita* Analysis

A feature that has remained invisible in the foregoing analysis is the direct role of population-size in determining transport access. This is now examined by plotting country positions for *per capita* spatial access to transport by individual modes against *per capita* spatial access to transport by all modes, in Fig. 1.3*a* & 1.3*b* for railways and *Fig.* 1.4*a* & 1.4*b* for highways. Comparing high-income and low-income economies, nearly perfect correlation is noted between plotting variables for highway transport when countries are ordered in terms of the relative sparseness of populations, although *per capita* road access is considerably lower for the LICs. This would establish, as a general principle, that the road access ratio for the population is positively related to sparseness of population, and that relative variation between countries in the length of highway networks does not materially change this order of relation.

***Figure* 1.3: Spatial Access of the Population to Railway Transportation**

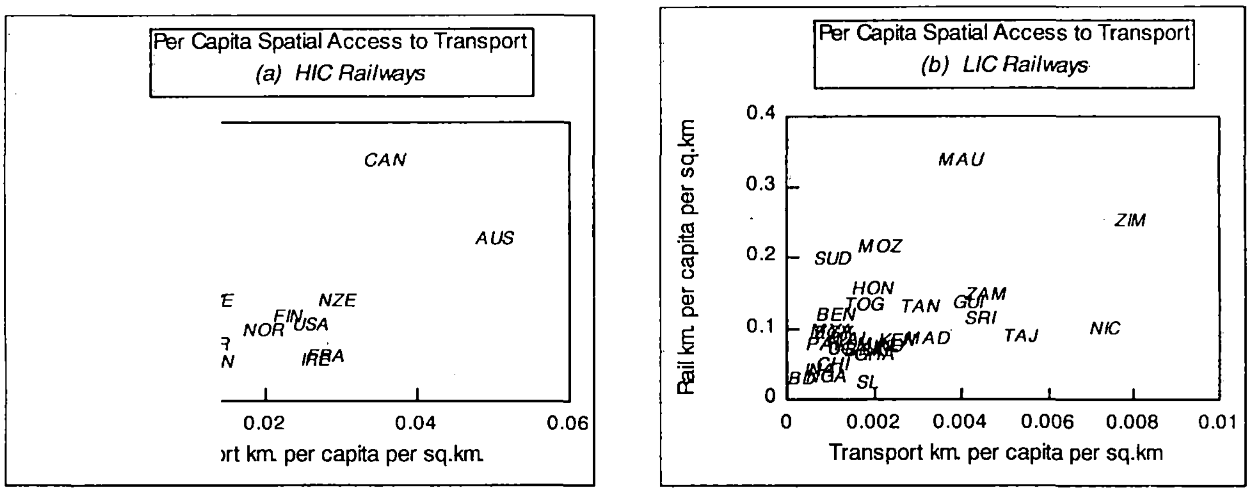
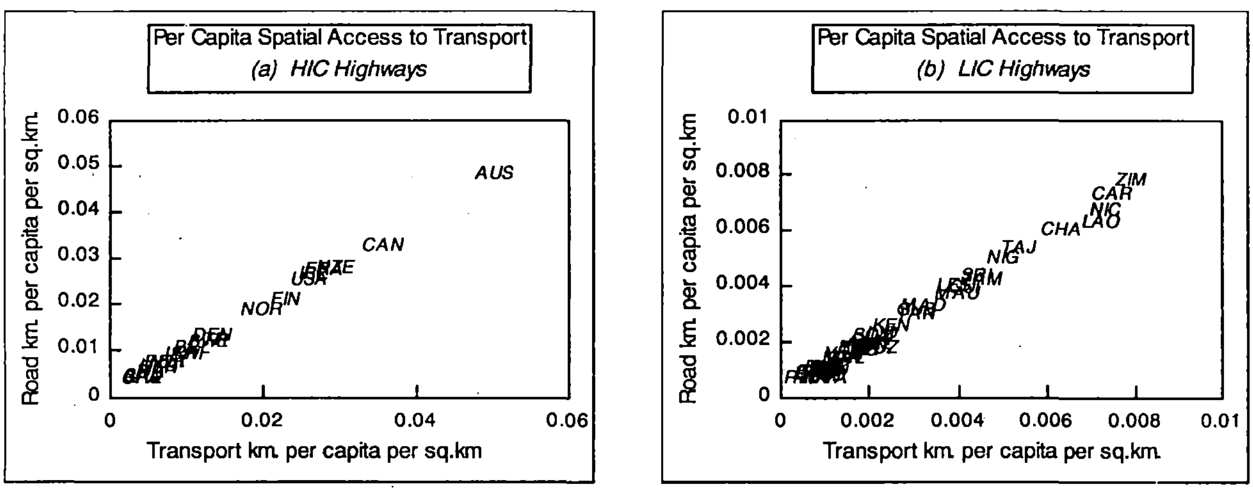


***Figure* 1.4: Spatial Access of the Population to Road Transportation**



Sources: Plotted Inter-Country Data using standard 3-letter country identifiers, from *World Factbook 1993*, CD-ROM Database incorporating US State Department Data, Wayzata Technologies, 1993

The same arraying of countries is retained for the corresponding railway plots. However the cluster plots for the railways show more obvious scatter, with the degree of scattering increasing for the LICs. Ignoring obvious outliers like Canada and Australia among the high income countries, and Mauritania and Zimbabwe among the LICs, all of whom share low population-to-land ratios, the principal difference between the former and latter country-groups appears in the directional spread of the cluster. While the higher income countries are more closely aligned along a SW-NE direction and would therefore show higher correlatedness between plotting variables, the position of the LDCs indicates more amorphousness in clustering behaviour. In general, the LICs are more deficient in railways as compared to highways in *per capita* terms, since railway transport inequalities visible in *Fig.* 1.3*b* - which in most cases are railway deficiencies - are made up when the highly correlated highway plot is also considered.

between 1850 and 1870 and its reverberations were felt in many countries of the world, including India. It may be noted however that the headiest expectations lasted during the phase of railway construction and had petered down by the time the railway companies entered the phase of railway operations and traffic competition. Another factor behind the reversal of expectations was the realisation by governments that railway enterprise could not remain unregulated, because of the transport monopolies that had been created. A third and more crucial factor was the drying up of foreign private capital flows after the end of speculation and economic downturn.

1.3.2 Private Funding for Railway Infrastructure

Although infrastructural development promises immense downstream benefits in terms of activity and productivity increases, the burden of financing this development is often daunting. The 'low-level equilibrium trap' identified in many LDCs springs therefore from both funding and infrastructural inadequacy, since the domestic funds flows can only be increased by putting infrastructure into place. In the absence of domestic solutions two options remain open of government subsidies *i.e.* 'merit goods' funding, and of foreign borrowing. In the context of railways, the problems are aggravated by the low returns to capital, compared to the scale of capital funding, which makes it difficult for railway enterprise to capture enough revenues to pay its own costs. As had been noted earlier, this situation argues for the provision of government subsidy so that infrastructure is not undersupplied. Similarly, the existence of high domestic or foreign interest rates which prejudices the public-borrowing option, argues for the same. In these circumstances, the past trend in most infrastructural systems had been to rely mainly on public finance and subsidised operation, even at the cost of efficiency losses leading to the sacrificing of future development in infrastructure.

Reviewing the history of infrastructural finance, the role of government guarantees and subsidies is well-evident and will be commented upon at length in the next chapter. The primary function behind these was to encourage the inflow of foreign capital, in an uncertain area where domestic investors feared to tread. Even the early American railroads, lavishly supported by land grants and federal construction subsidies, sought their finances from the money market in London.[6] While the railways constituted the major infrastructural innovation of the 19th century, vast investments in the same period also went into canals and dockyards, telegraph systems, roads and turnpikes, electricity utilities and the like. As a result, the success of the railway companies in competing for foreign capital lay in the magnitude of concessions they were able to secure from governments and the high returns they were consequently able to offer to their investors.

But, as remarked earlier, the period of railway capitalism might be subdivided into the phases of railway *construction* and railway *operation*. While the first of these phases were secured by various grants, subsidies and guarantees, the second was unsecured. The immediate consequence of the convergence of railway construction activity throughout the world financed by a single financial market was that with the eventual completion of the construction phase, the majority of the world's railways entered the unsecured operational phase together. The drop in financial returns that each underwent coalesced into a major market slump occurring in the 1870s, with no coordinated world revival of railway funding having occurred since then. This would hold that the success of privately-funded railway infrastructural development - for which the 19th century is held up as example - was in the Schumpeterian sense, a 'historic individual', and cannot argue for private infrastructural finance as necessarily being the superior alternative.

1.3.3 Infrastructure Finance Theory

An important consideration in treatments of the finance of infrastructure is the concept of *asymmetric information,*[7] whereby the financial promoter is more informed about the risks of enterprise than the investor. Where infrastructural capital is raised through private promotions within the stock market, the possible extent of asymmetry that would prevail is the obvious cause of high returns promised to the investors in risky capital issues. The resultant rise in interest rates outprices safe capital issues and increases the overall risk portfolio of the market, in the financial phenomenon technically known as *adverse selection*. It thus becomes easier and easier for the speculative promoter to promote high-risk infrastructural issues, since the investors are lured away from safe investments into the vortex of higher and higher investment risks by promises of higher interest rates. This is technically the problem of *moral hazard*, as a consequence of which higher interest rates actually lower the investor's expected returns. The more marked the information asymmetry, the greater will this divergence be.

Although the presence of speculation with asymmetric information pushes up interest rates in anticipation of high rates of capital returns, it also goes to the detriment of those high risk projects which may yield high potential returns because of the crowding of purely speculative issues. In such cases, the promoter's liability to subscribe to the capital of his own issue rises, and will lead to reluctance on his part to enter the capital market unless he finds his position protected by some form of interest guarantee. The defect of this system is that the guarantee also promotes the diversion of resources to nonproductive purposes.[8] In extreme cases, the promoters may resort to 'bankruptcy for profit' in a phenomenon called 'looting' noted in Akerlof & Romer [1993].[9] Financial prudence advises closure of firms whose earnings from the liquidation of assets outweigh the returns from enterprise. One modality of looting involves the draining out of operating funds receivable under the guarantee from the firm well in advance of this so that only a shell operation remains at the time of closure. Another more reprehensible method falsifies the accounting returns of the shell company to show low cost-to-return ratios in order to acquire new capital inflows on other ventures. The crux for fair operation of government guarantees on infrastructure is close monitoring of performance, which would however also undo the information asymmetry that commenced the process.

The theoretical analysis made above adequately reflects the prevalent mood of the financial market during the 19th century railway boom. As long as high expectations were fuelled by the abundance of new railway construction projects, investor response remained high. Following the completion of most major construction projects by the 1870s, a financial turning point was reached. Although private capital did remain engaged in railway operation for a considerable time to follow, both credit needs as well as informational asymmetry were much less in this case and hence did not lead to the earlier response from the financial markets. The next development following the commencement of large-scale railway operations was the advent of extremely low returns to operating capital so much so that the anticipation of shared profits under which the government had originally extended guarantee support failed to materialise. Instead the governments found themselves making a constant outgo of funds to finance the guarantee. It was this unhappy experience - common among all governments who had financed railway construction through guarantees and subsidies - that led to the spate of railway buy-backs and takeovers once the promoters' sleight-of-hand became apparent.

Early transport infrastructure projects were usually characterised by extreme asymmetries of information because of their innovative nature, the lack of demand projection, and a dearth of respectability among their promoters. An added factor was the fact that the actual resource potential of newly-opened regions, on which potential traffic would depend, had not been properly assayed. In contrast, project promoters and their privileged friends resorted to vast speculations in the lands through which the railways would pass, because of insider information. Financial market reluctance to finance uncertain infrastructural issues in distant lands was overcome when the State acquiesced to the provision of an incentive structure of operating subsidies, interest guarantees and collateral land grants to underwrite the issues. Although the eventual impact of each was identified, the respective incentives operated on different individual sentiments in the market. The subsidy reduced the risk premium on the investment. The guarantee relaxed credit rationing by counteracting informational asymmetry. The land grant provided security and reduced collateral risks. Much of railway finance in the 19th century was raised in these circumstances, from foreign financial markets, and provided a major impetus to further development of these markets.[10] Even in the comparatively-rich US, railway securities constituted more than half of the outstanding foreign debt till 1914.[11] The alternative model of local finance was experimented with, *e.g.* in France's Freycinet, but proved a failure in mobilising adequate infrastructural finance. Since with time common knowledge has grown, the asymmetry has lessened, making it extremely difficult today to raise finances in the same degree and manner.

1.3.4 Promoting Infrastructural Finance

Investment in infrastructural facilities like railway transport is also characterised by the fact that a major part of the initial capital investment into the building of networks is either irrecoverable or recoverable only at some future date when the scale of operations has mounted to a point when credible operating profits begin to appear. Moreover, a large part of such costs need to be 'sunk' and ignored in future references to 'profit', leaving only incremental costs undertaken to keep the service running open for consideration.[12] The period of low returns to capital is justified by the gestation lag between the building and operation of an infrastructural facility. In the best of circumstances, the rate of returns remains low because of the social nature of the good provided makes it necessary to keep user-prices low to the user to maximise the stream of social benefits. Most infrastructural services are thus priced at marginal cost so that only the incremental operational costs are actually recovered. The unattractiveness of investing at such low rates of return adds to the difficulty of mobilising funds for the development of infrastructure. Experience with private commercial investments undertaken towards developing the railways in Britain and India during their early phase as also with the more recent entry of private investment in India's power sector shows that such investment is forthcoming only at premiums where governments assure a guaranteed rate of interest irrespective of capital gains or losses. As just illustrated from the literature, the incentive can prove highly ineffective when the investing companies begin to find it more appropriate not to show any capital gain on their investment in their accounts lest the guaranteed interest be withdrawn. Governments bearing heavy interest burdens because of the guarantee eventually find it more worthwhile to invest on their own rather than carrying the burden any further.

The alternative sweetener of offering free land grants to companies investing in infrastructure which was tried with some measure of success in several countries including the US and India is particularly attractive to overland transportation infrastructure such as railways and roadways, since these require large acquisitions of land to build route networks. However this option becomes progressively more limited as lands are occupied by settlements necessitating evictions for the land guarantee to operate, and is therefore less appropriate to present world circumstances.

It is seen then that the major hurdle every country has had to cross in the development of infrastructure is the limited access that such projects have to commercial sources of finance. The twin reasons behind this are the 'lumpiness' of the investment required for building infrastructural capacity, and the recurrent need for subsidiary investments thereafter in order maintain capacity at optimum levels. Financial investment in transportation infrastructure and in the railways in particular during their formative period, as experience widely shows, has generally been organised by private enterprise. Even so, intervention from the State has come sooner or later because the strong public-good characteristics of transportation services associate its development with the fulfillment of social welfare goals that a profit-maximising private firm may have scant regard for. Partly because of this, the huge scale of financial demands for infrastructural investment render it effectively impossible for private enterprise to develop more than a nominal component in any infrastructural project. Experience with private investment during the development of the early railways has therefore generally demonstrated that while private endeavours during the primary developmental stage have the merit of consolidating the capital made available from the partial contributions of several small investors, investments on that low scale only bring about piecemeal development of transportation and cannot ultimately provide an integrated railway transportation system.[13]

Another set of impediments to infrastructure development arises from the *opportunity costs* of investment, *i.e.* the scarcity-determined choice criteria by which an investor selects from among alternative investment avenues. Although accumulation of idle capital in Britain during the early 19th century from the fruitful consequences of British mercantilist and industrialisation policies of the earlier period provided the capital required for the development of domestic railways as well as for later commercial investment on the American and Indian railways, such investment outflows took place only after the limitation of opportunities for investment at home and the promise of phenomenal returns elsewhere. The question might arise whether similar circumstances are today being mimicked in the infrastructural development scenarios of the world. The major circumstance that is missing in today's scenarios is the colonial situation of the previous century, where it served the interest of the colonial power to build infrastructure in order to maximise the benefits derived by the home country from its colony. Thus where government policy in the home country may have once proved instrumental in determining the direction of international financial flows, in today's scenarios the borrowing countries have to compete equally or unequally for capital funds with the home country. Whereas the scarcity of capital is definitely more acute, such as in the LDCs, the ability to offer attractive rates of return is diminished both by the lack of riches and the lack of spending power. The infrastructure sector in such countries is therefore caught in a trap of government indecision on whether to go ahead in building infrastructure or to augment other spheres of economic activity. Similar dilemmas are faced by potential financiers in investment decisions on whether to invest in infrastructural sectors which offer low rates of return but stretch their yield for a considerably long period, or in other activities which offer more attractive returns but for shorter durations. While both dilemmas can be theoretically resolved through yield-maximisation, the presence of greater levels of uncertainty and high risk premia in infrastructural investment eventually queers the pitch against it. A similar perception also guides the choice of investments between alternative transport modes, such as between the roadways and the railways.

Such weaknesses of the private financial process and the character of railway transportation as a public good has shifted the onus of developing railways almost entirely to governments, and even though ownership of the railways may differ between countries, the dominant presence has been of public ownership at some stage or the other, with the sole exception of the US. Circumstantial changes that may have taken place in this in context of the present moves towards privatisation would need to be reviewed from the context of the concerned countries, rather than comparing and emulating dissimilar situations.

It will be interesting to identify the considerations governing infrastructural investment decisions in the present global reference. While an LDC like India still has to cope with acute capital shortages, it is offered the option of either curtailing its investments and slowing down economic growth, or borrowing from surplus countries to fulfil production targets and social objectives. This is a major factor guiding the largest directed flows of project investment today into infrastructural areas, since such finance as is forthcoming within the country is too small to sustain investment levels. While the non-viability of total dependence on private investment for the development of railways needs no further elaboration at present, it is necessary to explore the ways and means open to the State in funding the infrastructure for future development. Fiscal policies of the government may well provide resources for public investment, but other imperative needs may require that the major portion of such funds be diverted to other important economic sectors such as agriculture or industry to maximise production and employment. This leaves governments with the option of public borrowing by attracting investments into bonds and equities. While the first of these imposes the greater burden in debt repayment - a feature that is plaguing the railways in India presently, the latter involves both risk factors and uncertainty, as well as dividend liabilities. The history of infrastructural finance shows in many instances that the breakthrough in such circumstances has been made by tapping foreign financial markets where idle capital exists, although private participation in infrastructural development has eventually to be bounded by government regulation. Although in the absence of direct equity participation for reasons of this kind, investments in infrastructural bond issues by foreign investors may be welcomed, it will be worthwhile to remember that such investments are forthcoming only because the opportunity cost of investing in such bond issues is presently low, and when better investment opportunities become available elsewhere the flow of money into the development of subsidiary infrastructure is liable to dry up, leaving the borrowing country in a deeper crisis than before. Thus caution needs to be exercised when initiating such capital flows.

The only recourse left ultimately to the railways and other infrastructural organisations is to augment their own resources through efficient utilisation of assets and minimisation of operating and other costs. While efficient cost structures therefore need to be devised, the important strategic initiative comes from the ability of the government or the organisation to market transport services, and to increase traffic elasticities by creating capacity in excess of demand. While pricing modifications such revisions of tariffs and fares can also help in building up a surplus in infrastructural revenues, it is important to channelise these surpluses into expansion and modernisation of operations in order to attract new traffic, rather than squandering them in other areas which will yield few developmental dividends.

1.4 Infrastructure as a Public Good

Infrastructure, also referred to sometimes as *social overhead capital*, is defined in the classic literature as any sector providing "services basic to any production capacity"[14] and as including "all public services".[15] Particularly in case of transport infrastructure, certain classical arguments have commonly been advanced for the public ownership of utilities. One of these drawn from the economics of information suggests that the state, being more informed than the market, is more qualified to make provisions in this respect. Other arguments draw on 'natural monopoly' attributes, negative social and environmental externalities, distributive equity of benefits, or the provision of merit goods, to advance the case. However, the generally low world levels of investment in expansion and renewals of facilities in a period when demand for transport and other infrastructural services has been rising have led to obvious bottlenecks over the 1970s and 1980s, and to mounting concerns in many countries about the adequacy of infrastructure to sustain economic growth and development into the future. Such concerns have related in part to the pricing of these services as public goods, in which case inadequacies and inefficiencies in infrastructure have been directly attributed to *market* *failure*, rather than to failures in the underlying government processes.

Areas of conflict emerge on examining the literature on the role of transport infrastructure in promoting economic development. The approach of 'new economic history' applied in railway studies such as Fogel [1964],[16] Fishlow [1965][17] and Hawke [1970],[18] is sometimes cited for evidence of 'what would have happened if specific transport infrastructure had not come into place'. The approach however suffers from obvious limitations because of its heavy reliance on hypothetical econometric projection. Studies of long term macro trends, *e.g.* Biehl [1991][19] or Andersson & Strömquist [1988][20] indicate strongly positive association between the provision of transport infrastructure and economic development, without necessarily establishing the causality between the two. On the other hand, studies at micro level on the regional and local impact of transport services, *e.g.* Blum [1982],[21] Nijkamp [1986],[22] Rietveld [1989],[23] and Lakshmanan [1989][24] lead to ambiguous or even opposite conclusions on the terms of association between transport development and spatial disparity, since increases in production in specific regions can be deemed to have occurred either because of site-specific creation of new economic activity, or because of transfer of economic activity from other regions. In particular, issues of *public* versus *private* provision of transport infrastructure bring in comparisons between the relative transaction costs and efficiency levels of each, which are seldom explicitly addressed in the literature.

Canonical *public goods*, which in the terminology of public economics[25] involve the externalities of *non-rivalry* and *non-excludability* on the part of their users, can only really exist in market situations when supply is considerably ahead of demand. This creates obvious conceptual difficulties in the efficient pricing of such goods, since the imposition of user costs that realistically reflect the costs of production of public goods necessarily introduces some measure of economic excludability, even in unsaturated markets. More serious difficulties are created by underpricing of scarce services in transport markets which are usually congested, where overuse of facilities by one user physically excludes some other, and the canonical requirement in case of public goods, that all users consume the service, is not met. Another argument, again drawn from public economics, relating to the provision of transport infrastructure on noncommercial terms dwells on the conceptual apparatus of *merit* goods, satisfying "wants sò meritorious that their satisfaction is provided for through the public budget"[26] The social obligations of railway undertakings that require the provision of certain services priced well below cost, or the continuance of specific services under conditions where they cannot break even because of the dearth of adequate traffic, are much cited instances, although it may also be noted that the provision of merit goods does not *ipso facto* enjoin that they must be provided under public ownership.

Another argument that becomes intuitively appealing particularly when advanced in relation to railway infrastructure is based on technical indivisibilities in sunk and fixed capital costs which generate increasing returns and decreasing unit costs as the scale of infrastructural services expands. The implication that the optimum scale for provision of infrastructure is too large to be efficiently provided by multiple enterprises, and therefore that a *natural monopoly* exists, argues for the activation of public ownership so that services are provided at reasonable and regulated costs, instead of being set at the high potential monopoly rent-seeking levels that market-based pricing would inevitably lead to. One strong counter-argument that militates against this derives from the spatial impact of centralisation and the distortions in location that can result from it. Other weaker arguments question the degree to which infrastructural costs might actually be deemed 'indivisible', and whether the regulation of monopoly rent-seeking actually necessitates public ownership or legislative protection.

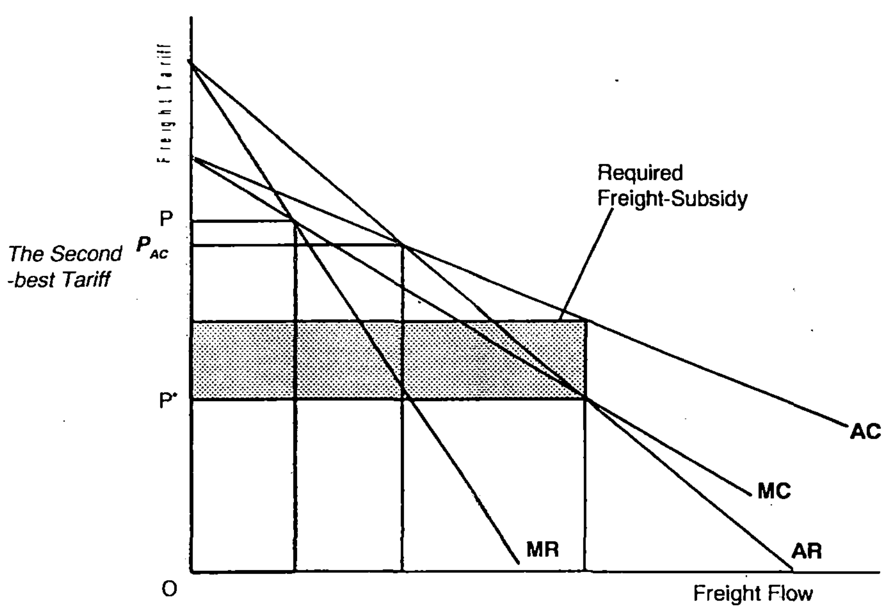
The more deep-rooted historical rationale behind public provision of transport infrastructure however derives from apprehensions that privatised provision would lead to suboptimal supply and inadequacy in services, both in terms of their density and spatial spread. Whether such fears are verified by fact requires examination of the comparative history of infrastructure development to see whether phases of private ownership led to squeezing of investment and services, and whether transition to public ownership reversed that trend. In the contemporary situation of infrastructure through much of the world, it is widely apparent that public ownership has not in fact solved the problem of resource inadequacy which lies at the heart of the inadequate provision of infrastructural services.

1.4.1 Pricing Infrastructural Services

As such, the issue at the core of both historical and theoretical approaches to the allocational efficiency of infrastructure and therefore to its ownership - whether private or public - relates to the pricing of its services. Were publicly-owned transport infrastructure to be treated as a non-marketable merit good, any consideration of demand and supply would be irrelevant to the determination of its nominal price. The problem of market-based pricing and allocation however becomes more and more tractable as one moves further and further from canonical definitions in determining the true character of infrastructural goods. Thus the questions now examined relate to whether nominal *i.e. ad hoc* pricing of the type usually resorted to is the only means of pricing infrastructural services at reasonable levels, or whether an exercise in market pricing can indeed be made.

The key feature that delineates infrastructure is in practice defined by the decreasing-cost/increasing-returns-to-scale envelope within which it is provided,[27] and any efficient pricing solution must be appropriate to this. Temporal considerations are also involved. The realisation of higher per unit prices in the short run can augment the resources invested on the provision of infrastructure in the long run. Conversely, the maintenance of equity pricing at levels oblivious to infrastructural costs in the short run can lead to inadequacies in investment and services in the long run. The question whether social and equity considerations will be served by market-determined prices would then rest on whether the prices so determined would in fact be so high as to apply a squeeze on the extent of services provided and to exclude a subset of users, or whether a tractable solution could otherwise be found. The intrinsic structure of the pricing decision involved appeals intuitively to application of second-best pricing which is examined geometrically below. Symbols in the diagram carry their usual meaning.

***Figure* 1.5: The Second-best Problem in Transportation Pricing**



The monotonically declining cost curves seen in the figure would allow a private monopolist to earn rent-seeking profit at a unit-tariff P. If instead, resort were made to Pareto-pricing at MC = AR = unit-price P* of the infrastructural service, the service-provider would sustain a loss equivalent to the shaded rectangle because of average price realisation at levels lower than average cost of the service, with the gap between AC and AR having to be made up by providing an equivalent state subsidy if the continuation of the service were sought. The general opinion in favour of public ownership in natural monopoly conditions argues that the state is best placed to monitor the efficient use of its subsidy, and any other form of organisation leads to waste of public money. But an alternative method that obviates the need for subsidies sets the price for the infrastructural service at a level that ensures acceptable returns. If the acceptable level of returns is defined at break-even levels *i.e.* at normal profit, the second-best price P_{AC} would be set at AC = AR, under the average-cost pricing principle also applicable under natural monopoly conditions to contestable markets for infrastructure outlined, for example, in Baumol *et al* [1982][28] In sufficiently open i.e. *contestable* markets, monopoly suppliers of infrastructural services would be obliged to price at average costs, rather than at rent-seeking marginal cost price, to maintain their market share. However, the foregone cost of services, defined as the difference between average cost and marginal cost, would constitute an uncovered social loss attributable to the non-marginal character of pricing. The standard solution[29] under such conditions is to move from single pricing regimes to discriminatory pricing regimes which would recover the full costs of service provision without setting prices so high as to result in exclusion of users, so long as the relevant cost curves were not significantly higher than the disaggregated demand or AR curves. The system is usually followed for yield management and revenue maximisation in several instances of contestable markets such as airline cartels, motor syndicates, etc.

Even though inadequacies in infrastructure are often blamed on market failures rising out of the public good character of infrastructure, reasoning of this kind can often obscure the underlying failures of government policy. Government intervention of the wrong kind can worsen the overall impact of market imperfections or failures, in situations where market forces might have offered better solutions. One of the widely prevalent practices in partial charging for the use of infrastructure for recovery in addition to user rates is to resort indirectly to lumpsum charges, the yields of which are usually not earmarked for reinvestment in infrastructure. Thus, to the extent that infrastructural costs to the service-provider exceed direct recovery in the form of user-charges, the amount foregone represents a deadweight loss to the service provider. The case is usually descriptive of government failures in the provision of transport services, which lead also to overuse and congestion of infrastructure in the short run, and to a shortage of resources for investment in infrastructure in the long term.

The impact of the long term problem might be separately examined. Firstly, the inability to levy adequate direct rates on infrastructure use sends out wrong signals on investment needs and priorities. Secondly, long term provision of infrastructural services deteriorates both in technological quality and extent. The Public Choice School's[30] reasoning therefore argues for earmarking of all revenues realised from public infrastructure.

The new interest that has arisen around privatisation of infrastructure as a potential solution for the problems of cost-inefficiency and capacity creation in publicly-owned infrastructure is now examined. Although privatisation is supposed to internalise congestion costs and optimise long run capacity, in practice such assumptions too would require idealised conditions unlikely to be fulfilled by real world situations. Arnott *et al* [1993][31] demonstrates that while a private monopolist might set capacity at cost-efficient levels to minimise total costs, including those he transfers to the user, the service charge levied does not necessarily yield socially optimal usage, because of the markup imposed, and because the privatising monopolist's markup price would turn out to be rather sticky even when cost-efficiency ultimately reduces marginal cost.

1.4.2 The Theory of Contestable Markets

Infrastructural pricing problems of the kind alluded to above - also known more illuminatingly as problems of 'bottleneck' pricing - spring mainly from the nature of the infrastructural goods concerned and the restrictions to entry that apply to the domain of the infrastructural activity because of the presence of sunk costs. This is of particular relevance to the railways, where the infrastructure required involves a high percentage of sunk costs and where, because of social objectives, railway services assume the form of a public good. Public ownership of infrastructure has generally followed the apprehension that bottlenecks become inevitable if the alternative of market pricing is resorted to, because of the diminished productive and allocative efficiency of the market mechanism in services that have pronounced merit goods characteristics. While providing sufficient instance of this, the railways also constitute an infrastructural sector where effective competition is not possible immediately owing to the vast spectrum of services offered. The various modes of operations that have been followed historically by railway systems across the world have therefore ranged until very recently, from outright government ownership to strict control of railway pricing under statutory regulation of rates. Developments since the 1980s which reveal the inefficiencies of regulated systems have however seen a consolidated movement towards more open railway pricing systems, as the underlying theory of infrastructural pricing has become more and more robust.

A theoretical transition to deregulation theory was accomplished in the early 1980s following developments around the theory of contestable markets. Most concisely stated in Baumol *et al* [1982][32], the theory holds that in *contestable* markets *i.e.* markets where no significant sunk costs are involved and no barriers prevail on entry into the market, only internally-efficient firms offering an optimal multiproduct mix and operating at optimum scales and cost-structures that involved no cross-subsidisation, would eventually survive. However the operation of differential time-lags between the instantaneous demand response to the foray of any new contestant into the market, and the reaction of existing incumbents to his entry would endow the former with the 'hit-and-run' ability to enter and contest the market, to charge short-term prices above competitive rates, and to exit the market without having to bear any exit costs well before rivals could retaliate. Since the theory assumes additionally that all new contestants stand on level footing, the initial market structure prevailing in the contestable market is irrelevant. In the absence of cost-barriers to entry and exit, incumbents in the market are left no alternative but to acquiesce to the contest, and would, in the interests of survival, provide goods and services at most reasonable prices in attempts to foreclose the contest. Thus with *perfect* contestability, the social objective of welfare maximisation is ensured, as the industry under deregulation - regardless of the number of participating firms - performs under perfectly competitive conditions, where neither excess profits exist, nor can inefficient firms survive. The task of government in this context is no longer to determine and protect the 'optimal structure' of production, but to ensure instead that there are no restrictions on free entry that would limit the credibility of the threat of competition. If conditions of contestability obtain therefore, even monopoly firms will behave as if subject to factual competition, in order to avoid attracting new contestants who would destroy the monopoly.

In the case of infrastructural multiproduct monopolies such as State Railways or otherwise regulated systems with restriction on entry, imperfect contestability prevails. Static welfare could then conceivably be maximised through discriminatory Ramsey pricing[33] of infrastructural goods above their marginal cost to recover full costs. In practice however, the threat of hit-and-run entry would always impose certain restrictions on the set of sustainable multiproduct prices from which the optimal Ramsey price would be charged, and thereby hinders fulfilment of the welfare objective. In a departure from perfectly contestable markets, a multiproduct monopoly which can force barriers to entry can actually charge very high Ramsey rates for exclusive services, against less-than-competitive rates for other services. Contestability theory thus bridges the entire price spectrum from marginal cost pricing to Ramsey pricing, by introducing the concept of a contestable monopoly which could theoretically maximise its profits through average cost pricing at least-cost production, but will resort to Ramsey pricing under the threat of entry. Ramsey pricing in such cases would thus fulfil welfare objectives even though the underlying market situation would be different from the theoretical formulation of perfect contestability.

The attack that contestability theory has however faced on several fronts proves the concept inappropriate to contexts which demand the achievement of firm viability in the long run. In the railways, for example, the requirement of railway plant and capital equipment is fixed and highly specialised, and the irreconcilability of fixed costs with the assumption of zero sunk cost made under the theory renders the market uncontestable. With reference to the objective of long term viability, the promotion of contestability through deregulation of industry can in fact lead to welfare losses by depriving the incumbent firm of its ability to attain revenue adequacy and establish a viable natural monopoly by utilising the existence of sunk costs in its favour through discriminatory Ramsey pricing.

The paradoxical character of this situation now becomes apparent. Enhancement of direct competition among incumbents and promotion of contestability in the market has adverse impact upon economic welfare because it drives prices to marginal cost levels and deprives firms from the benefits of Ramsey pricing. This however is inconsistent with the theoretical underpinning of contestable markets based on their welfare-maximising structure and contestant behaviour. If vigorous intramodal competition in transport infrastructure produces revenue inadequacy, with losses in pricing freedom[34], it logically follows that sunk costs, cross-subsidisation, etc. can materially improve welfare if they reduce price competition among existing incumbents. The encouragement of contestability via enhanced competitive access is rejected therefore, because it erodes the market power required for the practice of Ramsey pricing in industries undergoing a transition to deregulation.[35]

1.4.3 Ramsey Pricing

The discussion on the Ramsey pricing system[36] extends into methods of demand-based second-best pricing, as alluded to earlier. It allows the consistent choice of welfare-maximising prices that ensure adequate revenue for a regulated multiproduct firm to cover its costs, against recurrent losses due to marginal cost pricing under conditions of decreasing marginal costs and increasing returns to scale. Since fixed costs alone would not lead to Ramsey pricing, the system has often been applied to studies of 19th century railway value-of-service pricing[37], where owing to the presence of scale economies, railways were unable to generate sufficient revenues to simultaneously cover investment and operating costs. The advantages of the Ramsey pricing system are most apparent for natural monopolies which deter entry of other firms to maintain market power.

A point to be specially noted with respect to the Ramsey rule is its assumption of zero cross-elasticities of demand, which in turn imply the avoidance of cross-subsidisation. Ramsey pricing in effect postulates stand-alone cost tests as a means of escaping cross-subsidies.[38] However the possibility of cross-subsidy cannot be ruled out in practical applications of Ramsey pricing to multiproduct firms, since the presence of strong complementarities can lower prices of some of the services below marginal cost levels, while the prices of the remainder exceed marginal costs by more than would have been necessary to maintain revenue adequacy. But cross-subsidies of this kind also provoke the entry of new competition, thereby undermining the Ramsey pricing scheme, which can then only be tenable under an entry barrier.[39] On the other hand, the prohibition of cross-subsidies to obtain fair pricing may sometimes reduce total welfare, since it would be inconsistent with the Ramsey pricing principle for infrastructural and other services that show strong complementarity.[40]

Most theoretical treatments of Ramsey pricing are made under the assumption that the regulated enterprise sells directly to final consumers. In the alternate situation where firms purchase their inputs from a regulated firm while optimising their own costs, adjustments to the Ramsey pricing principle would ordinarily be required,[41] and only if the downstream enterprises are perfectly competitive will the Ramsey rule apply. Adjustments would invariably be needed wherever the downstream industries under reference are neither price-takers nor cost minimisers. This limits the applicability of Ramsey pricing to railway freight services which provide inputs to regulated industry. In case of the freightage of coal to rate-of-return regulated utilities such as electric power plants, the prices chargeable by railways under the Ramsey principle would need to be reduced, firstly because the utilities would tend to produce less than optimal output, and would therefore require reduction in their coal input-prices in order to augment output, and secondly because such utilities tend to overcapitalise, the price of their coal inputs would also have to be lowered in order to constrain capital investment.[42]

In cases where both competing road and rail lines are operated by regulated firms and are under complementary use, the welfare-maximising prices of individual transport services would lie below the Ramsey prices that would have been set for each transport mode separately. Such a situation might occur when the costs incurred on each service differ in magnitude, reflecting differences in routes and lengths of carriage. But revenue-pooling Ramsey pricing which maximises the cumulative revenue yields of both transport modes would ensure equalisation of marginal cost pricing at identical utility levels, which makes the Ramsey principle at least the second-best pricing method. The alternative to maximising pooled revenue would be to let one modal firm break even, whilst the other profited behind an entry barrier, corresponding to the method of 'totally regulated second-best' pricing mentioned in Brauetigam [1979].[43]

The Ramsey pricing method was devised to ensure minimum revenue yields that fully cover the costs of providing infrastructural goods. Critical evaluations of Ramsey pricing in railway applications argue that the principle proves untenable in face of the inability of railways to generate increasing returns to scale in situations of excess capacity that are marked by a high cost-to-revenue ratio. Excess capacity becomes unavoidable in the case of railway freight transport, which aims at maintaining the interregional balance in outbound and inbound payments, while not necessarily implying a balance in the respective tonnages. Empty haulage on one journey-leg thus becomes inevitable.[44] Nevertheless the debate continues, and proponents of the Ramsey pricing principle would see no hindrance in applying the method to the determination of railway rates under conditions of excess capacity.

1.5 A Review of Literature

A survey of the literature relevant to the present study has been undertaken, in order to strengthen focus on the issues and problems that need to be dealt in evaluating the development of railway transportation infrastructure in India. Areas in the literature considered to be pertinent relate to existing studies on economic and industrial development, on transport economics, and on railway transportation in particular. These are reviewed briefly in separate sections below.

1.5.1 Literature on Economic & Industrial Development

Development literature identifies one of the major challenges in economic development as being the provision of infrastructure services to match sectoral demands of the economy. World Bank national accounts, reported in the World Development Report [1994], estimate the value added by infrastructural services - of which transport is the largest - as 7 to 11 percent of GDP. It has been revealed in Ratter [1973] that World Bank lending is largely focused on building infrastructure in the LDCs, and that one-third of total lending by the Bank since its inception in 1946 has been to the transport sector. Bennathan & Johnson [1987] is a recent study of transport in general economic contexts, which explores its input-output linkages. Another study on transport infrastructure is Galenson [1987], which addresses labour absorption in the transport sector. It may be noted that transport alone commonly absorbs 5 to 8 percent of total paid employment.[45] A point of interest in infrastructure studies relates to assessments of the productivity impact of infrastructural investments. Canning & Fay [1993] is a seminal study of this nature, whose scope is extended into the empirical realm by the exploration of fiscal policy - economic growth relationships in Easterly & Rebello [1993].

It is a moot point whether infrastructure leads economic growth, or the reverse applies. This causality has been explored by a number of studies which include Duffy-Deno & Eberts [1991], Holtz-Eakin [1988] & [1992], Mera [1973], and Uchimura & Gao [1993]. The gamut of research results cover both one-way causation in either direction, as well as dual causation. It is seen in these studies, however, that veracity of the causal hypothesis is conditioned by the econometric methodology adopted, so that the studies under reference do not always concur, but may instead have differing conclusions; an example is the opposition between the two Holtz-Eakin studies where the use of more sophisticated econometric modelling in the later study reverses the conclusion. Mera[46] makes an interesting spatial analysis of the Japanese case while exploring relations between social overhead capital and production functions of regional character.

An alternative to the measurement of infrastructural impacts measures their influence in reducing production costs. A survey of studies of this genre is provided in Aschauer [1993]. Although no consensus exists on the magnitude or exact nature of the impact of infrastructure on growth, most studies agree on the high potential payoff in terms of economic growth. The role infrastructural investment plays is substantial, significant and often much greater than investments in other forms of capital, although actual realisation of payoffs depends also on the economic policy-frame. This aspect, namely the differential impact that private-sector or public-sector orientations in the policy-frame have upon the productivity of infrastructural investments, is investigated in studies such as Ford & Poret [1991], or Hulten & Schwab [1993]. Munnell [1992] is a useful perspective on infrastructural investment & growth.

Literature sources on the general economic and sectoral impacts of infrastructure shed considerable light on processes of assessment. Kessides [1993], in reviewing general developmental contributions made by infrastructure, makes an entry into associated policy issues. Peters [1990] is more revealing on the developmental impact of transport in India: analysing data from the farm sector from 85 districts over 13 states, the study shows among other things, that increased market access concomitant on lowered transport costs has resulted in an agricultural spurt that is further bolstered by the enhancements in bank support occasioned by easier communication. The role played by infrastructural status as a determinant in the location of international investment-flows is explored in Wheeler & Mody [1992]. Access to at least minimal infrastructure has important welfare connotations in poverty contexts. The urban aspect of this is investigated in terms of transport and mobility needs in Kranton [1991].

An important determinant in the impact of an infrastructural investment is of course the quality of services provided - inefficient and poorly maintained infrastructural utilities lead to unreliable services. This problem, particularly acute in developing countries, is explored in context of the electric power sector, in Besant-Jones [1993]. Another glaring feature of infrastructural services in LDCs is the unequal access provided to the poor; this is studied in terms of spatial inequalities in transport facilities, in Camara & Banister [1993]. It is pointed out that although transport services are often subsidised in order to maintain low tariffs, the attendant benefits are cornered by the more affluent, while further expansion in services is curtailed by their nonprofitability.

Infrastructural services are often public goods provided by public organisations. Arguments exist that endemic organisational failures and generally poor performances could be better tackled by privatisation rather than by public-sector reform. The alternative, in the face of sociopolitical compulsions, is to give public infrastructural organisations some measure of autonomy and financial independence. General issues and experiences in public enterprise reforms are summarised in Shirley & Nellis [1991]. Nellis [1988] investigates the alternative of private-sector tieups through contractual arrangements, which maintain social objectives while improving performance. Trivedi [1990] is a study of such performance agreements in Indian contexts.

The explicitly public mode of organisation prevalent over most of South Asia is explored in Seabright [1993], which also addresses reform issues. Corporatisation as an alternative to official control, is one of them. The more radical solutions involve partial or total privatisation to allow free play of market forces. Reforms in the infrastructural sector thus have many ramifications. A concept central to public organisation is the existence of a 'natural monopoly' in such services because of a market situation where a single provider can serve the market at lower cost than multiple organisations. This argument has come under challenge in modern contexts where diversification in organisational services has meant that such a provider is often performing in areas outside the natural monopoly.

As such, some of the literature under reference explores the potential for sectoral unbundling - the dissolution of monolithic organisations and services into separate enterprises, very often independent of each other. Moyer & Thompson [1992] reviews the scope for this in the case of railways. Nilsson [1993] analyses regulatory reforms on the Swedish Railways. A study of railway privatisation and its effects in Japan is provided in Fukui [1992]. Ramamurti & Vernon [1991] lays out general principles for privatisation and control of state-owned enterprise.

Where infrastructure is privately-owned, quality and quantum of services provided may be maintained voluntarily through self-regulation. Gwilliam [1993] investigates the possibility in urban transport services. Voluntary maintenance of product quality in public utilities is studied in Rovizzi & Thompson [1992]. Participative means of regulation also obtain, although these entail consumer information and more competition. Sectoral reorganisation of public utilities in India are investigated in this light in Paul [1993]. The economics of regulation are outlined in Viscusi *et al* [1992], and Winston [1993].

The last major area of relevance in the literature on infrastructure development surveyed in this review relates to the sources of finance for infrastructural investment. Although public funding has been the major conduit for such finance, the issues that the literature identifies are created by the growing inability of governments to bear ever-escalating infrastructural costs. In the face of the general resource crunch that governments today face, capital spending on infrastructure is the first to be discarded; operations and maintenance closely follow. Reductions in infrastructural spending inevitably impose long-run economic penalties, but governments find this to be politically more expedient than reducing public employment or wages. Hicks [1991] elaborates on this problem in developing-country contexts.

The alternative to government funding is private funding. Besides meeting the resource-gap, private funding is regarded in some studies to be more efficient. Kay [1993] reviews the veracity of this argument. It is pointed out in Lane [1992] that government's natural advantages in raising large funding for infrastructural projects are squandered if there is an accumulation of excessive debt. Project financing has certain established principles, outlined in standard references such as Nevitt [1989]. The case for private financing of infrastructure is enunciated in Pyle [1994], Gomez-Ibanez & Meyer [1993], and Martinand [1993]. The latter two studies have transport contexts. Since modes, operations and organisational character of infrastructure undergo evolutionary transitions over time, no one paradigm might be said to exist. Grubler [1990], for instance, makes an exhaustive survey of the underlying process.

The economic envelope for the present study is provided by the economic and industrial perspectives that have determined the direction of development policy in India over the planning era. The study is undertaken in reference to the infrastructural linkages that associate these planning perspectives with the process of economic development. To this purpose, a reading has also been made of several studies which explore the Indian development experience. Among these, studies which focus on the changing patterns of industrial growth in the country over different periods prove most relevant to the investigation of transport policy linkages. In studies of this nature, the alternating high-growth and low-growth phases experienced by the Indian economy are explored in Ahluwalia [1992], Sandesara [1992], Kulkarni [1991] and Alagh [1995]. Alagh[47], particularly, addresses the infrastructural context as a rationale for recent economic reforms in India, exploring the strategies and models that underlie Indian planning while showing how past experience could help determine future development strategy. The conclusions drawn in the studies under reference are relevant for the analytical exploration of infrastructural issues in the development of transportation to be carried out by the present study.

1.5.2 Literature on Transportation

The literature sources on transportation are diverse, covering matters of policy, theory and evaluative study. Distinctions between transport as an element of infrastructure, and transport economics as a discipline are dealt with in Winston [1985], among others. Transportation is here described as a service vital to economic development, while the economics of transportation addresses ultimate 'real world' policy implications of providing this service. The developmental linkage of transportation is further explored in Sharp [1973], and is historically reviewed in various studies surveyed in the subsequent subsection.

The principal exercise in many transport studies is transport demand-analysis. Houthakker & Taylor [1970], for example, is a particularly wide-ranging econometric projection of U.S. demands over a vast range of goods and services, including various items of transport. In the case of transport, income elasticities are found to be more important to demand-determination than price elasticities. It has been pointed out in Stubbs *et al* [1980], that there is no 'correct' unit of transport output that can be used universally in studies pertaining to transport, because the unit of supply is often larger than the unit of demand. Although the problem is not acute in railway freight studies, where wagonload consignments are common, it still persists in the case of railway parcel traffic where consignments accepted are less than a trainload or wagonload.

The main theoretical interest in the character of infrastructure originates from the fact that it is the archetypal 'public good'. However as later refinements of analysis have shown, its nature as a public good varies from pure to impure, depending on mode of provision and pricing. Publicly provided infrastructure contributes positively to the growth of private sector activity and output, indicating some complementarity between the two, rather than subsitutability. Changes in the mode of provision, such as the privatisation of railways, transform the character of infrastructural goods. The growth model of Barrow & Martin [1992] therefore distinguishes between the cases of publicly-provided private goods, and impure public goods, or publicly provided goods subjected to congestion where latecomers are excluded from the user-market by saturation of services. This line of analysis is also reflected in Aschauer [1988] and Lynde & Richmond [1992].

Another area of concern in the case of publicly provided infrastructural capital relates to the degree to which this is optimal. Berndt & Hansson [1991] thus provides a measure of optimality under assumptions that infrastructure is a pure public good. In such a case the total marginal benefits of public capital are a summation of shadow values over all private sector firms, plus a summation of all marginal benefits accruing to final users. In a uncongested user-markets, total marginal benefits can then be the largest benefit that accrues to a subset of users, rather than the sum of benefits to all potential users, and must then equal the social cost of providing public infrastructural goods for pricing decisions to be reached. This raises the important question as to whether the sum of marginal benefits to all potential users can actually be estimated, in the case of public infrastructure? However, with user-market congestion, the above result would become qualified.

The traditional analysis of public infrastructure assumes typically that infrastructure is an unpaid factor in production. In practice, this does not hold since various rates and charges do apply to infrastructure, along with taxes, license fees and levies. Exclusion of these from consideration in fact overestimates infrastructural impact. Barro & Martin[48] shows that recovery of the costs of providing infrastructure as a pure public good is better accomplished through lumpsum user taxation, since social returns to investment can thereby be maximised. However when infrastructure is provided as an impure public good, the task is best accomplished by general taxation since this internalises excessive use of infrastructure. The possibility of financing infrastructure through public borrowing rather than public taxation throws up new questions. In general, the literature holds that both modes of financing have the same impact on the economy in real terms. However this would imply that private consumption and expenditure remain unchanged when short term levies and cesses are imposed as tax-means to finance infrastructure, as implied in Ricardian debt-neutrality. In capital market situations where the cost of borrowing is high, the tax-means of finance would probably be more efficient than the creation of new debt. It is only when government funds are earmarked for the development of specific infrastructure rather than for general expenditure that the optimal mix of tax and debt for infrastructural finance can be defined.

One of the other questions explored in the literature concerning infrastructural investment, and investments in transport in particular, pertains to the process of project selection. Social benefit-cost analyses which are often applied to the purpose involve evaluation of future streams of expected benefits. Theoretical issues in Cost-Benefit Analysis receive thorough attention in Dreze & Stern [1987]. New directions in project appraisal and planning are deliberated upon in Little & Mirlees [1990], and Squire [1990]. A general consideration of problems of project appraisal is found in Henderson [1965], which stresses the need for government to evolve a common discount rate for both private and public investment, to obviate inconsistencies that might otherwise arise in project preferences. Peacock [1973] summarises the debate on the choice of an appropriate discount rate. Discount rates based on Social Opportunity Cost [SOC] and Social Time Preference (STP) are examined in Feldstein [1972], as criteria for choosing between investments in alternative transport modes. The preferred discount rate varies: Hirshleifer [1961], for example, advocates the use of the SOC rate, where opportunity cost on every investment would be measured by returns foregone on projects which might have alternatively been undertaken. Henderson,[49] on the other hand, states that since investments in transport infrastructure involve risks and uncertainties and deferred benefits, and are subject to depreciation over time, the STP discount rate which establishes present values for future consumption would be more appropriate. Sensitivity analysis is identified in van Horne [1977] and Bromwich [1976], as the commonest method for assessing and measuring risk and uncertainty associated with durable transport asset-investment; the technique is often applied to transport demand-projection studies.

The economics of transport occupies itself with concerns of the pricing of transport services. Dupuit [1844] had established the classic principle that 'the best tariff would be one which makes all users of communication pay a toll proportionate to the utility they derive from the passage', extending the Marshallian concept of consumers' surplus into transport pricing applications. Pricing considerations are important in determining the viability and long-term sustainability of transport services. Millward [1971] is a thorough analysis of the marginal cost pricing principle, which also delves into the presence of externalities in transport as implicit transport costs. The study makes the observation that social cost pricing in transport cannot be applied conjointly with marginal cost pricing elsewhere. Turvey [1968] finds long-run marginal costs to be generally more appropriate as a basis for transport prices because benefits from durable transport assets with an extended lifespan will then at least equal or exceed the value of resources expended in acquiring them. This of course has special relevance when the replacement of an asset or an expansion of the transport network is being considered. For comparison, an assessment of marginal cost pricing problems and spot pricing in the electric power sector is found in Bernstein [1988].

Problems do arise in applying such general costing principles to specific transport contexts. The marginal cost pricing principle is often at variance with governmental or developmental priority; various tariff commissions such as the Rail Tariff Enquiry Commissions in India have explored this rationale. It has been reflected in Howe & Mills [1960], that opportunity costs of railway assets, which have alternative uses, may be less than the accounting costs of interest and depreciation allocated to them. The principal problems in railway pricing, i.e. joint costs and indivisibilities, can however lead to significant and persisting divergences between short-run and long-run marginal costs, as pointed out in Joy [1971]. For such reasons, price discrimination is normally resorted to in order to maximise revenue from services provided. Continuance or closure of an existing service is then defined by whether this revenue exceeds long-run marginal costs, with this principle being particularly applicable in the case of pricing of freight services.

Another aspect of costs in transport services relates to the role of time, since the transport service essentially involves transit over time between specific spatial points. Alternative theoretical approaches have been devised to handle time and also transit-delays. Lee & Dalvi [1969], for example, use a notional 'diversion charge' in their model which subsumes the role of travel time in determining that change in period of transit or transport tariff which would induce a shift to an alternative transport mode. Else & Howe [1969], using the cost-benefit formulation to compare road and rail transport modes over two distinct traffic-zones, shows that the use of this approach does not always lead to consistent appraisal over all sectors, and that the all important factor in the incompatibility of conclusions stems from the time element.

A number of studies in the transport literature relate to government policy. Gwilliam & Mackie [1975] makes observations on how regulations and often state ownership have now pervaded all sectors of transport. Four main spheres that government transport policy controls are identified in Stubbs *et al* [1980]; these are the quality, quantity, and organisation of the transport sector, and the efficacy of the resource allocation process. Railway services have a non-marketable character which is conducive to their operation under government. Intervention in the transport market is also necessary to ensure an optimal traffic flow that utilises full capacity, and an optimal modal split in transport services which avoids needless competition between alternative modes. Other factors providing the rationale for government participation in the transport sector include the need to exploit the scale economies available to large undertakings in situations where normal economic forces would not lead to mergers, and the need for policy controls in sectors where government has a large fiscal involvement through subsidy to operations.

The origins of transport subsidies in the railway sector are identified in Joy [1964] with government grants to cover losses on unremunerative but socially beneficial railway services. Joy [1973] details the consequences of exposure of railways to free competition in both passenger and freight sectors, which would bring pricing down to equivalence with short-run marginal costs, and would permit utilisation of railway assets (e.g. wagons) over their full life, or to the point of technological obsolescence, with the effect of reducing capital expenditure on asset-replacements. Lee [1977] introduces a discussion of objectives into the policy debate. The upshot of this discussion is that while subsidies to railway freight operations should be terminated, those to railway infrastructure (assets) should continue. The study comments on the effectiveness of subsidies in altering modal choices in transportation via resource allocation policy.

A problem that has particularly stimulated research is the optimal modal-mix in transport services, where questions of competitiveness or complementarities between roadways and railways enter. Using international cross-comparisons, Silbertson [1970] constructs a simple model which shows that rail services may not be close substitutes for road transport services. These competitive dimensions are also explored in Stubbs *et al*[50], which shows, however, that in the case of Britain, road traffic has been able to make great inroads into rail traffic. This competitive element is of course of great relevance to a study of the transportation sector in India.

1.5.3 Literature on Railways

A large segment in the literature on railways relates to the historical development of railway transportation, commencing in Britain. Aldcroft [1976], for instance, observes that the transport revolution which ushered in the 20th century was accompanied by unprecedented growth in the use of transportation services as well as the changing importance of different transportation modes. While recounting the vicissitudes that the American and British economies have been facing from the increasing demands for personal transportation, stress is laid on the pressing need for policymakers to deal with such demands expeditiously. Because of imperial imperatives, railway development in India did not lag far behind railway development in Britain. The early history of the Indian railways is comprehensively surveyed in Tiwari [1937] & [1946], Sahni [1953], MacPherson [1955], Hughes [1964], and, more recently, in Christensen [1981]. The MacPherson study, particularly, looks at railway financing in India during the formative period, while Tiwari [1937] examines the evolution of railway rate-structures in the light of Indian industrial development. The role of government in the railway development process receives comment in Christensen,[51] in respect of the efficiency and quality of railway transportation services.

With the advent of the Railway Age in the middle and late 19th century, financing of transportation infrastructure assumed new dimensions. Although the initial development came at the hands of enthusiastic private investors, this did not preclude the need for government intervention, particularly in newly-developing countries. The rationale offered for government intervention through controls, assistance and subsidies has already been covered above. The character of railway services as a public good to society and the lessons learnt about the inadequacies of private handling of this public utility have been studied in the context of US railways in Eichengreen [1995], and in Cain [1980]. The former study, while providing an overview of the transition from private funding to public funding of railways, also has the importance of identifying various negative implications of public funding in developing countries. A policy prescription of 'back-to-the-future' is suggested as a means of ruling out inefficiencies in public funding while tapping local finances, and also in order to reduce excessive dependence on external borrowing for completion of projects. Cain,[52] in extension, points to negative aspects of the 'public service' image that railways were increasingly forced to adopt, which ignored managerial and operative inefficiencies that the system might be suffering from.

Railways by nature have technical advantages over other modes of transportation: they can transport heavy loads over long distances with minimum energy consumption, and at a speed competitive to other means of surface transportation. Railway investments however entail bulk capital expenditures on a considerable inventory of immobile assets like tracks, bridges, marshalling yards, etc. Irrespective of the ownership of railway capital, the fact thus remains that huge capital assets of permanent nature have to be created for railways to serve transportation needs. Meenakshisundaram [1972] observes that as demand for transportation grows faster than GNP, suitable policy-criteria for guiding investment have to be recommended. Returns from investment on permanent capital assets can only be realised as deferred benefits; thus this choice of present investment for future consumption assumes importance in the railway literature. Although much has already been stated contextually to the pricing of transport services, specific issues regarding railway freight rates remain that need review. In view of the fact that the railways as a transport utility are characterised by joint supply of both passenger and freight services, the joint cost principle has often been referenced in many studies. The fixation of freight rates and of different principles that can be applied to their determinations are explored in Srivastava [1971], Pulley [1969] and Chandra [1969].

In developing economies like India, where the root problems are to maintain demand-supply equlibria over all sectors of the economy, and for the provision of freight services to be made a step ahead of demand, it is quite likely that pricing considerations would be important in maintaining sectoral balances in the economy. Peculiarities inherent in investment, services provided and the monolithic structure of the Indian Railways [IR] and other such factors also impinge upon any exercise in price fixation, as observed in Srivastava[53]. The pricing principles experimented with by railways over an extended period of time include the 'cost of service', 'value of service', 'joint-costs', 'ability to pay' and 'what the traffic can bear' principles, along with flat rates and telescopic rates. While Pulley[54] suggests five major variants of pricing policy, including marginal-cost pricing, and marginal cost pricing with uniform-increment price discrimination, as viable alternatives for the railways, studies with reference to the Indian railways consider the telescopic-rate principle to be the most scientific method of assigning freight rates. The recommendations given by various rail-tariff commissions such as the RTEC are explored in this light elsewhere in this study.

Another important operational sphere of railway transportation concerns freight flows within the network. Demand-supply relationships in freight services assume formidable significance in developing economies, where any disequilibrium perpetuates instability and has deleterious effects on economic growth. Studies on this theme in an Indian context form core references for the present study. An overall picture of railway freight operations in India, including projections of anticipated railway freight demand in the future, is found in the Report of the National Transport Policy Committee [1980]. Other reports of relevance include those of nongovernmental organisations like Tata Economic Consultancy Services [TECS], reports of the Railway Board for the Ministry of Railways and various Corporate Plans of the Indian Railways, published by the Government of India. Another important source for annual information on IR comprises the Indian Railways Yearbooks [IRYB] of different years. These public documents all provide data and analyses on various issues that are also explored by the present study.

Srivastava[55] studies different aspects of the Indian transportation system with attention on its development over time, and maintains a larger focus on IR. Problems commonly encountered in railway operations in India are duly identified and noted. More recent growth trends in IR operations are analysed in a regional framework in Rao [1984], where regression methodologies are incorporated. This study offers a holistic idea of the micro-level impacts of transportation, since it is framed for a particular Indian district. Freight-structure trends and the associated modifications of transportation planning these call for in India are well covered in the advisory report of the NTPC [1980]. The Committee recommends an intermodal mix that would optimise and ensure complementarity between road and rail transportation. While energy-use considerations are also examined by the NTPC study, the lagged responses within the infrastructure-economy linkage which affect freight flows and their commodity-character, are investigated through a distributed lag exercise. A theoretical formulation and empirical testing of the consequent supply-demand imbalances in Indian railway freight transportation is made using econometric procedures in Rao & Sriraman [1985].

1.6 Railway Tariff Formation

In any sector that extends services to the economy, the equilibrating role in matching service demand to the supply of services is played by the charge applied to the users of the service. In static contexts, the role of service charges in the tertiary sector of the economy is thus very similar to the role of prices in clearing markets in microeconomic theory. However, when applied to infrastructural services within a development context, this analogy must be modified because of the dynamics of the development process.

1.6.1 The Nature of Railway Costs

Railway plant requires huge investments in fixed and highly specialised capital suited only to the provision of transportation. Although rolling stock and even equipment can be physically relocated, a very large part of this investment that goes into grading and earthworks during line construction is not switchable to alternative uses. Hence as long as railway capital invested continues to yield some manner of return, railway services continue to be provided, since the abandonment of operations means a total write-off of immobile investments. However no returns or low returns reduce the inducement to maintain railway plant and to replace worn-out assets. New investments in railway services may nevertheless be summoned if they increase the possibility of returns being yielded by the original investments, although, because of both lumpiness in initial capital costs and regulative barriers, large profits accruing to one railway enterprise do not immediately induce the competition to build rival lines. Barriers to fast capital-inflow and outflow in railway enterprise also prevent these from acting as regulators to the level of railway tariffs and rates.

The large volumes of investment represented in existing physical railway plant thus account for peculiarities in the character of fixed costs and variable costs (or 'prime' costs) involved in railway operation.[56] For a given level of railway plant and property, railway fixed costs, along with the interest outgo on bonds with which these are financed and rental values of railway lands tend to remain constant regardless of the volume of traffic. Many of the railway costs classified as variable costs or operational expenses too, such as expenditure on maintenance of lines and structures are independent of the volume of traffic carried, even though expenditure of this type is usually undertaken or deferred depending on the volume of business and profits and fund availability. Maintenance expenditure on railway equipment such as traction and rolling stock, although more variable, also does not vary in exact proportion to the volume of traffic carried. The same is true in excess-capacity situations for personnel wage bills, fuel expenditure and miscellaneous other costs included in railway budgets as *transportation expenses*, since the variable costs involved in transporting partially-loaded trains is nearly the same for trains with full load.

Transportation enterprise is generically subject to certain economic laws apart from the regulation imposed by legislation. The principle of increasing returns asserts, for instance, that expenditures do not increase to the same degree as revenues when the volume of business increases. Once a transportation system has been established on the foundations of fixed capital investment, an expansion in the volume of shipments causes operating expenses to rise, but has little effect on constant expenditures and results in decreased expense per unit. This holds true as long as unused plant capacity is available, that is until, for instance, double tracking on a railway route is necessary, or increased equipment and terminal facilities are required along a highway. In each mode of transportation the relationship of constant to variable expenses depends on its physical equipment and the nature of its operation.

Although estimates of the proportion of fixed costs in railway enterprise have now been scaled downwards from the two-third proportion found in early literature, the fact nevertheless remains that a large mass of the short-run costs of railway enterprise is invariant in respect of the volume of traffic. In circumstances such as these, with increasing volume of traffic, unit railway traffic costs tend to decline uptil the point of optimal utilisation of railway plant, and rise thereafter because of crowding of existing railway traffic handling facilities. Thus under situations of substantial excess capacity, railway operations are subject to increasing returns from economies of scale for two inherent reasons. The first of these arising from the efficiencies of more complete plant utilisation., spreads fixed railway costs over a larger number of traffic units. The second arising from the efficiencies of holding larger and technologically-upgraded plant, significantly lowers the unit fixed costs of operations.

The economics of increasing returns under which railways tend to operate inevitably predicate large swings in the net revenues of railway enterprise because of increases and decreases in traffic, the exact extent of which would depend on the operating cost elasticities involved. However, the common practice of deferring maintenance expenditure when railway funding is short renders the magnitude of these swings opaque, because net revenue surpluses may seem to occur in bad traffic years and net deficits in good traffic years relative to whether maintenance has been deferred or undertaken.

1.6.2 Railway Costing Principles

One of the principal economic laws that guides the process of railway tariff formation is the Law of Joint

Costs, which is always of particular relevance when output processes involve the production of two or more products from a single operation. Particularly in a railway situation, haulage of various categories of passenger and freight traffic over an identical set of tracks precludes the imputation of costs specific to any given traffic category on a scientific basis. In this distinctive economic milieu, problems of railway rate-making rank assume no less importance than the investment decisions that augment transportation infrastructure. Even though analysis of the existing structure of railway costs assists the evaluation of existing rate structure and the reformulation of rate policy, the railway rates defined cannot be set exclusively on considerations of costs but necessitate accounting of the social benefits derived from facilitation of transport.

Thus from the early days of their advent, it has been usual for railways to assume the role of 'price takers' and adopt rates determined by the railway regulatory authority.[57] While their success as an enterprise then depends on the volume of traffic and freight forthcoming at the rates offered, the railways do not wield much control over their business, since in their role as 'common carriers' they are obligated to carry the traffic offered.[58] It is hence often a matter of pious hope that the regulated tariff will exactly cover average operational costs without overstating or understating certain cost elements in the midst of the rigours of accounting procedure. With the emergence of competition and the gradual withdrawal of the state and its social concerns, many railways have sought the appropriation of rights to negotiate their own rates and choose their own traffic. However this also necessitates then that the railways critically evaluate their existing cost structure before setting 'meaningful' tariff charges.

The Micawberish concerns of railway administrators in the past to meet total expenses entirely out of revenues generated had often led to oversight of the basic structural characteristics in a railway system. When traffic costing commenced in Britain in 1949[59] the railways thus had to realise afresh that they could no longer remain a monopoly where cost accounting did not matter, and that they were specifically a multiproduct firm which had operations much larger and more complicated than the largest of private enterprises. Better accounting for railway costs therefore demands proper identification of the structure and sources of railway costs.

Two variants of costing procedures that are commonly encountered are *particular costing* and *generalised costing*. Particular costing is more appropriate to the charging of traffic regularly available in full trainloads or else in several wagonloads, where separate charges can be computed for marshalling and shunting services and terminal haulage and so on. Generalised costing may be invoked in the costing of 'smalls' traffic where particular costing usually leads to low realisation of charges or cumbersome costing procedure. The principle followed in this case assumes lowering in the tonnage costs of haulage as the ratio of consignment size to wagon capacity increases, but proportionately higher haulage costs for lighter consignments.[60] The generalised costing procedure is subject to a considerable amount of averaging, but proves more worthwhile when the extraction of cost information specific to separate items in the railway service imposes an additional computational burden on the railways.

Allocation of *joint* or *indirect costs* has always posed a nearly insurmountable problem for the railways. The characteristic of jointness in true joint costs can be attributed to technology and persists through all points in time. A common example drawn from the railways relates to the provision of technological inputs in the form of the terminals and marshalling yards that serve both freight and passenger trains simultaneously. In such cases, the charging of identical services at different costs depending on the user cannot be justified, especially since input depreciation is more because of age and obsolescence than from use. Segregability of specific service costs is however more appropriate to the *common costs* (more usually found than joint costs in railway references) which arise in investments that prove supportive to multiple freight shipments or passenger services.[61]

It had already been stated that while economics accords the *marginal cost* pricing principle a major role in the efficient allocation of resources, the contexts of infrastructure pricing raise the problem of whether to equate prices to *long-run* or *short-run* marginal costs. In the particular context of railway pricing, this involves evaluation of whether marginal cost pricing is at all efficient for a public utility services that involves a considerable margin of 'sunk' costs. A reformulation of marginal railway costs as *social marginal costs* that include *congestion costs* then becomes imperative, since expansion of railway user volumes reorder user-costs of fixed facilities that have gradually become overcrowded.

1.6.3 Rate-Setting Principles & the Differential Tariff

The demand for commodities and for transportation of commodities, although distinct, are related at absolute levels by market prices and market demands for those commodities. Even so, transportation demands can be considerably low depending on the freight tariff rates borne affecting the location of production facilities and distribution channels for commodities, without however affecting their levels of absolute demand. Immobility of commodities occasioned by high freight tariffs on them reduce market prices and increase market demands for them in contiguous production areas, while acting conversely in more distant distribution areas. Thus a threshold tariff exists beyond which commodity movements cease.

Transportation rates in all countries are based on the fundamental economic laws mentioned earlier in this section. When a freight rate is high, it is normally a small proportion of the selling cost. Under the law of increasing returns, revenues to the carrier increase disproportionately to costs, especially when constant costs are a large part of the total costs. On the other hand, a commodity with a low margin or profit per unit may be charged a low freight rate to facilitate a wider market and bring the carrier a greater volume of traffic. The increased volume compensates for the lower rates only when the return pays the variable expenses and contributes something toward the constant costs. Some dissatisfaction with this method of rate making by the railroads has been expressed by domestic water carriers in the U.S. Inland shippers believe that their industry has suffered because of this method, and they favor their system of fully distributed costs as being more just.

In a practice known in the literature as *differential charging* or *discrimination*,[62] tariffs charged by railways on commodity freight tend to vary in reflection of relative traffic demand., because of this huge underlying mass of fixed costs. Thus low tariffs just covering railway prime costs and not covering full costs of carriage might be applied to commodities for which traffic volumes are highly cost-elastic, since realisation of traffic spreads out fixed costs and minor upswings occurring in their traffic would lead to large revenue gains. Levy of higher tariffs on the other hand might shut off this traffic altogether. Differential freight tariff-setting thus refers to all situations in which differences in tariffs charged between commodities cannot be explained by differences in costs of carriage. The role played by the magnitude of fixed costs in determining the practice is made abundantly clear from the theoretical circumstance of a transport enterprise where fixed costs are nil, and all costs incurred are variable, in which case the levying of tariffs not covering full costs would always lead to loss unless compensated by higher-than-full-cost tariffs on certain categories of traffic.

Differential freight tariff-setting usually takes the form of discrimination between commodities and is made operable through the classification of freight into a limited number of commodity-groups for each of which common tariffs are applicable, and by the granting of special commodity-rates on articles not addressed by regular classified tariffs. Differences in rates that reflect differences in freightage and handling costs arising from bulk-character of certain commodities whose freightage costs per unit-weight are greater that costs per unit weight-density, or from requirements of specialised equipment and handling, expedited delivery or differences in handling risks and liabilities do not qualify as discrimination. Discrimination on the other hand refers to tariff-setting that is reflective of differences in the "ability of the traffic to stand high transportation charges.[63] and draws its rationale from the existence of fixed railway overheads and excess freightage capacity.

Railway freight tariff-setting in India incorporates these typical pricing principles within a structure of tapering telescopic rates defined on the commodity-classes for which rates are being set. Separate rates are set under the system for the three categories of smalls, wagon-load and train-load traffic with minimum chargeable weights and distances being set for each category. Differential rate-setting is incorporated within the process of commodity-classification in which the basic or Class 100 rate-scale is set, and from which all other class rates can be computed as multiples. Theoretically, the Class 100 rate is set so as to recover the fully distributed average costs of freightage, with the tapering rate structure affording concessional haulage to freight that is booked for longer distances. With rate classes on IR ranging from Class 80A to Class 300X, freight classes rated below Class 100 offer subsidised haulage while those above Class 100 recover more than the fully distributed average costs of freightage including terminal charges. Additional rate exemptions announced from time to time in the Railway Budget for certain commodities are accommodated by introducing new letter-suffixed rates derived from the appropriate class rate. Over time, the exemptions granted have seen the number of class rates go up to 60 from a basic rate structure involving 34 commodity classes. The telescopic element in each rate schedule also varies between commodity classes and has the effect of attracting traffic of desired specifications to the railways by offering cost concessions.[64] The practice of setting railway tariffs for certain commodities at below the prime costs of haulage and making up the losses incurred by realisation of tariffs on certain other commodities at rates higher than full freightage costs amounts to the extreme form of discrimination known as *cross-subsidisation.*

A form of differential tariff-setting that qualifies as discrimination in the true sense of adjusting tariffs to traffic demand involves setting of commodity rates that bear no relation to traffic leads through devices such as setting varying commodity tariffs for equal freightage distances, setting equal tariffs for unequal distances, framing progressive tariff rates where the rates of progression per unit of distance are less than the rates at which carriage costs increase, and the extreme case of discriminating between long-lead traffic in preference to short-lead traffic travelling on identical line and direction through levy of higher tariff rates on the latter. Freight tariff equalisation which was adopted in India for almost three decades uptil the late 1990s to compensate for the locational disadvantages of power plants and industries to which coal and mineral traffic had to be carried over very long leads provides an instance of this tariff-setting principle. Tariff equalisation however ultimately undermines the economies of scale and the economies of location and has often been criticised on these grounds. Another less frequent mode of tariff discrimination concerns the setting of special rates personal to the shipper to secure particular classes of traffic. However the economic justifications for following this practice are less convincing, even though it will be seen that it is in vogue in France and has also been recommended in India as a means for railways to hold on to major freight clients, in the face of freight competition from the roadways.

Discriminatory tariff-setting is fostered under the monopolistic structure under which railway enterprise tends to operate. The principal reason for absence of competition in railway enterprise is the fact that struggles for traffic shares between rivals would drive tariff rates below service cost levels to the point that returns on capital invested would be too low to justify renewals of railway plant. This again reflects the presence of the high mass of fixed overhead costs involved, which justify continued operation of the freight service so long as it makes some contribution towards the cost of overheads, particularly when excess capacity prevails in the short-term. This aspect of railway tariff-setting has been a point of classic focus in the literature (*cf.* the Taussig-Pigou controversy on whether the determinants of discriminatory tariffs for transportation are *joint* costs or *constant* costs, to which Pigou's reply is paraphrased in Pigou [1920],[65] which postulates that a discriminating railway enterprise in a competitive setting will face immediate competition for the traffic for which it has set the highest tariff, which in a discriminatory situation will be that traffic which makes more than a *pro rata* contribution to defraying overhead costs. The resultant struggle will force down rates on this traffic, while at the same time pushing down tariffs on other lower-rated traffic if excess capacity exists to levels below prime-costs.

Except for differences in route-coverage and in the qualitative nature of service, such factors also influence competition between railways and roadways on the evidence of countries like the US and France, leading to measures by railways to protect traffic shares by tariff incentives such as special rates for freight delivered in full trainloads or wagonloads, or fixed container charges without tariff discrimination on the basis of their commodity contents. At another level, roadways are unable to enter tariff competition for low-grade traffic which moves at rates well below those defined by the cost economics of road transportation define. In India, this has led over time to the surrender of low-bulk high-rated short-haul commodity traffic by railways to the roadways, while low-rated bulk traffic with long leads has remained with the railways because of the cost advantages enjoyed by that mode of freight. Although rising competition from roadways remains the bane of the railways in almost all countries around the world, possible long-term solutions dictated by similar duopoly situations that arise in industrial economics point towards eventual tariff coordination between railways and roadways in order to permit both to survive. Of course, the more disaggregated the road freight operation, the likelihood of subcontracting arrangements being used to break down rate agreements with the railways multiplies.

Although tariff discrimination in railway freight is also sustained because of apparent independence of individual transportation demands for most commodities from those of others, a relation may well exist between certain commodity-pairs whereby transportation demand for one commodity is increased by the decline in transportation demands for others on whom higher tariffs are being charged. Similarly, low rates on raw materials relative to high rates being charged for finished products can increase mobility of the former, eventually destroying the economics of locational advantage.

In sum, the three special characteristics that have distinguished the setting of railway freight rates are prevalence of discrimination and lower-than-cost tariffs on certain commodities because of the high proportion of operational overheads, prevalence of monopolistic structure in railway operations and the existence of transportation-demand independence between many pairs of commodities.

1.7 Elements & Scope of the Present Investigation

The conceptual framework that relates infrastructure to development theory is founded on the role of infrastructural capital in forming and servicing the expanding economic base. Railway transportation is accorded considerable prominence in the economics of public infrastructure because of its ability to interlink wide economic spaces and facilitate the economical movement of goods and resources between them. Both in India and elsewhere, the historic developmental role of railways has thus rested on the spatial economics of transportation through which economies of scale and scope created through vast investments sunk into the railway infrastructure are translated into economies of production in the form of reduced transportation costs. By carrying balancing movements of freight between surplus and deficit areas, the railways are also able to mitigate the locational diseconomies of production, aiding the outward dispersal of urban settlements which catalyse industrial activity.

Although the present investigation shall mainly focus on the economics of railway freight operations in India, the infrastructural role of Indian railways shall be explored in the background from the twin perspectives of economic history and national economic planning, where the Indian railways have played a remarkable role. In development contexts, efficient freight transportation services that raise the productivity of producing sectors also expand the monetised economy because the resulting increases in income widen domestic markets by augmenting effective demand. In developing countries like India, where capital constraints are an impediment to economic growth, a burgeoning service sector will set the pace for parallel industrial growth. This is particularly true for infrastructural development and transportation, which lead to both creation and efficient deployment of investible and other resources, thus catalysing the process of capital formation.

1.7.1 The Railways in Indian Transportation Infrastructure

Among various transportation modes, surface transport has been the most accessible form of transportation for centuries with waterways being a popular mode of surface transport since the early years of transportation history. But waterways had their limitations in the sense that they could be adopted as a principal mode of transportation only in those countries which are well connected by rivers and canals. With the advent of the railways, waterways gradually lost their old importance, and over the period since, railway transportation has assumed a prime position in the hierarchy of transportation modes wherever railway infrastructure exists. However, the motorised roadways which made their advent long after the railways, progressed considerably over the 20th century, and have since begun to offer vigorous competition to the railways. Nevertheless, the railways with their advantage of being efficient in the transportation of goods and men at higher speeds and in greater quantity than the other modes of surface transport, and in the present scenario of increasing fuel prices, they are still a favoured mode of transport. The present study is an attempt to make an assessment of this popular mode of transport with specific reference to Indian Railways [IR] freight operations.

In commodity-terms, the output of the railways transportation sector is a service for which demand can be both direct and indirect. Direct consumption of railway transport service takes place for instance, when a family travels for recreational purposes, or when consignments of consumable commodities are transported to their final consumers. Indirect consumption of railway services arises as a result of direct consumption, e.g. when factors of production have to be moved to manufacturing points to facilitate production *i.e.* in consequence of derived demand. Although both direct and indirect flows of men and materials that take place along transportation networks are important to economic contexts, it is the latter that account for bulk utilisation of transport capacity in commodity shipments. Passenger flow along the transport network is however also capable of increasing the mobility of human resources and leads, over time, to greater degrees of urbanisation as a result of the association between industrialisation and the growth of towns. But transportation also involves freight flows, the volumes in which are good indicators as well as determinants of development.

1.7.2 Freight Operations on the Indian Railways

Freight movements within an economy take place through surface transportation over land and water, and also by air. Within the surface transport category, it is the land-based means that are predominant. Although land-based transportation includes both roads and railways, the two are not perfect substitutes, because of variations in their cost-efficiency and in the freight-mix they service. In India, despite developments in other modes of transport over the last quarter-century, the Railways have been able to retain their unique position as freight hauliers. Dominance of bulk commodities like foodgrains, metal ores, coal, cement, fertilisers and steel, etc., in the freight-mix largely explain their pre-eminence in internal goods transport.

A study of the history of IR shows that freight operations has been the prime consideration towards the development of railways in preindependent India. Indian railway history originates not from the construction of the first railway lines, but from the necessity to prevent famines that had plagued the country recurrently and were devastating enough for the colonial power to devise means to distribute foodgrains efficiently to the famine prone areas. The need to transport raw materials from the hinterland to ports and the reverse traffic movement of manufactured goods from ports to the domestic consuming centers also encouraged the British to invest in this rather expensive venture. Along with these economic motivations political considerations towards movement of military provisions and troops also contributed to the development of railways in India.

Freight movements in the post-Independence era had to traverse a long and winding path. Impending needs of the country to industrialise necessitated the movement of raw materials to production centres and as the economy grew, manufactured items found its way to the various consumption nodes. Retaining its character as a public good the IR also has to give preference to essential items like foodgrains and mineral ores for the core public sector industries. Thus although freight traffic has borne the characteristic of transporting broad based categories, there has been a gradual tendency to concentrate on bulk traffic over longer journey leads. As a consequence commodities that were previously carried by IR in the initial years of post-Independence, many categories have found their way to the fast growing roadways.

The National Transport Policy Committee in its report in 1980 had projected a 72:28 share of freight by the railways and the roadways. However recent trends have identified the share to be 40:60 for the respective sectors. While the projected freight tonnages for the 1990s have been achieved as will be seen in the study, the target has been attained with only 40 percent share in the intermodal freight movement as against the projected 72 percent. In order to increase this share from the present 40 percent it is necessary to bring back traffic from the roadways, a problem that IR has not attempted to solve until recently. For the general improvement of the degrading financial health of IR this alternative has become necessary along with the imperative of minimising the costs incurred to maximise its resources. The study while dealing with the freight movements on IR attempts to shed some light on these problems and possible solutions to overcome them.

1.7.3 Railway Freight-Capacity Planning & Transport Policy

Although passenger transport has an obvious productive dimension when it refers to movements of migrant and commuting labour, by far the most important productive flow along transportation networks is the freight flow in raw, semi-finished and finished goods.

Freight transportation has two pronounced aspects: it is a 'production facilitator' insofar as it is a bulk carrier of primary and intermediate inputs over economic space; it is also a 'market facilitator' in determining the size of demand brought to bear on basic, intermediate and final outputs produced within the economy. Inadequacy in freight transportation facilities is inhibitory to the actual process of development. Such inadequacies affect the economy in totality, but have a differential impact in spatial terms because of the regional imbalances they generate. Whether freightage capacity and the freight flows within it have commensurately met trends in the demands for freight services is worth investigating. This problem provides the formulation for the present study. The problem is studied with a focus on freight-haulage capacity and movement.

Several studies devoted to the estimation of transportation demand are found in the literature. Sriraman and Rao [1985], in an empirical study of railway freight demand in India identifies factors required for freight movements such as the length of haul and the quantum of shipment and factors affecting the relationship between them. Effect of the changes in the relationship will be manifested in the change in the demand for wagons and this necessitates the operational decisions leadiing to an observed supply of freight services. Bottlenecks arise when the increased demand is not met by an increased supply of wagons. Thus alternative policies are required to augment the carrying capacity of the railway network and or reducing the demand for freight services that is unlikely to occur in a growing economy.

For an evaluation of freight services of the Indian Railways, different indices like commodity-tonnages originating and net tonne-kilometre haulages have been widely used in studies of the growth of freight traffic operations. Viewed in the long-term infrastructural context, time-series in these, have consistently pointed at emerging capacity-constraints. However, it is not enough merely to identify infrastructural lacunae in terms of transportation bottlenecks existing at a point of time. A longer time-frame of study is necessary, since infrastructural development in any case is not a short-period variable. The period under observation commences with the inception of railways in India, *i.e.*1853 and analysis has been undertaken till 1994-95, while the recent developments on IR are also presented to assist in the future policy formulations.

Limitations in empirical study of long-range infrastructural development have been the need for extended time-horizons for analysis and the complexities of time-series modelling of infrastructural impact, in the face of which short-run planning mechanisms are particularly inadequate. Most infrastructural analyses in economic-history frameworks lead to heuristic conclusions that are poor in respect of operational rigour and therefore country-specific and often not incontrovertible.

While the shift in the planners' perceptions regarding the quantum of investment necessary and its mode of application within the freight infrastructure has been conscious and can be grouped into three distinct time-phases of the Indian planning experience - namely expansion, recession and post-recession - the economic consequences of such shifts have hitherto been glossed over in the absence of analyses that embrace the long time-horizon. Keeping in mind that the two schools of thought on social overhead capital alluded to the time-horizon conflict, no reconciliation of the shift from the long-run perception of transport development as a precursor to economic development to short-run exercises in capacity-shortage management can be achieved without distortion in the attendant development processes. This will be the problem highlighted in each of the empirical exercises that the study undertakes to reveal that the development of freight facilities in the Indian economy is characterised by a distinct hiatus, in consequence of shifting plan priorities. By all indications, such shifts in plan foci are deleterious and inhibitory to the pace of economic development that has been realised.

The basis that transport provides to development emanates from its infrastructural role. Transport augments the size of demand which will pull all other economic resources into economic activity through general market interlinkage; this in turn brings significant pressures to bear on transport networks. Thus transport infrastructure generates development, which generates the need for additional transport facilities. Serious bottlenecks may however be present in this process causing shortages of capacity and affecting the flow of resources and outputs important to economic development.

A priori, one would anticipate that as Indian planners had emphasized infrastructural augmentation sincerely in the early Plans, development - in terms of any economic indicator - would show up eventually. However, the feedback signals then appearing would require progressive investments in transport infrastructure. For progress to continue unhindered, effective coordination with the growing economy and appropriate phasing out of lumpy investments on transport capacity expansion would have had to be implemented. But public investment in the transport sector as a whole instead showed a declining proportionate trend, after the initial thrust witnessed over the first three Plans. Evidence in the chapters suggests also that actual expenditures too fell short of plan-outlays in real terms over almost every Plan, resulting in significant spillover of capital projects between Plans.

It will be worthwhile to mention that the Plan allocations that decide the fate of the capacity augmentation on IR is also responsible for the growth of the other production sectors in the economy. The targets set for the various industries and agriculture are dependent on the Planning Commisssion's decision of providing investment support through the Plan allocations. Thus shortfalls in one sector, *e.g.* the railways, can affect the other sectors of the economy as supply of freight services will be restricted due to lower capacity augmentation. On the other hand, declining Plan allocations for the agriculture, mining and industrial sectors would imply a shortfall in demand for freight services due to fall in production levels and would adversely affect the transport sector through revenue shortfalls. The Railways were the worst affected by this resource crunch. A slowdown of the economy thus affected the IR because of freight target shortfalls and in the face of rising railway costs that are necessary for the maintenance of the capital stock and to sustain operations, led to increased dependence on the budgetary support from the Government. Consequently the subsequent Plans failed to sustain their earlier impact on the economy, and slackened the pace of infrastructural development.

Infrastructural thrust evident in the early FYP in India sought to provide the economy with a strong industrial base by facilitating the movement of raw materials and finished products without any constraints. The commodity freight-mix comprised of both light-weighted and bulk, short and long lead, low and high rated ensuring an even distribution of freight-flows from surplus to deficit regions. However the nonfulfillment of the production targets in the 3FYP and the consequent excess capacity existing within the railway transport network created an avenue for the planners' to bring about a shift in policy with a diminished infrastructural thrust and resort to demand management. This shift in the attitude of the planners failed to generate momentum in the railway transportation sector in the years that followed the lowering of investment in plan allocations and consequently had a deleterious effect on the development of the economy. Extraneous factors like famine, wars and oil shocks aggravated the crisis and the transport policies adapted themselves to combat such unforeseen circumstances. To overcome the uncertainties that affected the generation of traffic, freight flows on the Indian Railways (IR) were shifted deliberately towards bulk traffic mainly originating from other public sector units (PSU) ensuring some traffic as a better alternative to none or uncertain traffic. While essentials like foodgrains were mandatorily accomodated by the IR in consonance with the public utility nature of the railways, many short lead, low bulk and high-rated traffic were dispensed with to accomodate the PSU bulk traffic. For efficiency reasons freight policy stressed on long-haul, bulk traffic while the 'smalls' were forced to find alternative mode for transportation. Whether the policy shift from capacity management to demand management or from a mixed-bag of commodities to a specific commodity set has been for the betterment of the railway organisation and the economy as such is one of the concerns of the present study.

As a result of this deliberate policy to concentrate on long lead bulk freight, the IR freight-mix became unfavourably poised towards freight smalls and thus diverted towards other modes of transport like the roadways. The roadways sector partly under rate-competition and partly as a deliberate policy of altering the freight-mix as observed in the thesis could expand at the cost of the railways. Besides the fact that traffic in this category often involved highly-rated commodities, the switchover in transport mode also induced a loss of efficiency since several of these commodities still involved long leads. Loss of high-rated traffic resulted in revenue shortfalls and railway finances came to be heavily dependent on Budgetary provision from the Government. This along with the resource crunch affected the IR investment decisions adversely and led to formulation of policies that had a strong impact on infrastructure. The thesis examines the impact concentrating on the production sectors affected by the constraints in the supply of freight services and continued specialisation of the freight composition on the IR.

Another important aspect present in the infrastructural issues and the transport policy of the IR is the role of transport infrastructure in achieving an organised spatial distribution with respect to both production and consumption flows in order to achieve balanced regional development. Any bottleneck arising owing to capacity constraints or specialisation of freight traffic is bound to create a distortion in the regional growth pattern within a developing economy, where inadequacy in freight flows can jeopardise both the production and consumption activities.

Because of the importance of the issues that need to be investigated for development prospects in the future, for infrastructural expansion, and for the evaluation of Government policy in this respect, it is hoped that the study will break new ground in the study of infrastructural linkages and will provide insights useful to the reformulation of national transport policies.

1.8 Structure & Methodology of the Study

Considering the critical significance of the Indian Railways in meeting the country's infrastructural needs for passeneger and freight transportation over long distances, a scientific review of the entire transport planning process in prospect and retrospect is necessary. Identification of the lacunae present would aid the formulation of new coordinated policies for effective development of infrastructure.

Fairly comprehensive published data covering diverse aspects of freight operations are available from Railway and other Government sources, from the Planning Commission and from National Transport Policy documents. The study has been mainly carried out on timeseries data assembled from this secondary database and on material drawn from documentary sources in the literature.

The present study is essentially an exploration of transportation economics and railway freight operations in India over an extended period of time. Chapter 1 (the present chapter) lays the foundation for the study by formulating an approach that can address the inherent infrastructural issues in transportation and railway development. An overview for this is developed through a cross-country analysis that illustrates the importance of surface transportation, and specifically its two principal modes namely the railways and roadways. It is seen that the preference for the dominant mode of transportation is determined by the geographical space occupied by a country and its population density, revealing that the choice of transportation infrastructure and the scale of capital investment committed to it is guided by spatial principles. In India, the geographical space is large enough to demand dual modes of transportation. Consequently, the capital requirements for developing infrastructure are accordingly large. An exploration of the theoretical literature and of development history reveals that although the provision of infrastructure has a social purpose, the method of infrastructural finance has varied between private and public investment. In the case of the railways an important method of financing infrastructure has been the partnership of private capital and the state. By granting leases, franchises and concessions, the state is placed in a powerful position to mobilise and direct private capital investment. Yet, because of its public utility character, the sunk costs of railway infrastructure cannot be recovered. Hence, the need for periodic refinancing arise.

In order to develop a comparative understanding of the development of railways in India as a background to study of the current problems faced by the Indian Railways, an exploration is made in Chapter 2 of the current productivity and efficiency of the railways in Britain, France, China, Japan and India. The comparative sizes of these networks are seen to have an important bearing on the relative passenger and freight intensities of the operations. The operational history of these railway systems is briefly explored to obtain a common understanding of the infrastructural issues that presently confront the Indian Railways. Although this choice of countries may seem arbitrary, some thought has gone into their selection. The railways in Britain are the oldest railway system in the world. Unlike the Indian railways the British system is passenger oriented because of the limited size of the country. Since it was British capital which brought the railways to India, similar patterns of financing guided the building of railway infrastructure in the two countries. The French railway system developed under the strong leadership of the state. Hence, social imperatives have always guided its operations. After nationalisation, the enhanced role of the state has made SNCF one of the most advanced state-owned railway systems in the world. Many of the technological initiatives made by Indian Railways under the Plans have sourced their knowhow and consultancy from SNCF.

The railways of Japan and China constitute two non-identical Asian railway systems. Like the British Railways, the railways in Japan are technologically advanced in passenger operations but carry limited freight because of their island character. Both the British and Japanese railways have undergone recent privatisation. The Chinese railway system is a large state-owned enterprise which has seen among the highest rates of network expansion in recent times. While the importance of the railways to China and India are similar because of their relative size and because of the undeveloped character of many parts of the two countries, their modes of railway operation and their technological choices differ considerably. The American railway system receives a special mention both as one of the largest railway systems in the world and also as one that has remained under disaggregated private ownership from the start. It also has among the most technologically advanced freight operations with high levels of running efficiency. Thus although the Indian Railways resemble many of these systems in some respects, they differ in many others. However, the historical study does not seek to reproduce the well-documented histories of these individual railway systems. Rather, it attempts to identify the common ground between the questions of public and private infrastructural funding, state and company ownership and the response to transport competition that have characterised the development of railways throughout most of the world. The study of the alternative solutions found by these railway systems provides a relevant perspective on many of the issues that currently confront the Indian Railways.

Chapter 3 thus commences the analysis of the trends of various indicators of railway operational performance

Chapter 3 thus commences the analysis of the trends of various indicators of railway operational performance which have bearing on the movement of freight by railways in India. A long-period analysis is first made of the capital situation of the railways with reference to the returns to capital-at-charge, and the changes in the patterns of capital funding are identified. These are related to trends in asset acquisition and the operational trends of the Indian railways. While both originating tonnages and journey leads are seen to increase continuously over the post-Independence period, a tendency to shift the focus of railway operations to certain bulk commodities is also noticed in the face of declining support from budget allocations. Since the augmentation of freighting capacity has not kept pace with the increasing demands from traffic, the railways have had to devise their own means of carrying additional bulk-freight through the substitution of other commodities.

Chapter 4 makes a study of the railway wagonfleet in India. The patterns of wagon acquisition by the railways and the technical changes in the wagonfleet composition that have been made to accommodate the needs of specialised streams of freight are identified from the data. It is seen that irregular acquisition of wagons has imposed freighting constraints in the railways and has also driven the Indian wagon-fabricating industry into industrial sickness. The character and evolution of the industry is also studied contextually, and the impact of wagon shortages on the efficiency of railway freight operations is identified.

Chapter 5 studies the patterns of fund allocation to the Indian Railways in successive Five Year Plans and also the internal allocations of these funds by the Railways for different infrastructural uses. The policy reasons behind the slowdown in wagon acquisition and the changes in wagonfleet composition are examined through a comparative assessment of important Railway reports and freight projection studies. It is seen that wagonfleet inadequacies have led to the emergence of transportation bottlenecks in the country. In the technical part of the chapter the distributed-lag model is applied to identify the determinants of freighting capacity of the railways. The econometric analysis studies the changes in wagon acquisition and the railway wagonfleet in relation to changes in the haulage of freight and in other operational and economic variables. The disequilibrium between the various freight projections and the rates of wagon acquisition are identified and analysed in terms of its impact on the economy. It is also seen that the shifting transport priorities in the course of the Plans lie at the core of the problem.

The technical study in Chapter 6 seeks to devise an econometric basis for the exploration of the economic and distributive consequences of transportation bottlenecks in India, on secondary data reflecting the longterm trends of railway freight operations and the cross-dependent patterns of commodity movement. An extended timeframe of 35 years, commencing at the end of the First Five-Year Plan and extending uptil the end of the Eighth Five-Year Plan, allows the technical study to bring out the essential freight demand and freight supply characteristics in the operational management of the Indian Railways. Wagon loadings of 15 major commodities on the two principal gauges *i.e. broad gauge and metre gauge,* are used as surrogates for railway freight productivity and a comparison across gauges is undertaken to identify the impact of freight policy on the sectors associated with the production of these commodities. While production of agricultural commodities as well as light industries are located in dispersed corners of the country, the freight in certain commodities had a metre gauge (MG) dominance earlier since it fed the feeder lines of the railways which also served as connecting links to the backward areas of the country. The infrastructural impact of the intermodal transportation policy of phasing out MG railway operations and concentrating on the broad gauge (BG) that was part of the National Transport Policy report in 1980, on commodities carried on the MG network is thus analysed in order to identify the displacement of commodities from the MG to the roadways. The chapter undertakes a multiple regression analysis on the wagon-loading data for commodities that belong to different sectoral groupings, and seeks to define the basic sectoral flow and composition of railway freight traffic in India. To understand the patterns of serial correlation which are present in the data, the longterm cross-variability of freight flows is studied through a phase-analysis of the systematic component of the residual errors which identifies the patterns of freight shortfalls and subsequent substitution of commodities that has led to increasing railway freight cyclicity over successive plan periods. The commodity coefficients are then estimated using the Cochrane-Orcutt adjustment procedure and interpreted in the order of their importance to railway freight operations in India.

The spatial and sectoral impact of longterm shifts in transport policy are studied in Chapter 7. The profitability positions of India's zonal railways are analysed with respect to their gauge-networks and the intensity of their freight and passenger operations. The impact of the changes in railway freight-flows that have been observed previously are found to fall disproportionately on regions served by MG-dominated railway zones. Multicollinearity in the data is studied through use of the factor analysis approach to identify the patterns of commodity dominance and displacement in railway freight operations over the extended timeframe. The patterns captured by the factor analysis are reformulated into an econometric freight-adjustment model which identifies the most common freight demand and supply situations encountered in railway freight operations in India. It is also shown that these commodity displacements are essentially caused by the inadequacy of railway infrastructure and freighting capacity, which have led to increasing competition in the Indian freight market from the roadways.

Chapter 8, which is the final chapter, draws together the various strands of analysis from the preceding chapters. While the focus of the present study remains on the freight operations of the Indian Railways, several larger issues concerning railway planning and the financing of infrastructure are found to have entered the analysis. By its very nature, railway infrastructure or any other form of infrastructure offers limited scope for profit-taking but extends the developmental benefits of economies of scale for a very long period of time. This is seen to have occurred through the construction of railways in India. However, railway infrastructure continues to require periodic support for renewing its physical plant and technology which demand huge capital investments. Since the present study has partially explored the consequences of inadequate capital renewal on railway freight operations in India, the ultimate question asked relates to the current capital needs and future sustainability of the Indian Railways.

The basic need to identify such displaced commodities arises from the need to observe the infrastructural impact of the transport policies on the downstream industries. While a certain freight-mix has been present in the early plan periods there has been a noticeable shift towards bulk traffic especially catering to various PSUs. As a policy objective to carry essentials and PSU traffic at a lower rate, the IR have failed to generate resources to finance their investment projects. Unlike France, it has not tried to bring back the commodities that has diverted to roadways because of the NTPC policy to maintain a higher average journey lead to keep the IR as a viable organisation. In addition to this the IR has to provide a high capital-at-charge for the maintenance of the present capital stock as well as contribute to the general finances in the form of dividends. However it is also required to increase capacity to attract more traffic from the roadways. With dwindling plan allocations the avenues of an expansion through renewed investment are almost absent and the railways are gradually losing grip over their finances. Thus on the one hand to generate more resources through increased traffic it is imperative that IR expands its capital base and on the other hand to enhance its capital base the IR either has to increase its traffic to earn more revenues or the government has to fully undertake the responsibility of rejuvenating the IR.

Thus in the present study of railway development in India, the contrasts between the colonial and the post-colonial pace of infrastructural development and the auguries these may have had on the economy of the country are present within the econometric results of the study. The point of interest for the study relates to how changes in developmental perceptions and priorities over along period of time can de-emphasise the earlier goals of infrastructural history and whether these can be reestablished by the reorientation of development policy into longer timeframes, as has been accomplished by other modernising countries. Thus, the conclusions from the study extend outside the Indian situation and point towards plausible reformulation of development studies in general, to capture the role of infrastructure.

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Chapter 2

COMPARATIVE OPERATIONAL HISTORY OF MAJOR WORLD RAILWAYS

2.1 The Railway Impact on Development

Reviewing the advent of railways and their impact on economic development in Western Europe, Patrick O'Brien[1] identifies three broad aspects of the process that were found in common among all countries which adopted railways as their principal mode of transportation. The first among these were *forward* linkages which influenced resource allocation, labour migration, rates of capital formation and differential regional growth by altering the ratios of relative prices and by widening and laterally integrating regional and national markets. The next were *backward* linkages which led directly to the rapid expansion of iron & steel, construction and engineering industries in many of these countries over a short span of time. The third were *social* savings resulting from the lowering of inventory needs that followed railway development, which were influenced also by the relative endowment of these countries with alternative transport modes, and by the speed and frequency of the new railway services. It is mainly on the third count, which reflects upon the state of pre-industrial development in roads, canals and other waterways following the growth of the early towns, that noticeable differences may be discerned between different European countries.

Not all scholars however have concurred readily on the occurrence of such events, a marked divide separating the views of the transport historians from those of statistical scholars. Econometric studies of the railway impact on economic growth that gained momentum during the second postwar decade following the work of Fogel[2] and Fishlow[3] on the US railroads, and of Hawke[4] on railways in Britain during the initial phase of development between 1840-1870, have generally agreed that the social savings directly created by the railways through the expansion of passenger and freight transportation were relatively small at around 10 percent of national income.[5] Although the true impact of expanded transportation may well have been understated by social savings concepts, econometric measurements of the external technological economies arising from railway development - such as the inducement for industry to adopt technological innovations and to concentrate investments in certain agglomerated geographical regions - also show paradoxically low scales of impact. The historical approach on the other hand has taken more cognisance of the prolonged influence of railway development on downstream development of industries, entrepreneurship and capital markets, apart from the immediate quickening achieved in freight transits,[6] and will be the method adhered to in the present discussion.

Despite such variations in the scholarly standpoint, comparative railway history studies from an Indian perspective can broaden insights into the role of infrastructural investments and into why the downstream benefits from railways accruing to India had differed for a considerable period of time from those derived on other world railway systems. Although India figures quite prominently among the countries which made early ventures into railway development, the transportation linkages that have been outlined above did not gain much ground during the early phase of railway development because of the lack of parallel growth of towns and manufacturing activity. Instead, the veneer of industrial transformation that may be attributed to the railways was restricted to the vicinity of the few major mercantile centres, and was circumscribed by a dearth in domestic entrepreneurship which would otherwise have spread it outwards. Thus the patterns of transportation linkage commonly observed in Europe only become relevant to the study of the railway impact on India after commencement of the planning era, although their antecedents might well be traced back to the history of colonial enterprise.

The institution of planning in India, which swiftly followed the achievement of Independence, articulated a national commitment to draw level with the rest of the world through the selective application of economic policy and will. As part of their structural objectives, the Five-Year Plans [FYPs] have since then sought to maintain parity of growth between the transportation sector and other producing sectors of the economy, in order to achieve integration between infrastructure and manufacturing capacity. Although forward and backward linkages are evident in the reciprocal relationship between industrial growth and transportation volumes, these remain statistically unspecified because of the difficulty of decomposing the mutual interaction of the two into economic *cause* and *effect*. On the other hand, it cannot be overlooked that the basic prerequisite for establishment of large industrial enterprises is the creation of a large unified market, which is substantially accelerated when efficient transportation brings spatially-dispersed market centres into a common web of exchange.

2.1.1 Comparative Railway Development

Viewing the course of Indian economic history, the impact of railways might conceivably have differed from that observed in other countries because of dissipation of the 19th century boom in railway construction much before it could produce coincident downstream expansions of manufacturing in India. It was not until the consolidation of infrastructural investments in the economy during the planning era that a railway boom recurred on a smaller scale. Nevertheless, comparative study of railway development across select countries brings out features of common experience which would go unnoticed were study to be made of India alone, while also building conceptual appreciation of the role of railways as a component in infrastructure. As the preeminent mode of transportation for well over a century, India's railways have provided essential support to all economic transactions that have required spatial barriers to be dismantled in order to ensure mobility of resources and efficient distribution. Till the commencement of planning, the cumulative indirect or social linkages of railway development have greatly outweighed the direct upstream and downstream linkages of railways in India and the comparison between selected world railway systems should be made in this light.

Comparison may commence from a review of contemporary operating positions on IR versus those on British Rail plc, SNCF [*Société Nationale de Chemin de Fer*] or the French National Railways, AMTRAK or the Class I intercity passenger railroads of the US, the US Class I freight railroads comprising some 28 individual freight lines, Japan Railways and the China Railways. Comparisons between these are made in the table below. Selection of this cross-section of world railways has been guided by the historical or geographical affinities between them which render crosscomparison meaningful. British Rail and the Indian Railways, for instance, have common antecedents in the mix of state policies and investor speculations that marked the commencement of the Railway Age in Britain, and both systems became state enterprises at around the same time. Despite nearly parallel origins, SNCF was directly promoted by the agency of state and was accordingly nationalised much earlier. Like IR, it has since remained wholly under state control till the present time. Though respective booms in US railroads and Japanese railways both occurred during the second phase of railway development, finances for the former were drawn from private external capital borrowing, while the latter was funded by domestic surpluses that had been mobilised by the state. Thus while throughout their history the US railroads never came under direct state operation and were merely subject to state regulation, Japan Railways were among the first nationalised transportation systems and remained under direct control of the state till privatisation occurred during the 1980s, a period during which British Rail underwent a similar experience. After a relatively belated start and slow development, the China Railways were consolidated by huge public investments made during and after the 1950s and thus partially share their experience of planned consolidation with the development of IR under the Five-Year Plans, both systems serving the needs of *developing* rather than *developed* nations. The world railway systems selected for comparison thus represent a mix of state railways, recently denationalised railways and entirely private railways, each supported at different times by both state and private infrastructural capital. Thus the table enables meaningful assessments to be made of differences in performance and overall efficiency levels between systems with apparently shared or similar histories and heterogeneous operating characteristics. The remainder of the chapter is given to exploring their individual infrastructural histories.

Comparison yardsticks are set up on the one hand by the gigantic network of nearly 200 thousand track-km operated by the US Class I railroads with over 600 thousand freight wagon units and nearly 19 thousand traction units, and on the other by the trim network of under 10 thousand track-km operated by the AMTRAK intercity services in the US with just 318 traction units and under 2 thousand passenger coaching units. Against these entirely compartmentalised networks, every other railway system presents an amalgam of varying intensity between freight and passenger services, with plant, equipment and personnel needs being defined accordingly. While comparison is made in terms of these principal efficiency parameters, it needs to be remembered that spatial dispersal or concentration in railway services becomes an important determinant of railway operational performances as well as equipment needs, and should be factored into the assessments.

Table 2.1: Railway Infrastructure & Operations on Selected National Railway Systems

Country	Network [km]	Rail-Track Locomotive Units	Traction Wagon Units	Freight Coaching Units	Passenger Personnel Workforce	Railway Operations [million]	Freight Tonne-km Operations [million]	Passenger-km Operations [Ratio]	Freight Intensity of Railway
British Rail	*UK*	16584	2227	39313	3100	135321	15986	33191	0.482
SNCF	*France*	34070	5542	148100	11640	202081	49677	63761	0.779
AMTRAK	*USA*	9540	318	-	1983	24000	-	10095	-
US Class I	*USA*	193158	18835	604672	-	216424	1530742.8	-	151.634 *
JR	*Japan*	20254	1659	30170	21587	193763	26803	237551	0.113
China Railways	*China*	53378	13592	364966	27261	3381000	1060100	263530	4.023
Indian Railways	*India*	62367	8417	346103	31843	1651100	229601	295644	0.777

*Note: *for combined US Class I Railroads & Amtrak*

Source: Recompiled from *World Railways*, 'Statistics on Railway Scale and Traffic Characteristics', *cf.* RFFC [1993]: *Railway Fare and Freight Committee Report*, 1(4):91-92, Annexure 4J

The comparison reveals apparently close resemblances between IR and China Railways in terms of network-size and freighting capacity, but striking distinctions between them in traction equipment, passenger coaching fleets and workforce - China Railways in fact being the only major railway system that has carried steam traction into the current century. Comparison of a relatively close order also relates JR to British Rail, both systems having high passenger intensities of operations since they serve island nations which require the provision of high-density commuter railway services over relatively small spatial areas. With overall freight-intensity in operations being expressed as the ratio of freight-km to passenger-km, extremely high commuter density is indicated for JR which runs upwards of 26 thousand trains a day. Despite operating a track network just over half the size of IR, railway density on SNCF is observed to considerably exceed that on IR, both in terms of traction equipment as well as personnel deployment. Overall freight intensity on SNCF is also much higher than on IR. The operations of the China Railways indicate strikingly high specialisation in freight, with over 4 freight tonne-km being hauled for every 1 passenger-km carried. But despite a smaller coaching fleet, aggregate realisations of passenger-km on China Railways do not lag far behind that of IR, testifying to high overall utilisation of railway services in China and to the consequent need for larger staffing and traction fleets. The IR network being older and the China Railways network being of more recent vintage, much of this growth of traffic and freight intensity on the latter has occurred relatively recently.

Table 2.2: Railway Productivity & Efficiency on Selected National Railway Systems

	RAILWAY PRODUCTIVITY INDICES					*RAILWAY EFFICIENCY INDICES*				
Railway	Traffic Units achieved per Route-km *['000]*	Traffic Units achieved per Traction unit *[million]*	Tonne-km operated per Wagon unit *['000]*	Passenger-km operated per Coaching Unit *['000]*	Traffic Units achieved per Employee *['000]*	% Wage-costs per Revenue unit *[%]*	% Passenger-km per Traffic unit *[%]*	Unit Passenger Fares to Freight Rates *[Ratio]*	Average Passenger Traffic Lead *[km]*	Average Freight Lead *[km]*
British Rail	2965	18.6	407	5169	363	78	67	122.3	44	116
SNCF	3330	19.7	335	5478	561	90	56	119.3	76	359
AMTRAK	255	31.4	-	5091	421	n.a.	100	604.7	455	-
US Class I	7925	81.3	2532	-	7073	28	-	-	-	1184
JR	13052	64.9	888	11004	1364	70	90	173.4	29	452
China Railways	24997	97.4	2905	9667	391	26	20	163.8	278	n.a.
Indian Railways	8422	59.6	663	9284	318	45	56	29.6	77	741

Source: Recompiled from *World Railways*, 'Statistics on Railway Performance', *cf.* RFFC [1993]: *Railway Fare and Freight Committee Report*, 1(4):93-96, Annexure 4K

Comparisons of the scales and intensities of operations indicate extremely high freight intensity and relatively insignificant passenger intensity of railway operations in the US. The other railway systems all carry much higher passenger-traffic volumes. By inference, the relative intensities of freight operations achieved by each system relate directly to the spatial span of the concerned rail network, while those of passenger operations appear to relate inversely. Although hidden from the present analysis, the presence or absence of comparable transportation alternatives would also appear to play a determining role. The substantial existence of motor freeways, and the high incidence of automobile ownership and high frequency of domestic intercity air services are all important factors in reducing passenger dependence on AMTRAK services in the US. In comparative terms, passengers in less developed countries such as India and China depend much more on railway services, although much less freight is transported on IR than on the China Railways. Since technology levels and capital vintages inducted by each railway system into its traction, coaching and freight equipment remain imponderables within the comparison, summary assessment of railway performance on the basis of track and equipment inventories alone would probably be inappropriate. Even so, both China Railways and SNCF present pictures of more rounded utilisation of railway services, while either freight and passenger services disproportionately dominate the other systems because of their spatial or technical circumstances.

For better comparative assessment of current railway performances across the selected systems, analysis may therefore be made of the productivity and efficiency ratios that are included in the subsequent table. With cumulative traffic units being defined by the sum of passenger-km and tonne-km levels achieved on each national railway system, it becomes readily evident that the highest intensity of railway utilisation occurs on the China Railways, followed by JR. The main distinction between the two railway systems is that traffic units for the China Railways have a larger and therefore heavier freight-tonnage element, while the JR traffic units are highly commuter-intensive. The freight-intensive China Railways and US Class 1 Railroads both put relatively large traction fleets to efficient use, realising a greater number of traffic units per traction vehicle, even though the traction technologies differ considerably between the two systems. Freight-capacity utilisation on the US Class 1 Railroads and China Railways is again remarkably high because of higher freight-intensity, with the latter railway system again occupying top slot. Traffic realisation per traction unit is also relatively high on JR but is much more commuter-intensive, compared to which the corresponding traffic realisations of SNCF and British Rail are low. Nevertheless JR, with a relatively small wagon inventory, achieves efficient per unit freight traffic realisations to accompany its highest per unit realisation of passenger traffic. While US Class I and JR traffic realisations are achieved at lower labour intensity, railway services provided by the other systems appear to be more personalised, particularly on AMTRAK which caters exclusively to intercity passengers. It would bear noting however that other factors such as average commuting distances and passenger-comfort levels, as reflected in class of travel, also affect passenger traffic realisation by each railway system, some indication of which can be gleaned by crossreference to the associated average passenger-traffic leads and to the ratios of passenger earnings to freight fares. British Rail and JR for instance show the typically short passenger leads associated with commuter traffic, while AMTRAK, with its reliance on intercity passengers, and China Railways show more evidence of long-lead passenger traffic, albeit at widely diverging levels of passenger-comfort as implied in the associated fare realisations.

The peculiarities of IR's current operating situation become readily apparent from the comparison. In terms of traffic realisation, IR occupies a relatively favourable position even though IR traffic is relatively less freight-intensive than the China Railways. Passenger traffic realisation on IR is also fairly creditable, although achieved over relatively short average commuting leads, and at very low fare and comfort levels. It may be inferred therefore that the high realisation of short-haul passenger traffic on IR is in fact an impediment to better freight realisation, with existing routes and traction units being heavily precommitted to the operation of passenger services. Despite a relatively large workforce, the average wage-cost per revenue unit on IR is not unduly high when compared to railway systems other than the freight-intensive US Class 1 Railroads and China Railways. Low per unit wage-costs on the latter systems are not immediately attributable to low labour deployment or high capital intensity of operations, but - particularly in the case of China Railways - are the consequence of higher freight traffic realisation as well as relatively high fare realisations from passenger services. On no other railway system in fact is relative passenger fare realisation as low as it is on IR, pointing to several simultaneous anomalies in IR's operational situation. The combination of short-lead dominated passenger traffic, highly subsidised passenger fares, and the probably high incidence of ticketless travel prevents correction of traffic imbalances, perpetuating high freight rates and cross-subsidisation, lower freight realisation and a surfeit of uneconomically-operated commuter services, which eventually tell on the financial health and resource-mobilising capacity of IR. As the ultimate consequence and in marked contrast to the China Railways, IR infrastructure remains weak and its traction and freight equipment inventories too meagre and of too old a vintage to permit the provision of freight services on the scale warranted either by India's development needs or IR's large track network.

As a prelude to more contemporary evaluation of the IR freight-infrastructure and recent operational trends, an exploration of the economic history and infrastructural impact of selected world railway systems becomes necessary and is made below.

A. The First Foundations: The European Railways

2.2 Railways in Britain

The beginnings of railway enterprise represent an innovative response to the increased transportation needs created by the growth of towns and mercantile activity in Europe, following the dismantling of feudal institutions and the freeing of artisans and serfs. Although these developments occupied the greater part of the 17th and 18th centuries, the earliest infrastructural responses reflected the adaptation of existing transportation technology methods extending the use of animal and wind power onto commercial turnpike roads and existing riverine channels, rather than the immediate inculcation of new technology. It took a long time for commercial needs to build up to the point where transportation along these traditional channels became clogged and so slow as to warrant the investment of time and money on evolving new transportation technology. Retracing the technological events of that time, the growing focus evident in inventions such as Thomas Newcomen's steam-driven mining pump [1712], James Watt's improved steam engine [1769] for mining and other applications, or Nicolas Cugnot's self-propelled steamcar [1769] built for military haulage of cannon, was on the need to accomplish work volumes lying beyond the physical competence of human or animal power, implying also the need to harness new energy resources such as coal to the fulfilment of new economic needs. Technology provided the singular means of achieving this, and each technologically-superior invention found ready commercial application.

It is interesting to reflect on the long preceding chain of infrastructural innovation that led eventually to the industrialisation of Europe and made the railways its prime movers. European products in the precapitalist era mainly comprised light town-based manufactures produced under local artisanship which obviated the need for developing bulk transportation. Although natural coal was already known and was being mined as a metallurgical resource, the preferred fuels for manufacturing processes continued to be either wood or charcoal. It was only when wood supplies had dwindled by the early 17th century because of the deforestation which followed the mass shift from agriculture to manufacturing in Western Europe,[7] that the mining industry and its need for economic bulk transport became inviting targets for technological innovation. Both the waterways and railways were early outcomes of an innovative engineering process which sought to enhance the bulk haulage capacity of horse-drawn transportation by applying physical principles of lessening resistance, smoothing momentum and maintaining the velocity of transit along a *permanent way* that could be kept free of all other traffic obstacles. The mechanical advantages of transporting heavy loads upon rails had been known and applied at the waggonways in the mines of Europe since the 16th century. Paired wooden rails nailed onto crossties were used there to offer a hardwearing and evenly-spaced wheel bed on which horse-drawn wagons could haul much heavier payloads. By the end of the 18th century, considerable innovation had gone into the replacement of wooden rails by metal and into improvements of rail geometry and wagon-wheel design, leading to introduction of flanged wagon-wheels that did away with the frequent inconvenience caused by derailments of the heavy mining wagons. In all these innovations, a technological lead was consistently maintained by Britain.

2.2.1 Dawning of the Railway Age

Economic and technological transitions in Britain over the 18th century had brought increasing focus to bear on the mining and metallurgical industries. The strong consequent demand for the transportation of bulk materials such as coal and iron spurred the construction of a system of inland canals and waterways which considerably lowered the costs of towed transportation relative to those on roadways. The close association that developed between railways and the new mining and metallurgical industries was much more than coincidental. Coal found principal use in the smelting of metals. Besides directly transporting coal and ore materials from mining pitheads to the nearest river-ports, the iron railways also became the principal consumers of metallurgical products, for wheels and rails, and also for carriage and bridge work. Accordingly, the growth of the iron foundries was also stimulated by backward linkages from the construction of iron railways, and considerable technological innovations were incorporated by the improved rail designs. While the initial competition between the bargees and road operators in bulk transportation had principally been a market contest where the point of entry for railway transportation was its ability to offer a combination of better transit speeds and bulk economies similar to those of waterways at sunk costs relatively lower than those incurred in canal construction, railway construction was also favoured by strong investor support from the mining and metallurgical industries. Entering the contest, railway transportation was able to transfer the *permanent way* principles of canal transportation to transportation overland, thus mounting a much stronger challenge than roadways transportation had ever encountered before when the Surrey Iron Railway built by William Jessop from Croydon to Wandsworth near London in 1803, took these innovative advantages far afield of the mines by providing the world's first railway service for the carriage of public goods.[8] The haulage efficiency of railways in general surface transportation was established beyond dispute when horses drew trains weighing upto 55T [55 metric tonnes] along this railway, and fuelled further commercial interest in railway development. Several other horse-drawn railways came into operation during the first quarter of the 19th century.

After establishing their viability in terms of haulage capacity, the railways also needed to prove their competitiveness in terms of speed. The steam engine, which had attracted a flood of late-18th century innovator interest as a potential source of horseless motive power, had till then developed around Watt's low-pressure design which suited it mainly to static applications such as the dewatering of mines. The first adaptation of the steam engine for use in commercial freight transportation occurred across the Atlantic in the USA, where the need was primarily for bulk river transportation to and from ports, along broad estuarine waterways to which both tow-barges and deep-keeled sailing craft were inherently unsuitable. After John Fitch had invented the powered paddlewheel steamboat in 1787, its commercial viability for ferries and freight services was established in 1807 by Robert Fulton's *Clermont*, built around an engine supplied by Watt. By 1809, steam engines on Watt's design were being regularly used for oceangoing shipping and the first steamboat crossing of the Atlantic was accomplished in 1819.[9]

However the limitations which till then had hindered the application of steam power for railway transportation - namely the relatively heavy mass of Watt's steam engine and the great weight of the fuel it consumed - continued to remain the focus for further technological innovation in Britain, where the need was primarily for rapid overland transportation. Further improvements in the steam engine design had to await advances in precision engineering and machining techniques that allowed an increase in engine-power ratio relative to engine and fuel mass. Hence the earliest prototypes of powered railways were based on the principle of cable railways towed over fixed distances by a static engine. Nevertheless, by 1804, Richard Trevithick had already demonstrated the feasibility of running a high-pressure locomotive engine at the Newcastle coal mines without requiring special rack-and-pinion arrangements on the track. Fundamental innovations on the locomotive design made by George Stephenson reduced its power-to-weight ratio considerably. Stephenson was therefore commissioned by the new Stockton & Darlington Railway in 1821 to further improve his locomotive design for regular coal haulage. The trial run of his new locomotive in 1825 with a mixed train of 36 freight and passenger wagons was an unprecedented success. Railway development in Britain began in earnest after this event, with approval being given to the Liverpool & Manchester Railway Bill by Parliament in 1826 and commissioning of the railway in 1830.[10] Foreseeing the market potential of steam locomotives, Stephenson along with his son and their principal railway promoters, had already shown considerable foresight in forming an engineering company for their commercial manufacture. Reaching speeds nearing 40kmph on the new railway, Stephenson's 'Rocket' locomotives completely revolutionised the haulage of both passenger and freight traffic and heralded Railway Mania, quickly precipitating the demise of commercial horse-drawn railways in Britain.[11]

The transportation revolution which occurred after the mid-18th century, culminating in the advent of railways, may thus be viewed as the product of a continuous stream of innovation in which Britain was a noticeable technological leader. Purely *physical* innovations such as the building of turnpike roads, canal construction and the deepening and widening of natural waterways, and construction of horse-drawn railways augmented freight volumes, creating the infrastructure for industrialisation of the British economy. The high pace of infrastructural innovation, supported by rising mercantile profits and consequent interest in the commercial development of the transportation sector, was generated by the competition between different transportation modes, as they sought to contest the temporary monopolies that were created by each infrastructural innovation.

After the escalation in freight volumes had triggered the growth of mining and metallurgical industries which depended extensively on the movement of bulk materials, the focus of the freight contestants turned to *engineering* innovation in order to improve transportation efficiency and running speeds. Technological attention inevitably gravitated towards coal and steam which had already revolutionised factory manufacture, and at the summit of this innovatory wave, the *mobile* steam engine or *locomotive* was born. Although the commercial history of this innovative process has remained largely unrecorded, the exclusive returns to patented inventions from their commercial application worldwide spurred the development of new transportation concepts and their application to newer fields. While the roadways also sought to reenter the freight contest in Britain through early 19th-century innovations such as the macadamisation of road surfaces, without backward linkages their freight interest remained confined to the relatively uncontested piece-goods segment, and was quickly demolished when animal power was supplanted by steam. With time, railway engineering principles even entered the realm of urban transportation through the development of horse-drawn, and later, powered tramways.

2.2.2 Railway Enterprise & Operations

Close association was also observed between railway engineering and railway enterprise in Britain. Soon after the success of steam railways had established them as a technologically superior alternative to the roadways for intercity transportation, a number of important lines were constructed by railway entrepreneurs to link contiguous cities. The concept of a *trunk* railway was born after the first flush of railway construction was over, when the Grand Junction Railway was built in 1837 to link the Liverpool & Manchester Railway to Birmingham. By 1838 the trunk line had already been extended to link with the London-Southampton Railway. The technological importance of the trunk line concept lay in the rapid standardisation it brought to railway gauges and equipment in Britain. The first British railway lines had been laid by private companies over numerous small routes. Initally, their choice of gauge tended to be arbitrary - the 1.435m (4'8½") choice of gauge on the Stockton & Darlington Railway, which had been based on the width of the local colliery waggonway, being adopted as standard gauge by several other railways. Citing the advantages of better locomotive stability and speed, greater train safety, and higher haulage capacity, the eminent 19th-century engineer Isambard Kingdom Brunel however chose the broadest-ever railway gauge of 2.2m (7') for the Great Western Railway which was built between 1833 and 1841 to connect London to Bristol. A Royal Commission was therefore appointed to investigate gauge standardisation on the British railways, paving the way to enactment of the Gauge Act in 1846, under which the 1.435m gauge was declared the standard railway gauge all over Britain. To allow standard gauge trains of the other railway companies to pass through the London-Bristol trunk section, the Great Western Railway was consequently compelled to add a third rail on its tracks, and maintained this until 1892 after which it wrote off its old inventories and converted completely to standard gauge.

During the Railway Mania years between 1830 and 1850 the stance of the British government remained regulatory in nature, since private railway capital could only be raised from the money markets by the companies against individual railway schemes that had been approved by Parliament. By 1850, railway trunk routes in Britain already extended over a network of more than 9600km from Scotland to Southampton. As the trunk lines were completed and the pace of railway construction within Britain began to slacken, entrepreneurial interest shifted to mergers and acquisition of smaller railway companies, as their larger neighbours settled into the business of running railway services profitably. By 1844, the 'Railway King' George Hudson had already amalgamated the Midland Counties Railway, North Midland Railway and Birmingham & Derby Railway into the *Midland Railway*, later also acquiring the Birmingham & Gloucester Railway and Bristol & Gloucester Railway to build a zonal railway empire spanning 1600 track-km. Amalgamation of the London & Birmingham Railway, the Grand Junction Railway and the Manchester & Birmingham Railway into the *London & North Western Railway* occurred in 1846. The need for prior parliamentary sanction thus also enabled the British government to regulate the sequencing of railway construction and amalgamation. Consequently the *Great Northern Railway* which was proposed in 1827 to link the northern mining and industrial regions in Yorkshire to London did not secure parliamentary approval till 1846, after the Midland and London & Northwestern railway networks had already been put in place, and was only completed in 1860. Similarly, the *North Eastern Railway* was only formed in 1854 after the amalgamation of the York & North Midland Railway, Leeds Northern Railway and the York, Newcastle &

Berwick Railway, and eventually absorbed the South Durham & Lancashire Railway, Stockton & Darlington Railway and West Hartlepool Railway between 1863 and 1865. Railways in the northern territories relied heavily on the transportation of coal and other raw material freight, and were allowed to come into being only after appropriate economies of scale had been created by the rest of the network. Railway consolidation in Britain occurred through the building of zonal monopolies for the amalgamated railway networks, which secured their profitability and operational position. Meanwhile, the railway construction and finance companies had begun to carry their expertise overseas, accompanying massive exports of British capital, iron rails, locomotives and other railway materials. Despite railways in Britain being built and operated entirely by private companies, the role of the government in railway development is thus seen to have been proactive, ensuring a continuous flow of infrastructural benefits to the economy from backward and forward linkages.

The cyclic sequence of drawn-out market booms deemed collectively as Railway Mania, followed by noticeable slacks in 19th-century British capital markets has been the subsequent subject of much economic and policy analysis.[12] During boom conditions, individual railway investors felt their investment risks were indemnified in the mass response attracted by railway equity issues. Railway capitalisation hence rose appreciably during the phases of 'low risk' perception which accompanied railway construction, enabling the companies to build an equity base strong enough to tide them over through succeeding periods of financial stringency. During the latter, when railway companies made greater resort to financial instruments such as loans and debentures, the accumulations of paid-up capital acquired earlier provided the collateral to offset lender-risks. In this sense, the market process served to iron away ebbs and eddies in railway capital flows, underwriting the railway companies against sudden money market failures.

After domestic railway construction in Britain had been largely completed, the British railway companies were thus enabled by their accumulated stores of capital, engineering expertise and investor confidence to participate aggressively in global railway construction through the remainder of the 19th century. Periodic accusations of overcapitalisation by railway companies nevertheless arose within Britain, which were scrutinised by several parliamentary committees between the 1840s and 1850s.[13] A subsequent debate among British railway historians has thus arisen on whether these high levels of capital accumulation represented the phenomenon of adverse selection, *i.e.* the inability of capital markets to distinguish correctly between true market potential and speculation. Tracing Railway Mania through the successive transfers of railway construction activity to other countries, one position within the debate deems that the market allocations were generally efficient and ensured capital flow into the most viable railway projects at hand. The competing argument however relates sharp divergences in constructional and operational costs of railways in Britain vis-a-vis other countries to waste of resources encouraged by overcapitalisation, inevitably leading to low rates of return on railway capital. The high institutional costs of land surveys and acquisition in Britain which raised railway construction costs to £5000 per mile, or nearly twice the construction costs incurred by the French railways and eight times more than construction costs on the US railroads, were invariably cited by the railway companies before parliamentary investigations as the main reason underlying the high railway capitalisation needs of Britain.

It can still be surmised that promoter competition and the piecemeal mode of railway development adopted in Britain were at least partly responsible for the high construction costs of British railways. Unlike sparsely-settled countries on the Continent or the US where land was granted to the railways as a state prerogative, land in the British Isles already commanded a high premium, which escalated further as open contests emerged between rival railway promoters while government procedures sought to secure landed citizens against arbitrary land dispossession. Railway development in Britain was therefore constrained by competitive inefficiencies arising from promoter competition and inappropriate company network sizes that proved too small in practice to yield adequate economies of scale. Quite clearly, these guided the consolidation of natural railway monopolies through company amalgamation and buyouts in the subsequent period.

From the early 1880s, operating performance on the British railways steadily deteriorated as their *operating ratios*, or percentage of working expenditure to gross receipts, rose substantially and annual net rates of return on railway capital declined from the peak of around 4.5 percent achieved in 1870.[14] Sharp accompanying declines in the growth of railway productivity also provided evidence of diminishing returns to railway investment. However the deterioration in operating ratios did not reflect declining operational efficiency *per se*, since it was partially attributable also to rapid escalation of working expenses relative to the growth of gross railway earnings, following the rising labour and input cost trends of late 19th-century Britain.[15]

Following the 1870s, railway extension in Britain largely comprised the construction of branch and suburban lines and provision of special passenger services and amenities, each of which required disproportionately high cost outlays at higher average unit operating costs, because of their lower traffic density. Returns on suburban traffic, which was composed mainly of workmen commuting to and from cities on concessional fares, were also low since the clustered peak-hour density of suburban services necessitated high deployment of personnel and railway rolling stock, even when traffic capacity remained underutilised for the remainder of the day. In several instances, peak traffic even interfered with the flows of more profitable mainline traffic. Commercial adaptation to the presence of railways was also noticed among British retail traders and distributors who began to lower inventories in order to reduce stock expenses and market risks, relying on the quickened freight transit offered by railways to meet business orders. Needless to say, this reduced consignment-sizes while increasing shipping frequency, turning hitherto large freight consignments into traffic smalls. Although the standard tariff-setting principles being followed set low rates for cheaper freight commodities and high rates for those with higher unit-values, the proportion of underrated traffic carried at low profit margins increased substantially. Thus by 1914, nearly a third of all freight transits on the British railways comprised low-rated coal traffic. Meanwhile, the capture and consolidation of passenger traffic required induction of expensive coaching and rolling stock and the provision of additional station amenities, on which the costs of maintenance were also commensurately high.[16]

Regulation of railway rates through extended government control rendered it difficult for the British railways to pass on these increased costs to freight shippers and the travelling public, since the justifications to be submitted while proposing upward tariff revisions to the government required the segregation of freighting costs from the costs of passenger carriage, which proved difficult to accomplish in practice because of the joint-cost character of railway operations. On the other hand, railway rates were less sticky downwards since special preferential rates were regularly negotiated between the companies and the major freight shippers. Thus during their early phase, the British railways were sandwiched between rising unit-costs and falling average revenues and charges, as rising proportions of freight and passenger traffic entered the cross-subsidised traffic categories. In fact, it was not until the advent of serious roadways competition much later that these patterns of cross-subsidisation were called to question, because they tended to encourage selective transport competition in the highly-rated traffic segments.

2.2.3 Railway Technology & Institutions

In the face of their inability to pass on increased costs in the form of higher charges, the logical alternative for the railways would have been to raise productivity and reduce working expenses through fresh inductions of technology, especially in view of growing traffic volumes and density. No such mitigatory course was seen to have been adopted in Britain, causing the economist George Paish to point out at the turn of the century that substantial reduction in unit-costs had been achieved by the American railways by inducting improved technology into railway freight handling methods and carriage.[17] These had in fact allowed the running of heavier trains, justified by the longer haulage-distances and larger consignments transported on the American system. Delayed inductions of railway technology were particularly noticeable in British freight operations. Apart from the lack of improvement in railway marshalling and handling, a significantly large part of freight inefficiency on the British railways arose from inadequate wagon design. Improvements in wagon capacity were thus wholly neglected, and the 8.13T and 10.16T (ton-equivalents=8 and 10 British tons) 'toy truck' design remained the standard British railway wagon till 1914, sacrificing economies of size. Even in the 1930s, wagons of the improved 20.32T (20 ton) design constituted only 3 percent of the British wagonfleet, although it was well recognised that substantial operating cost reductions had materialised from their use because of the highly favourable ratio of additional earnings to additional capital costs, reductions in maintenance and marshalling costs, and the increase in tractive handling power of locomotives consequent upon their higher payload-to-tare ratios.[18]

Thus while acknowledging that the distinct character of railway freight traffic in Britain had to some extent determined the type and technology of services provided, the Beeching Report on structural reforms for the nationalised British Rail [19] commented later that glaring innovatory failures were also involved in the evolution of a traffic pattern under which freight continued to be moved at slow speeds in very small loads to a multiplicity of stations, and where much of the traffic originated and terminated in single wagonloads. Consequent upon this practice, the railway wagon had become the primary unit of movement passing through

British marshalling yards, with through working of trains being neglected till the point where variable and cumulative delays in the marshalling process had made the overall freight service slow and unreliable. The obligation of the British Railways to fulfil the role of a mover of freight smalls over a vast network of branch lines despite their being technically unsuited to traffic in this category, was observed to have led to sacrifice of the speed, reliability and low operational costs of trainload services even along mainline trunk routes. Other innovatory failures are also deemed to have arisen from the unwillingness of British Railway to introduce modern braking technology on wagons which would have contributed to their operational efficiency and economical running, and from the lack of standardised designs incorporating uniform axle boxes and suspensions which would have lowered both the costs and complexity of railway maintenance. The low cost of British coal was similarly noted to have led to the neglect of railway technology improvements, which could have increased tractive efficiency through modifications of traction design and the phased introduction of diesel and electric traction.[20]

The outbreak of World War I brought a salutary improvement to railway performance, providing evidence also that considerable slack existed on the British system, since with less rolling stock and depleted manpower, more traffic was moved between 1914-1918 than had ever been moved previously. Much of this improvement was achieved by transport coordination and was attributable to unified working of the entire freight infrastructure and the various railway companies under exigencies which allowed government to invoke the provisions for wartime railway control included in the Railway Act of 1871. The measures adopted for coordination eliminated the light loading of wagons, and consolidated freight, particularly that with military character, into full trainloads through point-to-point allocations of traffic. Secondly, they reduced congestion at railway sidings and terminals by confining maximal traffic flows to the handling capacity of sectional networks on which they were being transported. Substantial freighting efficiency was gained by pooling the limited wagonfleets owned by individual railway companies, thereby ensuring the reloading of wagons close to their points of discharge and the reduction of wagon turnarounds.[21] Such traffic and efficiency gains, no matter how substantial, resulted from the wartime scenario rather than commercial reorganisation and thus tended to evaporate when the railway companies reverted to individual operations at the conclusion of WWI.[22] Nevertheless technological innovations in freight handling and the use of heavier wagons that had been introduced by the more enterprising railway companies marked a qualitative change between prewar and postwar periods, while logistic improvements which had followed the provision of better statistical inputs on wartime traffic movements also improved the quality of railway monitoring after the war.

While the nature and organisation of British railway operations did differ markedly from those on the American railroads, the failure of the British railway companies to set a desired pace for innovation was rooted elsewhere, namely in the company railway institution rather than in its operations. Certain railway companies innovated while others did not, establishing that company initiative could have played a free part in reorganising traffic operations on more economical lines. The fragmentation in traffic that rendered bulk handling and movement inappropriate resulted to a large extent from the priorities accorded by the railway companies to specific traffic categories of traffic, regardless of the costs involved. Thus passenger services on the British railways offered the highest levels of passenger amenities - such as separate dining cars, for instance - even when such amenities were very expensive to provide, and their full costs could not be passed on to users. Similarly, the low demurrage rates in vogue on the British railway freight system provided an inducement to the freight consignees to use railway wagons as a cheap warehousing facility, reducing their effective deployment for traffic operations.

Much more than this however, railway innovation by the companies often encountered the institutional deterrent of investment at high and unaffordable capital costs, since the character of technological innovation on the railways usually involves cascading downstream investments on the adaptation of other facilities, thus greatly amplifying the eventual infrastructural cost of any improvement in equipment. Since the principal avenues for operational improvement involved the induction of heavier and larger traction and rolling stock, the absolute limits to which these could be sustained were laid down by route gradients and the radii of track curves, bridge heights, tunnel clearances, and the sidings and handling facilities at user-terminal installations. Having pioneered industrialisation since the first half of the 19th century, Britain now began to suffer limitations from the vintage of its capital and railway assets, while a late-industrialising nation like the US was favoured on the other hand by closer technological compatibility between its railway, industrial and port infrastructure. Secondly, the effectiveness of transport innovations applied by the railways depended on the willingness and ability of major railway clients like the mines to invest on the upgradation of their own facilities to bring them into conformity with those owned by the railways after technological innovations had been effected. In most cases such willingness was not forthcoming, and thus most British client installations were unable to accommodate 20.32T or larger wagons, which most American client installations could.

Another form that the interrelatedness of railway institutions assumed arose from the existence of privately-owned rolling stock amounting to over half of the total wagons then in use on the British railways, as a partial carryover from the early railway days when traders had been required to provide their own wagons. Around 90 percent of these belonged to the colliery companies, who strongly opposed the introduction of larger wagons because of the restricted permissible heights of coal-pit headings and limitations of the existing track and sidings.[23] Railway companies on the other hand were unable to singly bear the development costs of these because of limitations on their rates and revenues, upward revision of which was also strongly opposed by their clients. Although it might superficially appear that joint efforts would have overcome such institutional obstacles through the sharing of development costs, new problems would inevitably have arisen over the apportionment of joint costs between the respective parties, and in any case the strong preference of freight consignors and consignees to send and receive their shipments in smalls instead of pooling them into trainloads did not warrant investment from them on bulk handling methods. At the other end, because of the commercial empire-building that was intrinsic to early railway enterprise, railway owners relegated the efficiency of operations to a secondary position while concentrating their attention on aggressive expansion of networks, which often implied the duplication of facilities and promotion of uneconomic lines and services in the effort to outdo rival companies. This single aspect is deemed to have contributed considerably to the lowering of average net returns on railway investment, since the provisioning of marginal lines entailed higher proportionate costs than the mainline system, in some cases even exceeding marginal revenues so that sectional losses occurred. Weaknesses also arose from the lackadaisical attitude of the railway companies towards the maintenance of statistical performance records of the type that had been advocated by Acworth and Paish. In fact the only data that were adequately maintained were of the balance-sheet type, accounting for profits earned and dividends distributed by the railway companies. Again, this was a carryover of the mindset of company construction and promotion of railways from the early railway days, which prevented British railway operations from acquiring the characteristics of a scientific transportation system. Rationalisation and reform of railways was also delayed on this account, because of the paucity of statistical information capable of identifying uneconomic sections of the company networks. This situation continued till the collection of adequate data was made compulsory by legislation just before WWI.

In contrast to British shipping, which was wholly unregulated, the development of railways in Britain from the 1830s onwards was never free from legislative controls. The peak period of regulation in the pre-nationalisation era occurred when government requisitioned the entire British railway network during WWI and vested its control with a Railway Executive Committee [REC] constituted by the general managers of major railway companies, against the incurred liability of compensating the companies at par with the net incomes they had earned in 1913, for the period that the railways would remain under government control.[24] Since payments on this account were to be met from traffic revenues, some focus naturally developed on the efficiency of operations. Traffic load on the British railway system over WWI increased immensely and traffic performance was equally creditable, because of vast reductions in operating expenses and the development of cooperative modes of operation, represented particularly in the pooling of company wagonfleets. Although the railways depended much less than British shipping on the scale of international traffic demand and physical damage to the British railway network resulting from war had been minimal, severe asset depreciation had occurred from the running down of rolling stock and equipment. The lessons of wartime railway coordination made it abundantly clear that there would be no going back to the prewar competition and that railway coordination was there to stay, and the REC's opinions in this regard were fully endorsed in 1918 by the Select Committee on Transport, which proposed the unification of railway ownership.[25]

Although government was thus persuaded to extend the period of control and guaranteed net receipts while a decision was pending, the commercial situation rapidly deteriorated between 1918-21, following sharply increased working expenses and higher compensation being paid out to the companies. The government's eventual intentions had already become clear, since railway nationalisation had occasionally been mooted in Parliament as a possible solution.[26] It was however the decline in the financial position of company railways which provided the first avenue for reorganising the railways. Accordingly, a Ministry of Transport was established in 1919, to which considerable powers over the railways and other modes of internal transport were transferred. Most important among these were powers to set and alter railway rates flexibly, with the eventual intent of bringing these into line with working expenses. After a proposal for nationalisation was rejected in 1920, sharp enhancement was allowed in railway freight rates to wipe out the operational deficits that had placed an additional financial burden on government on account of the guaranteed net revenues that were being paid out to company owners. The operational situation was further compounded by general economic recession and recurrent strikes which had led to partial stoppage of the coal trade, and by the raised scale of maintenance expenditure to restore track and rolling stock back to health. Piecemeal tariff increases did not therefore appear to be capable of providing the ultimate solution. Although nationalisation was rejected as a possible alternative, the urgent need for operational reorganisation of the British railways had become apparent. Accordingly, the government set about reorganising the 130 assorted British railway companies then in existence into a few major groups and unifying the total existing rail network of about 40,000km, to ensure standardisation of equipment and operations and to eliminate direct railway competition as far as practicable.[27] The smaller individual railway companies were amalgamated under the 'Big Four', namely the Great Western Railway [GWR], the London Midland & Scottish Railway [LMSR], the London & North Eastern Railway [LNER], and the Southern Railway [SR].[28] The amalgamation resulting from the Railways Act of 1921 strove to preserve the combined net revenues of the amalgamated companies by allowing each newly amalgamated group the freedom to set railway rates that would compensate for losses in individual revenues. The 1921 Act is thus regarded as the most important piece of railway legislation following the original Railways Act of 1844, since it invested the amalgamated British railways with the responsibility for scientifically coordinating their operations. Meanwhile, a cumulative amount of £60 million was paid out as compensation by the government in full settlement of the claims and charges of the erstwhile owners.[29] Despite the newly granted flexibility in setting railway tariffs and downward revision of these in the hope that traffic elasticity would help to raise revenues, general slack conditions did not immediately let the reorganised railway system be restored to profitability. The results of post-WWI decontrol of railways were therefore mixed, in the sense that while operational efficiency improved, financial performance did not follow suit.

2.2.4 The Response to Competition

The decade immediately following WWI also witnessed the free and unregulated development of road transportation in Britain. The motor transport boom had commenced worldwide in the 1920s when, in an atmosphere of unbridled enterprise, thousands of small companies had entered the coaching business. Severe competition between these companies led to duplication of facilities, undercutting of fares, as well as resort to unscrupulous trading practices. Under the new clout over transportation modes that had been provided to the Ministry of Transport under the 1921 Railways Act, it now sought to regulate roadways development. Since safety and maintenance were also being given short shrift by the roadways, a Royal Commission on Transport reviewed the situation between 1928-31, and was accompanied by enactments of the Road Traffic Act of 1930 and the Road & Rail Traffic Act of 1933 to provide legislative means to the Ministry for imposing licensing regulations on the roadways.[30] With licensing being stringent, it constituted a sufficient barrier to the entry of the roadways into the preserve of the British railways, although allegations persisted that licensing stifled good competition along with the bad. Licensing nevertheless allowed the retention of passenger traffic by the railways at a time when railway development was stagnant relative to the boom in motor transportation, and also ensured intermodal coordination between the British railways and roadways. Fierce opposition from the railways to roadways services on the grounds of duplication also dwindled as the amalgamated railway companies gradually acquired an interest in running parallel roadways operations. Subsequently therefore, greater inclination emerged on the part of rail and road operators to enter into agreements which coordinated their respective services on long-distance as well as suburban routes. In sum, it might be said therefore that railways in Britain were not unduly protected by the regulatory legislation on the roadways. In fact, it was observed that the presence of the alternative mode spurred the amalgamated railway companies to compete through improved services, particularly for medium and long-distance passenger traffic where competition was stiffest.

A significant opportunity was provided by the advent of roadways for the technological upgradation of railways. The most remarkable railway innovation, after the initial introduction of steam, was the introduction of electric and diesel power into railway traction. However, inspite of the availability of this new technology by the early 20th century, the observed tendency on most world railway systems was to persist with the use of steam traction for several decades thereafter, thereby giving it an extended lease of life well past the century where it had first appeared. An identical tendency was also noticeable in the case of the British railways, with no attempt being made to abandon steam traction till well after WWII. Thus in 1955, when the British Transport Commission launched its Modernisation Plan for the railways, steam still accounted for 87 percent of the total tractive haulage, against 10 percent for electric traction and 3 percent for diesel traction.[31] The majority of electric and diesel-powered services in any case comprised short-distance multiple units (*i.e.* EMUs and DMUs) for suburban passenger traffic rather than locomotives, while the mainline services still relied heavily on steam traction. The British railways, which had by then been nationalised and consolidated into British Rail, thus had a traction fleet of nearly 18000 steam locos, against just around 500 diesel and electric locos. The lag in the introduction of new tractive technology for nearly five decades after it had been proved viable needs to be explored, since delays of this long order were not witnessed in other railway systems. In the US for example, diesel traction had made rapid headway by the mid-1930s and accounted for over 12 percent of freight mileage and between 25-30 percent of passenger and marshalling mileage on the American railroads at the time of commencement of WWII and the construction of new steam locomotive units had practically been abandoned.[32] Sufficient evidence had also existed since the 1930s of the benefits to be drawn from the introduction of electric traction, including the provision of clean, fast and frequent services at lowered operational costs which could bring back traffic to the railways. The flexibility offered by EMUs also made them eminently suitable for suburban services. Of the amalgamated British railways however, only the Southern Railway had introduced electric traction from the 1930s and had made sufficient headway in traction conversion by the time of the outbreak of WWII.[33] Although financial results from this Railway revealed that substantial transportation economies had been gained, the other railway companies showed no inclination to follow suit. The situation persisted even after nationalisation, with no immediate advance being made in the introduction of diesel traction either, despite the similar scale of benefits it offered.

For the introduction of new technology, certain preconditions had to be fulfilled. Thus while average operating costs of the new technology had to be consistently lower than those for the technology already in service, the net expected returns had to be substantial enough to meet all interest charges arising from new investment. Even where such financial conditions were fulfilled, other features of the sector under consideration could conceivably constrain innovation. With respect to innovation on the British railways, the ***natural monopoly*** character of transportation services and the need to service innovation with further downstream investments in order to maintain compatibility between railway technology and other railway and industrial infrastructure, acted as powerful deterrents. Another limitation arose from pessimistic business expectations and the reduced availability of easy railway finance. With cash reserves running low over the interwar period, the pressure to innovate would have necessitated extensive market borrowing, for which neither resources were forthcoming, nor was the overall financial health of the railways system capable of inspiring investor confidence.

Other constraints on railway innovation were far more specific to the nature of railways. Because of Britain's strong domestic mining industry which moreover was the principal client of the British railways, relative factor prices favoured the continued use of coal, while depressed wages in the recession years firmly discouraged the adoption of capital-intensive innovations in traction. Meanwhile, as serious competition emerged from roadways transportation, the initiative taken by the railway companies to combat competition involved their entry into auxiliary motor transport operations, which in fact delayed railway innovation. The companies therefore continued to repose their faith in tried and tested steam traction into which a massive amount of railway capital had been sunk, instead of risking new experiments.

The major apprehensions inhibiting electrification of the British railways were institutional in character, relating to the magnitude of downstream investments to be made and sunk costs to be written off. The railway companies were strapped for funds because of commitment of a large part of current net revenues towards paying dividends and fulfilling the arrears in maintenance works which had accumulated over the WWI period.[34] By the end of the 1930s, an extraordinary financial situation already prevailed because of the outbreak of WWII. The situation was only reversed after wartime restrictions on capital investment were removed, and the shortages of labour and fuel which had constantly pinched the British economy during and after WWII made the foray into electrification inevitable. The Southern Railway, which was the only British railway to have made a serious foray into electrification before WWII, was assisted by the suitable nature of its traffic.[35] Nearly 80 percent of its revenues accrued from high-density peak loads of suburban passenger traffic, which required rapid transit to avoid congestion. Since the major competition was from passenger roadways which also offered quick and efficient transit, the pressure on the company to improve service quality and reduce operating costs encouraged the adoption of EMU-type electrification, which the company could well afford to because of its more lucrative traffic earnings.

Diesel traction, which offered many of the advantages of railway electrification without requiring extensive adaptation of railway infrastructure and could be economically operated at lower traffic densities, had already become a viable and widely accepted option on the American railroads during the 1930s and 1940s.[36] The reluctance of the British railway companies to explore this alternative, stemmed from the auxiliary forays they made into motor and air transportation to ward off the competition. Investments that might have been fruitfully made into dieselising traction went instead into such monopoly-sequestering alternatives, in a classic case of adverse selection under which resources vital to improving railway efficiency were squandered elsewhere. The other major blindspot of the railway companies was their persisting faith in steam. This faith was founded on generations of railwaymen who had been reared in the environment of steam, and whose skills rested there. The technological response from this community to seek ways, instead, of increasing the efficiency of steam traction through engine redesign and streamlining of trains, etc., in the belief that the steam locomotive could be made to compete technologically, and still had a future. It was only after dramatic improvements in railway efficiency were witnessed in countries which had chosen to shed steam traction, that this mindset changed.[37]

2.2.5 Nationalisation & Denationalisation

Indifferent railway performance over the Depression period and the emergence of sharp competition from the roadways eventually prompted the government decision to consolidate the railway companies under the nationalised British Rail, and they passed into public ownership in 1948. British Rail commenced unified operations on 1 January 1948, amidst the wave of postwar nationalisation in Britain under the Labour government which had taken over the reins of power. Although a new phase of railway modernisation followed, recurrent revenue deficits began to occur from the mid-1950s, which no amount of general subsidies, reinvestments, closures of services and individual subsidies to unprofitable lines could undo. Restructuring of British Rail in the 1960s under the Beeching Report thus sought to rationalise these deficits through selective service closures. In the 1970s, clarification of the public service obligation [PSO] of British Rail allowed the commercial restructuring of other railway services, while reformulations of railway management over the 1980s laid the ultimate foundation for the privatisation of British Rail towards the end of the 1990s. The last significant change before actual privatisation was the internal reorganisation of railway management into the management of several business sectors resulting in cost consciousness, investment appraisal and controlled resource utilisation.

Private enterprise has been an almost permanent feature of the British economy, except for the short interregnum of nationalisation under the Labour governments that held power immediately following WWII. The railways were nevertheless among the last of the formerly-nationalised British enterprises to be privatised by the Conservative government in the early 1990s, the delay stemming mainly from the inability of the proposed privatised managements to subsidise uneconomic passenger routes that had to be maintained for sociopolitical reasons. Although a mechanism under which subsidies could continue was ultimately devised to avoid largescale route closures, this prevented the divestment of British Rail from yielding large revenues to the government, unlike those that had accrued from the divestment of other public utilities such as gas, electricity and telecom.

Alternative structures proposed for privatisation of the British railways at the time included

(a) *single-unit privatisation* under BR plc,

(b) *sectoral privatisation* which would hive off sectoral business,

(c) *regional privatisation* on the old structure of route-based companies,

(d) *track privatisation* under a private track authority which would exercise separate control over the track network while permitting competition in the use of the track, and

(e) *franchise privatisation* under arrangements where different categories of railway services would auctioned out to private bidders.

The eventual choice of the track authority and franchising mode was followed up in the Railways Act of 1993 that came into operation on 1 April 1994. Under provisions of the Act, British Rail was split up into several distinct entities, among which Railtrack took over infrastructural responsibilities including signalling, stations and depots, power supply, in addition to construction and maintenance of track. The costs incurred on these were to be covered by charges for the use of facilities, with provisions for a commercial rate of return on these assets. *Railtrack* was privatised in 1996 by listing its equity on the stock market. The franchising option was exercised in the case of passenger services and in channelling government subsidies to the franchisees. A regulatory authority was also set up to arbitrate and to ensure equitable access and reasonable railway charges, and empowered to direct and oversee Railtrack also regarding these aspects. Railway safety was entrusted to a separate executive which would monitor the compliance by individual railway operators to safety regulations. Under the arrangement, all existing railway passenger services, excluding charters, special trains and Eurostar Channel Tunnel services, were then franchised out under 25 separate components which the franchisees were to operate with rolling-stock leased from railway leasing companies formed within British Rail. Apprehensions did surface that sharp fare increases might occur on profitable traffic sections where the railway franchisees held a natural monopoly. However general fare controls introduced in 1995 reduced the scope for these through the introduction of a three-tier ticketing system on which fares were frozen on specific lengths of time.

The separation of infrastructure from services attempted through incorporation of Railtrack was primarily intended to make the provision of railway services more contestable by increasing the scope for transport competition. While this was eventually to be attempted by allowing open access, competition in the initial phase had to be limited to attract franchise bids. Thus under both initial and proposed bidding systems, franchisees were required to demarcate the services being competed for on the basis of point-to-point flows, with competition gradually being open upto various threshold levels of the total revenues represented by these flows. While franchisees could bid freely for various point-to-point services, overbidding on their part would raise the quantum of revenues bid for and proportionately open higher revenue threshold levels to competition, while underbidding would conversely reduce the degree of revenue protection offered. In operational terms, this was expected to optimise the competition by preventing individual franchisees from becoming too large or remaining too small.

Freight and parcel services on British Rail were also privatised - in the case of the latter, interestingly, by nominal sale to the management team. Trainload freight services however had to be reorganised by adding contract services, and regional separation of the organisation into *Loadhaul* which would cater to service and depot arrangements, *Mainline* which would administer the traction fleet, and *Transrail* which would handle long term contractual haulage arrangements. Although still separate, these were bought as a package by the American railroad company Wisconsin Central, which, again interestingly, also bought over rail express systems and appeared likely to takeover international rail freight. Two power utilities dealing with electric and nuclear power also set up their own freight operations for captive traffic by acquiring their own traction.

The principal object of privatising British Rail had been to induce competition in railway services which would improve efficiency, reduce costs, and improve service-quality and technological development. The competition that did develop particularly in passenger services however appeared at the bidding stage rather than ontrack, and route competition was therefore limited. Considerable competition did emerge in railway leasing operations particularly during renewals of leases, but the least degree of competition was seen in freight services because of the package sale. It was expected however that substantial competition might develop later in the maintenance of track and signalling infrastructure, one of the main items of outgo on the part of most railway systems. Under provisos that quality and safety would be strictly regulated, this was expected to lower overall railway costs substantially.

2.3 The French Railways

As in Britain and its other European neighbours, the growth of commerce in France had been triggered by the construction of state waterways during the 18th century. Riverine traffic had thus risen to a peak between 1750-1800, before declining thereafter. Railway development in France was also preceded by the complementary revolution in road transportation that commenced in 1730 under the agency of the state. Since several economic impediments had already been removed by the 1820s through creation of a superior internal network of roads, the subsequent development of railways in France did not quite fill an empty space.[38] Nevertheless severe regional disparities between northern and southern France, traceable to the uneven provision of transportation facilities, had obstructed the creation of a national market during the preceding period. While the concentration of cities in the northern region had been a stimulus to the evolution of an intricate and efficient network of trunk and branch roads in their immediate periphery, transportation in the south had developed in a more unorganised manner and the localised roads around the few urban centres such as Marseilles and Bordeaux barely complemented the rivers and canals.[39]

2.3.1 The Railways under Monopoly

Development of the railways in France was therefore considered by the Railway Commission in 1839, which also examined possible modes of financing their construction. While a few horsedrawn railway lines had already been laid between 1826 and 1832, it was only from 1842 that railway development took off in earnest, under a well-conceived plan for constructing 9 radial trunklines from a railway hub at Paris to link the Rhineland to the Mediterranean and Atlantic seaboards. Construction and operation of these was to be undertaken by private railway companies under 40-year charter terms, with free provision of land, track beds and terminal facilities by the French government.[40] Under the principle of 'finance by the state and operation by concessionary companies' established in the Railway Bill of 1842, state support for the railways did not take the immediate form of direct subsidies, but was rendered in state loans and equity participation. Although the opening of the first railway between Paris and Rouen in 1843 was quickly followed by a construction boom, the problems that could have arisen from railway competition were eliminated through rapid consolidation of the French railways under 6 large monopoly companies.[41] Following the completion of the trunklines however, railway construction underwent a slump because of investor disinterest stoked by the 40-year charter limitation on private operations, and the lack of competitive stimulus. Consequently, the Railway Plan of 1842 was modified in two important respects by extending the charter duration to 99 years and by providing government guarantees on the minimum rates of return that would accrue to private capital investments. Capital for a renewed railway development phase was also mobilised domestically through bond issues on which the French Government guaranteed 4 percent interest.[42] Serious rethinking on the earlier financial principles and the minimalist role that had been occupied by the state began to surface however after three decades of railway development, following frequent skirmishes between the concessionary railway companies and industrial users regarding the alleged charging of complex and unfair rates for particular industrial traffic such as iron & steel.[43]

A concerted state programme for building a national navigation network in France was therefore revived in 1879 under the 'Freycinet Plan'. The objectives of this were to resume the grand 18th century canal-building works which had been interrupted by construction of the railways, and to classify the navigational gauges of French rivers so that a standardised barging fleet could be developed. While marking the first attempt at intermodal coordination in French transport, the Freycinet Plan also reflected the changing political mood of the period as the French Republicans sought to expand state participation into the provision of infrastructure. Although the Plan objectives were technically laudable, the basic difficulties in implementing Freycinet, which became evident by 1882, related to its weak financing arrangements as well as to the implacable opposition it encountered from railway operators. Thus while new canal works initially proceeded as planned, investment on the maintenance and improvement of the existing network lagged behind. Progress on the new canal works was also soon retarded by opposition from the railway companies and their political lobbies. As a direct consequence, investments on canal development which till 1883 had been rising, registered a sharp drop by 1887 and continued to fall steadily until 1899, before a new effort was made to revive the Freycinet Plan. By then the *free traders*, had become the main supporters of the proposed canal network, while *protectionists* still favoured the construction of railways. Mutual distrust between these two groups and the lack of cooperation from local and regional authorities considerably reduced the private investor response to both canal and railway works, despite the subsidies and toll concessions which were being offered under financing arrangements. Traffic response on the waterways also tended to be mixed, and while the number of boats declined between 1880-1913, their loss in numbers was compensated by the increase in their individual capacity under the policy of standardisation. As such, the contribution made by French waterways to the overall expansion of transportation facilities and towards economic growth between 1880-1914 was not particularly significant. This was then limited further by the economic recessions of the early 20th century and by the strong rate-competition on freight traffic that the French railways began to offer after 1907. The regional imbalances in the French transportation network could not therefore be rectified, and network development remained aligned along the northern axis leading from the major port of Le Havre to Lyon.

The lingering economic depression between 1874-78 was also responsible for the failure of the Freycinet Plan, since it created pessimistic attitudes among the French industrialists who found themselves battling a financial crisis. Although the economy recovered slightly during 1879, it plunged back into renewed depression in 1883-87. The Freycinet Plan had apparently aimed at reconciling the free-traders and protectionists, through a compromise between state repurchase of railways versus continued concessionary funding of them by the state. But the projected order of state intervention envisaged under the Plan failed because of the inability of the state to mobilise sufficient funds for railway construction. Accordingly, the Railway Convention which was adopted in 1883 marked the demise of the republican ideal of active state participation, even while it brought into being state controls on railway rates and compelled the private railway companies to integrate less profitable lines into their respective networks. In retrospect, this has been seen as an alliance of *laissez faire*, under which private profits could be generated by the railway companies, and the Saint-Simonian public-utility concept, where the railways were to carry the obligation of providing public services through state regulation of their tariff structure and the continuance of uneconomic services. It was observed in practice that this alliance of objectives caused companies financing and operating lines in low-traffic conditions to run up considerable losses which they were not in a position to recover through the medium of tariff hikes.[44] From the practical perspective therefore, the railway companies did not exploit the state, since their combined investment on the less-profitable services they were forced to integrate greatly exceeded the minimum revenues guaranteed to them by the state. Operating performance consequently deteriorated and the railway companies that were running deficits proved incapable of financing incremental construction during the depression years between 1883-87. A case in point was the Ouest railway company serving western France which constantly lost money because of its high proportion of unprofitable lines, and had finally to be bought up by the government in 1908. On the other hand, more profitable networks such as the Nord flourished independently, proving that the nature of relationship between the railway companies and the state was in fact determined by the operating performance of each company network.

Historical review of railway development in France would thus divide the prenationalisation period into four distinct phases. The first of these between 1845-67 covers the grand period of railway construction, when the railway network was being created. The ideological battles between free traders and protectionists on the question of state participation in financing infrastructure leading up to the Freycinet Plan marked the second phase of railway development between 1867-83, during which however exceptional increases in traffic were recorded as usage of the network intensified. As no enduring arrangement for financing railway development could be reached, minimal investment was made on network expansion over the third phase from 1883-1914, despite rising costs. But as traffic expansion continued nonetheless because of increasing efficiency in railway operations, the period also saw growing control of the state over railway operations and the imposition of unrequited social burdens on the railway companies. The final prenationalisation phase between 1914-37 saw listless railway investment on account of the war, financial depression, and the rise of road competition which retarded the recovery of the French railway system from the destruction of WWI. The response to this further amplified the regulatory presence of the state through the Railway Convention of 1921, and culminated in nationalisation of the French railways under the Convention of 1937 which reconstituted them as the Société Nationale de Chemin de Fer [SNCF], or French National Railways, from 31 December 1937.[45]

The history of railway development in France was thus marked by periodic and lengthy debates between the merits of private ownership and commercial operation versus public utility arguments drawing from the Saint-Simonian formulation of social ownership. The first phase of infrastructural investment which focused on the construction of mainlines and a rudimentary secondary network was financed by private companies against guaranteed minimum rates of return on their capital investments. The frenetic pace of railway construction during this phase inevitably caused the emergence of 'excess' transport capacity, which was however soon absorbed by traffic development during the subsequent period. Falling profits and pricing anomalies nevertheless laid the foundation for government intervention and eventual takeover of private concessionary interests. Nationalisation which followed a period of sustained operating deficits for the railway companies, also represented a situation where the companies did not want to bear, at very limited profit, organisational responsibilities for an enterprise whose costs depended on government pricing-decisions outside their direct control.[46]

Certain similarities are observable in the French and British inland transportation situations where traditional waterways and the nascent railways remained principal players for a long period of time following the 19th century industrialisation of these countries. Until full articulation of the railway network had been achieved, the relation between waterways and railways was either strictly complementary or benignly competitive, depending on the specific location and industry being addressed, while the railways slowly substituted road transportation in the passenger segments. Hence it was only after railway lines began to spread into industrial hinterlands traditionally catered to by water transport that competition began to emerge around the relative transit speeds and pricing per tonne of respective freight services. In France, till at least the early years of the post-WWII period, waterways remained the major rivals of the French railways especially along the principal axes of the transportation hub, and only in later years did roadways comprehensively displace the waterways in importance to become major competitors to SNCF.

For the greater part of the period under historical review, the role of the railways in freighting operations across the world was augmented through two roughly sequential expansions of freighting capacity, namely a *spatial* expansion of line networks and consequently of tonnages borne, and a *technical* expansion of carriage through incorporation of technologies augmenting axle-loads, trainweights and train running speeds. That the first of these should have preceded the second would appear quite logical in view of the lumpiness of infrastructural investments involved, since after each spatial expansion of the railway network, it took some time for traffic to grow past the point where the freighting capacity of the network had to be expanded by further investments in technology. Only after saturation was reached on both spatial and technical counts did a traffic situation emerge which warranted further expansion of the network in spatial terms.

It also becomes apparent, when examining the nature of industrial growth induced by railways in France during the prenationalisation period, that the decline in private investment and the increase in operating costs that accompanied the gradual evolution of the French railways into a state-regulated enterprise ultimately began to tell upon the backward linkages of railways with industry. As such, the initial market advantages of railway operators in selectively placing bulk orders for railway inputs with metallurgical and other industries was soon countered by cartelisation among the private input producers, who used their influence with government to secure better distribution of orders. However, since the mining and metallurgical industries of the French Rhineland were able draw both support and technological diffusion from the process of railway development, the backward linkages of railways remained pronounced in France. Railway development also generated forward linkages which promoted the nascent domestic industrial sector by inducing reduction in the pricing of its inputs. However cyclic traffic-to-cost relationships became peculiarly evident within the transmission process. The periods of falling industrial costs between 1852-67, 1872-83, 1888-1908 and 1920-29 succeeded periods with high levels of railway investment and technological advancement, which resulted in underutilisation of the augmented railway infrastructure and manifestation of excess traffic capacity while these forward and backward linkages were taking effect. Rising industrial costs during the intervening periods reflected the increased intensity of network-use without much augmentation of railway investment, so that the materialisation of new traffic first added to operating costs and then provoked upward revision of railway rates. Strong public opinion in France had initially opposed differential tariff-setting which, by allowing rate fixation relative to actual haulage costs, might have partially alleviated these cost-cycles. In fact during the later incursions of roadways competition that commenced from the 1920s, a transition was permitted to railway rates not unduly influenced by the public-utility principles of unity and equality, allowing railway rate-setting in France to become more flexible and more representative of actual railway costs. Shortly thereafter however, this sequential process of transport development and traffic rationalisation was rudely interrupted by the outbreak of WWII, which brought untold catastrophe to the French economy and the railways in its wake.

2.3.2 Early Railway Innovations

The virtual freight monopoly held by the French railways between 1842-1929 encouraged considerable technological and operational innovation on the French system, designed to improve traffic coordination and consolidate the railway economies of scale against wasteful competition. An important principle within this was the optimisation of freight-flow through the railway network. The French system was thus among the first to adopt a regulatory framework under which negotiated railway tariffs were imposed by the Government. Under the system, differential freight tariffs were charged after prioritising the traffic into the fast [*Grande Vitesse*] GV and slow [*Petite Vitesse*] PV categories.[47] While PV freight rakes carrying nearly 95 percent of all railway freight initially ran as service trains offering economical rates, which halted at intermediate terminals in order to mop up piecemeal traffic, the GV rakes were assembled from high-priority parcels as traffic grew, to serve the freight-flow which had previously been attached in freight parcels to passenger trains. By offering guaranteed time-of-delivery to perishable traffic and retail consignments, the system also allowed the differential charging of priority consignments at higher rates. Gradually, as freight-flows expanded with the development of industry in France, a new freight stream developed comprising full wagonloads of critical industrial inputs like coal and metallurgical ores. These were consolidated into single rakes that could be directly routed without halting delays to their destination in the industrial belt in northern France. Segregation of freight-flows on the French network into three distinct streams with different priorities and running speeds allowed optimal technological innovation. By 1897, heavier wagon payloads and traction was introduced to facilitate efficient haulage of specialised industrial bulk-freight. Thus the improved 20T freight wagon with a loading tare of 9-10T soon became the *standard wagon* on the French railway system.[48]

Another important example of early technological innovation on the French railways was the quick interlinking of the French system with the landlocked Swiss railway systems. Although remarakable railway engineering was called for in order to achieve railway traverses over the Alpine passes, the building of the St.Gothard traverse in 1882 was soon followed by several others. The construction of these traverses provide early examples of railway cost-sharing between adjacent countries in order to derive mutual transportation benefits. By increasing tourist traffic to Switzerland, the interlinked system gave a competitive edge to the French railways over their other European competitors.[49] Freight competition between the French railways and other European railway networks had been quite significant, since the traffic to major European lading ports such as Marseille, Rotterdam and Genoa could be carried over more than one system. Mutual traffic-sharing agreements soon became common between the French, German and Italian railways, and even today the extent of port sharing continues to be a decisive factor in the operating efficiency on the French and other European railways.[50]

While continuing to operate through the agency of 6 large railway monopoly companies with zonal jurisdictions such as the *Ouest* (West), the *Nord* (North), the *Est* (East), the *Midi* (the midlands) and so on, the operations of the French railways were closely coordinated by the French Government. The importance of the railways for subsequent economic and industrial growth induced the regulation of railway tariffs and the imposition of public-service obligations on the companies, which included commitments to operate all franchised lines regard of their cost-of-carriage and profitability, and to accept all traffic entrusted to them and build transportation infrastructure accordingly. As a public-utility measure, the companies were also required to equalise rates and charges over their rail-routes regardless of the cost of sectional carriage on each line. By making the transportation of bulk-freight economical, the French railways aided agricultural and industrial development and the integration of the national market. Freight tonnages consequently rose continuously from 12MT in 1842 to 224MT in 1929-30.[51] Nevertheless, the construction of the network of low-density light railway lines (the so-called 'third network') between 1880-1892 began to eat into the operating margins of the railway companies, because of the increase in workforce costs without commensurate increase in operating revenues.

2.3.3 Impact of Railway Nationalisation

Wartime exigencies after the outbreak of WWI temporarily brought the French railway companies under the compulsory control of Government. Since France was an important theatre of war, railway operations were adapted to military perspectives and the devastatation caused by the war to the network was extensive. Although, the economic recovery after WWI restored financial balance to the railway companies temporarily, the looming global depression caused another economic slump between 1930-38 which affected the French railways adversely. During this time, the waterways began to offer renewed competition to the railways and increased their freight share from 18 percent to 33 percent. Meanwhile, the new public roadways had begun to compete with the French railways and were assigned a specific traffic quota in 1935. Since higher density of use made road transportation economical and the operators did not have to carry the costs of their infrastructure, the French railways proved unequal to this new source of freight competition and slipped back into a financial deficit. The freight monopoly of the French railways was now over.

Much before the nationalisation of the French railways, a Supervisory Committee had been constituted under the Convention of 1921 to coordinate the activities of the French railway companies in order to put an end to wasteful freight competition between them. Since strict tariff regulation and the public service obligations were being widely held to blame for the dire financial situation of the French railway companies, a series of remits had been offered to the railways. The first of these was the Act of July 1933, which freed the companies from the statutory obligation of running a minimum number of trains on each line. Under several presidential decrees between 1933 and 1937, the process of tariff ratification was liberalised and the obligation to maintain services was relaxed on routes where the level of traffic had showed extreme decline. This was followed by the grant of tariff autonomy to run freight services at contracted delivery schedules and rates by mutual agreement with major railway clients. A scheme was also proposed in 1935 for regulating the roadways and preventing their reckless proliferation. Because of the persisting failure of these measures to restore efficiency to railway operations in France, the 6 large railway franchises were nationalised under the Convention of 1937 and renconstituted under SNCF.[52]

The nationalised French railways began functioning as SNCF in a favourable commercial environment following the end of the global depression. In the period of railway restructuring that followed, power was given to SNCF to restore closed services or to close sectional services where deemed necessary, and also to open new branch lines to the mines & quarries, ports & warehouses and industrial factories to secure a monopoly over bulk-freight from these sources. The 35 railway zones that had been created in 1935 became traffic districts on the SNCF network, and had increased to 140 by 1946. Organisational reorganisation also took place and new commercial and market research divisions were created to complement general management. This allowed SNCF to market new commercial services to railway clients. Several steps were taken to relieve the terminal delays that had become characteristic of the railways. These included the 'particular branching' of lines to provide doorstep service to major railway clients with financial support from SNCF. This single measure gave the railways a major advantage in the freight competition with roadways, since the heavy industriexs were not equipped with handling facilities for loading and unloading road vehicles. The branch lines on the SNCF system consequently grew steeply in number from 4300 in 1914 to 7700 in 1948.[53]

Besides marketing innovations, technological and organisational improvements were also needed that would increase the efficiency of freight flow through the SNCF network, since the success of the French roadways in wresting freight traffic away from the railways was based principally on the speed and efficiency of their services, with low detainment either of consignments or vehicles. In the case of the railways, considerably more time was being lost in the handling terminals and marshalling yards. The GV and PV channels into which freight movements had been categorised had by now metamorphosed into the *Régime Accéléré* (fast-track) and the *Régime Ordinaire* (slow-track). Of these, freight trains on the *Régime Accéléré* passed through special marshalling yards and were run on the trunk lines at accelerated speeds of upto 100kmph in order to provide fast freight services with guaranteed delivery times. In contrast, the *Régime Ordinaire* which preserved the traditional PV freight channel through slower sections of the SNCF network was proving inadequate in to the mounting challenge from roadfreight services, because of running inefficiency, slow speeds and irregular delivery times.[54]

To improve the attractiveness of PV services, land and warehousing was rented out to clients for private parcel terminals. Engineering innovations in braking and traction also increased the speeds of PV trains from 50kmph to 70-80kmph. An experimental PV subchannel had been offered to full-wagonload consignments since 1932, which guaranteed consignment delivery within a specified time. In 1933, a tariff in terms of wagon-km was introduced irrespective of the nature and weight of the freight transported, and provision was made so that the wagon could be hired by the client for a renewable period of three months. Thus since 1933 new methods were devised to counter balance the road competition. However the extra time spent in switching full wagons to other rakes in the marshalling yards made it difficult to maintain delivery schedules, and hence the channel was closed down by SNCF in 1939. Thus, while the fast-track freight services of the *Régime Accéléré* [RA] were unassailed in speed and efficiency by the roadways, the *Régime Ordinaire* [RO] was the main freight segment into which the roadways were able to make inroads. Hence a partial return was made in 1935 to the parcel system, under which fast parcels were attached to fast passenger trains.

Meanwhile, SNCF also tried to introduce an 'origin to consignee' approach, which provided home delivery to parcel consignments in order to match the door-to-door concepts behind the success of roadfreight services. Extending this approach, containerisation of piecemeal freight began from 1935, although the rate of growth was low till after WWII when a container company CNC was established as a separate commercial entity to attend to the needs of railway clients who booked full container space. Technological adaptation was also made within the SNCF wagonfleet, by introducing an increasing proportion of special wagons designed for meeting specialised transportation needs. These included tankwagons, flatwagons, hopper designs, sealed chemical carriers, shelved automobile transporters, etc. Consequently, the SNCF wagonfleet declined from around 528,000 wagons in 1930 to 187,000 wagons in 1970. Against this, the stock of special wagons increased from 33,000 to 70,000 over the same period. The adaptations made to the standard covered (canopied) wagons to meet client and handling needs, which included the addition of big door panels, moving roofs and so on, also showed a high rate of adaptive innovation by SNCF to either win back or retain the freight market. The pooled space on most of these special wagons was used as a group and marketed through subsidiary service companies.[55]

Thus the immediate impact of nationalisation on the French railways was largely positive. The injection of new capital support from the French Government enabled the technological renewal of railway assets and encouraged commercial and marketing innovations, which allowed SNCF to compete aggressively with the roadways by focusing on the natural strengths of railway transportation, namely volumes, economies of scale and advanced technological specialisation. The key to the success of this package after unification of the French railway network under the unified administration of SNCF lay in organisational innovations that allowed the state-owned network to introduce a commercial focus in its freight services, which had been lacking under the monopoly companies. Soon after the end of the decade, however, WWII broke out and the French railways went into another spell of uncertainty and wartime devastation during the foreign occupation.

2.3.4 Postwar Railway Reconstruction

In the aftermath of war devastation during the German Occupation of France over WWII, the overwhelming postwar priority was on national restoration using planning as a coordinating instrument. The Monnet Plan for postwar reconstruction of the French economy thus laid the foundation for concentrated flow of investment into key economic sectors for a period of three decades or the 'Trente Glorieuses' between 1945-1975 . While this scale of priorities included the French railways, 38 percent of initial railway investment between 1947-1950 went into the restoration of the SNCF network and only 8 percent into railway modernisation.[56] Only after the First Plan (1947-53) did planning emphasis shift towards intensive modernisation of SNCF. Particular thrust was thus laid uptil the end of the Fourth Plan (1962-65) on the electrification of major SNCF arteries;[57] in order to create the technological capability for cost-efficient haulage of heavier trainloads which ultimately made SNCF the cornerstone of the postwar recovery in France. With the heaviest flows of traffic being located between mines and industry, electrification of the major rail artery between Lorraine and the Nord in Northeast France was accorded highest priority and was completed within three years of its commencement in 1952. Electrification then swiftly extended to capillary lines linking the mines to the steelworks, with the result that steam traction had completely disappeared from the main line by 1957, and from the last industrial capillary in 1965. Later technological improvements in diesel technology then provoked a reappraisal of the comparative returns of diesel versus electric traction, since the lower initial unit-costs of the former held intrinsic advantages for railway axes with lighter traffic loads.[58]

In contrast to the other smaller Western European railways, special advantages accrued to SNCF from operating over a large national space of 547,030sq.km, and from the vast scale of postwar investments on railway electrification. These provided greater insulation to the French railways during the inevitable increases in railway costs following the Oil Shocks of the 1970s. Formation of the European Community [EC] on the other hand worked to the advantage of the roadways, because of incompatibilities between the French railway system and those of neighbouring countries in terms of spatial coverage, trainloads and average trainspeeds on long-lead freight traffic. Although the comparative disadvantages to the French railway operations have been made more severe by the persistence of organisational handicaps such as the technical and commercial 'border problems' which reflect pre-EC administrative hangovers, the SNCF eventually stands to gain from its vantaged location vis-a-vis the major Atlantic ports that form the hubs of the international transport and trading networks in Europe.

2.3.5 SNCF Tariff Reforms

Historically, the modern period of declining SNCF freight operations since the mid-1970s has been divided into two separate phases.[59] While the first phase of railway freight decline between the mid-1970s and the mid-1980s is thus attributed to *structural* change in the French economy with progressive decline in importance of the mining and heavy industrial sectors accompanying the rise of new locational patterns that reflected industrial diversification and dispersal, the second phase of decline since the mid-1980s is attributed to emergence of formidable freight competition from the French roadways following their liberalisation in 1985. The principal adaptations made by SNCF in response to these events were a shift from a historically-rooted structure of rigidly administered railway rates to a more market-responsive rate-structure, and a change in the balance between the various categories of rail-freight traffic in response to intermodal competition and structural change, which assumed the collective form of spatial polarisation of traffic and a slimming-down of the rest of the SNCF network.

The year 1974-75 marked a watershed in freight operations under SNCF, which had grown almost continuously in the past. The all-time freight peak that year was very soon followed by sharp traffic decline that set in from the subsequent year. The decline in the SNCF share of the freight-market over the period had till then been masked by the overall increase in the level of economic activity. The gains in market share made by roadfreight accompanied the increasing economic importance of commodity-freight with high value per unit weight and diffuse origins and destinations, to which the roadways were best adapted. However, the advent of economic recession in 1974 triggered a sharp decline in bulk-freight which had been the most profitable traffic segment for SNCF. Although railway freight movements had remained spatially concentrated till 1973, the freight-flows in 18 out of 27 mode-product groups were found to diffuse between 1971 and 1976. Diffusion in semi-finished products, in which SNCF specialised was still the least, although the tendency for these to diffuse was strong [60]

The response of SNCF to rising roadways competition was to accelerate tariff reform. To avoid abuse of transport monopoly and ensure market transparency, the French railway companies of the prenationalisation period had been compulsorily required to issue published schedules of rates that had been ratified by Government. Any change in railway tariffs had to be notified and approved by the Government. In a continuance of this practice, the *Cahier des Charges* adopted for SNCF at the time of nationalisation in 1937 had also required ministerial approval and publication of contracted rates. Till 1969, SNCF was thus required to submit its tariff-proposals for approval to the French Ministry of Transport.[61] Besides the published rates scheduled by distance for each commodity-group, numerous special tariffs existed for commodities like French coal, for which protection against foreign imports was deemed necessary.[62] Progressive reductions in freight tariffs were also offered by SNCF in the 1950s to mobilise heavier trainloads, with special terms being negotiable when private wagons and sidings were used.[63] Thus, special rates well below those published in the schedule could be negotiated with larger railway clients. The system of public notification of changes in the *Cahier des Charges* was thus seldom followed in practice, leading to about 900 secret contracts being in force in 1975 which represented 34 percent of railway freight-tonnages and 37 percent of gross SNCF freight receipts.[64]

The original structure of published SNCF rates schedules had been constantly afflicted by several inherited problems such as non-distinction between low and high cost routes during tariff-setting. Periodic reforms which sought to address this anomaly as part of an attempt to allow SNCF some flexibility in rate-setting, included the major initiative taken in 1962 of weighting charged distances to reflect actual costs of freight operations over specific track sections.[65] It is interesting to note that the factors entering the spatially-selective computation included the mode of traction (electric/diesel), the maximum trainload on the relevant track section under given traction, sectional profile, and transit speed. General tariff revision directed at raising overall rates on short-haul traffic while reducing those on traffic with very long leads also took place concurrently, along with narrowing of tariff differentials on various categories of traffic.[66] The impact of these tariff reforms was immediately felt by the roadways and waterways, which accused SNCF of undercutting them on key traffic routes. Regional protests in areas such as Brittany which were largely serviced by the so-called 'difficult' routes on which the new tariff mode would imply significantly increased freightage costs forced a selective retreat which reduced SNCF rates on goods considered essential to the regional economy, especially agricultural products. This in effect amounted to a regional transport subsidy, for which SNCF was duly compensated by government. The regional subsidy remained a bone of contention for a long time to follow, since the larger industrial enterprises in the region claimed that it offered SNCF an excuse for not extending special rates to them.[67] Later, the Gillaumat Committee also criticised the subsidy as "a flawed form of regional assistance",[68] and at the eventual behest of the EC, the subsidy was abolished in 1985.

However further reforms that had eased state control on SNCF in 1969 and had given it more authority in setting its own freight tariffs, had also increased its latitude vis-a-vis the roadways to reduce specific rates, with the provisions of ministerial discretion now applying only to cases where the proposed rates either appeared to abuse SNCF's market-dominant position, or conversely to be insufficient to cover marginal costs. Under the new dispensation, further retreats from the time-honoured practice of *ad valorem* freight pricing took place following tariff restructuring undertaken on the recommendations of specially-commissioned studies in 1974 and 1975. However, the government continued until 1979 to restrict general levels of tariff increases to limits set by its policies against inflation. Following the Gillaumat Report, this last vestige of state control was dismantled via the *Contrat d'Entreprise* of 1979 between the SNCF and the government which ended anti-inflationary capping, and invested SNCF with the twin freedoms of structuring its services in line with the evolving economy and determining its tariffs on competitive principles, the latter of which it promised to do by cautiously increasing average tariff levels and widening the lateral spread between commodity charges.[69]

Realignment of tariffs downwards along those offered by roadways was unavoidable in any case in the general recessionary climate where an excess supply of transportation services was chasing dwindling freight demand, particularly on transport axes where competition was fiercest, with inevitable consequences that were enveloped with controversy. For instance, the maintenance of tariff escalation on the transport of cereals to Belgium and the Netherlands at low levels of 8 percent to circumvent competition from roadways was perceived by animal feed manufacturers in Brittany who faced 23 percent tariff escalation to have led to the export of the raw materials of their industry.[70] Again imported iron ore was being carried by SNCF at kilometre-rates well below those being offered to French ore.[71] While in principle, all SNCF rates had to be pegged at floor-levels which would cover marginal costs, the policy required systematic information on costs in order to tag them to particular shipments, rendering the idea unworkable in practice. Instead, accord between French and German railways which simplified tariff setting on the new international Nord-Mediterannée so that quick comparisons of intermodal rates became feasible, brought in the flexibility to align tariffs with roadways on case to case basis. Over the postwar period therefore, the SNCF was compelled to adapt to economic situations in a manner that made it behave "more like an enterprise and less like an administration."[72]

2.3.6 Impact of Roadways Competition

Tight state control over the French roadways between the 1930s and the 1980s had imposed fixed licensing quotas and controlled freight tariffs on long-distance roadfreight haulage to protect the SNCF share in this segment. The road tariffs fixed through the *Tarification Routière Obligatoire* [TRO] system quoted maximum permissible rates for a given haul, allowing downward modification through negotiation between operators and clients. In 1979, it was estimated that considerable subcontracting was taking place in the roadfreight sector, since while the bigger roadways operators found it difficult to offer covert reductions on the minimum TRO tariff, the smaller firms could oblige. Consequently, it was surmised that at least half of all roadfreight movements were being contracted at minimum or below-minimum tariffs.[73] However, although the system of regulating the roadways through licensing had been criticised by the Gillaumat Committee in 1978, the French Ministry of Transport replaced roadways licences by authorisations only in 1985 and also cushioned existing licensed holders from the possible impact of competition by continuing indefinite licences until 1996. This action nevertheless led to rapid expansion in the number of roadways operators.

The particular criticism of TRO had been in respect of international routes, where pricing was unrestricted even though quotas applied. This had permitted Belgian and Dutch transporters to steal a march over the French road operators and had made foreign ports such as Antwerp far more competitive than the French ports.[74] Thus in 1987, TRO was replaced by a system of nominal rates on bulk and heavy goods which were indicative but not obligatory, and even these were annulled in 1989. Meanwhile, the significant fall in world diesel prices between 1985 and 1989 considerably lowered operating costs for the roadways sector, particularly for heavier vehicles and long-lead consignments. The atomistic character of private roadways enterprises led to a cascading impact on subcontracting and leasing, bringing roadfreight tariffs down by over 7 percent between 1987 and 1989, against 3.6 percent rise in costs. Although the rate of financial failures was consequently high, the constant entry of new roadways firms helped to maintain subcontracting and low tariff conditions. Meanwhile the larger firms graduated into controlling roadfreight inventories, orders and flows where greater profits could be earned, leaving the actual task of freightage to subcontractors who had multiplied in number from 4,000 to 10,000 in the five years from 1986 to 1991.[75] Chronic overcapacity in the roadways sector created cutthroat tariffs for the road subcontractors, leading to the French truckers' strike of 1992 which ultimately forced the Government to intervene and to ensure observance of minimum health and safety norms by the private road subcontractors.

International road transport had also been regulated quite severely in the past by bilateral quota agreements between countries. This began to ease with the renegotiation of EEC-wide quotas as part of the policy of lifting quantitative restrictions between EEC member-countries, and with the growth of the contract hiring system that began in the late 1980s While by 1988, 10 percent of the heavy vehicles on French roads were estimated to belong to foreign operators, their share in tonne-km terms was estimated at 20 percent and at 25 percent for freight traffic on the motorways.[76] Since Belgian and Dutch roadways firms had lower operating costs on account of differences in fuel taxes and VAT, and the ready availability of turnaround freight, the French operators had to cut margins by 1989 in order to align with the competing tariffs. More recent changes induced by the coming together of the European Community include the issuance of *cabotage* licences since 1990 w59hich have enabled licensed operators to freely transport consignments within the EC-member states, and the eventual full liberalisation which was due for attainment by July 1998.

2.3.7 Reorganisation of Freight Operations

Although after the 1974 peak and subsequent slide, SNCF domestic freight recovered temporarily in 1979 and a roadfreight peak was also reached the following year, the railways, roadways and waterways all showed freight declines during the recession of 1981-82. Nevertheless, while roadfreight rose steadily thereafter until 1991, SNCF freight volumes fell steadily and its share in intermodal freight traffic began to decline from 1985. Because of their larger shares in international freight traffic, the roadways and waterways thus began to tower above SNCF in terms of combined intermodal share. While the decline in railway freight partially followed the decline induced by the Oil Shock in industrial sectors like steel, coal and coke, minerals and construction material where the railway presence had traditionally been high, it also reflected the productivity gains made by the roadways through the use of heavier and more fuel-efficient vehicles. This was strengthened by the falling prices of diesel during the late 1980s, which forced SNCF to forego tariff increases for two years between 1986 to 1988 in order to combat roadways competition induced by falling diesel prices.[77] The freight competition from roadways mostly came in high-valued short-lead segment. Average freight leads on SNCF thus increased from 281km to 363km between 1970 and 1991, with. 53 percent of railway freight in 1991 having distance leads of more than 300km against 37 percent in 1972. Absolute tonnages carried by SNCF also fell over all distance bands. Thus while long-lead freight tonnages fell from the peak of 97.1MT to 72.6MT, freight tonnages with leads of less than 50km fell from 48.6MT to 11.4MT between 1974 and 1991.

Two segments of SNCF freight operations had proved successful and relatively profitable over the period between 1970 and 1988. These comprised SNCF freight operations under the *Régime Accéléré* and the operation of freight traffic in full trainloads. While the first of these offered premium commercial freight services and thus realised high revenues per traffic unit, its profitability was based more on rates than on traffic volumes. The full trainload freight services catered exclusively to bulk-freight and SNCF's major users, and thus operated in a traffic segment where railways held a natural monopoly on account of their technological advantages By contrast, freight traffic under the *Régime Ordinaire*, comprising traffic-smalls such as single wagonloads which had to pass through the marshalling yards declined rapidly over the same period.[78]

2.3.7a The Régime Accélére

Freight in the *Régime Accélére* had higher revenue-elasticity over equivalent tonnages and distances than other SNCF freight because of its premium rates. As such, freight-flows on the *Régime Accélére* in 1977 amounted to 19.6 percent of SNCF's tonne-km traffic, but contributed 21.2 percent of SNCF's freight revenues. Its share in total freight traffic rose progressively to a peak share of 28.8 percent in freight tonne-km in 1986 and was still high when the system was discontinued in 1988.[79] The average freight lead on the *Régime Accélére* was also higher at 576km in 1988. Hence, while more than half of the freight tonne-km traffic was being hauled on private wagons on the *Régime Accélére* against less than a quarter on the *Régime Ordinaire*, the freight carried in tonnage terms accounted for a much smaller proportionate share of 17.6 percent in total SNCF tonnages.[80] The *Régime Accélére* combined two distinct freight segments. The first of these, namely the Special Organisation coordinated all point-to-point freight operations including the movement of containerised traffic under Combined Transport in block trains, and also the transportation of fruit and vegetables, automobiles and auto spares, and groupage. Another section within the *Régime Accélére* was responsible for coordinating all freight traffic including diffuse container traffic or Combined Transport which passed through the special *Régime Accélére* marshalling yards. In 1990, traffic leads under the Special Organisation were longest for perishable goods, while the lead for Combined Transport averaged 598km.[81] Although freight trains under the Special Organisation trains ran according to timetables and were routed directly, bypassing the normal marshalling yards, they generally carried lighter trainloads. The *Rapilège* which was introduced in 1977 ran trainloads of 500-600T.

SNCF's top-of-the-line *Fret Chrono* service commenced in 1987 and numbered 20 fast trains by 1989, which guaranteed delivery times and generally ran at night. Trainspeeds were gradually raised from the routine limit of 80-90kmph and *Fret Chrono* set a speed record of 160kmph on its regular overnight service which supplied perishables to Paris. Premium tariffs for *Fret Chrono* services were relatively high.[82] By 1988, 10 trains under the Special Organisation were running at 140kmph and another 100 at 120kmph. But in spite of such high physical speeds, consignment delivery by roadfreight was still deemed to be faster, because of the losses of time at train terminals.[83] Thus, while the share of freight traffic under the Special Organisation in traffic under the *Régime Accélére* rose considerably between 1981 and 1987, mainly because of the rise in the proportion of block trains and the haulage of automobiles and parts, significant decline occurred in the traffic in fruit and vegetables. Over the same period, the proportion of small and medium container traffic under diffuse Combined Transport which passed through special marshalling yards under the *Régime Accélére* declined by 16 percent. To combat this loss of traffic, SNCF began consolidating the loads of different shippers into regular *Traincharters* which ran from point to point between different zones. Fast international freight services were also pioneered in 1981 by TRES [*Train rapide èconomique et sûr*], which were controlled in France under the *Régime Accélére*, and catered to freight originating in the Trieste-Venice-Ancona region of Italy and transiting via Verona and Bologna. The reverse flow of French exports to Italy however faced more difficulties because of the higher freight volume involved, and because of delays at the frontier yards caused by the shortage of freighting capacity on Italian Railways which had led to a quota system in 1974. Through the latter half of the 1980s, guaranteed delivery times and international through rates were also offered by SNCF on new block trains that provided point-to-point linkage between specified zones in partner countries like Belgium and Germany. This was aimed at drawing new freight flows onto the French network. Nevertheless, in 1984, *Rapilège* services carried only 2.1MT of freight, while TRES and other fast international services accounted for a mere 4 percent of the international freight traffic of which only a minor portion was genuinely new to the railways. Official reports thus noted the negative economic impact of these services on SNCF arising from the high volume of capital investment on specialised wagons, which also resulted in increased running of empty wagon kilometres on the turnaround journeys,[84] and it was decided to do away with the *Régime Accélére*. SNCF's Special Organisation was left as a sectional unit when the *Régime Accélére* was abolished in 1984, while its other remnants including its two special marshalling yards were merged into the *Régime Ordinaire*.[85]

While laying stress on speed as one of the aspects of high-quality freight services, the SNCF Contract Plan for 1990-94 thus also sought to streamline single wagonload operations so that 300 principal freight stations from the 1200 that would remain at the end of the Plan would offer fast-track transportation under the *Fretexpress* service which bypassed the intermediate marshalling yards. In addition, guaranteed delivery times and assured frequency were to be offered under contractual terms to the clientele of full trainload services, extending the old SNCF policy of offering special marshalling and distribution terms to its historical clients, such as the steelworks. More customers would be offered special tailormade contracts, which would also holistically embrace stocking, packaging and accounting as additional value-added services. This was expected to help the railways to recapture a larger market-share of the traffic in high-rated low-bulk freight, which depended on the minimisation of freighting delays. SNCF was expected to gain substantially from computerisation of services under ETNA and the *EDI-Fret* [EDI=Electronic Data Interchange] service that had been created for full trainload traffic in 1990 and had been extended to *Fret Chrono* trains in 1991. These systems were expected to provide prime SNCF customers with real time information about the precise position of their freight shipments.

2.3.7b Full Trainload Traffic

The Gillaumat Report had envisaged in 1978 that the path to increased profitability for SNCF lay in widening the field of application for full trainload techniques of stock control and distribution management. It has been in the full trainload segment of consolidated freight that SNCF has achieved lowest operating and infrastructural costs and highest productivity, and can offer the most competition to other transportation modes. Full trainload traffic on the SNCF reached peak levels of 27 billion NTKm in 1974 and 1980 and stood at 24.42 billion NTKm in 1991. In proportion to total tonne-km traffic, the share of freight traffic in full trainloads rose steadily from 32.5 percent in 1970 to a peak of 49.4 percent in 1991, providing a stable base for French railway freight operations. By the 1980s, full trainloads were routinely of 1300MT, rising to more than 2000MT on better track.[86] Full trainload traffic however tended to have a shorter lead compared to traffic under the *Régime Accélére*, even though average leads had shown an increasing trend rising from 216km in 1977 to 302km in 1988, Full trainload traffic tended to originate and terminate at the private sidings of SNCF's major clients and thus involved the largest use of private wagons.

2.3.7c The Régime Ordinaire

The *Régime Ordinaire* has however continued to pose a major problem for SNCF, with the greatest loss of market share occurring in this segment. Freight operations under the *Régime Ordinaire* involve the coordination of small freight shipments in single wagonloads that have to be assembled and dispersed through the marshalling yards. This remains a problem because of marshalling delays that raise wagon turnaround times. While small freight services had historically played an important role in allowing rural industry direct access to rail freight services from nearby terminals, they have traditionally been loss-making both in terms of lost revenues and in terms of lost time. SNCF traffic volumes in this segment have thus shown continuous declines in recent decades, thereby also raising operating costs as a result of underutilisation of marshalling yards, terminal facilities, and certain sectional routes. Precisely for such reasons, road freight proves more economical for spatially diffused traffic.[87] The Gillaumat Report had identified the principal commodities passing through French marshalling yards in single wagonload consignments as including food products and other merchandise, motor vehicles, chemicals and finished steel, of which the first category had especially been showing fast decline. To restore competitiveness to SNCF, the Report suggested formation of a core network which would still be able to cater to the major part of traffic by selective shedding of uneconomic nodes. The Report's calculations envisaged a trimming down of SNCF's freight nodes from 4253 terminals down to 1649 terminals would form a core network which would cater to 93.3 percent of the net tonne-km traffic under the *Régime Accélére* traffic and 82.8 percent of the traffic under the *Régime Ordinaire* traffic, while still carrying all full trainload traffic and providing all mainline passenger services. The 2603 SNCF terminals which would have to be closed were to include 2020 terminals that were generating less than 30MT of freight per year *i.e.* less than 100T per working day.[88]

To achieve the purposes envisaged by the Gillaumat Report, SNCF set up a series of *Gares Multifonctions* [GMF] terminals comprising relatively central freight stations which would follow a 24-hour work schedule and would organise zonal collection and delivery of single wagonload consignments, availing both rail and road facilities as needed, and offering stocking, handling and other "logistical" facilities on contract to individual clients, instead of despatching trains no matter what the level of demand. Each of the 25 SNCF regions set up its own GMF and 578 were already functioning by 1987. However, the overall set of recommendations made in this respect by the Report were not fully implemented, as a result of which around 4000 separate terminals still existed on the SNCF network in 1986 and the new GMFs were still largely being served by rail. Several functioning sectional routes were still generating traffic of less than 100MT per day which did not cover their operating costs.

The studies that followed the Gillaumat Report had realised that a policy of cutbacks in freight tariffs to increase market shares and traffic volume would eventually raise SNCF's operational deficits on account of such lines where marginal costs were not covered. Nearly four-fifths of SNCF's losses on railway freight operations were attributed to inefficiencies in the coordination of single wagonload services under the *Régime Ordinaire*.[89] Accordingly, more stress was laid on improving SNCF's freight organisation.

Between 1987 and 1989, SNCF implemented the ETNA [*Etude Technologique pour un Nouvel Acheminement*] scheme for computerising the movement of single-wagon freight traffic through the marshalling yards. The introduction of ETNA coincided with the abolition of the *Régime Accélére* and *Régime Ordinaire* which had been used for prioritising SNCF freight since 1946. In replacement, a dedicated computer network was established around a central server located at Lyon and 30 local terminals at each of SNCF's marshalling yards. ETNA was designed to keep individual track of the movement of each wagon, whose progress through the marshalling yard would depend on the priority attached to it. Three priority levels were now recognised for freight traffic passing through marshalling yards. The fastest of these SNCF services was the premium *Fretexpress* which was to offer guaranteed delivery of the freight consignment within 48 hours or less. The delivery time offered by the slower and more moderately priced *Fretrapide* service was to be 72 hours or less, while delivery by the slowest *Fretecho* service would require 7 days. Among these schemes, SNCF was most optimistic that the *Fretecho* scheme in particular would raise traffic volumes by undercutting intermodal rate competitions, although critics pointed out that *Fretecho* would only the attract lowest-rated traffic, and that the underutilisation of SNCF installations as a result of decline in traffic and the rising costs at the marshalling yards would nullify the productivity gains from ETNA.

The extent of traffic decline in SNCF's freight operations is reflected by the fall in the number of loaded wagons handled by the marshalling yards from 12.4 million in 1964 to 3.4 million in 1984. Hence in its plan for 1990-94, SNCF sought to trim down single-wagonload freight through drastic thinning of terminal facilities. Although 3500 freight stations existed in 1990, 92 percent of freight passed through only 800 of them. By the end of 1991 they had been cut back to 2500 and further reductions were contemplated to bring them down to 1200 by 1994., concurrently with closure of 2200 private sidings from the total 7900 that existed in 1991. Over a long time previously, the number of such sidings had in fact gradually declined although in terms of traffic volume handled they remained more important than freight stations. The Bourdillon Report submitted in 1991 partially reversed the assessment by arguing that instead of abandoning single wagonload traffic altogether, it could be restructured to cover sections which assured daily absorption of a minimum 70 percent of freightage capacity and easy marshalling of wagons, thus maintaining the competitiveness of rail freight, so that its share in total rail freight might eventually stabilise at 25 percent of traffic.

2.3.7d Intermodal Transportation

Intermodal transportation involving the combined use of railways and roadways had earlier constituted the Combined Transport segment under the *Régime Accélére.* This SNCF freight service comprising the rail transport of lorries, their containers, or their loading units, has grown appreciably, to recent levels of 7.74 billion tonne-km with a share of 15 percent in total SNCF freight traffic. Carriage of this growing traffic has required special technological adaptation by SNCF because of the nature of the loading units. Loading units of the semitrailer type with vertical or horizontal loading are carried along with their road axles on special pocket wagons. Loading units with swap bodies and vertical loading which do not require the transportation of their road axles are better adapted to carriage on pallet wagons. The swap body has been increasing in popularity and includes isothermal units for carrying perishables controlled through *Chronofroid*, and liquid tank variants for chemicals and so on which are controlled through *TransEurochem*.[90]

Transport of semitrailers and swap bodies in most of Europe is a joint operation between railways and roadways. The operator in France is *Novatrans*, in which roadways hold 60 percent shares, while SNCF with 40 percent shares has only a basic haulage role, with no powers of control. Novatrans had 22 transfer terminals by 1990 which included 4 in the Paris region and owned 700 of the 1600 trucks at its disposal, as well as the transfer equipment at the terminals.[91] Domestic container traffic was controlled by *Compagnie Nationale des Cadres* [CNC], wholly owned by SNCF, which also controlled swap body traffic whenever the intermodal transfer unit was handed to the railways by the client under direct contractual terms. The importance of piggyback and container traffic as an area of new growth in railway freight holding vital importance towards the future of SNCF had been realised way back in 1986, when the operation itself was barely profitable.[92] Part of its potential arose from concerns about the environment, which viewed railways as a clean means of transport. The Bourdillon Report had devoted special study to its potential and towards the identification of road freight-flows with leads of over 500km that were being carried on heavy road vehicles and could eventually be converted to Combined Transport. Hence the SNCF Contract Plan for 1990-94 proposed an investment of 1 billion francs towards raising its share in SNCF freight to 25 percent by 1994 The Bourdillon Report concluded subsequently that the investment for the development of Combined Transport under the Contract Plan was grossly inadequate. The Report therefore advocated an expansion in state support to SNCF, including financial support for infrastructural investment in the construction or upgradation of lines and transfer terminals.[93]

B Other Asian Railways

2.4 Railways in Japan

Construction of the Japanese railway lines formed an integral part of the concerted thrust towards industrialisation witnessed by the Japanese economy during the Meiji restoration. [1867-1912] The railway boom which took off from the late 1880s culminated in the peak years just following the Sino-Japanese war of 1894-95, during a period also characterised by significant growth in capitalism in Japan and the remarkable progress of light industries such as textiles. Extending this process, manufacturing industry in Japan's erstwhile rural districts also displayed significant downstream growth, as the market expansion required as a direct consequence to high economic growth rates over the period made it imperative to provide fast transportation interlinkages between the rural districts and Tokyo and also between the districts.[94] The large-scale promotion of private railway companies in Japan witnessed between the 1880s and 1890s thus reveals that railway development in Japan proceeded in response to, rather than as a precursor of, the growth of the domestic market.

The first Japanese railways had already commenced operations in 1872 when transportation services were launched between Shimbashi and Yokohama.[95] The early railway ventures made entirely in the government sector had operated 984km of routes, but the eager entry of private railway companies into the fray during the railway boom some fifteen years later quickly expanded the route network to 2124 km by 1892.[96] Yet even though private lines thus had much greater presence in terms of route kilometerage, nationalisation of Japanese railways excluding select urban lines was resorted to as early as 1906, and the nationalised railway system thus commenced operations with a route network of 7,153km, of which only 2562km had been directly developed by government. A phase of rapid railway construction immediately followed nationalisation and the network had expanded to 9991km by 1919 and to 15,000km by 1931. By the end of WWII the nationalised railways in Japan operated over 20,056 route-km, substantially exceeding the 5543km of routes still under private operation. The Japanese National Railways [JNR] were subsequently incorporated in 1949 to take over the management of the nationalised railways while capital investment continued to be sourced from government, but from that time till 1981, JNR was only able to extend route kilometerage marginally to 21,419km.[97]

2.4.1 Investment by JNR and JR

With limited capacities of land transportation attributable to the size and topology of the country and the consequences of war devastation, it was necessary for Japan to first recover rail and shipping capacities and gradually develop road and air capacities. With high economic growth between mid-1950s and late 1960s, demand for transportation increased commensurately. Increased operating revenue encouraged investments from JNR to strengthen capacities, which in turn furthered demand and for 7 years from 1957 to 1963 there existed a balance between income and expenditure. This favourable cycle soon shifted to road transportation after the 1960s and the equilibrium could not be sustained because of indiscriminate investment in the near future without commensurate increase in train fares. Pressure from government to maintain low fares and the continued demand from the public to invest in new tracks in areas where there were existing tracks and expressways to meet the transport demand, led to the non-viability of many investment projects and the surrender of financial independence on the part of the JNR. During the 1960s JNR was subjected to sharp increase in investment liability and interest payments. Its long-term fiscal debt rose in proportion from 89 percent of its operating revenues in 1960 to 227 percent in 1970 and 486 percent by 1980. The associated interest outgo over the same period increased from 5.9 percent of operating revenues to 13.3 percent in 1970 and 24.9 percent in 1980.

The toll of increased liability without any capital forthcoming, was very heavy. By 1960s the JNR had lost its capability to finance its own investments. At this stage adequate subsidy for serious investment could have saved the JNR. Continued investment to meet the overestimated demand on the part of the Government made things worse. If demand had risen as estimated then the operating revenues could partially offset the fiscal deficit. Freight transportation had lost to competition from trucks by 1966. However after reaching its peak in 1970 freight transportation had declined. JNR failed to switch to new directions for survival and continued to invest inspite of falling demand and the gap between JNR and road transportation continued to widen.

2.4.2 The JNR Crisis and Railway Reforms

Till WWII, the railways in Japan held the helm in surface transportation, and also appear to have been in good financial condition since no tariff revisions were made between 1920 and 1940. Although WWII radically altered this position, JNR managed to ride the storm of financial crises during postwar reconstruction and inflation by resorting to increases in railway rates in order to maintain financial and operational stability. But with the advent of the Japanese automobile industry in 1955, JNR traffic had begun to suffer from the inroads of the growing roadways. Consequently, the financial position of JNR also began to deteriorate from the loss of the railway monopoly over surface transportation. By 1964, JNR was operating at a deficit, even though it had just launched highly profitable passenger operations on the newly commenced ultra-fast Tokaido Shinkansen 'Bullet Train' service. The deficits rose sharply in the subsequent years to a point where the accumulated profit balances of past years had been liquidated by JNR's effort to contain the growing shortfalls in its revenue. The government effort at restoring JNR to its prior profitable position by allowing periodic tariff escalation proved counterproductive, since this increased the loss of traffic to the railways. Although as many as 13 tariff hikes were administered between 11974 and 1986, they failed to salvage the situation, and JNR sank deeper and deeper into financial distress. The annual operating losses also rose sharply and reached 15,500 billion yen in 1986, just prior to the privatisation of JNR.[98] The annuallly repeated fare-hikes on the JNR since 1974, and the recurrence of strikes accompanied by allegations of arrogance among JNR workers had previously led to a sharp exodus of passengers. As result, railway productivity in terms of passenger-km in 1986 was only 94 percent of the 1974 level.[99]

Coalesced within the financial and coordination failures that had confronted JNR was Japan's own critical situation following two consecutive Oil Shocks in the 1970s. The Second Ad Hoc Commission on Administrative Reform was therefore constituted in 1981] to improve conditions within the Japanese economy through the instrument of financial reforms.[100] The Report of the Commission held strongly to the view that financial and operational efficiency within the Japanese railway system was crucial to the economic health of Japanese trade and industry, and consequently proposed the privatisation of JNR . The Commission also held that since Japan's limited territorial area vis-a-vis settlement was manifested in transportation terms by intrinsically high densities of traffic, railway operations could be restored to profit through appropriate and purposeful reforms. Past JNR management policies were criticised in this regard for having misplaced their emphasis, since instead of restructuring JNR's traffic operations, these had been extended to the point where they became too unwieldy to be handled efficiently, under social compulsions that had committed JNR as a public corporation to the maintenance of uniform nationwide services. The Commission noted that the recurrent tendency in public corporations to fall back on government during times of crisis would in any case have proved such operational restructuring redundant. Observations of such nature led the Commission to recommend the rather drastic reform step of privatising JNR and breaking it up into 7 separate railway companies out of which only one would be catering to freight operations, in the belief that the return to private management would resuscitate the Japanese railways and restore their profitability. With the passing of related legislation in 1986 by the Japanese Diet, the JNR were reborn as the privatised Japanese Railways [JR] in April 1987.[101]

2.4.3 Causes of the JNR Crisis

Investment in transportation facilities often commences on identified high-demand segments to correct perceived shortages in capacity. The massive scale that railway infrastructural investments assume however brings about sharp and immediate upward swings in costs against slow rise of revenues. Thus in its initial operational stages, new railway enterprise can conceivably incur large losses which may nevertheless be offset by enhancing revenue realisation from the more profitable lines. However if in spite of the circumstances, the enterprise is compelled by national policies on price control to adhere to constant tariffs even in face of mounting losses, its efficiency is affected at both operational and organisational levels. Overestimation of traffic demands or underestimation of construction costs while investing in the creation of transportation facilities often leads transport undertakings into serious financial difficulties. When the investments made originate with government, the incidence of on-account financial burdens may ultimately shift to taxpayers.

The Japanese railway investment crisis was exacerbated by convergence of several subsidiary factors. Completion of the Shinkansen extension coincided with simultaneous growth of automobile ownership and air networks. Although traffic demand had been projected to rise commensurately in continuation of the high growth manifested over the 1960s, these expectations were falsified in the 1970s when there was a general shift from high to low economic growth rates, aggravated by the Oil Shock of October 1973, both contributing to the slowdown of traffic on all modes of transportation. Scarcity of land and building space in Japan's densely-populated larger cities also prevented the building of efficient service facilities along newly-laid railway tracks.[102] Consequently the deficits that the Japanese railways had already incurred on account of the large capital injection into the Shinkansen extension registered continuous increase, which the railways were unable to compensate by timely revision of tariffs.

It is not as if deficits that originated in the creation of excess transportation capacity compounded by the effects of general economic slack were not felt by the other transportation sectors. The new toll system introduced in 1972 to finance highway development, whereby profits from the Tokyo-Osaka Expressway were invested on the enterprise of extending the expressway, was also afflicted by high construction costs and low realisation of traffic demand. This reduced the room for independent manoeuvre on the part of the expressway vis-a-vis terms of financing, expenditure and income, in a process similar to that encountered by JNR. However as the oldest of Japan's transportation service providers and because of its investments in other non-profitable sections that were made under political pressure, the Japanese National Railways suffered the largest revenue shortfalls among transport undertakings. The impossibility of sustaining this deficit position contributed eventually to the privatisation of Japanese railways in 1987, after nearly eighty years of operations as a public undertaking.[103]

The railways in Japan had operated in the government sector since their nationalisation in 1907. The partial privatisation of Japanese railways that occurred in March 1987 dates to losses earlier incurred by the Japanese National Railways on the huge investments made in extending the Tokaido Shinkansen high-speed railway line beyond the lucrative Tokyo-Osaka section. By 1975, the railways were already in deep financial trouble because the levels of such investment proved to be unwarranted by the level of traffic demand.[104] Their predicament was rendered more severe by their inability to enhance tariffs to finance the investments, because of the exigencies of the national regime of price control. Thus the Japanese example and its aftermath of growing railway privatisation reveals how political expedients that underlie policies of price control can often work to the detriment of transport networks.

2.4.4 Transport Pricing on Japanese Railways

The fundamental operating principle for railway operations in Japan since their commencement had been pricing of the transport service at full user-cost. However, in all transportation sectors, a gestation lag is known to operate between inception of traffic service and attainment of break-even levels by passenger and freight traffic. Hence mechanisms must be devised for sharing the costs of development of new services, especially when extensions are demanded on the low-profit sections of the transportation network. These usually assume the form of subsidies that cover a part of capital-related construction costs, the burden of such subsidies eventually being borne by the taxpayer. To mitigate competition from roadways on traffic sections where competition is likely to occur, operating costs may also be lowered artificially by means of additional cost subsidies, the incidence of which is also liable to fall on the taxpayer. Certain differences exist between the modes of accounting for development and operational costs of road versus rail transport, and while the *investment* head under roadways includes all categories of construction, maintenance and improvement costs, *investment* on railways only includes the capital costs of construction, while maintenance costs are separately accounted for under the head of *operating costs*. Thus the only items in railway expenditure that carry reflections of the investment outlays on the development of railways are depreciation provisions and the funds set aside for meeting dividend and interest obligations arising out of railway equity and debt. During the earlier era of the JNR, railway costs were classified as *operating costs*, which included staff, energy and material costs, and *capital-related costs*. The concept of dividend therefore did not exist, since interest payments were included within operating costs while the capital provisions for meeting interest and depreciation obligations qualified collectively as capital-related costs. Only since privatisation has interest been deemed non-operating expenditure by the Japan Railways.[105]

Besides providing passenger services in the larger cities on the Shinkansen lines as well as local railways, the Japanese railways also cater to the needs of long-distance and intercity passenger transportation, as well as freight transportation. Thus new railway projects can remain financially independent so long as construction is completed at minimum cost, and so long as the project will serve either one of these functions, which ensures there is traffic demand for its services. This conditionality becomes exceedingly difficult to adhere to with competition from other modes of transport. In the case of loss of financial independence from non-profitable lines, cost sharing by taxpayers is the ultimate resort.

Although there has been more reliance on railways for freight transportation rather than roadways to reduce pollution and energy cost, investment cost in this sector is still borne by the JNR/JR and not the taxpayers. This is primarily because the magnitude of freight transportation in Japan is limited by line capacity and loading gauge, and the pressure to bear the investment cost devolve son taxpayers. However, construction costs by and large were borne by JNR/JR or private companies since the pressure was mainly on the existing lines and substantial investment was therefore not required. Incremental investment was met by a moderate increase in fare.

2.4.5 Railway Privatisation & its Aftermath

The Japanese railways are not strictly comparable in situation to those in Europe because of the geographical conditions in an island country which compel dense populations to settle in districts surrounding large cities. The most prominent of these are Tokyo District with 30 million residents, Osaka District with 16 million residents and Nagoya District with 8 million residents, all concentrated in the northern part of the island of Honshu. Railway operations in Japan therefore impinge heavily on passenger services. A single privatised company, namely JR East, operated over 110 billion passenger-km over its 7,600 km route network in 1988, considerably more than passenger traffic handled in the same year by the German Deutsche Bahn and SNCF, and traffic density on JR East is six times higher than density on the combined DB and SNCF networks.[106] The main difference between passenger traffic in Europe and Japan, is that while in the former, passenger fares are individually borne by the railway commuters, in Japan such fares are borne by the employing companies. As a result, passenger fares in Japan can be pitched higher and in fact can almost cover railway costs. As such therefore, passenger-based railway services in Japan provide a much stabler revenue source than under other systems, without the burden of subsidised deficits that the latter face.

Although experiences associated with bad financial and operational decisions made by railway managements during the JNR era had initially created reservations among the railway workforce regarding the possible working of the new JR railway companies. A new edge was added to these by anxieties about the possible consequences of competition between the JR companies when profitability became their prime consideration. Under the terms of privatisation, while liabilities on account of debts outstanding and rehabilitation responsibilities for surplus personnel were to be shouldered by the JNR Settlement Corporation, the rest would have to be borne by the seven companies that comprised the reconstituted JR. Thus misgivings also existed among the workforce that the new companies might immediately resort to yet another fare hike to relieve the outstanding financial liabilities that had carried over from the erstwhile JNR.[107]

Inspite of such apprehensions, the financial results from railway operations that immediately followed privatisation proved favourable to the new JR companies, mainly because of substantial reduction in debt liabilities by 268.2 billion yen in 1987 and 357.9 billion yen in 1988. The interest rates chargeable on debts outstanding were also lowered from the 7.13 percent level that had prevailed in 1987 to 6.89 percent in 1988 and to 6.47 percent in 1989.[108] The financial stimulus from these events was supplemented by improved traffic handling. This was achieved through overall productivity increases in terms of train-km and passenger-km per railway employee, without a corresponding augmentation in workforce numbers. Another factor that is deemed to have supported favourable operational trends under the reconstituted JR was the change in personnel attitudes that had occurred after privatisation.[109] Although JR operations had commenced amidst general misgivings among the workforce since the government would no longer be there to stand surety for the railway employees, the resurgence of their will to rebuild railways in Japan into a profitable enterprise soon overcame such anxieties. Decentralisation of railway activities also contributed substantially to streamlining the operations of the new railway companies. Instead of the centrally-controlled operation that had existed on the JNR, the 'frontline-first' principle adopted by the privatised companies was more appropriate to the worksite character of railway business, since it allowed railway workers to play a direct decision-making role. As a result, the trade union relationship between the railway workers and private managements also stabilised because of their mutual consensus over the necessity of raising JR's profitability and avoiding discord. The return of economic buoyancy to Japan after 1987 created a positive environment for improved railway performance because of the increase in business-related traffic demand. Commuter traffic trends, particularly towards Tokyo, showed a continuous increase which resulted partially from the soaring land-prices in that city which were compelling increasing numbers of people to reside in distant suburbs.

Since the true yardstick of the successful privatisation is the ability of the privatised railway company to pay a stable dividend without recourse to fare increases, this requires a reduction in the ratio of personnel costs to revenue, so that salary revisions do not introduce a strong cost-push factor. In its heyday in 1974, the JNR had an personnel-revenue ratio of 86 percent which had declined marginally to 63 percent in 1986. Privatisation of JNR however brought about an immediate decline in the ratio to 28 percent in 1988, considerably raising labour productivity. The eventual target is to reduce personnel from the present 68000 employees through introduction of high technology and computerisation, so that the personnel cost ratio stabilises at 20 percent.[110]

Like railway companies elsewhere, JNR held substantial land-assets at the time of privatisation. However, such assets not directly bring used in the railways, such as commercial lands suitable for housing, office blocks, and so on were transferred to the JNR Settlement Corporation rather than to the new railway companies. Although the prospects of commercial development of railway landed property are therefore limited to station and right-of-way lands, soaring land-prices in recent years render such development profitable and will expand railways. Another area of commercial advantage is the development of subsidiary business by the railway companies, particularly since surplus personnel can be reallocated to these. Again however, such business has to evolve around the concept of optimising the use of railway lands, since expansions in routes and services can hardly be expected to continue indefinitely. Although at present the ratio of traffic-to-other business on the Japanese railways is largely weighted towards the former, the new privatised companies anticipate a reversal of the ratio by the 21st century.

2.5 The China Railways

The first railway in China was the Shonghu line which was laid in Shanghai in 1874.[111] However the 16km light railway which ran from Shanghai to Wusong had been built without authorisation by British merchants. Hence it was demolished on orders of from the Chinese government soon after it was opened in July 1877. Through the early phase of the Railway Age, the Chinese government continued to resist the building of railways financed by foreign capital because they were averse to the entry of more foreigners into China. Although an abortive attempt was made in 1889 to build the Beijing-Hankou line using Chinese capital, it proved almost impossible to mobilise the sums required. Meanwhile a 10km mule-drawn line had been laid in 1880 by an English engineer C.W.Kinder at the Kaiping coalmines in Tangshan, on which steam traction was placed shortly after it was opened. This line was later to form the first stage of the Beijing-Shenyang line. After extension of the line was authorised, it reached Tianjin in 1894. In 1890 the Hanyang Iron Works had been built, which laid the foundation for the industrialisation of China. Thus by the end of the 1890s the Western powers had gained ascendancy over the Imperial Qing (Manchu) Court and compelled it into granting them concessions for the building of China's first major railways, which were to be financed by foreign capital. The three new lines to be authorised were the Beijing-Hankou and Kaifeng-Luoyang lines which were to be built by a Franco-Belgian consortium, the Tianjin-Pukou line which was to be built by an

Anglo-German consortium. The Beijing -Shenyang line was to be completed by British capital. Extensive Russian lines were also being laid at the time, including the Trans-Siberian line from Vladivostok, which touched Harbin in Manchuria, north of Beijing.[112]

Despite this early construction, the pace of railway development in China was much slower than elsewhere in the world. It was only after the Republican Revolution of 1911 had deposed the Imperial Qing and the foundation of the Chinese Republic had been laid that railway development started receiving serious attention. After taking over as the Director-General of the National Railways, the father of the Chinese Revolution Dr.Sun Zhongsan [Sun Yat Sen] forecast that China would need 160,000km of railways by the middle of the 20th century. Nevertheless, between 1874 when China's first railway had been built at Shanghai, and 1949 when the Proletarian Revolution led to the establishment of the People's Republic of China, only 21,800km of railway track had been laid.[113] Vast areas of China were still without railways, since the existing railway system was almost entirely in eastern China. Of the two main lines, the first stretched northward over a route of 2313km from Guangzhou (Canton) to Beijing, and then onwards to Shenyang and Manchuria. Another main line stretched southward over a route of 1462km from Beijing to Shanghai until it linked with the Guangzhou route. China's other railway routes that headed westwards soon had to cross hilly terrain.

2.5.1 Railways after the Revolution

After the Proletarian Revolution, Chairman Mao Zedong had targeted the country's need for railways at 200,000km. After 1949, railway construction was accelerated and track increased by 187 percent to reach a total of 62,615km in 1995, 54,616km of this track being laid directly by China Railways [CR], another 2965km by CR joint ventures, and 5034km by China's regional railways. China's rail network included around 17,000km of double-tracked lines and 9700km of electrified track, with diesel-powered trains servicing another 24,749 km.[114]

Freight handling by railways in 1995 totalled 1.59 billion tonnes of originating freight and 1283 billion tonne-km, or around 40 percent of the intermodal freight kilometerage in the country. China Railways also catered to 45 percent of all passenger mileage.[115] However, although the railways have proved the mode of transport most suited to the spatial circumstances of China as a country with vast population spread across a vast geographical territory, and faced with uneven distribution of natural resources, the tremendous volume of passenger and freight that are generated in these circumstances continue to pressure the railways, as a result of which many trains run at near or over capacity.

Although the high rate of expansion of railways reflects the rapid growth of China's economy since 1949, railway development has lagged economic growth and a gap prevails between what the railways can deliver and the economy's unfulfilled needs. The present 60000 km might therefore be considered a major bottleneck that impedes economic development. It is estimated that only 30-50 percent of freightage demands are currently being met in the heavily-used railway sections of Jiaxing, Pingshi and Xujia districts. Thus the current extent of railway services meets around 50-70 percent of the railway freight demand for the country as a whole. There is therefore considerable need for further expansion of railways to narrow the gap. At the rapid pace that economic growth has now assumed in China, increase in traffic demand to 1.6 billion passengers and around 2 billion tonnes of originating freight by the year 2000 is not unreasonable. Commensurate growth of the railway network would imply the construction of between 80 to 90 thousand km of additional track, and increase in freight handling volumes at the rate of 8 percent p.a. just to satisfy the growing demand.

2.5.2 New System Needs

However due to constraints, most notably the lack of capital, railway development will not be able to match demand, and only 70,000 km of track will exist by the turn of the century, if present trends continue. Accordingly, the feasible annual rate of increase in freight handling would be 4 percent, and China's railways would only be able to service 1.5 billion passengers and 1.8 billion tonnes of freight in the year 2000. Thus contradiction between rail capacity and development is a problem needing equal redress in China as well.

The two-pronged strategy adopted by China Railways to meet ever growing demand involved continual improvement to the rail infrastructure, and construction of new lines. The technical improvements made, including electrification, double-tracking and conversion from steam to diesel or electric traction, were aimed at providing greater carrying capacity and faster transportation, and speeds of 160kmph on limited express trains, upgradation of the weight-capacity of specified tracks to carry 10,000T coal trains and in some cases also to handle 5000T freight loads on wagon-trains have since been attained.

Key railway construction projects undertaken since 1949 reflect the priorities of China's geographical regions. The strongest railway presence is found for historical reasons in the northern and northeastern regions where most big cities are concentrated. However the fact that average railway penetration in the northwest exceeds that in eastern, south central and southwestern China is the result of specific policies adopted by the People's Republic. New railways built between the Fifties and the Seventies thus reflected national strategies of regional self-reliance, military preparedness, establishment of heavy industry and dispersal of economic development over all parts of the country, particularly western China. Around 156 major planning, building and renovation projects were undertaken in many cities, along with the construction of intercity lines. Over the Eighties, national policy emphases realigned towards regional transportation in order to foster balanced regional development and to increase the rate of urbanisation, both considered critical for development of the country as a whole. The Nineties have drawn attention to the transportation bottlenecks which affect the pace of economic development, leading to a strategy devised to ease corridor transportation of freight and fuel at greater efficiency and speed, particularly freightage of coal from the mining areas. New construction works undertaken along the North-South, South-West and North-East corridors include double-tracking, electrification and other improvements. It is estimated that 6000 km of new track will have been laid by the turn of the century, enabling the railway network to reach the targeted length of 70,000km. Containerisation of freight and launching of high-speed trains are other leading projects, for which import of heavy-duty diesel and electric locomotives has been allowed from the US, France and other advanced countries. Comparative studies are also being conducted on the high-speed technologies of Japan, France, Germany Sweden, in anticipation of the proposed high-speed rail link between Beijing to Shanghai.[116]

2.5.3 Financing the New Railways

Most of the capital invested in building China's new railways after 1949 was drawn from the State budget. In 1985, the government began substituting the internal allocations with loans, and a new reform instituted in 1988, a new reform introduced special levies and other forms of development funding. From 1 March 1991, China Railways were allowed to charge freight fees of 0.002 yuan per tonne-km which was gradually increased to 0.028 yuan by 1 April 1996. In view of the expected growth of freightage capacity and traffic, the measure was anticipated to yield 60 billion yuan between 1996 and 2005.

To reach desired track-length of 70,000 km, 7400 km of new track would have to be laid. The financial requirement for this, along with the maintenance and upgradation of existing railway stock, would be 30 billion yuan p.a. between 1996 and 2001. However, the total cumulated borrowing by China's railways from domestic and international lenders also stood at around 30 billion yuan, and was growing at the rate of 3 billion yuan p.a., and between 1990 and 1995, only 10 billion yuan had been repaid as interest and principal. To overcome the standing crisis which threatened railway development, the Chinese Railway Ministry had entered into joint railway investment ventures with the national and regional governments since October 1981, and studies indicate that some 5000 km have been laid under this program, with cumulative investment of 15 billion yuan. The level of success achieved by this financing scheme offers model solutions to the difficult development situation faced by most world railways and might therefore be upheld as a paradigm for railway finance.

Since 1980, China Railways also began to enlist foreign capital for its projects, earmarking them mainly towards construction of new trunk lines and purchases of rolling stock and upgraded equipment, reflecting the new post-liberalisation strategy of technological modernisation. The inflow of foreign capital on this account was 3 billion USD between 1980 and 1990. To raise further finances, approval was also accorded to railway bond issues for 10 billion yuan by the Chinese Railway Ministry. Railway projects currently underway in China involve total onstream investments of 95 billion yuan.[117] The principal means adopted for raising this finance involve attracting domestic and foreign capital into railway development, attracting equity through promotional stock issues with market borrowing as a secondary credit source, encouragement of joint stock and other forms of stock holding as prevalent modes for reorganising new railway enterprise, and the laying by of a certain amount of railway funds for investment in business diversification and other related projects.

The amount of development funding required by China Railways at the turn of the 21st century is estimated to be huge. Of this, 77 billion yuan would be generated through internal resource mobilisation, with an expected realisation of 60 billion yuan from freight and 17 billion yuan from special imposts on fast-transit traffic at rates of 1 yuan per passenger, and 1 yuan per freight-tonne. Budgetary support of 4 billion yuan would also be forthcoming for construction and development of the high-speed lines. Domestic debt instruments would raise another 15 billion yuan through loans sourced from the Chinese National Development Bank and the issuance of High-speed Railway Construction Bonds. Externally-sourced funding comprising both debt and equity instruments is also anticipated. 400 million USD is expected to flow in from international loans and 555 million USD from the global issue of development bonds in the name of the People's Republic by the Chinese Finance Ministry. Equity issues on the Hong Kong and New York stock markets would bring in 500 million USD.[118] To this would be added an unspecified amount raised through leasings of rolling stock.

C The Indian Railways

2.6 The Mercantile Prelude

The Commercial Revolution which had defeudalised Britain and Europe over the 15th and 16th centuries laid the foundation for eventual industrialisation of the West. Among the principal flag-bearers of the mercantile age following the liberation of commercial enterprise was the East India Company [EIC] whose original charter had been granted by Elizabeth I in 1600 in order to break Dutch domination of the spice trade with the East Indies. Before the eclipse of that bid with the massacre of English traders in Indonesia by the Dutch in 1623, the EIC had already established a foothold for trade at Surat in Western India, from which it expanded its foray into India by founding another trading post in Madras in 1640. The new charter granting monopoly to the EIC in 1657 and renewable every 20 years redirected its operation towards India while increasing the Company's extra-commercial powers by assigning it rights of striking its own coinage, of exercising temporal jurisdiction over British subjects at its trading posts and of waging war and peace with the non-Christian powers of the subcontinent. The old Portuguese trading post of Bombay, acquired in dower by Catherine of Braganza's marriage to Charles II, was handed over to the EIC in 1668, and Calcutta, which was to become the EIC's main seat of power, was founded during the eastward expansion of operations in 1690.

The advent of the EIC also marked the first entry of foreign capital into India, which on account of monopoly profits accruing to the Indian trade earned British investors a dividend that averaged 25 percent *p.a.* between 1660 to 1700. The rise of the EIC to temporal ascendancy over India commenced with the subjugation of Bengal in 1757 by Robert Clive, and acquisition of revenue rights from the Mughal court at Delhi. As the trading monopoly declined with the imposition of regulations on the Indian trade, the India Act of 1784 instituted a board of governors to administer the Company under the Governor-General. The tenure of Lord Cornwallis in this position between 1786-93, oversaw the transformation the EIC from a commercial enterprise to an instrument for the spread of British power in India through alliance of military expertise with rampant palace intrigues in the Indian princely states, and by outright annexation of those where the erstwhile rulers had died intestate. What had begun under Cornwallis grew to strength under Lord Dalhousie over the first half of the 19th century, as more and more of India came under the EIC's sway. The annexationist policy, while proving conducive to the construction of infrastructure such as roads, railways, bridges and irrigation works, and to establishment of posts and telegraph services, also saw most of the EIC's commercial revenue being consumed by the costs of warfare and governance. Long before its trading monopoly was broken in 1813 and then virtually abolished in 1833, the EIC's commercial privileges had been progressively eroded during each renewal of its charter, and as such its profits increasingly came from the China trade. In 1853, its administrative functions were also clipped by the introduction of examinations to the civil service in a move to improve governance and allay suspicions that had been aroused by reformist legislation on the abolition of *sati* and slavery and by the institution of modern education. But the resentments continued to linger and rose to head during the Indian uprising of 1857. The following year, after the uprising had been quelled, the EIC was dissolved, and India came under the direct rule of the British Crown.

A number of changes occurred in the economic complexion of the country during the period of rule by the

EIC. For the first 150 years, the main focus of the EIC had been on the expansion of monopoly trade in the traditional handicraft exports of India such as indigo, spices, silks and other textiles, which before the discovery of the sea route had been carried over the difficult overland route. But acquisition of temporal power by the EIC over the later period at the expense of the Indian native states ended the royal patronage which had hitherto supported the artisan structure of the country, thereby killing the proverbial goose that laid the golden egg. Efforts to revive local industry after the institution of governor-generalship inevitably failed on account of the simultaneous rise of manufacturing in Britain and the framing of protective tariffs, along with improvements in communications that reversed the prior flow of manufactures and developed India into a market for British goods. After the middle of the 19th century, this pattern became firmly institutionalised.

Over the two centuries of growing EIC ascendancy prior to the introduction of the Indian railways, mercantile commerce had relied extensively on the waterways since the roads were rudimentary. The EIC thus operated from the port-cities set up to service its trade. Although no major navigable canals had been constructed over the period, the rise of Calcutta as a mercantile port marks the importance of riverborne freight to the EIC. Calcutta, on the estuary of the Ganges, stood at the headworks of the major navigable river of the country, and served as the point of transhipment of freight traffic to and from river boats to coastal or international shipping vessels. But dearth of navigable channels in the rest of the country meant that pressures inevitably arose for construction of railways to link the different regions of India.

2.6.1 Early History of Railways

The building of railways in India marks one of the most fascinating eras in the economic history of the country. Introduction of railways had in fact been opposed by many in Britain, as well as by certain distinguished Indians, as a premature and expensive undertaking or else a hazardous and dangerous venture. But the saga of railway development over 150 years speaks for the ingenuity and dedication of the ordinary Indian people who provided the actual labour, although railway construction and operation was initially entrusted to British companies on liberal terms to the exclusion of local enterprise.[119]

Railway development in Britain had required little more than guidance from state and parliament. Railway enterprises had grown with remarkable alacrity, soon providing popular means of transport to citizens who adapted themselves to railway travel when it became the cheapest transportation mode benefiting from economies of scale. It was argued that in India the position would be entirely different, since while it was anticipated that goods freightage would come to occupy a sizeable share in the total anticipated traffic, nothing could be conjectured with confidence about passenger traffic.

The Commercial Revolution in England and later in France had commenced along the network of inland canals which was later supplemented by the expansion of railways. Prior to the construction of railways, transportation infrastructure in India too comprised trunk roads and inland waterways. However, the association between railway and waterway systems that subsequently emerged in this country differed from the experience of most others. In India, the two transportation modes did not merely serve as twin alternatives within a unitary or consolidated commercial transportation network, since hardly any canals existed in India that had been built for transportation purposes, and since inland water transportation was only available along larger rivers which remained either fully or partially navigable throughout the year. The logistic weaknesses of the Indian transportation system were revealed particularly by the 1857 Indian revolt, which almost had adverse military consequences on the colonial power. To consolidate their rule over the country, the British therefore soon felt the imperative of constructing the Indian railways.

Plans for extending railway infrastructure to India were made under Lord Dalhousie, whose famous Note of 1853 exclaimed optimistically that 'great tracts are teeming with produce they cannot dispose of.'[120] It was also Dalhousie who drafted initial sketches of the routes to be followed by the main arterial lines. Railway development proceeded on the scheme of having grand trunk lines of the uniform gauge of 5'6" (1.6764m or the present Broad Gauge) traverse the length and breadth of the country, linking its larger inland cities with major ports at Calcutta, Bombay and Madras. Attention was therefore diverted from connection of contiguous commercial nodes, and from catalysis of intraregional trade by systematic construction of feeder lines within the districts which the trunk railways traversed. The trunk lines constructed were meant instead to open communication with the main agricultural tracts in the interior in order to facilitate the export of agricultural produce. It became possible, for instance, to reach Ahmedabad and the Gujarat cotton tracts, Nagpur and the

Khandesh and Berar cotton tract and Sholapur, and the adjacent Karnataka cotton tract from Bombay before 1870.[121]

The first railway extensions outwards from Calcutta headed towards the rich but congested northern provinces of the Ganga plain, and the Raniganj coalfields. These new rail routes also traversed inland cities such as Mirzapur, Allahabad and Kanpur. Bombay was connected by railway to Calcutta via Jabalpur in 1870, and to Madras in 1871. Calcutta and Delhi had been similarly connected in 1867. The trunk lines constructed helped to establish Calcutta as an important exit point for exports of produce originating in the Gangetic provinces. Karachi only acquired prominence as a port much later when the railway to the Punjab was opened. The most important of Indian foodtracts, Chattisgarh, was only linked by railway in the 1880s, with immediate impact on the food prices and food scarcities experienced by other parts of the country. The Deccan cotton-belt too had not been completely accessed when the railway reached Raichur, and other important centres at Belgaum, Dharwar and Hubli were linked only in the late 1880s. For the most part, however, the spread of railway communication was rapid and had touched the most important commercial centres fairly early, when over the 'Dalhousie-decade' between 1859-69, more than 8000km of railway lines were laid.[122]

Introduction of railways into India had in fact been delayed several years while the EIC directors had mulled over whether government should in any way mitigate the risks of private construction enterprise. It was only when Dalhousie assumed administrative charge that the matter was settled, since the new Governor-General staunchly believed that it was no business of government to get involved in railway enterprise. The initial government policy on railway construction executed through the Public Works Department operated therefore on the principle of *guaranteed* companies *i.e.* privately-held sterling companies which executed railway construction works on free land grants by sinking their own capital.[123] A return of 5 percent interest on their capital was guaranteed by government at the fixed conversion rate of 22 pence to the rupee, well above the interest yields on the London money market at the time. Surplus profit, if any, above 5 percent was to be equally divided between government and the private party. Under guarantee arrangements, government also reserved the right to repurchase the constructed lines after periods of 25 or 50 years at the mean valuation of the company on the London money market.[124] Although till 1869, railway construction in India was generally carried out on these guaranteed terms, the system soon proved uneconomical since government found itself paying out substantial sums as interest to construction companies which had incurred massive cost overruns on line construction, while virtually no operational profits accrued. Hence the system was abandoned and the government began the experiment of constructing railway lines entirely on its own between 1869 to 1879, after being granted authority to raise loans from the London money market in 1867 to finance its own public works.

A more drastic corollary of railway development in the second phase of construction after 1870, was substitution on the new lines of the uniform BG of 1.6764m (5'6") contemplated in Dalhousie's original plan by the reduced gauge of 1.0000m (3'3"or the present metre gauge [MG]) as a means of lowering construction costs after money market interest rates and the debt liability became worrying. Although the measure may have made short-run sense at the time because of the inevitable lag in traffic development, it also eventually saddled India with a large and incompatible MG network, which was to become the primary factor in later traffic bottlenecks, and which is still in the process of conversion to BG at heavy construction and write-off costs.

The system of guarantee as a means of railway finance had assured plentiful supply of capital, and Thorner has noted that 'capital which moved from England to India under these terms formed the largest single unit of international investment in the nineteenth century.'[125] Although with abandonment of the guarantee system, the onus of raising railway capital now passed to the state and had significant consequences on subsequent railway development, over 12,000km of railways had been constructed before 1878 at a total cost of 170 million pounds, combining costs of works and land as well as debt liability.

The Indian railway companies after the first quarter century of railway development were yielding operating profits. The time would then have been right for their takeover if the original thought behind their development had still prevailed. The first option for repurchase of concessionary lines however came and lapsed in 1874, when the concessions were renewed for another 25 years by the Home Government over the protests of the Government of India. Then, after ten years of government entrepreneurship, private companies were granted reentry into railway construction in 1880. This time around, there were no interest guarantees, and the companies were instead supported financially through government loans and, in most cases, free land grants. Meanwhile, the British Indian government and the Indian princely states also continued with their own parallel construction works. Ongoing debate between the Home and Indian Governments at the time on the relative merits of protective *versus* productive works reflected similar debates around that time in countries such as France. The notable difference was that, in India, unprofitable railway lines remained the responsibility of the state and not the railway companies, as proof of the earnestness of government in restoring *laissez faire* conditions in railway *operation*. The Indian railways during the 19th century thus witnessed rapid and continuous development because of strong inflows of British capital, and the final decade of the century found India with an extensive and well-developed railway network. The existence of the guarantee initially, and then its subsequent replacement by financial support, did not however allow the extension of *laissez faire* conditions into railway *development*, especially after 1896 when curbs were placed on market borrowing by the railway companies. By becoming the *principal agent* in initiating railway development, government acquired the power to control railway construction and administration. Following the turn of the century, no major construction needed to be initiated immediately, and the effort now shifted towards fuller utilisation of railway capacity. Invoking repurchase clauses after recurrent operating losses, the government had by 1914 acquired all railways built under the old guarantee system. The Indian railways thereafter by and large became state-owned, since 'private' extension in the later period was insubstantial.

In their actual working, the modalities of railway construction and operation described above had important macroeconomic implications for India.

2.6.2 The Phase of Consolidation

Railway policy in India was thus mainly formulated around two major decisions made by Government. The first of these related to the network-plan on which the new railway lines would be constructed; the second was the mode of management of this enterprise.[126] At the background however lay the pressing need of the colonial government to establish its writ over Indian soil. The advent of railways itself may be dated to the opening to public traffic of the first railway line in India on 16 April 1853, which extended 33.8km. between Bombay and Thane in Western India. The first section of the East Indian Railway covering a distance of 37.01 km. from Howrah to Hooghly was opened shortly after on 15 August 1854, heralding the advent of railways in the east. The south did not lag behind either. The Madras Railway Company opened its first 104.6km. section from Rajapuram to Arcot in 1856. By 1867, construction of arterial rail-routes between Calcutta and Delhi, and Calcutta and Bombay was complete. Occurrences of war and famine between 1872 and 1890 then compelled government to initiate the construction of a large number of branch and feeder lines based on welfare, commercial and strategic considerations, such as those voiced by the Famine Commissioners in 1880 that had pressed the strong and immediate need for adding another 8045km (5,000 miles) of new track as a measure for the avoidance of frequent famine.

The principal part of the rail network in India comprising major trunk lines linking ports to hinterlands had thus largely been built in the first phase of railway development till the end of the 19th century. Construction since then till the outbreak of the world war concentrated on development of around 16000 km of branch and feeder lines as a means of strengthening the primary system. The lower expected traffic density on these was sufficient justification for growing state involvement in the building and running of railways, and with increase in the proportion of government-owned lines, the old mode of administering them, along with roads, irrigation, etc., through the Public Works Department [PWD] proved impracticable. Accordingly, the Railway Board was constituted under the Railway Convention of 1905 and took over charge from the PWD, although the financial burden of state funding continued to be met from general government revenues. By 1914, a combined rail network of 55762 km was already in place, three-fourths of which was owned by the state leaving around 14000 km under the ownership of small private companies or the princely states. Yet of the network of 41691 km under government ownership, only 11635 km was directly operated by the state leaving the major part to be run by private managing agencies.[127]

One consequence of the succession of phases in which the Indian railways were constructed and the manner in which rates were set was that the first development impact was the expansion of foreign trade because of concentration of the main trunk network on the port-hinterland axes. Even after the subsequent development of the secondary network, the structure of railway tariffs remained unchanged till 1914, and firmly discouraged the development of internal industry and trade, because freight operations by the railways were mainly confined to the arterial routes serving the ports. On the other hand, the Indian plantation sector which came into being almost coterminously with the development of the railways became a major user or railway services because of its export orientation, and the quick pace of railway development in fact hastened the establishment of plantations over vast areas of previously underutilised lands through the system of land grants. Two other economic sectors that also rode the wave of railway development were the coalmines and the cotton and jute textile industries.

The Afghan Wars in particular had led the British Indian government to consider extension of railways as a means for improving movement of troops to the frontier. Augmentation of carrying-capacity on existing lines was also considered as an efficient means of linking the principal cantonments with each other. Heavy strain was again placed on the railway network which had evolved by the transportation needs of troops and war materials during World War I, which had to be accorded top priority. British India was also called upon to serve the heavy staffing and material needs of colonial and strategic railways being built in East Africa, Mesopotamia and elsewhere during the period. Uptil March 1916 for instance, foreign expeditionary forces had been provided 50 locomotives, 600 vehicles, 265.5km. of rails and fastenings, and half a million railway sleepers.[128] Large quantities of equipment for the construction, maintenance and operation of railways were also being requisitioned for military purposes in East Africa, and railway workshops were asked to divert their resources to the production of high-explosive shells, hospital trains and other war equipment.

The Indian Railways emerged devastated and dilapidated from the War, facing shortages in stock, worn-out tracks and ageing locomotives. Thus this war-torn period was a setback to railway development. Criticism in the Legislative Assembly was sharpened by revelation of a number of cases where railway companies had worked against national interest. Consequently the Indian Railway Committee under the chairmanship of Sir William Acworth was appointed in 1920 to devise alternative methods of administrative and financial management on state-owned railways. The Committee extensively reviewed the contentious issue of operational losses which had been under critical focus from the time of the old guarantee system, and estimated the cumulative railway deficits, exclusive of interest liability, between 1858-1918 to be Rs.77 crore [*1 crore = 10 million*], against cumulative surpluses of Rs.67 crore, leaving a net uncovered operational loss of Rs.10 crore.[129] One of the defects that the Indian enquiry shared with the enquiry on the operations of British railways also conducted by Acworth was that interest charges on the losses was left unreckoned, masking the true cumulative effect of railway losses. Nevertheless, on the Acworth Committee recommendations, many privately-managed lines were brought under state management on expiry of their operating contracts. By 1924, total route length on the Indian Railways stood at 61,285km. against the target of 160,900km (100,000 miles) set by the Mackay Committee for attainment by 1908. At the time of Independence, this had reached 65,203.1km. of which 10,521.3km. was apportioned to Pakistan Railways by the process of Partition, leaving Indian Railways with a post-1947 route-network of 54,681.9km.

The phase of post-WWI economic prosperity lasted till 1930, after which unparalleled recession affected the global economy till World War II. The recessionary impact of the Great Depression on the agricultural economy of India led to deficiency in freight traffic and resultant financial losses for the Indian Railways. The slowdown in the turnover of railway freight also reflected gradual commercial inroads being made into the transportation sector by nascent roadways. Although WWII itself was a period of financial prosperity for the railways, the spillovers from its ravages elsewhere and from intensification of the nationalist struggle for freedom also prevailed upon railway development to a great extent.

Railway development in the pre-Independence era is therefore seen to have passed through three distinct policy-phases. From inception uptil 1869, both construction and operation of railways was left entirely to the railway companies, under some form of guarantee. The argument favouring the guarantee system was that the initial injection of capital required for railway projects would not be forthcoming without an assurance that there would be returns on it at acceptable rates. But with the actual capital costs of construction and operation of the trunk lines significantly exceeding previously-anticipated levels, government coffers were severely taxed by the obligation of meeting the interest guarantees. With hindsight, the guarantee system is thus seen to have been a rather inefficient mode of railway finance, eliciting comment from observers that the railway companies had no inducement, on account of the guarantee, to be economical in their management.[130] During the later decade between 1870 and 1880, also part of the first phase, all new railway lines were therefore constructed under the direct agency of the State with finances from the State Fund.

From 1880 onwards till 1907 during the second phase, both the State and the Company railways operated concurrently, in a partial reversal of the previous policy. Thus while profitable routes were leased out to private operators, less profitable routes were either directly or indirectly constructed and operated by the State. The return of private railway construction companies has been mainly attributed to the 'co-existence of financial stringency with the necessity for accelerated construction' of lines.[131] However the new railway construction companies that began operation over the period were not guaranteed returns even though they received capital assistance from government.

After 1907, when all major railway lines had been acquired by the State and leased out to private agencies for management of operations, Company railways in India can no longer be characterised as private enterprise in the pure sense of the term., since their controlling interest in the railway undertakings did not resemble that of ordinary joint-stock companies. With nominal capital outlay and guarantees of interest, these companies were only managing agencies who worked the rail routes on behalf of the Government of India. By 1920, Government owned 73 percent of total route kilometerage in the country. Excluding the lines owned by the Indian Princely States, private railway companies would then account for route-ownership of only 250km (155 miles) from total network kilometerage of 59,580km (37,029 miles). However, inspite of its predominance in ownership, the State operated only 21 percent of the railway system, while 70 percent of it was managed and operated by the companies.

The Company railways operating in India were administered by Boards incorporated in England which delegated specific functions to their managing Agents in India. On the eve of Independence there were still as many as 42 different State and Company railway units that were subsequently merged into the nationalised Indian Railways, which became the largest public-sector undertaking in the country. The process of takeover of company-run railways had in fact commenced in 1925 under public pressure. Financial control over the railway companies had also been exercised in varying degrees by Government from the outset through its general budgetary provisions. Railway finance was eventually brought out of the ambit of the General Budget on the recommendation of the Finance Separation Convention of 1924, which also laid down the manner in which the Railway Budget was to be framed and placed.

The overwhelming stress on company management of railways however deprived the system of advantages that could have accrued from single-owner operation, and frivolous competition between railway companies often detracted from the national interest. Certain intrinsic differences in the consequences of competition, arising from the character of railways as an infrastructural sector also need to be analysed. Although the role of industrial competition in controlling mobility and directing the flow of capital-seeking investment held true for the railway companies, a major difference existed vis-a-vis the degree of mobility possible in railway investment, since railway capital tends to be immobile over short periods. In the case of railways, mobility of capital was therefore only possible in the long term. Again, in businesses from which capital can be withdrawn without sustaining substantial loss, an entrepreneur would be free to suspend operations temporarily or even permanently if they became unremunerative because of competition. However the competing railway company would be compelled to work the lines even when it was not earning any profit. Very little of the capital invested in railway construction by the company could be withdrawn. Many of its working expenses were independent of traffic, and three-fourths of total expenses would continue as a fixed cost even if operation ceased, because of the high ratio of fixed capital : working capital. Thus in unprofitable situations, the railway companies withheld investments from new lines, while financial pressure on existing lines also led to deterioration in the quality of service provided. This in effect was the general operating picture of railways in British India.

2.6.3 The Phase of Modernisation

At Independence, railways in India depended almost entirely on imports of capital equipment such as rolling stock, signalling equipment, rails and other track materials, bridge girders etc. Steam was the only mode of traction, except in the Bombay suburban area where DC electric traction had just been introduced. The standard Broad Gauge freight carrier was the 4-wheeler railway wagon with an axle-load of 16 tonnes, and only a very limited number of 8-wheeler bogie wagons were available for the transport of rails and other special traffic. The speed of trains was severely restricted by the semaphore mode of signalling, with the vast majority of railway stations being equipped with only the standard single signal system or rudimentary interlocking, and by the morse instrument providing the sole means of communication. Running-track quality was poor and not conducive to carriage of trains with heavy loads, with even the trunk routes having only single line tracks, comprising 45kg rails laid on wooden, cast-iron or steel-trough sleepers, with dog-spike or key fastenings, and a density of 1300 sleepers per km.[132] The subsequent growth of the post-Independence Indian railway system has been closely linked with the agricultural and industrial development priorities instituted under planning. Thus construction of new lines was undertaken concurrently with the tapping of mineral resources like iron ore and coal, construction of steel and power plants and establishment of other major industries. A number of the new lines were also provided transportation links to new ports for furtherance of imports and exports.

From an initial focus on physical expansion of network and capacity during the early plans, railway infrastructure has subsequently also acquired a new focus on the technological expansion of capacity, and has been modernised in order to to handle steadily growing needs of different sectors in the economy which had led to increased movement of both men and materials. The rolling stock required for these expanded operations has either increased in number or has improved considerably in capacity. Thus, the number of wagons online had risen from 205,596 in 1950-51 to 400,946 by 1980-81 and had then declined to 312,405 in 1993-94, but their carrying capacity had increased several times over.. The number of locomotives had increased from 8486 in 1950-51 to 10908 in 1980-81 and had then declined subsequently to 7202 in 1993-94, but steam traction has largely been replaced by electric and diesel.[133] Consequently the numbers of passengers carried and the tonnages freighted by the Indian Railways has increased phenomenally. Performance and growth of railways since Independence has therefore been quite commendable. There has been manifold increase in traffic as well as technological upgradation to deal with this. In sum, the picture that railway development offers is one of expansion in traffic volumes handled, expansion and extension in capacity of technological equipment, and a shift progressively towards high-volume, high-density operations.

2.6.4 Reorganisation of the Indian Railways

Besides the events that demarcate the evolution of the Indian Railways from their advent to their present physical form, there has also been change in their mode of organisation. The structure of the Railway administration in India has evolved periodically, to accommodate operational exigencies and also to promote better coordination between the railways and Government. But while the predominance of private management in railway operations over most of the colonial period might superficially suggest the existence of competition between the railway companies, the colonial state exercised full control over their supervision, organisation and development. in furtherance of its own commercial and administrative interests.

Thus although the railway administration vested in the hands of the State Railway Secretariat during in the early phase of railway development, which was established in 1874, the Government decided to tighten its reins of control and constituted a Railway Board under terms of the Railway Board Act [1905]. All supervisory powers over the railways were assigned by the Act to the Board, which was placed under the Department of Commerce & Industry. In 1908 and 1921, the Mackay Committee and Acworth Committee made recommendations towards strengthening the Railways Board's position relative to the Government. The Government eventually did not assent to most of these .Although the Railway Budget was dissociated from the General Budget under the Finance Separation Convention of 1924, this did not bring appreciable improvement to the financial administration of railway undertakings. The Government of India Act [1935] therefore made provision for a Federal Railway Authority which was never implemented.

The shift in national perspective after Independence sought to refocus the Indian Railways towards the economic rejuvenation of the country in the aftermath of colonialism and Partition. The new mindset was strengthened by the recommendations of the Railway Enquiry Committee [1946-49] for setting up a Central Controlling Authority for the Indian Railways and the Railway Board was asked to provide the *raison d'etre* for its continued existence. Although no steps were taken to constitute the CCA, the Railway Board was reconstituted and assigned with even greater powers of central control. Since then and uptil the present, it frames railway policy and operates also as a corporate regulatory body analogous to a board of company directors for the Indian Railways. The present responsibilities of the Railway Board include the coordination and maintenance of all IR operations and also the preeparation of plans for the future development of the railways. A Directorate of Planning guides the planning systems of IRs zonal railways.[134]

IR's zonal railways were formed when the older State and Company were regrouped during the 1950s. Zonal regrouping had also been a part of the railway debate during the 1920s and have been considered by the Acworth Committee. It had also been studied by several Committees who had made recommendations for and against it. While the companies had insisted that flexibility of operations was a key to railway profitability, it was also seen that large pre-Independence railway networks such as the East India Railway and the Great Indian Peninsular Railway ran more profitable operations than the branch railways. The railways in many other countries including France and Britain had been regrouped after the phase of railway construction was over. Regrouping was also justified by the arguments on the economies of scale from transportation. As a result, clusters of branch and trunk lines were amalgamated into networks in almost every country which had extensive railways. In India, this process had to wait till the nationalisation of IR and the setting of planning priorities for the country.

Zonalisation of IR began in 1951 when three large zonal networks were created. These were:

1. Southern Railway which was amalgamated from the erstwhile Madras & Southern Mahratta Railway, the South Indian Railway and the Mysore State Railway

2. Central Railway which was amalgamated from the erstwhile Great Indian Peninsular Railway, the Nizam's State Railway and the Scindia and Dholpur Railway

3. Western Railway which was amalgamated from the erstwhile BB&CI Railway and the Saurashtra, Rajasthan, Jaipur and Cutch Railways

Three new zones were created in 1952, comprising:

4. Northern Railway which was amalgamated from the erstwhile Jodhpur Railway, the Bikaner Railway, the Eastern Punjab Railway and the three divisions of the East Indian Railway which lay north-west of Mughalsarai Junction

5. Eastern Railway which amalgamated the remainder of the Eastern Railway with the erstwhile Bengal Nagpur Railway

6. North Eastern Railway which was amalgamated from the erstwhile Oudh-Tirhut Railway, the Assam Railway and the Kanpur-Achnera section of the BB&CI Railway

After zonal readjustment in 1955, a new zone was created, namely the

7.South Eastern Railway which was carved out of Eastern Railway, while Eastern Railway retained three railway divisions of the old East Indian Railway and the Sealdah division of the Bengal-Assam Railway

After another zonal adjustment made in 1958, another zone was created for strategic reasons, namely

8. North-East Frontier Railway which was carved out of the North Eastern RailwayIn 1958, the

The last major IR zonal railway was created in 1966, namely

9. South-Central Railway which was carved out of the Southern Railway, and includes the network of the erstwhile Nizam's State Railway as well as the erstwhile Madras & Southern Mahratta Railway.

Except for minor reallocations at divisional level, no major IR zonal railway was created thereafter. In a recent order however IR has proposed the creation of six more new zones by breaking up the existing zones and reorganising the divisions into more compact zonal railways. While the matter has been subject to some debate since 1996, when the proposal was first contemplated, the Chairman of the Railway Board has announced a rationale for the reorganisation. If the argument is accepted, the present IR organisation has become unweildy because of the growth in the size of its operations and in the number of trains. The Railway

Board now believes that leaner zones will be more efficient.

Reviewing the experience of the major railway systems that have been studied in the present chapter, it would seem that two scales of organisation are appropriate to railways. For large networks with a lot of freight-intensive operations, such as SNCF or IR, the benefits of technological modernisation can only accrue on large unified operations where good coordination is possible.On the other hand networks which cover a smaller area but have highly intensive passenger flows, such as British Rail plc. or JR, the compact mode of organisation is better because of the lower leads involved in passenger traffic . It will be seen in the next chapter that the character of operations on IR has been changing , and as passenger flows ahve expanded, the focus on freight operations has narrowed. Large parts of the IR network have become unviable because of the absence of adequate freight flows. Hence the decision on zonal railway reorganisation becomes critical for IR. Is IR to become a passenger intensive railway which runs compact operations to cater mainly to intercity passenger flows? Or is it to remain a large freight-based network which caters to the transportation needs of the entire country?

The financial health of any major railway system depends on the efficiency of its freight operations, unless passenger intensities on it are as high as they are on JR. The study of SNCF which has been made in this chapter becomes important in this light. SNCF has faced increasing competition on the roadways for several decades. As a state owned railway system, it resembles IR in many respects. The study of SNCF shows that a large railway system can only return the competition if it becomes more technologically efficient. While investment in railway infrastructure and technological renewal is most important, the returns from the large capital investments that have to be undertaken flow slowly and take some time to materialise. On the other hand the freight operations of a railway are commercial enterprise. In this respect, IR currently faces the same challenges as SNCF. However, the need for public investment on IR has not been recognised for some time, and the depreciation of IR's infrastructure has not been compensated in the manner needed.

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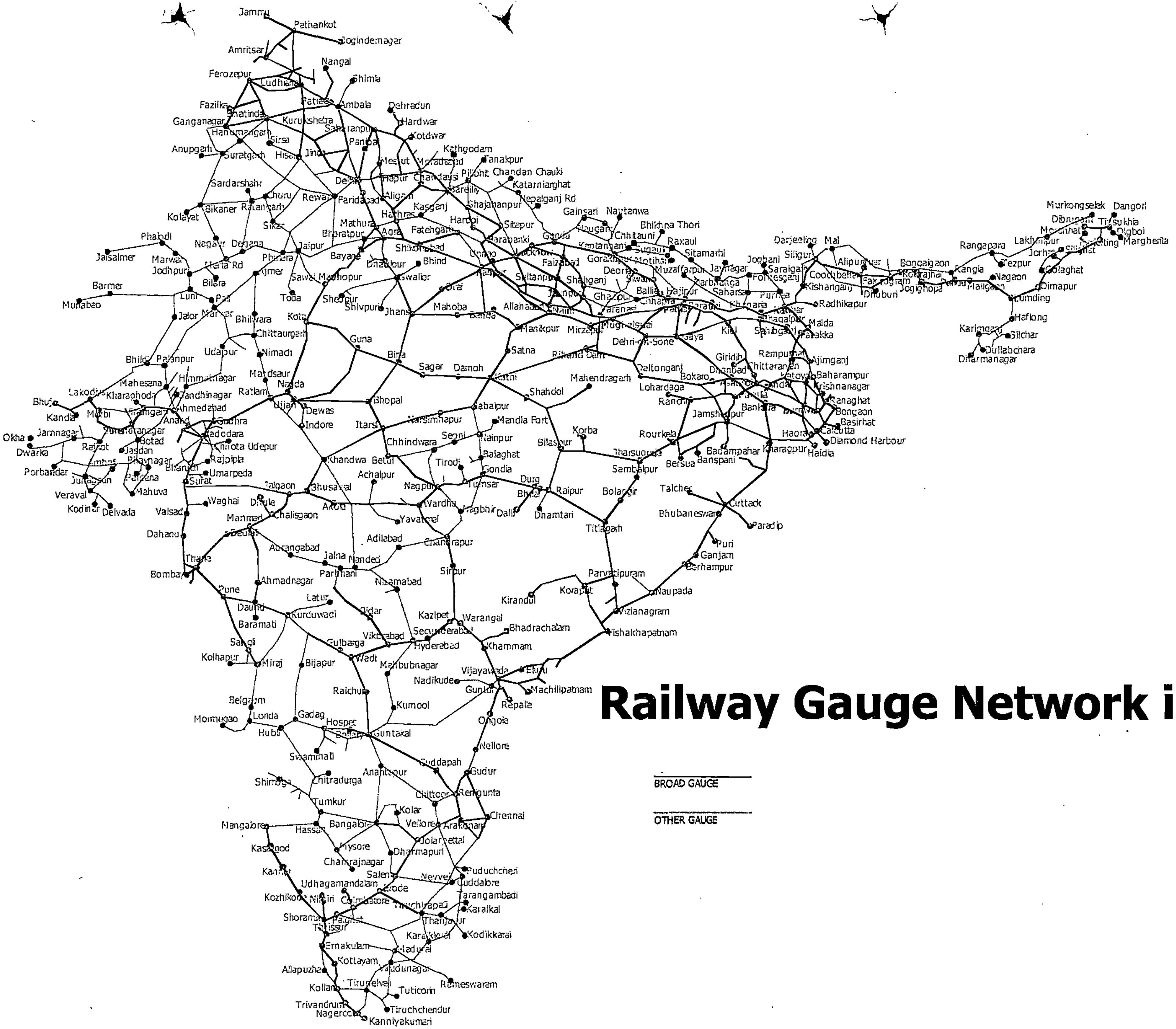
Railway Gauge Network in India



Chapter 3

OPERATIONAL PERFORMANCE OF THE INDIAN RAILWAYS

3.1 Factors in IR Operational Performance

The preceding exposition on the historical development of transportation infrastructure and the evolution of some of the best-known world railway systems reveals several common features between them, even though some appear to have fared better than others over the course of time. The principal aspects that have surfaced as common during the analysis are the rise of confrontation between railways and roadways, the difficulties of maintaining operational viability over all categories of railway freight against the backdrop of rising traffic costs and falling returns, and the methods for rejuvenation adopted by different world railways ranging from technological modernisation and upgradation, organisational streamlining and commercial specialisation, to the extreme policy recourse of financial autonomy, deregulation and privatisation. Despite the apparent abundance in solutions all directed to restoring the competitiveness of railway services so that they can effectively take on the roadways, traditional infrastructural problems of public-utility operation and social pricing of services still remain central both to railway economics and to the long-run interrelation of growth and development in transportation infrastructure to the economy.

Because of the social and developmental roles that impinge on the railways as a vital constituent of modern transportation infrastructure, assessments of comparative performance of a railway system across time and space must simultaneously cover both operational and financial aspects since commercial objectives and the maximisation of capital returns and profit cannot be the *sine qua non* of railway operation. Thus although railway development and the evolution of railway economics has broadly followed the same sequential course across the systems just studied, a range of policy experimentation has also been witnessed on each national railway system, which has had the object of bringing about the best working results given the resource endowment and the economic milieu of each country. The basis of all such experimentation has generally been the need to improve operational performance of the railways within a socially-constrained cost structure.

3.1.1 Growth of Intermodal Transportation Infrastructure

It has just been seen that the development of railways in India proceeded over three distinct phases. Initial commencement during colonial days followed the structure of guaranteed companies securing guaranteed minimum rates of return on private venture-capital. Later wisdom however saw the gradual takeover of private proprietary interests, so that by 1914, most lines were state-owned, although still operated by zonal railway companies without a coherent transport policy having been put into place. The benefits that accrued from the first phase were a levelling of foodgrain prices that preempted recurrent famines, cropping shifts following growth of an export market in primary agricultural produce, and impetus to internal trade and industry. Outward extensions of these benefits during the second phase saw urbanisation and the growth of towns and a strengthening of urban industry based on the hinterlands served by the railway freight network. Railway development in the second phase thus followed these internal imperatives adding more coherence to transport policy.[1] The extensive railway network that had been built over the colonial period was however trifurcated by Partition in 1947 into the regional networks of India, West Pakistan and East Pakistan, requiring a reorientation of the freight linkages within the old system through the institution of transportation planning.

In planning transportation infrastructure, the case for advance creation of transportation capacity in anticipation of future demand theoretically rests on two considerations: *firstly*, transportation is a non-traded commodity whose services are not importable, and *secondly*, investment in any kind of infrastructure is lumpy in character. It may become necessary therefore to fund the creation of transportation capacity even when current levels of demand for such services do not justify investment on the basis of commercial viability, while the lumpiness of investment may also make it necessary to create capacity on a larger scale than is immediately justifiable if the benefits from economies of scale are to be drawn.

While development of the IR system subsequent to 1947 has expanded the railway network to 62,660 route-km and 108,513 track-km by 1994-95 (of which 79,495km constitute running-track), spread over 59 operating divisions and 7056 stations and staffed by 1,602,051 permanent and 69,000 casual employees, rolling stock deployment currently includes 6908 locomotives, 291,360 wagons and 39,214 conventional, EMU and other passenger coaching units. Thus the network now represents a total capital-at-charge of Rs.21,762.92 crore excluding the investments made on mass rapid transit projects, and caters to originating freight tonnages of 364.96MT [93MT in 1947] and 3.195 billion passengers.[2] Despite such apparently phenomenal growth, railway development in India after Independence has followed the reordered priorities set by national development planning, with the multiplication of goals and activities of the Indian state leading to severe resource-crunches and shifting plan-focii. Thus with more stress being laid recently on technology-oriented modernisation instead of on spatial proliferation of networks, a write-off of around Rs.2925.51 crore of railway capital since 1992 in metre-gauge stock and steam-based traction has reduced the number of operational stations from 7116, the number of locomotive units from 8268, and the number of wagon and coaching units from 346,394 and 39,283, respectively.[3]

Transport capacity constraints emerging due to a decline in investment in transportation infrastructure can become a matter of grave concern to a developing economy. Plan outlays made on the transportation sector and on the railways in particular, since the institution of Five-Year planning enable a reading to be made of changes in government infrastructural policy. In India, a sharp reduction in investment shares for transport and for IR is noticed particularly between 1966-79, for which there is no apparent rationale.[4] As a result serious transportation bottlenecks occurred during the 1970s, with consequent retardation in the rate of industrial growth. While the stepping up of plan allocations since the 1980s has partially eased that extreme situation, the falling value of plan allocations in undepreciated rupee terms has been acknowledged and in the review of achievements of the Seventh Five-Year Plan [7FYP], the Planning Commission notes that allocations to transport, power and communications in the past period did not reflect the high priorities attached to them, hoping in fact for private sector investment to bridge the gap.[5]

The sharpest growth in transportation infrastructure in India over the planning period has been witnessed by the roadways sector rather than by the railways, conditioned however by the fact that - at Independence - the roadways were in virtual infancy. Between 1950-51 and 1991-92, the Planning Commission estimated 475 percent augmentation of the road network in the country from 0.4 million km to 2.3 million km, with 1857 percent increase in the number of light and heavy commercial vehicles [CVs, *i.e.* trucks and other freight vehicles] from 82 thousand to 1.61 million. Over the same period, the number of passenger buses has increased by 988 percent from 34 thousand to 0.37 million. Corresponding percentage increases in railway infrastructure have amounted only to 17 percent for route network, 102 percent for traction and 171 percent for freight wagons, against 126 percent for passenger coaches.[6]

Quite obviously therefore, the buildup in freighting capacity over the era of planning has been strongly weighted in favour of the roadways. Interestingly, the Plan component in this has been largely confined to the construction of 1.9 million km of roads - in itself a daunting financing exercise, which probably also restricted the expansion of the railway route network over the identical period to 9064km. The overall transport achievement in terms of the magnitude of highways and feeder roads constructed is immense. However the logical corollary of such development has been a phenomenal increase in the number of on-road vehicles, especially since no spectacular commitment of government funds has been needed towards this. Growth of the roadways in India has therefore been served by a backbone of private sector investment following massive public expenditure on roads. In effect, this has followed inability on the part of the state to maintain a parallel rate of expansion in the railways, where all expenditure - including investments on route, rolling-stock and establishment - have to be financed from the public exchequer. It becomes quite evident that expansion of roadways operations on the scale implied should eventually raise fierce competition with the railways for freight traffic shares. It is however of special interest to note from the above figures that a similar degree of competition did not arise in the case of passenger services, since the expansion in the number of buses has not been nearly as large as that in trucks and other freight vehicles. Again, the expansion in passenger coaching on the IR system is fairly high (compared to that in route-km, for instance) pointing towards the fact that the railways still remain the primary mode of transportation for long-distance passenger traffic. Since the corresponding increase in route-km and traction units has been extremely modest, increased density of passenger services would obviously be at the cost of freight operations, adding congestion costs to the latter. Bearing in mind that the social overheads borne by railways are already much higher for passenger than for freight traffic, a displacement of freight traffic by passenger services on congested routes imposes a severe social cost burden on IR.

It may therefore be noted, for most of the planning period, that the growth of roadways has been uncoordinated with the growth of railways. While later attempts have been made by Planning Commission committees such as the National Transport Policy Committee [NTPC] between 1978-80 and the Steering Committee on Perspective Planning for Transport Development in 1988, to promote transport coordination while retaining rail:roadway ratios for freight traffic ranging from 65:35 [IR Corporate Plan 1985-2000] to 72:28 [NTPC] projected for the year 2000, very recent estimates of the current intermodal ratios are 40:60 for freight traffic and 20:80 for passenger traffic[7] in 1996-97, much below the optimal intermodal ratios that had been projected by the expert committees.

Contrasting sub-periods, the bulk of growth in freight traffic in India has occurred since the 1980s, after the hiatus of the 1970s, with overall freight growth between 1950-71 having also been creditably high at 6.77 percent *p.a.* However the rate at which road freight has grown over the entire planning period, excluding the 1960s, has remained well over 10 percent (11.82 percent between 1950-71 and 12.81 percent between 1980-86). Railway freight, in comparison, grew at an average of just around 5 percent annually over both periods, and even between 1971-81 when the transportation sector as a whole suffered severe planning constraints as mentioned earlier, road freight grew at over 7 percent, compared to less than 3 percent annual growth for freight on the IR network.[8]

The current intermodal allocation of freight between roadways and railways would be deemed far from optimal, because of the efficiencies in energy-use, land-use and traction that are intrinsic to railways, particularly in long-haul bulk traffic. As such, road transport and rail transport are not strictly substitutes but in fact complement each other inasmuch as the advantages of one mode in one freight-category are compensated by advantages drawn by the other in another freight-category.

3.1.2 Social Considerations in IR Operations

Perhaps because railways have traditionally been run in the government sector in most countries, an onus has existed for their services to be treated as *public* goods, even though otherwise required to be run on commercial principles. The primary social objectives that are served by IR arise from having to provide mass rapid transit systems to the metropolises; intercity, medium and long-distance passenger transport; and low-cost prioritised haulage to several agricultural commodities and vital industrial raw materials. General subsidies on such services have to be recovered from the revenues drawn on other categories of freight, leading to the phenomenon of cross-subsidy. Another public utility aspect visible particularly in India is the use of railway construction as a development device to encourage flows of investment to backward and undeveloped areas. In face of low transportation capacity however, the pressure to maintain socially-preferred transport services has to be accommodated at the expense of commercially-preferable operations, leading up to a general loss of profitability. This is a problem which has constantly afflicted IR both in revenue and resource terms, culminating eventually in their current inability to fund the creation of transport capacity ahead of demand. Thus 'cross-subsidisation' dilemmas in the operations of IR manifest themselves at several levels, such as in competition between passenger and freight services and between different categories of freight services.

Suburban railway services have nevertheless formed a convenient hub for the mass rapid transit needs of the larger Indian cities where road space and other public transport systems have proved woefully inadequate to the task of moving masses of people to and from work, partly leading also to the recent explosion in metropolitan car-ownership. While because of overall economies of operation, railway-based public transportation systems of both the overland and underground variety are now being mooted as an ultimate solution and have in fact been initiated in certain metropolises, the major question that still has to be confronted is that of capital adequacy, since entrustment of MRTS systems to IR would reduce the availability of resources for railway development elsewhere. Secondly, as a subsidised passenger-based service, railway MRTS systems often develop at the expense of freight operations, applying a further squeeze on the economy. A partial solution to the problem can only be offered if funding for MRTS projects is separately provided through civic bodies, instead of having to be borne by the Indian Railway Budgets.

The other important public utility aspect relating to IR concerns the setting of tariffs that reflect regional equity concerns rather than commercial considerations. Thus the railways in India charge uniform kilometre-rates and tonne-rates throughout the country, irrespective of the actual costs of sectional carriage and of haulage over various gauges. Since the basic rates are moreover pegged low, this encourages the pricing of certain railway services well below cost and increases revenue deficits.

It must also be acknowledged that the character of the transportation demands made by the Indian economy have changed dynamically over the planning period and will evolve further. The aspects of change most prominent in this process are the increasing rate of urbanisation, vastly-altered regional demand and locational patterns, and the changing commodity-character of overall freight flows. For this reason particularly, no transport plan can actually be framed for all time to come, since transportation infrastructure has to remain adaptable to predicted as well as evolutionary changes. Even though public-utility orientation will remain paramount for the railways in India so long as they operate in the public sector and the priorities of development remain unredirected, the major adaptation to policy that has to be made immediately is the restoration of profitability of railway operations, preferably through cost-reduction rather than tariff revision.

3.1.3 Commercial Considerations in IR Operations

A clash between social and commercial objectives is often inevitable in railway operations. While the pace of railway development in the long term would depend upon fair returns being provided to capital investments in IR, the scope for such returns is in practice circumscribed by the extent of social subsidies. In this aspect, public railway systems everywhere operate as the antithesis of commercial monopolies. Nevertheless, the sustainability of social objectives in railway enterprise depends on constant ability on the part of the railways to operate efficiently and bring down unit traffic costs. The public character of IR proves an obstacle to this because of the addition of a tacit social constraint of maintaining the railway workforce at its currently high levels. While wage components in railway costs become consequently high, the scope for inducting cost-reducing technology is also affected. Even with upgraded railway technology having been incorporated in more recent years, the rate of factor application per unit traffic (*i.e.* input-output ratio) thus remains high on IR.

Another peculiarity of IR is that it has remained a departmental undertaking of the Ministry of Railways without acquiring separate corporate identity, even while multiplying manifold in both scale and operation over the era of planning. Complaints in the public media about lack of professionalism, management discretion and work culture might in fact be rooted in this outmoded form of organisation which - at least at operational levels - is viewed as the manifestation of monopolistic attitudes within a public utility. In some sense therefore, the successful competition from roadways not only reflects economic differentials but also quality-of-service differentials vis-a-vis railway services.

For IR to turn this around and to function on more commercial lines, the disadvantages of monolithic and monopolistic organisation have therefore to be overcome, even as the efficiencies and economies of scale resulting from that organisational mode are retained. Sufficient scope exists to improve the coordination between IR and the major railway users both in institutionalising present operations and in planning expansions, and also in the integration of railway development into regional planning exercises. Once again, the degree of coordination called for requires that IR shed its departmental attitudes of balancing budgets, and acquire a forward-looking professional mindset. It is fairly obvious that the first result of such a shift will be the planning of railway infrastructural capacity well ahead of demand and the creation of an ability to engage the government ministries constructively when seeking capital funding.

3.1.4 Freight Traffic Adaptation

As has been observed earlier, the rather slow pace of augmentation of railway network and rolling stock in India over the planning period resulted in substantial compensating addition to roadways capacity and traffic. Within IR, the effect of expanding transport demands acquired twofold character in view of the capacity constraint - while there was increase in traffic and tonnage, there was also substantial increase in traffic density particularly on major corridors. Considering the zonal character of this increase however, traffic density did not develop uniformly over all parts of the IR network and in fact followed the regional pattern of development. Certain rail transport axes - for example, North East India - therefore still carry low and even uneconomical traffic density.

Two reasons may lie behind this. Firstly, the character of industrial and locational linkages result in clustered development around regions where general infrastructure is strong, and it was therefore the areas served by major industrial corridors that attracted most of the industrial thrust of the Indian FYPs. Secondly and less obviously, the major traffic axes along which urbanisation and settlement is taking place in certain regions may lie at a distance from the alignments of rail routes and thus may be better served by the transport infrastructure on road rather than rail corridors. Either factor offers cogent explanation of the uneven patterns of regional development in the country.

It is particularly in the second case that the traffic forthcoming is in the form of small masses of goods and people, for the carriage of which railways are not deemed efficient. Sound economics underlies this. The high proportion of sunk costs and maintenance overheads on railway construction in any case adds considerably to the unit costs of carriage, and further, the optimum unit of carriage on the railways is the full trainload rather than individual wagon- or coaching-loads. With intergauge and intermodal transhipment also adding substantially to the costs of access and carriage, low-volume short-haul traffic proves to be non-optimal when freighted by railway. In contrast, the road operator bears very little by way of sunk costs since neither investment on road construction nor on fuelling facilities directly devolves on him. With the advantage of low breakeven points, it is but natural that low density traffic should gravitate to the roadways once roads are constructed, even where railway tracks have existed much longer. In North-East India, for instance, whatever traffic IR has been able to retain has been at the cost of substantial social subsidies.

The choice between public utility concerns and commercial considerations in such cases becomes difficult to apply. Discontinuation of uneconomic lines would release resources and maintenance funds for application where these are more needed. This would however mean also that costs already sunk into the development of these lines would have to be written off altogether, and several backward regions of the country would be sealed off from railway access for all time to come, with their subsequent development then depending entirely on the vagaries of roadways services. As the course of more moderation, IR has chosen instead to gradually withdraw from low-bulk, short-haul and piece-goods traffic (*traffic smalls*, in railway parlance). The reasons generally advanced for such withdrawal refer to the constraints on present capacity that render these services inferior and unremunerative. It needs also to be noted however that by doing so, the railways are surrendering the fastest-growing traffic segment, for which demand exists all over the country even on low-density sections at every point of time, the segment eventually being taken over by the roadways. Evidence for this emerges from the growing dependence of IR on a few select bulk commodities, which badly hits railway revenues in case of an industrial slowdown that affects the production of either of these commodities. Incidences of this have already occurred and have affected railway earnings in the past.

To restore themselves to a position of profit, it would appear that IR will have to take the roadways competition head-on by reentering the market for smalls traffic, both because traffic demands in this category are consistently steady and originate across the entire country, and because colossal wastage of the country's resources are involved when the smalls consignments travel over long-distance in single truckloads instead of being consolidated into railway trainloads. It is here that the most difficult questions emerge. It is well recognised[9] that the fact that railway capacity has gradually been committed entirely to core sector traffic of coal, POL, fertilisers, foodgrains and so on has left IR with no margin for the carriage of the general cargo and industrial traffic that is on offer. The excuse for allowing this residual capacity to lapse entirely has usually been the resource crunch, even though along with general cost-inefficiency of IR operations, implementation of IR's more grandiose projects like UNIGAUGE without proper traffic appraisal, and tardy execution of railway projects in general leading to phenomenal cost overruns might be held equally to blame for the paucity of investment in capacity creation at a time when growth of traffic demands has consistently outstripped capacity.

The need to move into containerised transport to build multimodal capabilities into transport infrastructure in India has also been recognised by the establishment of the public-sector Container Corporation of India [CONCOR] in 1989. However the essence of efficient container services over a transport network as vast as India's is the maintenance of competitive rates through multiplicity of agencies and services on offer. Thus the monopoly mode of organisation is inappropriate to rapid development of the container segment of traffic, at least at the initial stages when the spread of the services are far more important than their size. It is when the spatial spread of these services is deemed adequate that they can be consolidated to optimal size by mergers and takeovers of efficient operations.

Nevertheless the major obstacles to any remarkable thrust being made in multimodal transport is the lack of equivalent infrastructural development of ports, shipping and waterways, and of depots, freight stations, warehousing and other handling and lading facilities. The development of a vast subsystem of transport management services comprising shipping and clearing agencies, and freight forwarders and consolidators is equally important. A World Bank study[10] points out fragmentation of services, rigid controls and regulations, constraints on the private sector and inadequacies of infrastructure as responsible for the poor logistics of trade in India. The problem can then be viewed from the point of coordination, where although IR would provide the core of services, the task of developing traffic to utilise these services should rest elsewhere. In practice, it would be private sector investment and involvement that would have to be counted on to develop containerisation, road railers, and multimodal collection and delivery stations for break-bulk freight.

In the study of the operational performance of the Indian Railways [IR] to be accomplished in the present chapter, it thus becomes imperative to analyse railway performance on the trends of certain well-identified financial and operational indicators in common use all over the world to assess railway working results. Of these, while annual *returns on railway capital-at-charge* hold significant diagnostic importance in defining general financial health on railway systems, three other operational indicators principally pertain to railway freight operations. These are, namely, the annual *originating tonnage* of railway freight over all loading points, the annual realisation of revenue-earning railway freight traffic (*i.e.* net of non-revenue earning departmental traffic) in terms of *net tonne-kilometres*, and the average freighting distance or *average lead* realised on freight traffic booked in the course of the year. After quick review of the growth of transport infrastructure in India in the post-Independence period, the chapter will evaluate the consequential role of railway infrastructure in serving development needs of the Indian economy by making increased movements of materials possible, against IR performance measured by the four indicators.

3.2 The Problem of Adequacy of Returns to Railway Capital-at-Charge

Railway financing has been subjected to scrutiny time and again for the problems it encounters on account of being characterised by technical indivisibility of railway assets, the scale and lumpiness of railway-capacity investments that render these beyond the reach of private investors, and the 'sunken' character of railway costs and very low returns. This does not detract however from the importance of improving efficiency of supply of railway services. The overall situation under which IR has operated has assigned disproportionate importance to the social objective of achieving allocative efficiency, hence proving an impediment towards generating profitable revenues like other commercial organisations.

Capitalisation of railways is not a single period phenomenon but a process of continued flow of capital to sustain the establishment. Thus investment on capital projects to develop railway operations is liable to be undertaken only when incremental capital outlays are assured. While the initial investment is 'sunk' into track building, network expansion and building assets, it is followed by demands for further investment in track & asset renewal, railway maintenance, etc. For the creation of railway capacity ahead of demand, it is thus imperative that the incremental outlay of capital should increase over time. A slowdown in such investment proves detrimental to railway development because of the consequent inefficiency in operational performance. Thus *repeated-dose* capital investments form the backbone of sustained profitability in railway operations. A study of railway capital flows in India is undertaken next to identify the slack and peak investment periods that have affected the operational performance of IR.

Figure 3.1 derived in three parts from the extended form of the table below illustrates trends in percentage incremental capital outlays on the railways in India since the first endeavours made by the British to develop a railway network within the country. The original time series being in nominal terms, the computed percentage increments take into allowance the general trend rather than the actual or deflated incremental trends. An average decadal series in nominal terms of total railway capital outlay, gross and net railway earnings and railway working expenses is also provided to aid analysis.

Table 3.1: Financial Attributes of Railway Performance in India

(a) Gap-Year Analysis *[in Rs.crore]*

Year	Total Railway Capital-at-Charge	Gross Railway Revenues	Railway Working Expenses	*Average Operating Ratio [%]*	*Average Annual Return on Railway Capital [%]*
1853	0.4	0.009	0.004	*45.6*	*1.30*
1859	22.5	0.572	0.277	*48.5*	*1.00*
1869	89.0	0.613	3.05	*55.7*	*2.29*
1879	122.3	12.08	6.26	*51.8*	*4.25*
1889	205.0	20.49	10.38	*50.6*	*5.28*
1899	308.6	29.37	13.94	*47.5*	*5.25*
1909	429.8	47.06	26.38	*56.1*	*5.38*
1918-19*	549.7	86.29	41.80	*48.4*	*6.01*
1928-29	831.4	118.87	74.62	*62.8*	*5.35*
1938-39	847.8	107.15	71.18	*66.4*	*3.86*
1948-49	758.8	234.12	184.06	*78.6*	*7.02*
1958-59	1356.6	393.90	334.58	*84.9*	*5.96*
1968-69	3101.3	899.07	756.26	*84.1*	*5.57*
1978-79	5023.9	2161.30	1900.47	*87.9*	*4.37*
1988-89	12987.5	9528.62	8791.29	*92.3*	*5.23*
1991-92	17712.5	14113.74	12572.79	*89.1*	*7.43*

(b) Interdecadal Growth

Period	Decadal Change in Railway Capital-at-Charge	*Annualised % Change in Capital-at-Charge*	Decadal Change in Railway Revenues	*Annualised % Change in Gross Revenues*	Decadal Change in Working Expenses	*Annualised % Change in Working Expenses*
1854 to 1859	22.1	*971.20*	0.6	*1798516.01*	0.3	*2290.24*
1860 to 1869	44.8	*19.89*	5.6	*347.54*	3.1	*200.38*
1870 to 1879	33.3	*3.74*	6.0	*6.11*	2.8	*17.41*
1880 to 1889	82.7	*6.76*	8.4	*5.60*	4.1	*13.43*
1890 to 1899	103.5	*5.05*	8.9	*2.46*	3.6	*8.55*
1900 to 1909	121.3	*3.93*	17.7	*1.34*	12.4	*12.70*
1910 to 1918-19*	119.9	*2.79*	39.2	*0.59*	15.4	*14.87*
1919-20 to 1928-29	281.6	*5.12*	32.6	*0.59*	32.8	*7.79*
1929-30 to 1938-39	16.4	*0.20*	-11.7	*0.02*	-3.4	*-1.57*
1939-40 to 1948-49	-89.1	*-1.05*	127.0	*-0.10*	112.9	*17.84*
1949-50 to 1958-59	597.8	*7.88*	159.8	*0.34*	150.5	*8.68*
1959-60 to 1968-69	1744.7	*12.86*	505.2	*0.33*	421.7	*15.10*
1969-70 to 1978-79	1922.6	*6.20*	1262.2	*0.07*	1144.2	*16.69*
1979-80 to 1988-89	7963.6	*15.85*	7367.3	*0.07*	6890.8	*38.77*
1989-90 to 1991-92	4725.0	*12.13*	4585.1	*0.04*	3781.5	*17.39*

Source: Data abstracted from RFFC [1993] :*Railway Fare & Freight Committee Report*, 1(3):57-62, Annexures 3.I & 3.H

**N.B.: The railways in India switched over to financial-year accounting from the year 1918-19*

(c) Piece-wise Regression Results

Early Period: [1856 to 1910]	CR = 5.246 - 0.106 CO $r^2 = 0.610$ t-coeff = 9.353
Middle Period: [1911 to 1946-47]	CR = 5.628 - 0.029 CO $r^2 = 0.001$ t-coeff = 0.211
Post-Independence Period: [1947-48 to 1991-92]	CR = 4.871 + 0.074 CO $r^2 = 0.073$ t-coeff = 1.834
Reversed Regression	CO = 1.782 + 0.989 CR $r^2 = 0.073$ t-coeff = 1.834

Note: CaC_t = Railway Capital-at-Charge in period t
CO_t = Incremental Railway Capital Outlay in period t
NE_t = Net Railway Revenue Earnings in period t
CR_t = Return on Railway Capital-at-Charge in period t
& $CR_t = NE_t / \Delta CaC_t = NE_t / [CaC_t - CaC_{t-1}]$

3.2.1 Historical Analysis of Railway Capital Returns

A component that relates closely to incremental capital outlays is the net capital return on capital invested in the railways, defined as the ratio of net earnings to additional capital-at-charge in any given year, where net

Figure 3.1: **Financial Performance of Indian Railways over Different Historic Periods**

Fig 3.1*a*: *Financial Performance [1856 to1910]*

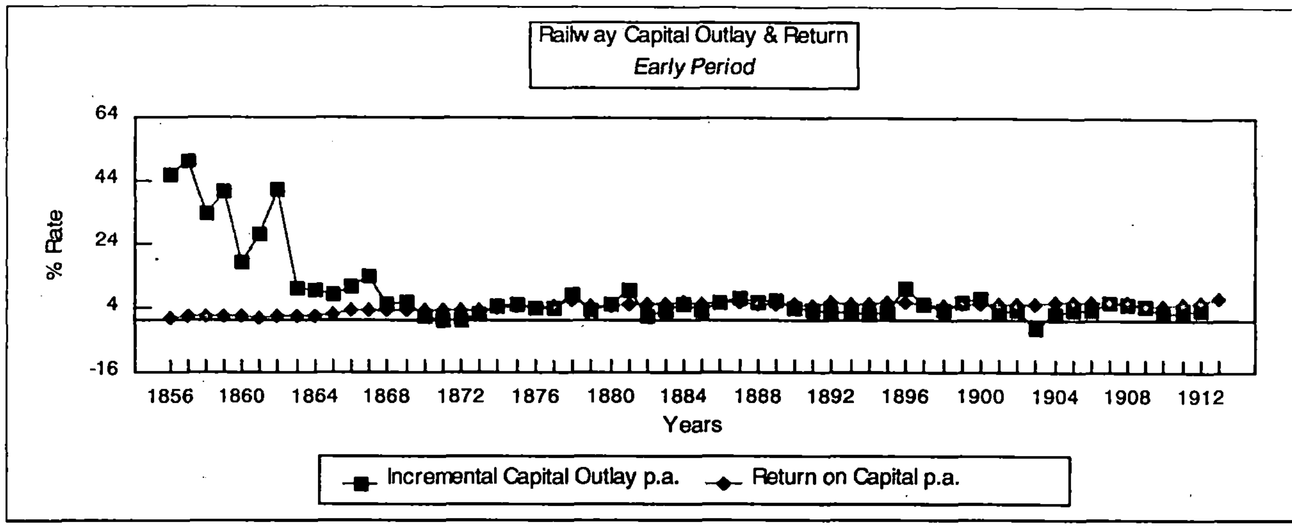


Fig 3.1*b*: *Financial Performance [1811 to 1946-47]*

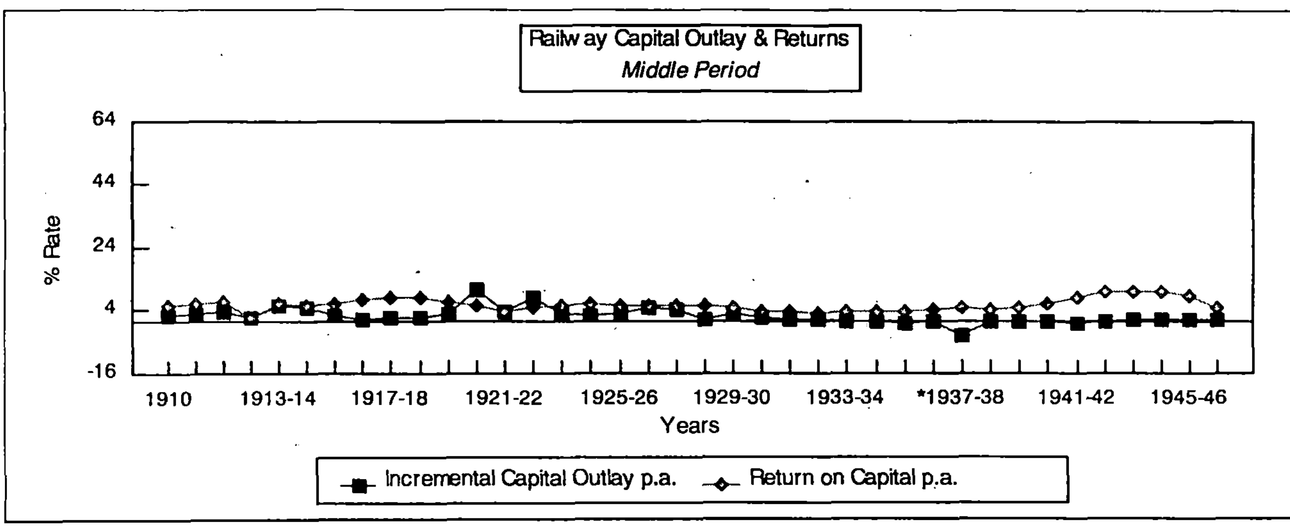
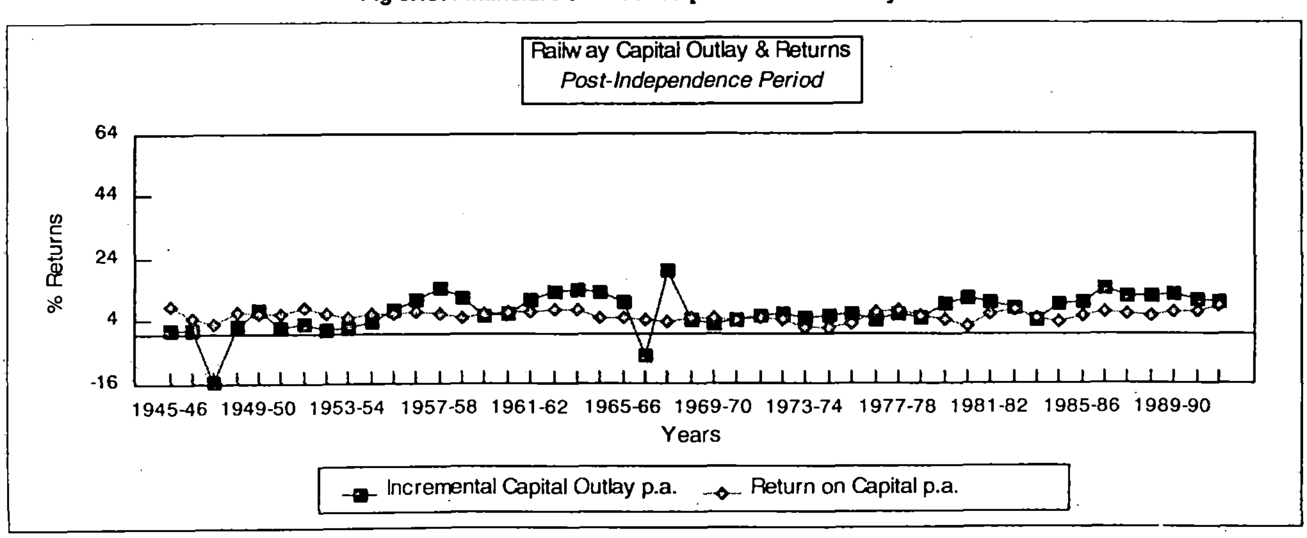


Fig 3.1*c*: *Financial Performance [1947-48 to 1991-92]*



earnings are total railway revenues net of normal railway working expenses. The level of net capital returns thus provides indication of the efficiency of utilisation of railway capital and also of the financial viability of railway operations. Although data for the above is available as a continuous timeseries beginning 1853, the summary of the decadal levels of returns since presented in Table 3.1 provide sufficient overview of the financial performance of railways in India over 138 years of railway operations. The associated graphical representation segregates annual capital increments and returns in growth (percentage) terms over the three phases of early, middle and post-Independence railway development. Examination is first made of the bivariate regressions of the capital returns series on incremental capital outlays for the three sub-periods mentioned, and yields interesting insights into the relationship between the two capital variables.

While increments in railway capital outlays over the first two periods relate inversely to capital returns, the relation becomes positive in the post-Independence period, implying that incremental capital investments in the formative stages of railway development do not bring immediate returns until railway operations have taken off. Thereafter, additional investment adds more credibly to railway revenue generation. From regression results, nearly two-thirds of the variation in railway returns over the *early* period can be ascribed to injections of capital made into railway construction with high correlation, although the investment relationship is inverse and significant. Since the bulk of private railway investment in India which went into construction of an extensive route network over the short spell of the first two decades after the advent of railways could be termed *sunk* capital, low returns on the same were unavoidable until traffic had developed a sufficient volume. Thus it was only towards the turn of the century that capital returns rose to a percentage level that exceeded the rate of capital increment, both because of traffic improvement and a drawdown in the annual rates of capital injection after the period of construction was over. Although the operational improvement is seen to have carried into the *middle* period, the relationship of capital returns with capital injections turns more unstable with a low correlation coefficient and an insignificant t-statistic. The middle period is partly an aberration from the rule in the sense that exogenous factors like the two World Wars and the World Depression between them affected capital flows as well as the operational performance of the railways - subperiods with the highest capital returns being associated with the war effort. The post-Independence period on the other hand shows radical differences. With the spurt in capital investment following commencement of planned railway development, the relation between capital injections and returns turns positive, with stronger correlation and higher significance. Low r^2 values over the middle and later phases of railway development render the relationship of capital outlays to returns unstable over time, implying that after initial construction of route networks, longer term factors like the level and utilisation of railway capacity come more into play in determining the level of incremental capital outlays. Since much less of this capital investment now goes into route expansion, gestation lags become correspondingly shorter and the returns more immediate so long as the traffic response is prompt. Incremental outlay of capital varies with the availability of resources for investment and for meeting the working expenses of railways. While an increase in availability enhances investment possibilities, a decrease seriously affects the level of capital increment with resources having to be diverted to finance working expenses. The reversed regression which seeks to identify the effect of capital returns on the level of capital investment thus shows a stronger positive relationship, establishing that in the most recent phase of railway development in India, it has been the prevailing level of railway returns which has effectively determined the quantum of additional capital investment and not vice versa. The changing relationship between the two capital factors during different phases of railway development warrants further elaboration because of the critical importance that capital returns have in determining the attractiveness of railway investment.

In India, railway investment has subserved different purposes at different times. During the early phase, the objective was moulded by the political and economic exigency of colonialism, which allowed the state to underwrite the vast corpus of private capital investment despite low capital returns. In the middle phase, the volume of investment was determined by the compulsions of war and depression and by the need for continuing state action to prevent recurrence of the famines which had periodically plagued the country. During the planning era on the other hand, railway investment has been largely focused around the urgency of establishing an industrial base and balancing growth of the country's regions. Within the pre-Independence period, the earliest decades commencing with award of the first railway construction contracts of 1849 were dominated by highly capital-intensive construction projects for route & track, financed by direct borrowings from a then-healthy London financial market. The initial phase was thus marked by network extension that bridged the spaces of the country and created new agglomerated markets. Fig 3.1*a* which illustrates the phase, displays highly fluctuating incremental capital outlays exemplifying the lumpiness of the 'sunk-capital' investments undertaken between 1856 and 1868, with negligible returns accruing to capital-at-charge. The relative position of railway outlays versus returns in India was in fact similar to all railway construction projects undertaken in other countries during the early period and moreover is generally characteristic for all infrastructural projects. Capital returns thus only registered an uptrend after 1861 when new traffic demands began to materialise from the newly-uplinked markets. Once operations stabilised after completion of major trunk routes over that period, incremental investment outlays declined considerably.

Railway administration had by this time entered another phase with government taking over the task of railway construction from private companies, who would henceforth be concerned solely with the operation of the railways. Because of the past experience with company renewal funds, whereby high accounting losses from railway operations could be shown because of the practice of debiting replacement expenditure to costs rather than to revenue capital, future safeguards were simultaneously instituted which included abolition of renewal funds. While the takeover thus saved the government from having to meet interest guarantees, the level of new investment also suffered as little private capital was forthcoming without assured incentives and because the London money market had in the meantime begun to dry up. Gross railway earnings as indicated in Table 3.1a however began to improve since 1869 with the railway companies showing better traffic performance. Till 1869, working expenses had also been at levels well below gross earnings, allowing a certain amount of reinvestment by the railway companies. Between 1873 and 1910 however, additional investment was restricted merely to maintenance of railway operations and thus averaged 4 percent as can be seen in the figure. The occasional spurts during the period indicate sporadic acquisition of capital assets to replenish stocks.

It is interesting to take note of the degree to which railway investment suffered after government takeover of railway construction. The returns on capital invested during the period show an apparent constancy, with no lagged response that is attributable to incremental capital outlays, probably because of the low order of these increments. Indian railway history however shows that a recovery from the situation of static railway investments which prevailed between the late-1880s and the turn of the century, had been made by 1910 when the Mackay Committee recommendation for further expansion of the route network marks a concurrent uptrend in incremental outlays. This phase was however shortlived, and the middle phase of railway development more affected by exogenous aberrations, as already stated.

Thus the period commencing in 1910 and ending with Independence, which is illustrated by Fig 3.1*b*, shows sorry levels of railway investment as a whole, although in several subperiods capital returns show a rise which can be attributed to intensive use of the railway system. Expansion of the network however remained depressed since the major trunk and feeder routes had already been constructed. Although the period would thus appear to present a transportation 'equilibrium' where a static network was being utilised with different degrees of efficiency which reflected in the annual rate of capital returns, an important evolutionary change was taking place in the economy during the period. Two parts to this change were internal developments within the markets that had been networked by the railways, and multiplication of their downstream linkages which generated increasing industrial demand for transport services and consequently yielded higher revenues from smaller traffic expansions. The WWI period was however marked by an initial investment slump and lowered returns as revenue-earning traffic had to make way for military materials and provisions. After the war, the initial spurt in railway investment which peaked between 1920-21 and 1922-23 was mainly on account of the replacement of overused assets. Then for the first time, the Indian railways suffered a major setback from sharp decline in their gross revenues consequent to the high cost of operations and to an industrial slowdown once the production impetus provided by war had petered out. This postwar setback was however temporary, and increase in the momentum of internal trade improved the rate of returns.[11]

By now, overall concern of the government had turned to the more longterm problem of making the railway companies self-supporting, rendered more acute by the fact that, with abolition of renewal funds, even the replacement of railway assets was then being financed by capital borrowings. Resultant deterioration in the capital position of the railways was sought to be reversed by the IRC recommendations of 1921. Although the IRC reforms endowed the Indian railway companies with financial autonomy, their impact on financial health of the railways is not seen as sustained. Thus while the reforms were successful in improving efficiency and revenue earnings, capital returns on the average declined from 6.01 percent p.a. between 1909-19 to 5.35 percent p.a. between 1919-29.

During the postwar recovery, economic prosperity had prevailed in general. The railways thus generated revenue surpluses and were able to substantially increase capital-at-charge, as a result of which investment projects for augmenting the network and capacity were undertaken in a hurry which adversely affected cost estimates.[12] As a consequence, the operating ratio (the percentage of working expenses to revenues) increased from 48 percent to 63 percent in just ten years following 1918-19. Recessionary conditions which then prevailed over the greater part of the 1930s reduced the chances for recovery since no investment was forthcoming, and returns fell further to an average 3.86 percent p.a. between 1929-39 with only marginal increase in capital-at-charge over the same period. While incremental capital outlay declined continuously and hit an all-time (negative) low in 1937-38, gross railway earnings after 1931 also fell drastically, raising operating ratios since the working expenses of the railways still had to be sustained. Additional investments made thereafter then remained at low percentage levels till commencement of a new phase after Independence. However intensive utilisation of railway assets during the WWII period raised capital returns to an average of 7.02 percent p.a. during the decade 1939-49.

Fig 3.1*c* which illustrates the post-Independence period commences in a sharp drawdown in incremental railway capital outlays and reduced capital returns over 1947-48, following division of railway assets and stocks between the Indian Railways and the Pakistan Railways. The years between 1948-1951 thus saw an investment pickup on account of the urgent need to replenish railway stocks. The period thereafter which begins with the commencement of planning then shows an interesting pattern of alternate rising and falling waves in incremental outlays and capital returns coincident with the FYPs. Capital investment increased markedly with the 1FYP when effort was made to restore the operational capabilities of IR. With the 2FYP, the plan objective of industrialising the country also sought a corresponding widening of the infrastructural base of the economy and was therefore marked by continuous rise in incremental capital outlays to the railways, with an investment peak occurring just after the mid-plan. A fall thereafter was soon reversed with commencement of the 3FYP. The trends for the two FYPs thus show twin humps of investment over consecutive plans until industrial recession commenced in the mid-1960s with a sharp dip in capital outlays during the annual plans. It is pertinent to note however that the increases in incremental outlays during the 1950s and 1960s did not bring about a rise in traffic and either immediate or deferred increase in the rate of capital returns to any appreciable extent, which probably proved a disincentive to the planning of further railway capacity increases ahead of existing demand. For this reason, the pattern of low incremental investment during the IR 'plateau' until the end of the 1970s appears to have been dictated by the low level of capital returns, rather than vice-versa. As a result, the reversed regression relationship appears more typical of the period after the 3FYP during which incremental capital outlays were determined by the expected level of returns rather than being autonomously determined.

Another observation about the overall post-Independence pattern of railway capital outlays and returns relates the unevenness of the investment on railway development. The period itself can be divided into three sub-phases of high capital growth during the early plans, a slump through the middle, and gradual recovery in the period commencing with the 6FYP. The question of causality is important here. Although the first sub-phase spanning the first three plans initiated forward-looking autonomous growth in railway capacity independently of traffic demand, the purpose of the high capital outlays made during that time was to strengthen the downstream linkages of IR in order to stimulate the later growth of demand. The shift in the policy attitudes towards selective management of demand through the modernisation of operations instead of general augmentation of capacity which is observed in the intermediate period accompanies dwindling capital returns, down from average levels of 5.96 percent p.a. between 1949-59 to just 4.37 percent p.a between 1969-79. Not till commencement of the 6FYP was there another a noticeable investment hump, which is seen to be followed by yet another during the 7FYP. An interesting feature of the relation between capital returns and outlays is the subsequent return to the original order of causality where incremental capital investments again apparently determine the level of returns, although with noticeable lag. This reordered relationship which again becomes prominent towards the end of the 1970s then continues into the contemporary period. The phase after the 5FYP can thus be described as a period of rejuvenation for the railways in India in capital terms, from their capacity slump in the middle period.

With reference to the whole period that is being reviewed here, which spans the history of the Indian railways from their inception, the striking observation can be made that returns to railway capital have average out to below 5 percent p.a.. Even if focus is restricted to the present century, in order to obviate the long 19th century teething-period when traffic was still developing, capital returns only rise to 5.48 percent p.a.. In comparison, railway capital returns over the post-Independence period average out to 5.40 percent p.a., *i.e.* are lower even than average railway returns over the nine decades of the century. It is well identified therefore that the problem of low capital returns on the Indian railways has persisted at all times, seriously affecting the prospects of railway growth in the long term. Although it might be argued in partial defence that the low percentage returns to post-plan capital investment occur at least partly as a result of the high level of incremental outlays which have rapidly increased the capital base of IR, the fact still remains that returns of barely over 5 percent are unlikely in the near future to stimulate growth of railway capacity and traffic. It stands to reason then that capital adequacy on the railway network shall for a long time to come have to depend on autonomous government support. It may also be noted that the highest annual returns of 9.9 percent p.a. recorded over the present century were during WWII in 1943-44. In post-planning era, the highest returns recorded were 8.7 percent p.a. in 1991-92, and in most plan-years have averaged well below 6 percent. Low returns to investment thus remains the bane of IR.

The foregoing analysis of investment trends and the financial position of Indian railways reveals that periodic replenishment of capital stock becomes imperative both for maintaining operational levels of the railways as well as for tuning transportation capacity to the momentum of development generated within the economy. While exogenous factors have from time to time been responsible for deterioration in the finances of the railways, policy attitudes towards infrastructural investment in general also assume a decisive dimension. Besides the limitation of a part of railway revenues having to be mandatorily deposited towards general revenues of the government, interest charges on borrowed railway capital lower net earnings and the scope for further incremental investment. As a result the depreciation reserves which are statutorily maintained for the renewal of assets have periodically been drawn upon to tide over a financial crisis, such as for instance, during WWII when withdrawals towards meeting working expenses were made from the Depreciation Reserve Fund and contribution to general government revenues had to be deferred.[13] The importance of the relative modes adopted for financing renewal and net investment on the railways hardly needs further emphasis, and is undertaken as an exercise in the next section.

3.2.2 Sources of Indian Railway Finance

Since times when the earliest railways were built in India by sterling companies, several metamorphoses in railway capitalisation occurred until the system finally settled into an eventual mode of government finance through plan and non-plan components of the General and Railway Budgets. The first guarantee arrangements were made with two sterling companies as early as 1849, at a time when railway development in Britain was also in its heyday. However the extension of guarantee only became *de rigeur* from 1856 onwards, when Dalhousie observed in his famous 'Railway Minute' that the conduct of commercial undertakings did not properly fall within the purview of government.

Over the period from 1858-59 until 1918-19, when the ownership of the railways in British India was repurchased by government against the payment of capital-at-charge and operating responsibilities entrusted to management companies, cumulative losses to the government on the payment of guarantees amounted to nearly 6.8 million pounds. The mounting burden of guarantees had already aroused criticism earlier, and for several years after 1869, capital expenditure on railways was in a large proportion being met directly by the state. An alternative experiment with 20-year subsidies that was tried out with two companies in 1862 failed to attract private capital. Nevertheless, following the Great Famine of 1878 which led the Famine Commission to stress the need for rapid development of railway, reliance was again placed on private railway capital without however conceding guarantee terms.

After 1893, when the trunk network had already been constructed, railway development mostly focused on the branch and feeder network where the scope for operating profits was lower. Hence terms of individual contracts were frequently amended with the overall object of sustaining capital inflow. While the major initiative for railway development by stimulating private capital inflows devolved on government, some of the Indian princely states also built railway networks of their own either under state or company ownership while District Boards also contributed to railway capital through special cesses, in both cases demarcating an alternative cost-sharing mode. Although by the time the IRC reviewed the position in 1920-21, only around one-seventh of the track network (or around 41,000km) remained under company control, extensive public pressure for state ownership of railways caused government to take over major systems like the East Indian Railway and Great Indian Peninsula Railways, and to let other lines revert through efflux of time. It is to be noted that the period coincides with the amalgamation of railway companies in Britain, reflecting the extension of thinking.

It has already been noted elsewhere in the present chapter that the period thereafter saw a partly exogenous slump in capitalisation levels which deepened with world depression, although no further change in railway financing modes occurred until the return to state finance with railway nationalisation and formation of IR after Independence.

3.2.3 Dividend Liabilities of Indian Railways

The more interesting aspect of the period after WWI relates to revision of the modes for financing replacement investment. Separation of railway from general finances was made in 1924 under recommendation of the IRC or Acworth Committee, with the purpose of rendering railway administration independent of Government's Finance Department, and for introducing in-house accounting procedures accompanied by annual contribution to a reserve fund explicitly set up to finance the renewal and replacement of railway assets. Railway finances have been administered since 20 September 1924, by the Financial Commissioner, Railways, in separation from the Accountant-General, Public Works Department. The first of the above purposes in fact indirectly acknowledged the need to delink railway capital flows from the trends in economic activity which define the size of government budgets. The IRC recommendations in general sought to professionalise railway management while maintaining constant internal capital support for railway operations. It needs to be noted that most of the pre-Independence railway network was already in place in 1924 when the IRC recommendations were made. Thus the object of the recommendations was not primarily to finance railway expansion, but to maintain existing operational levels without capital drawback - a position which remained fundamentally unchanged until the inception of planning in independent India necessitated the sinking of new capital into railway construction and upgradation.

In order to compensate government for the loss of direct revenues that would ensue from the separation of finances, the two substitute concepts that arose were that of a *contribution* or *dividend* from working surpluses earned by the railways, and an *interest* against railway capital-at-charge. The first of these, as an annual contribution to the general revenues of the government, was to be payable as first charge on net railway receipts, and would be secured against the reserve fund. The annual contribution was later reviewed and revised under the Railway Convention of 1943 into a specified sum payable as dividend. Since the contribution over and above interest on capital has been payable to general revenues in all years since 1924, with the eventual railway surplus or deficit only being accounted after its settlement, the dividend provision has become the bone of contention ever since the IR have begun to suffer shortfalls on the capital account and in budgetary support.

A Railway Reserve Fund had also been created for the Indian railways through the Separation Convention of 1924, to which credits were liable to be made from net revenues after the contributions to general revenues had already been made. The proportion of surplus that could be so credited was scaled by a sharing formula between the railways and government on the total magnitude of surplus earned. After the nationalisation of railways from 1950, the fund was renamed the Revenue Reserve Fund [RRF] and appropriations from the railway surplus could be credited to it subject to parliamentary approval. The RRF was to serve as security for dividend contributions to be made to general revenues, and could also be tapped to meet any deficits that might occur against railway operations. However the introduction of the principle of deferred dividend liability from 1978 led to dissolution of the Fund since its original purpose had been lost.

The review of railway conventions made in 1949 after Independence, endorsed the nationalisation of the Indian railway companies, according the general taxpayer the status of sole shareholder. The Government of India gave effect to this recommendation on 1 April 1950. Although - after slight modifications in their spirit - dividend contributions were liable to continue, dividend reliefs were given on certain exempt categories of capital including losses on strategic, new or unremunerative lines, and a part of railway works-in- progress. On the latter works however, and on shortfalls in net railway revenues, the payments due would cumulate into a deferred dividend liability payable against future surpluses. Total payments made by Indian railways to general revenues of the government between 1924-25 and 1992-93 amount to Rs.12,204 crore, or 62.66

percent of total railway capital-at-charge. Till the Railway Convention of 1949, railway payments had also included the concept of an annual contribution from surplus, and a contribution of Rs.474.86 crore over and above normal dividend had been committed on this count between 1924-25 and 1949-50, before the concept went out of force.

Dividend payments by IR have accrued against a perpetual liability on non-repayable capital loans sourced through budgetary support from general government revenues and bearing interest in perpetuity. Together, all such loans are accounted as railway capital-at-charge. A supplementary source of capital allowed since 1992-93 has credited some part of net revenues to a Capital Fund which can be used to finance capital projects. All other railway investments, are to be met from internally-generated resources, including expenditure on renewal and replacement of railway assets, which may be met from the Depreciation Reserve Fund [DRF]. Except over the depression years between 1930-31 and 1939-40 when there were temporary defaults in payment in the contribution or dividend part, the railways were able to make regular contributions to government revenues uptil the end of the 3FYP in 1965-66. Thereafter as net revenues slipped, regular shortfalls appeared which were made up either by withdrawals from the Railway Reserve Fund which secured them or through current borrowings from general revenues, or else were carried forward as deferred dividend obligations. The largest shortfalls in dividend payments occurred towards the closing years of the 4FYP, and at the commencement and the end of the 6FYP.

3.2.4 IR Provisions for Capital Depreciation

Other special-purpose capital funds maintained by IR at different points of time included the Development Fund [DF], the Accident Compensation, Safety & Passenger Amenities Fund [ACSPF] and the Pension Fund. Another source of extra-budgetary bond financing was created more recently with the establishment of the Indian Railway Finance Corporation [IRFC] in 1986 to organise leasing of railway rolling stock. Since the primary source for renewal and replacement funding had shifted in 1924 under IRC recommendations, from current railway revenues to the DRF, a few words might be said about evolution since then of the depreciation provisions. The 1924 Convention had first laid down as a scientific principle that replacement and renewal of railway assets should be financed by funds specifically laid by for the purpose rather than by drawing upon current revenues. Although the amounts to be credited to the DRF initially covered the original cost of renewable assets, it was decided after 1936-37 that drawals from the fund could be made on the basis of either original or present cost, depending on which of these was greater, even though any excess replacement expenditure over original cost remained chargeable to capital. Only after 1949 did the depreciation provisions become more realistic, since they now allowed the securing of railway assets at full replacement costs, allowing also for improvement and inflationary components. Annual contributions to be made to the DRF by the railways had, before nationalisation, been estimated either by accounting or *ad hoc* provisions against the depreciation of wasting and non-wasting assets. The principle of fixed appropriations was continued between 1950 and 1983, until the practice was changed under recommendations of the Railway Reforms Committees [RRC]. Contributions to DRF since then have been made at around 2.6 percent of the current replacement cost of assets, with allowance of 8 percent for inflation upto 1992-93, which was subsequently raised to 10 percent.

The RRC recommendations had basically arisen after the investigation by the Committee was confronted by huge physical arrears in renewal and replacement of railway assets which would require consolidated investments of Rs.26,000 crore (estimated at 1981-82 prices) to wipe out, and the 2.6 percent provision was calculated against the current replacements costs of these worn-out assets. The practice before this had been to subjectively fix the depreciation appropriations in line with the estimated withdrawal for every given year. Also, though DRF was not included within overall plan resources till the end of 4FYP, its inclusion thereafter had left IR powerless to decide its own priorities for replacement and renewal, leading to a paradoxical situation where as DRF balances rose steadily, the arrears in physical renewal also mounted. A certain amount of accounting jugglery between the Finance Ministry and the Railway Board was associated with this circumstance, which arranged that additional capital support to IR from the government's general revenues would be scaled according to the balances accumulating within the DRF. Although superficially, the arrangement should have had no effect on capital expenditure by IR, what resulted in practice was that the additional capital grant attracted perpetual dividend liability, which would have not been the case if the IR had been allowed to finance renewals from internal resources which had been vested in the DRF.[14]

Another RRC recommendation designed to ease unfair capital pressures on IR stated that appropriations to the DRF should not be given the goby in attempts to meet dividend obligations during years when the revenue performance of the railways had been bad. Previous occurrences of this practice had often bled IR of its internal resources.

Summing up the foregoing, the asset-renewal position on IR has hardly changed since the time when the IRC was constrained to make caustic observations[15] on the bad accounting practice of allowing old, overaged and fully-depreciated railway assets to remain on the books, instead of writing them off from Revenue. Since the practice has since continued through deferment of capital expenditure on renewals and replacement, and as just stated, through payment of dividends ahead of making DRF appropriations, the railways in India have often been able to present an 'unreal, rosy financial picture'[16] hardly reflective of their dire assets position.

The fact that no separate provisions have been made at any given time against the *arrears* of depreciation arising from the deferment of renewal expenditure has been another disturbing feature. High levels of such arrears have existed on the Indian railways system during the two world wars, the depression years and again, during and after the 1970s. Even the RRC recommendation requiring that special budgetary support of Rs.260 crore *p.a.* be extended as a subsidy for wiping out arrears has not been assented to. The RRC also noted specifically that tariff revisions should not be made against these arrears - which actually represent costs that should have been written off - since this would penalise current railway users for past omissions.[17] It may also be noted from the above that perpetual dividend liability has worked to the long term detriment of railway finances, since no consideration has been given to revenue shortfalls while requiring the dividend to be credited. Hence in such cases, the RFFC recommended waiver of the dividend shortfall for a maximum period of 5 years, over which IR would be required to nurse their operations back to health. Although no occasion has arisen to seek support, after the uptrend in rates and revenues following the recent revisions in tariff, the evidence of the past makes a strong case for inclusion of this provision.

3.3 Early Freight Performance of Indian Railways

Two distinct periods can be discerned in the history of railway transportation in India. Prior to Independence the main objective had been the introduction of a mechanised transportation system to serve political and economic policies adopted by the British government. In the post-Independence phase, transportation concerns have focused on meeting national needs adequately so as to register a sustained development of the economy.

Within the pre-Independence period, two features stand out that are not consistent with each other. Mechanisation of economic flows following from the building of the railways generated growing volumes of merchandise and trade, inspite of which the country failed to progress economically. Secondly, while the railways in India soon became the major mode of transport, fulfilling one of the essential prerequisites for economic growth, they proved wholly inadequate in generating development momentum. Early administrative policies of the government that had guided the construction of railways were not conducive towards their viable operation, but the losses arising against payouts of the interest guarantee had to be borne by the Indian taxpayers. Nor did the colonial policy of using the railways to facilitate the transportation of raw materials to British manufactures enhance the prospects of industrialisation in India and increased movements of freight on the railway system as its further consequence. Such obvious disincentives were further aggravated by a policy of levying low tariffs on freight originating in or destined towards ports, which effectively favoured imports of foreign manufactures and exports of raw materials.[18] This was especially detrimental to industrialisation, since while it generated activity around port- cities, the inland centres suffered the decline of many domestic industries including Indian handicrafts. Nascent industry nevertheless developed near the ports, as exemplified by the growth of textile manufacturing at Bombay, and of the mill sector comprising oil, flour and jute mills in the vicinity of Calcutta, both centres reaping benefits from low freight rates on their respective raw materials.[19] The mining of coal was also stimulated but did not bring forth the development of heavy industries until the advent of planning in the post-Independence era.

Although data availability for the early railway period is obviously limited, three operational aspects of growth in freight transport operations, namely originating tonnages, net tonne-kilometers and average freighting leads of Indian freight might now be scanned to identify factors in the growth of the economy prior to Independence. Although railway reformation brought on by the Acworth Committee Report of 1921 had endowed the Indian railway companies with organisational autonomy from the state exchequer after separation of Railway and General Budgets, this did not translate immediately into increased financial or operational viability. Boom conditions in the economy had in any case abated over the 1920s, and the larger part of the 1930s was beset with severe recessionary conditions, even though India with its low level of industrial development was somewhat insulated from the throes of world depression. But, as the Acworth Report had then commented, the railway companies did not maintain data other than standard financial indicators in the preceding years and hence the earliest compilations of technical data refer to a period well into the 1930s. These are presented in the table, with data for the years that immediately followed freedom in 1947 being included to provide a sense of their continuity.

Table 3.2: Early Freight Performance of the Railways in India

Year	*All-gauge* Originating Tonnage *[MT]*	*All-gauge* Traffic *[billion NTKm]*	Average Lead *[Km]*	Running Track Network *[Km]*	*BG+MG* Gross Passenger -Km	*BG+MG* Gross Freight -Km	*BG+MG* Total Train-Km	*BG+MG* Freight Train-Km	Wagon -Days	*BG+MG* Online Wagon Fleet	Wagons Daily Offline	Total Wagon Fleet
1938	85.75	35	408	38007	56.3	88.3	283.7	110.22	74898	199148	9836	208984
1939	89.82	37.1	413	37996	55.6	93.2	286.6	115.37	75386	199830	10237	210067
1940	90.63	40.0	442	37933	57.0	98.6	289.8	119.07	76365	202958	9400	212358
1941	95.00	44.7	471	38568	58.9	107.4	299.1	130.49	75932	201958	8592	210550
1942	92.36	44.8	485	38598	51.2	102.4	253.6	121.96	74167	197264	7927	205191
1943	93.17	45.3	487	38615	53.9	101.4	247.0	119.55	74076	196517	7416	203933
1944	98.15	45.4	462	38992	60.8	104.1	257.9	122.44	77388	206237	8610	214847
1945	98.25	46.5	474	39090	64.2	108.6	273.9	127.92	84752	226425	11232	237657
1946	89.11	43.0	483	39061	64.0	102.1	285.8	121.16	87995	235331	16858	252189
1947	70.92	32.5	458	32165	48.1	76.7	220.6	91.71	74620	198965	13028	211993
1948	79.76	36.4	457	32039	52.0	83.5	235.7	94.61	72552	193874	15278	209152
1949	89.11	40.6	456	32502	54.8	94.0	253.6	105.39	73235	194510	15068	209578
1950	92.87	43.7	470	32565	59.6	98.7	262.1	111.50	74857	198305	15133	213438
1951	98.25	47.0	478	34317	62.3	104.9	280.1	117.62	75283	198943	15777	214720
1952	98.66	46.8	475	34518	62.8	106.4	284.6	120.19	78197	206579	15943	222522
1953	99.67	47.7	479	34686	65.2	107.3	288.5	118.58	81461	215137	15854	230991

Source: Adapted from *IRYB 1953-54*, Directorate of Statistics & Economics, Ministry of Railways, Government of India, New Delhi; all figures have been converted to appropriate metric units

The period under consideration is influenced by two major political events which had transport consequences in India as well as the world. WWII which commenced in 1939 and culminated in 1945 involved the Indian economy into Britain's war effort because of its status as a British colony, and took its toll as resources were diverted towards serving and provisioning military objectives. The second event which had its impact within India was the achievement of independence from British rule in 1947. Euphoria over the end of colonial bondage was however severely dampened by the partition of India and transfers of territory, population and associated resources, which that event entailed, leading to partial recession within the economy.

3.3.1 Freight Traffic & Tonnage Trends

No marked tendency towards growth in tonnages carried on the railways is visible over the war-affected period of 1939-1945, although these nearly constant tonnages were being carried over greater distances because of the freight logistics of WWII and its eastern war theatre. As a result the rise in tonne-km traffic over the war period is much stronger than that in originating tonnages, and the dip in tonnages between 1942-43 is hardly reflected in the corresponding net tonne-km figures The second dip in both tonnages and traffic in 1946 is likely to have followed the lessening of the buoyant effect of the war on the railways, and marked contraction in both tonnages and traffic in 1947 was a direct consequence of the partition of the country and its railway system after the attainment of independence. It will also be seen that the division of India implied greater loss of originating tonnages than of traffic. The Indian Railways seem to have been occupied over the rest of the 1940s in recovering the traffic and tonnages lost as a result from Partition.

Further evidence of this divergence between tonnage and traffic trends is found in the figures on average freight leads. The immediate expansion in journey distances brought on by the onset of WWII is seen to have been largely maintained after the end of the war, although average freight leads declined slightly from the high of 487km reached in 1943. The immediate impact of Independence is seen to have been a fall in journey distances of which one of the principal causes was the separation of the major northern port of Karachi. It is only well into the 1FYP period that average leads begin to recover, along with tonnages and tonne-km traffic.

Considering freight tonnages and freight traffic on the Indian railways in the late-1930s and 1940s in associative terms, these are seen to have been more tonnage-influenced than distance-influenced at the end of the 1930s, also reflecting the lower traffic leads of that period. While WWII boosted both rail tonnages and freight traffic, the growth over the war period was influenced more by rising freighting distances rather than rising tonnages. The steepest fall in both tonnages and traffic thereafter occurred in 1947, and at least three years elapsed before these could recover to the pre-partition levels of 1946. While the degree of association between tonnages and tonnage-distances remained largely unchanging in most years under current reference, the correspondence was skewed towards tonnages originating in two periods of the late-1930s and again in the two years immediately following Partition in 1947. It might however also be noted that the intrinsic reasons for the skewing (as apart from historical reasons) were different between the two periods, since while the late 1930s saw quickly rising tonnage freight relative to average haulage distances, the events some ten years later brought about more contraction in journey leads than in freighting tonnages. The latter situation was obviously brought on by losses of territory and a part of the railway network.

It is nevertheless noticed that over the entire period under review between 1938 and 1953, tonnage trends were more static than growing, even though the traffic and distance composition would have been changing. An inference that could be drawn from the relative constancy of the former is that of full utilisation of the railway capacity then existing, without significant addition to this capacity taking place. Since the war effort would have involved new tonnage traffic, freightage of this could only have been possible through substitution of existing tonnages, leading to results as dangerous as the manmade Bengal Famine of 1942-43, which arose basically through the lack of timely transportation of foodgrains and other relief material because of saturation of railway capacity by military traffic. In fact, the reduction in military traffic with the end of the war is matched by an immediate fall in originating tonnages. The data would also imply that railway and freight operations in the colonial period were not growth-oriented, but simply 'marked time', in a manner of speaking. The lack of growth in tonnages would have been sustained by the relatively constant population with relatively constant living standards. In contrast, the recovery in railway operations following 1947 would have been qualitatively different since it had to be based on restoration of railway network and equipment through new investment, to meet the needs of a smaller population. Thus the main impact of Indian Independence on the railways was - for the first time - a forward-looking regimen of growing investment, growing operations and growing traffic demands.

Although this first assertion of infrastructure-building for a new country may seem somewhat unremarkable in terms of addition to tonnage freight, it needs to be remembered that the recovery just mentioned was achieved after the transfer of a significant proportion of the broad-gauge [BG] network associated with Karachi Port to West Pakistan. This transferred portion had been a major corridor for the carriage of freight to and from North India and hence had high traffic as well as high capacity from the use of the broader BG vehicle platforms. After Partition, the Indian portion of this traffic had to be largely rerouted through the port of Bombay.

3.3.2 Operational Intensity of Railway Freight

Substantiation for the inference on increased intensity of freight operations on the railway system because of military imperatives during the war years is found while considering relative passenger-intensity *versus* freight-intensity of rail movements in the period under reference. It is noticed that the war years between 1941-45 all show a common increase in freight train kilometres, while at the height of the war this increase had to be achieved through restraint on passenger operations, even at the cost of increasing empty haulages, reflected in deviation between net and gross freight intensity as represented in the freight-train-km and gross freight-km data. The fact that such a trade-off had to be made also substantiates the situation of saturated railway capacity faced by the Indian economy in those years. The effect of Partition on the relative intensity of freight and passenger operations is also observed to have caused an immediate fall in passenger movements to a sharper degree than the associated fall in freight intensity. But with recovery of the economy, freight and passenger movements also multiplied, with neither having to chase out the other, since railway capacity was also being augmented.

As had been earlier witnessed in respect of WWI, the onset of conflict brought about sharp escalations in railway operations, but at the eventual cost of overuse of railway equipment and inventory till the point of capacity decline. It would be interesting to examine whether this course of events was replicated during WWII. Consideration may therefore first be made of the associations between online railway wagonfleets and the intensity of wagon use. In general, over the time period under consideration the rate at which wagons were deployed for freight operations bore a more or less constant ratio to the available stock of wagons. However - especially in view of war-exigencies - the deferral of wagon replacement in order to sustain the high levels of freight operations necessitated by war would cause deterioration in the quality of online wagonfleet, and it needs therefore to be explored whether such a situation did indeed occur over WWII.

A part of this evaluation would rest on whether increases in the intensity of use of railway wagons as measured in *wagon-days, i.e.* as standard multiples of their standardised 5 hours of online deployment, were matched by lateral expansion of the online wagonfleet or not.[20] Where matching was maintained, the hours of wagon-use and wagon maintenance and replacement schedules would remain unaffected by increases in freight traffic, as operational intensity would have been optimised. But since such idealised circumstances could hardly have been sustained through a period of war, where replacements and maintenance could be expected to suffer because of prior commitment of financial as well as material resources to the war effort, periods might well exist when increased military traffic could only have been carried by extending the normal hours of wagon use.

Turning to wagon data for the war years, it can be seen now that the sharp increase in freight traffic during WWII were sustained on the increased intensity of wagon use, generally without significant augmentation in the online wagonfleet, although as many as 3128 wagons were added in 1941 as part of the war mobilisation. Since sharp falls subsequently took place in the availability of wagons online, the dip in tonnages in 1942-43 noted in the preceding study of freight operations is now seen to have been the partial product of static hours of wagon deployment over longer traffic leads, all reflecting the debilitated condition of the online fleet. Significant restorations of the wagonfleet were therefore necessitated as the war rose to a climax in 1944-45, in order to increase the availability of wagons for deployment. Once WWII was over, a fleet decline set in again after the fall-off in traffic reduced immediate freight pressures on the online fleet, and intensified in the aftermath of Partition because of further loss of traffic. The consequent pressures were absorbed by increasing wagon deployment, evidence of which is offered by the fast-increasing ratio of wagon days to wagonfleet, at least till 1948-49. Gradual recovery of the economy subsequent to that period saw fleet acquisitions rise over the planning era, lowering wagon deployment to more acceptable levels.

An important performance statistic widely used in evaluating railway systems across the world is the ratio of net tonne-km traffic to wagon-days, which serves as a productivity index for the deployment of railway wagons. Over the war-years, the increase in tonne-km traffic stayed consistently ahead of the increase in wagon deployment, reflecting higher tonnage loadings and longer haulage distance for each wagon online. The hill was crossed in 1945 when the war ended, and productivity per wagon dwindled further over the next three years, during which the Partition-induced slump in tonnages and traffic brought railway operational productivity down to a new low. The recovery in wagon productivity after 1948 may be deemed especially strong after consideration that the size of the railway network administered and the spatial spread of freight services had both been reduced by the loss of territory. Thus the trend set by the economic renaissance within the country after the achievement of Indian Independence, raised both traffic handled as well as productivity, with the implication that better utilisation of the online wagonfleet was being made. Since augmentation was also simultaneously being made to the online fleet, the improvement in productivity was not being achieved at the cost of wagon overuse and longterm deterioration of fleet quality, as had been the case when operational freight productivity had risen over WWII.

Another productivity factor usually defined for the railways relates to the intensity of track use, defined in turn by the running frequency in freight services. In terms of this index, clear demarcation occurs between pre- and post-Partition phases because of the underlying truncation in the IR network-size. Over most of the war-years, increases in freight demands were met more by increasing the intensity of wagon use than by increasing the intensity of track use, mainly following from the lack of idle inventories of rolling stock and traction units. The loss of a part of the running inventories consequent to Partition, immediately brought about a drastic reduction in the running intensity of freight services, both because of the lack of equipment and reduction in traffic demand, although the slow buildup in rolling stock thereafter would indicate that the constraints operating were more on the equipment side than in traffic demand. As a new pace for railway operations was then set by the advent of planning in India, increased productivity in railway operations has since been indicated both by more optimal wagon use and increased track use, as the data would indicate.

Table 3.3: Growth of Freight Traffic on Indian Railways 1950-51 to 1994-95

	FOR REVENUE-EARNING FREIGHT TRAFFIC					
Year	Originating Tonnages *MT*	*Indexed Growth*	Net Tonne-km Traffic *billion NTKm*	*Indexed Growth*	Average Traffic Lead *Km*	*Indexed Growth*
1950-51	73.2	*100*	37.6	*100*	513	*100*
1955-56	92.2	*126*	50.4	*134*	541	*106*
1960-61	119.8	*164*	72.3	*193*	603	*118*
1961-62	125.6	*172*	75.4	*201*	600	*117*
1962-63	139.4	*190*	83.1	*221*	596	*116*
1963-64	147.6	*202*	88.6	*236*	600	*117*
1964-65	148.8	*203*	88.7	*236*	596	*116*
1965-66	162.0	*221*	99.0	*264*	611	*119*
1966-67	164.0	*224*	99.2	*264*	605	*118*
1967-68	162.4	*222*	101.2	*269*	623	*121*
1968-69	170.8	*233*	108.1	*288*	633	*123*
1969-70	173.8	*237*	111.8	*298*	643	*125*
1970-71	167.9	*229*	110.7	*295*	659	*129*
1971-72	170.1	*232*	116.9	*311*	687	*134*
1972-73	175.3	*240*	121.2	*323*	691	*135*
1973-74	162.1	*221*	109.4	*291*	675	*132*
1974-75	173.6	*237*	121.4	*323*	699	*136*
1975-76	196.8	*269*	134.9	*359*	685	*134*
1976-77	212.6	*290*	144.0	*383*	677	*132*
1977-78	210.8	*288*	150.3	*400*	713	*139*
1978-79	199.6	*273*	143.9	*383*	721	*141*
1979-80	193.1	*264*	144.6	*385*	749	*146*
1980-81	195.9	*268*	147.7	*393*	754	*147*
1981-82	221.2	*302*	164.3	*437*	743	*145*
1982-83	228.8	*313*	167.8	*447*	733	*143*
1984-85	236.4	*323*	172.6	*460*	730	*142*
1985-86	258.5	*353*	196.6	*523*	760	*148*
1986-87	277.8	*380*	214.1	*570*	771	*150*
1987-88	290.2	*396*	222.5	*592*	767	*150*
1988-89	302.05	*413*	222.4	*592*	736	*144*
1989-90	309.97	*423*	229.6	*611*	741	*144*
1990-91	318.40	435	235.8	628	741	144
1991-92	337.98	462	250.2	666	740	144
1992-93	350.05	478	252.4	672	721	141
1993-94	358.72	490	252.4	672	704	137
1994-95	364.96	499	249.6	664	684	133

Source: Compiled from *IRYB*, various years, Directorate of Statistics & Economics, Railway Board, Ministry of Railways, Government of India

3.4 Railway Freight Trends over the Planning Period

After the upheavals that followed the partition of India involving dislocations of freight flow patterns and translocation of populations, as well as the loss of 10,523km of the railway route network, an initial slump in operations followed while the economy took stock of the residual Indian Railways infrastructure as it recovered. Estimates of traffic loss in 1947-48 would amount to 18.19 million tonnes-originating and 10.73 billion tonne km in terms of freight traffic, as well as 15.90 billion passenger km. As the losses in railway assets had also extended into rolling stock including traction, 29.44 million freight train km as well as 34.27 million passenger train km were lost over the year. Over 36 thousand wagons or nearly a seventh of the online freight fleet was transferred to the western and eastern Pakistan Railways systems. While the inventory loss represented the physical reduction in freight infrastructure , the traffic losses they caused combined traffic transfer to the Pakistan Railways, with traffic lost on the Indian network because of the uncertainties prevailing in the post-Partition period. Thus for IR, the years immediately after 1947 were years of recovery.

The momentum of this recovery did not however take long to escalate into a railway boom because of renewed impetus provided by the institution of Indian planning in 1950-51. The mood of the economy of decidedly upbeat in the early post-Independence period, partially because of the accumulation of sterling balances over WWII, and because the resurgence of nationalist feeling strengthened the Government resolve to build a strong economy. Table 3.3 above depicts operational trends of IR since then, with the annual figures from 1960-61 onwards covering the 35 years following the first two Five-Year Plans and occasional hiatuses that interspersed them. The performance parameters considered in the table all pertain to revenue-earning freight operations, with departmental traffic is excluded.

It may be noted in overview at the outset that the broad trends in IR operational performance indicate more or less continuous growth in freight operations spanning the entire period since institution of planning, as both loading tonnages and tonnage distances show several-fold increase. Reference to the indexed values of this increase in the table however shows that the growth of railway freight traffic in net tonne-km terms has been much stronger than the growth in freight tonnages, the sixfold increase in traffic generated by the quadrupled originating tonnage providing strong indication of widening in the distributional spread of railway operations coincident with progress of the economy. A more ambiguous trend is evident however in the table in figures for the average journey leads over which railway freight has been transported, which show a rise in freighting distances by nearly 50 percent. These overall trends are now analysed over various phases of planning in India in order to identify features peculiar to each which can provide operational indicators of the extent to which the development needs of the economy have been served by the railway infrastructure.

3.4.1 Rising Tonnages

Growth in originating freight tonnages over the planning horizon of eight five-year plans has not been smooth and has instead delineated phases of strong to moderate growth. The first phase of sustained growth covered the period of the first three FYPs from 1951-66 and was especially marked after the 2FYP, when the sectoral model for Indian planning was adopted and raised the emphasis on capital-led growth. As the railways were an infrastructural sector and moreover one with strong upstream and downstream linkages, a focus on railway investment was inevitable over the period and was initially encouraged by strong freight loading trends. Increase in railway capacity over 2FYP and 3FYP was in fact in advance of the growth of traffic. But with projected traffic failing to materialise over 3FYP and freight targets remaining under-fulfilled, slack appeared in IR's operational performance which continued into the period of the Plan Holiday and the 4FYP between 1966-74. It was also during this period that the first Oil Shock hit the economy and had cost-raising impacts on IR similar to those witnessed in the country- railway systems earlier reviewed. Thus the period between 1968-75 might be regarded as a 'plateau' period in railway operations when railway tonnages hovered around a static level instead of showing any marked tendency to increase.

In the meantime the excess capacity that had been created over 2FYP and 3FYP had dispersed as the economy slowly adjusted to the triple traumas of the 1965 Indo-Pakistan War, the 1966 famine and the rupee devaluation that followed. Adjustments to the two Oil Shocks however continued over the 1970s during 4FYP and 5FYP and the minor recovery in tonnages in 1975-78 after the first adjustment again went into a tailspin. The decade of the 1970s might therefore be considered as a period where the railways were not able to lead the revival of the economy, and financial performance over the period, which was considered earlier, will corroborate this. It may also be noticed in relation to Table 3.2 that the levels of plan investment on railways showed a sharp proportionate decline in the 1970s compared to the early plans, and the nominal railway outlay of Rs.1326 crore in the 3FYP was only surpassed during the 5FYP with a devalued rupee. The railways at the end of that plan were in virtual doldrums.

A study of corresponding plan investments will show a rise of nominal outlays on railways during 6FYP and after, reflecting belated realisation on the part of planners of the 1970s having been a 'lost' decade as far as infrastructure building was concerned. Although in proportionate terms, the outlay was smaller than in the previous plans, the impetus it provided combined with a recovering economy to push railway operational performance back into a growth curve. These trends continued through the succeeding plans uptil the present point of time, during which plan investments also continued to increase even as budgetary support dwindled. The period of the 1980s thus represents radical reversal of the earlier stagnation which had lasted for nearly 15 years following 3FYP, and needs to be accorded attention.

One of the important developments in Indian transportation planning, which coincided with the launching of the 6FYP, was the submission of the report of National Transport Planning Committee of the Planning Commission [NTPC] in 1980, to be discussed at length later. The NTPC Report was a coordination and perspective planning exercise that extended freight projections over the surface transportation modes into the 21st century and thus provided a stronger input for freight transportation planning in the FYPs. Despite dormancies in railway freight witnessed over the 1970s, the NTPC correctly diagnosed these as a symptom of general recessionary conditions in the economy rather than as more permanent lacunae, and predicted a rise in total railway freight traffic to between 435-468 billion net tonne-km by the turn of the century. It also held that uncoordinated growth of the roadways over the period reviewed had succeeded in diverting freight flows away from the railways because of overall shortages in railway capacity, and that the competition that had emerged was in fact wasteful as far as the allocation of planning resources was concerned, since bulk transportation capacity had to improve as a prerequisite to general economic recovery. Bulk transportation was in any case the preserve of IR and worked to the benefit of the PSU-dominated capital goods sector of the economy, hence the programme for economic revival stressed investment on the railways as an adjunct to plan and budgetary support for the industrial PSUs. These revisions of priority came at a time when official economic policy in India underwent its first liberalisation vis-a-vis the use of foreign capital funds and borrowings, which combined to restore buoyancy to railway freight operations.

The railway freight position in the 1990s has been coloured by the major tariff increases in 1992-93, after which a surplus character has been restored to the Railway Budget. Thus while financial performance of IR has improved since then, the enhancement in earnings has not entirely carried into the corresponding tonnage loadings which in fact show a setback immediately following the hike in freight rates, reflecting an elastic response. Nevertheless, originating freight tonnages at the present instant of time have risen very creditably to 430MT in 1997-98.[21] The major qualification that really needs to be made in this connection is that whereas the NTPC predictions were made on the basis of an ideal 72:28 ratio freight share between IR and the roadways, the current IR originating freight tonnages represent a loading share of 40 percent. In this sense IR is carrying less traffic relatively than would be warranted by the NTPC share projection, and traffic of around 32 percent - or around 344 MT of equivalent freight - has been lost to the roadways sector.

3.4.2 Growing Traffic Kilometerage

Complications are introduced into the study of long term railway trends by any changes that might take place in the commodity-composition of freight flows. In aggregated operational terms, this dimension of the traffic study would reflect upon the relative divergence of net tonne-km trends from trends in originating tonnages since for instance, increasing specialisation of railway freight operations towards carriage of bulk traffic would cause sharper rise in tonnages than in net tonne-km, and vice-versa. The patterns evinced by the data present phase-wise alternations, which shall now be considered.

As earlier remarked, the overall tendency has been for journey-tonnages, *i.e.* net tonne-km, to rise at a faster rate than tonnage growth. In itself, and for reasons opposite to those alluded to in the preceding paragraph, the relative observed patterns of growth in net tonne-km versus originating tonnages would indicate in all probability, that the increased tonnage traffic reflects spatial expansion of the national market as much as it does the growing specialisation of IR freight operations towards bulk carriage. However the oscillating relationships observed between respective trends indicates that phases exist when growing traffic has been more the result of growth in bulk-freight tonnages, than of multiplication in shipments, and the analysis of such phases merits attention.

On the theoretical plane, the relationship between originating tonnages and net tonne-km in a developing economy would follow the *ex hypothesi* course of tonnages rising because of GDP increases and traffic kilometerage rising because of market expansion. Over the period of the first three FYPs, tonnage and tonne-kilometre increases are observed to have proceeded in step, with parallel increases being sustained through rising capital investment over the Plans and consequently increased IR freightage capacity. The implication here would be that the growth of transport infrastructure led the growth of the economy and that expansions took place both in the size of market and traffic volume. However following the 3FYP, a noticeable plateau was reached in traffic - also noted earlier with reference to tonnages, the principal reason for this being the downscaling of capital investments on IR in the subsequent FYPs, mainly because traffic trends over the early 1960s aggregating 203MT over 3FYP had not met the Plan's projections of 248.9MT of originating tonnages.[22] With hindsight, comment has been made in respect of this plateau phase[23] that the cutbacks which took place in the plan investment scales in the railways, and in the transportation sector in general, now appear inexplicable in the face of the needs of the growing economy, although these may not have seemed quite so evident at that time. Nevertheless severe transportation bottlenecks,[24] along with the mix of other factors such as agricultural and Plan setbacks, industrial recession, Oil Shocks, etc., which had kept originating tonnages relatively stagnant between the mid-1960s and the end of the 1970s, were also responsible for the slowdown in market expansion, accounting for restrained growth of railway freight traffic when assessed in net tonne-km. The freight impact of the two Oil Shocks was much stronger in its traffic manifestations than in tonnage-terms - 1973-74 and 1978-79 being the only two years over the entire 40-year longitudinal series when there were significant absolute declines in traffic levels.

Although in net tonne-kilometre terms, freight traffic on IR has risen considerably overall during the time-frame of the present study, attention also needs to be paid to shorter periods where traffic has spurted or else has been relatively stagnant. Traffic patterns that have risen over the long term may then be summarised accordingly. In contrast to possibly exogenous traffic setbacks in the two years just identified, smart spurts are observed to have occurred in the commencement-years of every Plan since the 5FYP. However instead of these traffic spurts then being consolidated over the Plan into a marked and sustained growth of railway freight operations, the recurrent pattern has been that of an initial rise followed by relative constancy of traffic over the remaining plan-years. The point is more easily revealed by examination of the first set of associated diagrams in Fig 3.2.

Fig 3.2*a* among these reveals relative contrasts between tonnage- and traffic-rates of growth in Table 3.2. While the rate of growth of tonnages has been relatively steady as earlier remarked, the traffic- rate of growth has been an increasing function of the former. Nevertheless the strongest traffic spurts that IR have witnessed since 1960-61 occurred in clusters around the period from 1974-75 to 1976-77, from 1984-85 to 1986-87, and from 1990-91 to 1991-92. The three periods respectively mark the initiation of the 5FYP, 7FYP and 8FYP and indicate that the levels of infrastructural and/or traffic adaptations were remarkably strong within them. However the reasons for these spurts and their subsequent impact over the remainder of the plan need not necessarily have been identical. Thus traffic increases that commenced the 5FYP would partially have been the symptom of buoyant expectations induced by the plan, as well as an adaptation of the Indian transportation system to conditions brought on by the first oil crisis, which in fact rewarded the railways since the cost cascades they induced affected the roadways more severely. This latter factor would have noticeably been absent in the traffic spurts of the 1980s and 1990s, so that these would have resulted entirely from buoyancy induced by the plans.

Inferences drawn on increases in traffic in net tonne-km terms however tend to be ambiguous because of the dualistic construction of the net tonne-km traffic indicator, which reflects both originating tonnages as well as freighting distances. Thus the inference that traffic expansion during the mid-1970s proceeded at least partially from the temporary recovery of a segment of short-haul freight from the roadways because of sharp increases in cost needs further corroboration. This corroboration is provided by declines in average traffic leads during the period which would reflect a change in IR's freight-mix through carriage of a larger proportion of the short-lead and smalls (i.e. less than full-wagonload) traffic that was being carried on the roadways just prior to the oil crisis. Such features are absent in the declines in average traffic leads over the subsequent period, since no new oil crisis preceded them.

In sum, it might be said that IR freight traffic has risen ahead of IR freight tonnage both because of market expansion and development in a growing economy, and because a freight-mix change in this traffic has taken place as a result of exogenous as well as technological factors. It is particularly the technological factors in traffic adaptation that indicate the growing specialisation of a railway system, which however may or may not entirely be in consonance with the needs of that growing economy. It would also follow from the foregoing that the most significant change in the IR freight-mix, i.e. the shift to bulk, occurred in the mid-1970s and was therefore at least partially the consequence of the adaptation of the Indian economy and its transportation infrastructure to the allround cost-restructuring also noticed across the world, following worldwide escalation in prices of petroleum, oil & lubricants [POL]. However, the shift to bulk would also reflect a loss of other tonnages to the roadways and the confinement of the IR freight operations to the carriage of specialised freight with specialised freight-handling equipment and vehicular rolling-stock. This therefore warrants that the pattern of change in freighting distances for IR freight operations be more closely

Figure 3.2: Comparative Time-Trends in IR Originating Tonnages, Traffic & Average Freighting-Distances over the Planning Period

Fig 3.2a: Freight Traffic vs. Tonnage Freight

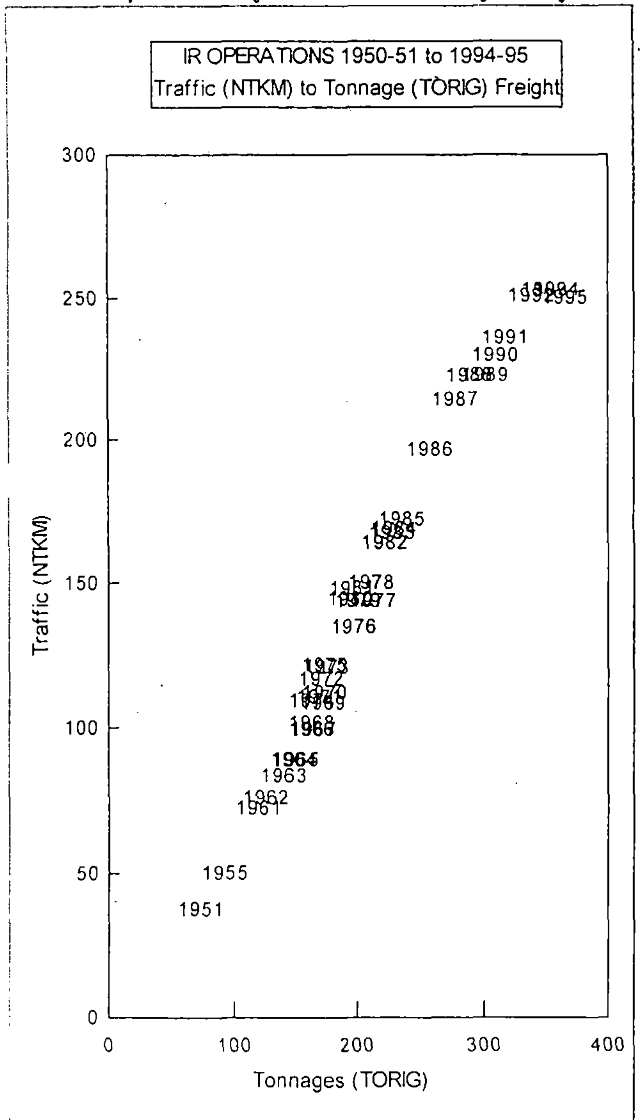


Fig 3.2b: Freight Traffic vs. Freighting Distance

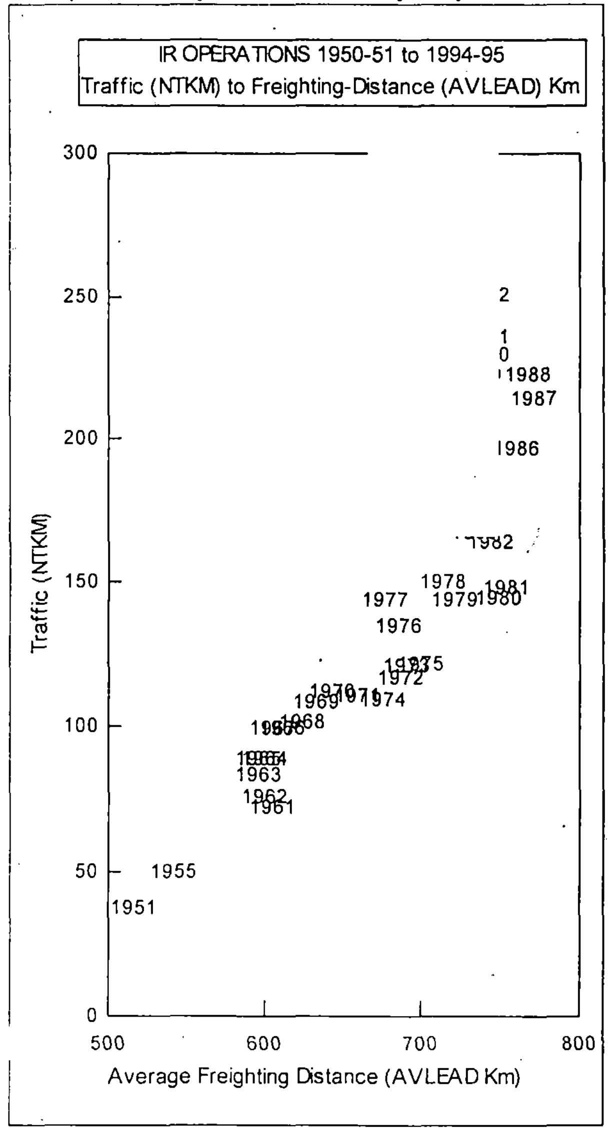
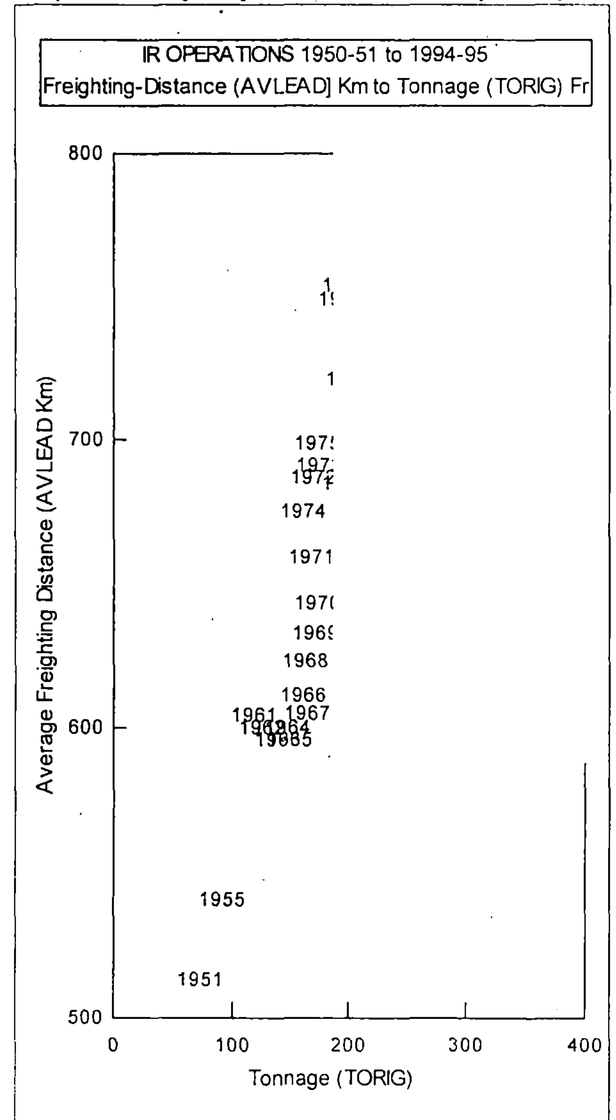


Fig 3.2c: Freighting Distance vs. Tonnage Freight



investigated.

3.4.3 Increasing Freight Leads

The importance of average freight leads as an indicator in railway operational performance arises *a priori* from the reflection that increasing economic activity has on market expansion and increases in freight traffic. While originating tonnages reflect the spurt in economic activity, the spatial dispersion of growth in the economy is reflected in growing average leads. However, an efficiency concept is also involved here, since average leads would not rise continuously unless the economy were characterised by extreme regional imbalance. The ideal and ultimate development situation might thus be visualised as one where, after the production centres become technologically linked, the domain of individual economic activities gradually becomes geographically compact,[25] so that average leads eventually decline over time after the economy acquires each stage of maturity. Declining average leads also indicate the growth of multiple economic nodes, implying the efficient use of unit geographical space and contiguous development.

It may then be seen in context that growth in average freight leads more or less matched the growth in originating tonnages over the first two FYPs, and is in character with *a priori* expectations about a growing economy which is experiencing simultaneous expansion of raw material hinterlands, widening of its production base, and integration of markets via transportation activity. The strong upstream and downstream linkages of railway infrastructure with growth of the economy make this consistent with the development of the Indian economy in its early planning phase. But this initially sustained phase of spatial growth was first vitiated during the 3FYP when average freight leads suffered a temporary lowering between 1961-65, from which they only recovered after the mid-1960s. From a general perspective, the period of the 3FYP may be seen as an aberration over all IR operational series, since freight setbacks occurred inspite of *pro rata* plan allocations for the railways having been among the best-ever in all the years of planning. Viewed with hindsight, the cause for the setback was overambitious traffic projection made by simply extending the earlier trends without simultaneously qualifying them either by the general productive capacity of the economy, or by the extent of production and availability of programmed traffic from the PSUs set up during the 2FYP.[26] Targeted traffic in the bulk category thus failed to materialise, leading to underutilisation of the new railway capacity added over the 3FYP and a deterioration in the IR freight-mix, and to consequent decline in the average traffic lead.

Analysis of longterm trends in average leads is also assisted by reference to the plots in Figs 3.2*b* & 3.2*c*. Over the ten years commencing with the 2FYP, average lead reached and crossed 600km, and surpassed the 700km level over the next ten years commencing 1965. The spatial increment in traffic by 100km over the period commencing just after the 3FYP till midway through the 5FYP was slightly higher in fact than the increment of 90km achieved during the period of the first three FYPs. Since average lead levels until 1977-78 were still well below the efficient traffic lead of 700km being targeted by IR, the increasing carriage distances of freight implied in the rising figures were in keeping with the general economic objective of expanding the spatial size of the domestic market. Fulfillment of such an objective would however also require that increasing average lead distances be attained without concurrent surrender of the railway share in short-lead traffic. Analysis of whether this was achieved by IR is taken up in a later chapter.

A clustering in average lead figures about a declining trend during the first five years of the 1960s while tonnages rose marginally substantiates the presence of exogenous factors mentioned earlier as being responsible for sluggish economic growth during the 3FYP. Monsoon failures and famine-like conditions hit parts of the country in the mid-1960s and consequent food aid imports through the ports necessitated extensive transportation of foodgrains over long distances to drought-hit regions. Another similar clustering noticed between 1972-77 is also associated with tonnage setbacks that occurred around this period as a consequence of economic adjustments to the first Oil Crisis, with further aggravation during the All-India Railway Strike of 1974 which substantially affected short-haul traffic realisation by IR. Although average freight leads then resumed their rise between 1978 to 1981, it was only during this later period that carrying distances first rose beyond the targeted IR lead of 700km. Unless it can simultaneously be shown that the commodity-mix catered to by railway freight remained invariant while tonnages increased, the inference would be that IR began to lose high-rated low bulk traffic over this period. The apprehension is strengthened from observation that while the second oil crisis brought about a slowdown in tonnages originating, average leads did not register any decline this time, unlike in the aftermath of the first oil crisis. This would provide sufficient indication that a conscious shift had been towards committed bulk and trainload traffic, fuelling the diversion of smalls carriage to the roadways inspite of the allround increases in traffic costs.

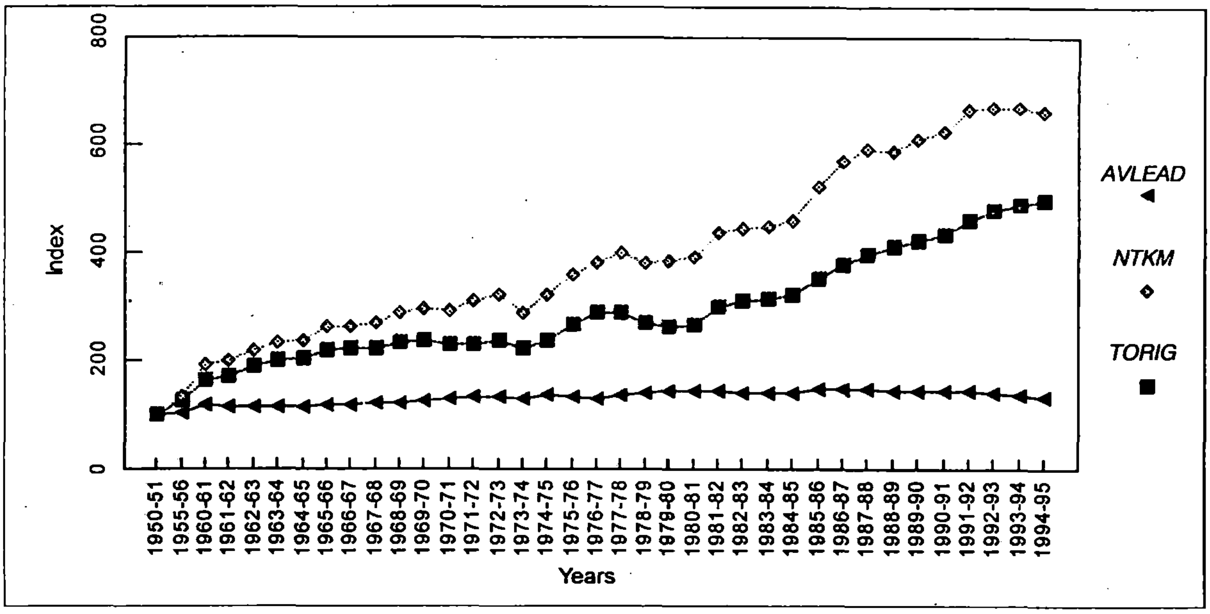
Considering the trend maintained by average freight leads over the 6FYP after their rise during its initial years, a decline is observed to have set in again in 1982 which was maintained through till the end of the 6FYP. That this decline coincided with relatively sluggish growth in tonnage and traffic, and represented a fall from the bulk-traffic influenced high value of 754 km reached in 1980-81, would imply a change in traffic composition that would have been favourable to IR in terms of the recovery of a certain proportion of higher-rated freight traffic. But the first three years of the 7FYP led again to rising freight leads and a sharp rise in tonnage and traffic implying that this growth would have largely comprised bulk tonnages rather than the more rounded composition that had just been restored to IR freight, and that increases in other categories of freight traffic over the 7FYP would have largely accrued to the roadways. The all-time high in IR freight leads was in fact reached in 1986-87 following spurts in tonnage as well as traffic, implying once again that shorter lead traffic was being transferred to the roadways. It was only towards the end of the 7FYP that a decline in traffic leads set in, which then continued into the 8FYP. It remains to be investigated whether the nearly consistent decline in traffic leads ever since commencement of the 8FYP represents a gain of short-lead traffic by IR, or the more disturbing loss of bulk traffic to the roadways.

The declining trend in journey leads which set in with the closing phase of the 7FYP and continued into the 1990s has in any case been a marked departure from past trends observed over the 45-year series. The decline that has taken place even as freight tonnages have risen is clearly discerned in the associated diagram tin terms of a steady fall after initial clustering at the beginning of the decade. The steepened fall after 1993 would support the inference that the major hikes in railway tariffs in 1992-93 induced a traffic setback extending even into bulk-freight, and that proportionately greater losses of long-lead bulk traffic were the principal cause in declining average leads. Although this declining trend could also be viewed in a positive perspective as implying geographical compaction of economic activities and multiplication of nodes as mentioned earlier, in the present context and with the evidence of tariff hikes, the same logical inference will be too far drawn, since average leads had already touched a high mark close to 800km before they started to fall. IR has over the recent FYPs sought to maintain minimum average leads of 700km on the grounds of economy in haulage, and has accordingly been deliberate in discouraging traffic smalls, less than full-wagonload traffic and short-haul freight. But it nevertheless becomes uneconomical for the railways to sustain the rise in average leads to levels well beyond the 700km mark, because of unsustainable losses of profitable high-rated short-haul traffic that this would imply. Of course, the optimum lead depends also on which cost factors in haulage can be lowered by increasing efficiency. Whether 700km is the minimum viable lead or not for railway freight operations is a matter of controversy, when viewed relative to developed railway systems such as the SNCF in France which target a breakeven lead of around 500km *[see ch.2]*. The implication of setting a higher minimum average lead is that several short-haul traffic segments considered a railway preserve on other railway systems are deliberately excluded from the IR's system and tell both on revenue shortfalls and on traffic losses to the roadways. This point will again be addressed in a later chapter.

Reviewing the comparative features of time trends in the main operational parameters of IR as depicted in the plots in Fig 3.2, against the contexts of the preceding discussion, it is thus established that while railway operations have had a definite infrastructural impact on the Indian economy since Independence, which has in turn been characterised by the rather complex process of alternate market expansion and spatial consolidation of activities, the pace generated has not been smooth or sustained over the different FYPs. Not all the discontinuities observed can be attributed to exogenous factors. Instead, the spasmodic growth of railway operations since 1964-65 would imply that the quality of transportation planning has played a deciding role. With India resorting to the planning model of five-year development plans from 1951, transport targets and outlays for the plan period are decided in the commencement year, while achievements against these targets are staggered over the next five years. A cyclic character was thus imparted to the operational and investment processes of IR freight operations. This is also revealed by the sequence of waves coinciding with the planning periods, that have been visible ever since 3FYP. If, nevertheless, the traffic targets of the FYPs had always been attained, the railways would have been insulated from revenue shocks. This however did not occur in practice.

Instead, the patterns observed in tonnage and traffic and further corroborated in average traffic leads establish that IR had hit traffic bottlenecks by the mid-1970s, which were only mitigated partially in the 1990s. Since

Figure 3.3: Indexed Growth of Tonnages, Traffic & Freighting Distances on IR
1950-51 to 1994-95



the cost at which railway tonnages have grown over the planning horizon has been a lengthening of average leads, assessment of traffic trends would prove ambiguous without recourse to further information on the commodity-composition of railway freight. Rising average leads indicate that while there has been market expansion, railway freight operations have not progressed apace with this. In consequence, the roadways have be come the principal gainers and have in fact spirited away the more profitable freight segments, leaving IR the lion's share of bulk traffic.

Bulk traffic in India has accounted principally for the increase in originating tonnages since the inception of planning. This trend became marked since the adoption of the Nehru-Mahalanobis model of capital-led growth since 2FYP, which led increasingly to the public-enterprise structuring of the Indian capital goods sector. In the thinking that has characterised Indian planning ever since then, the Railways as a public undertaking share a special symbiotic relationship with the PSUs. Thus the principal clients of IR since Independence have been the mining sector, the power plants, the steelworks and so on. Since the traffic they supply to IR has a bulk character, and is moreover available in full trainloads which can be handled and loaded at captive sidings, a preferential arrangement has developed whereby the freight-mix catered to by IR has become increasingly specialised towards PSU-traffic. It is this arrangement that is the dominant factor uniting trends in tonnages, traffic and freight leads. But this feature of the evolving IR freight operations cannot be trapped in aggregate operational statistics, and a disaggregated look has to be taken into the commodity composition of railway freight.

3.5 The Commodity Freight-Mix

Because of the natural advantages that railways offer to the carriage of bulk traffic, traffic development on railway systems is greatly stimulated by expansion in aggregate production, especially in the industrial and mining sectors, and also by movement of materials and equipment for large construction projects. Forward and backward transport linkages with these sectors had provided the principal impetus to the growth of railways in the presently advanced countries. India however, as stated earlier, had to wait for the institution of planning to give a stimulus to the industrialisation process and thus the headstart that had been provided by the early development of railways in the country did not have any markedly obvious industrial impact until large-scale industrial enterprises were created by the plans. It might thus be stated of colonial railway development that its forward linkages were deferred into the future.

Thus the commodity freight-mix catered to by the Indian railways over nearly 100 years of their initial existence largely comprised primary produce of agricultural origin and imported goods of industrial manufacture intended for consumption, rather than the normal freight-mix of bulk industrials that characterise a modern economy. However commodities like coal from the Eastern coalfields and iron ore and processed steel from private plants like the Tata steelworks (presently TISCO) and Indian Iron & Steel Company [IISCO] in the eastern region provided the first basis for bulk-freight operations by the railways in the pre-Independence period. The steelworks moreover, besides depending on the railways for the supply of ore and coal, were also the major supplier of steel rails and other structurals to the railway sector.[27] Nevertheless the scale of bulk-freight operations existing before 1947 might at best be described as having been limited. But the stimulus to growth emanating from the Five-Year Plans in the later period greatly raised the core demand for the production and transportation of bulk industrials, while additions of large amounts of producing capacity in the public sector multiplied the sources and quantum of traffic flows.

3.5.1 Importance of Bulk-Commodities in IR Freight

Over the period of planning presently under review, freightage of coal became the core operation of IR, with multiple demands rising from the electricity boards and the new PSU steelworks. Over 50 years this position has not changed and coal traffic today contributes half the originating tonnages transported by IR.[28] Similarly, the importance of cement as a commodity of bulk transportation has grown progressively because of the high pace of construction in an urbanising and industrialising economy. Mining and the heavy industrial sector have emerged as other major clients for IR following the growth of core industry.

The character of the traffic in bulk commodities that these sectors offer to the railways is such that it would prove uneconomical and therefore would not move on other competing transport modes. Inasmuch as they cater to this exclusive traffic, the IR serve as prime movers to the economy. Nevertheless the movement of bulk commodities stimulates the further flow of outputs from downstream industries which also have to be moved via the transportation network. IR thus receive commodity traffic from multiple points and diverse locations within the industrial process.

Operating as they do in a country with a large economic space, freight operations of IR could thus well be expected to show an intrinsic bias towards longer-lead traffic. But adequacy of transport infrastructure would require also that sufficient capacity be reserved by the railways for movement of downstream freight, both because of the necessity of maintaining efficiency and low costs in freight operations, and because of the simple operational necessity of ensuring that adequate new freight originates from downstream destinations so that freight hauls are not unidirectional and incidence of empty haulage on return journeys is kept low. Whether IR has been able to adequately maintain such freighting principles with the expansion in its freight operations in recent times is the point that will be considered next.

Table 3.4 below provides indication of the recent tonnage trends after the 1980s in prime bulk-commodities moved by IR. The table also reveals how bulk traffic has come to dominate railway freight operations in India, having risen proportionately from 85.6 percent of total freight traffic in 1980-81 to 96.2 percent in 1994-95, with actual tonnage increase by 183.2MT over the space of 15 years. Although earlier operational review had shown that the 6FYP and 7FYP spanning the first decade of this period were characterised by remarkable growth in IR freight operations, it can be seen now that such improvements were largely confined to the bulk-freight sector. The major improvement derived from the increased handling of coal which while raising its share in total IR freight, also increased tonnages by more than two-and-a-half times over the period, with marked acceleration over the 7FYP and 8FYP. Coming next in terms of its importance to IR was tonnage handling in iron ore, which however showed more fluctuation over the 6FYP years, while rising by 16.9MT over the period considered. In percentage terms on the other hand, even as the share of iron ore in IR shipments declined marginally over the period, the combined shares of coal and iron ore in total IR freight on IR rose from 47 percent to 59.5 percent.

Movements of foodgrains which formed the third-largest component of IR tonnage freight uptil the mid-7FYP years were subject to oscillation between a range of 18.33MT at the commencement of the period under review and 20.7MT at its end, with three alternate peak movements of 24.7MT, 30.1MT and 27.4MT occurring respectively in 1982-83, 1987-88 and 1991-92. Although foodgrains are not strictly a bulk commodity in the same sense as mining materials, their presence as an important constituent of IR bulk-freight derives from preferential tariffs hitherto offered to them as essential commodities, under the social obligations that govern IR freight operations. Most foodgrains traffic comprises shipments of procurement grain and/or food imports for public distribution by the state-sector Food Corporation of India [FCI] to deficit states and thus cannot be refused by IR. Peaks noticed in foodgrains tonnages would therefore bear upon the agricultural situation prevailing within the country in given years, which is substantiated also by the fact that the largest foodgrains shipments over the period occurred in 1987-88, a year of countrywide drought.

Table 3.4: Originating Tonnages of Bulk-freight Traffic on Indian Railways 1980-81 to 1994-95

[Freight figures in MT; italics %]

	Coal	Food-grains	Iron & Steel	Iron Ore	Cement	POL	Fertiliser	Limestone & Dolomite	Other Stones	Salt	Sugar	Total Bulk	Other Freight	Total Tonnage
1980-81	64.1	18.3	10.8	28.0	9.6	15.0	8.1	9.0	4.8	na	na	167.7	28.2	195.9
	32.7	*9.4*	*5.5*	*14.3*	*4.9*	*7.6*	*4.2*	*4.9*	*2.5*	*na*	*na*	*85.6*	*14.4*	*100.0*
1981-82	75.8	21.5	12.0	30.8	10.8	16.6	9.6	10.2	4.8	na	na	192.0	29.3	221.2
	34.3	*9.7*	*5.4*	*13.9*	*4.9*	*7.5*	*4.3*	*4.6*	*2.2*	*na*	*na*	*86.8*	*13.2*	*100.0*
1982-83	82.4	24.7	11.5	29.4	12.8	17.3	8.5	9.8	4.6	na	na	201.0	27.8	228.8
	36.0	*10.8*	*5.0*	*12.8*	*5.6*	*7.6*	*3.7*	*4.3*	*2.0*	*na*	*na*	*87.9*	*12.2*	*100.0*
1983-84	89.0	24.6	10.2	27.3	15.6	18.0	8.2	9.1	3.7	2.7	2.1	205.5	24.7	230.1
	38.7	*10.7*	*4.4*	*11.9*	*6.8*	*7.8*	*3.5*	*3.9*	*1.6*	*1.2*	*0.9*	*89.3*	*10.7*	*100.0*
1984-85	91.6	20.8	10.5	29.9	16.9	18.2	12.2	8.9	3.7	3.1	1.8	212.6	23.9	236.4
	38.7	*8.8*	*4.5*	*12.6*	*7.1*	*7.7*	*5.2*	*3.8*	*1.6*	*1.3*	*0.8*	*89.9*	*10.1*	*100.0*
1985-86	101.6	24.1	11.5	32.0	18.0	18.6	13.6	9.9	4.3	3.3	3.0	233.6	25.0	258.6
	39.3	*9.3*	*4.4*	*12.4*	*7.0*	*7.2*	*5.3*	*3.8*	*1.7*	*1.3*	*1.2*	*90.3*	*9.7*	*100.0*
1986-87	109.5	29.0	12.3	34.2	19.8	19.9	14.5	9.9	4.5	3.2	2.4	259.1	18.6	277.8
	39.4	*10.4*	*4.4*	*12.3*	*7.1*	*7.2*	*5.2*	*3.6*	*1.6*	*1.2*	*0.9*	*93.3*	*6.7*	*100.0*
1987-88	119.8	30.1	12.3	33.9	22.3	21.7	13.1	9.1	4.8	3.0	2.7	272.9	17.3	290.2
	41.3	*10.4*	*4.2*	*11.7*	*7.7*	*7.5*	*4.5*	*3.2*	*1.7*	*1.1*	*0.9*	*94.1*	*6.0*	*100.0*
1988-89	128.0	24.9	12.1	35.6	26.0	22.6	16.1	9.2	4.8	3.3	2.0	284.4	17.7	302.1
	42.4	*8.2*	*4.0*	*11.8*	*8.6*	*7.5*	*5.3*	*3.0*	*1.9*	*1.1*	*0.7*	*94.2*	*5.8*	*100.0*
1989-90	130.2	23.7	11.9	38.6	27.5	24.3	17.0	8.8	4.5	3.3	2.1	291.9	18.1	310.0
	42.0	*7.6*	*3.8*	*12.5*	*8.9*	*7.8*	*5.5*	*2.9*	*1.5*	*1.1*	*0.7*	*94.2*	*5.9*	*100.0*
1990-91	135.0	25.0	12.0	41.0	29.0	25.0	18.0	9.0	na	na	na	na	na	na
	na	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*
1991-92	146.4	27.4	13.4	40.9	30.8	25.6	18.6	9.3	4.8	3.4	2.0	322.6	15.3	338.0
	43.3	*8.1*	*4.0*	*12.1*	*9.1*	*7.6*	*5.5*	*2.8*	*1.4*	*1.0*	*0.6*	*95.5*	*4.5*	*100.0*
1992-93	157.7	27.3	13.5	41.4	30.4	26.4	19.0	9.6	4.2	3.5	2.3	335.2	14.9	350.1
	45.1	*7.8*	*3.9*	*11.8*	*8.7*	*7.5*	*5.4*	*2.7*	*1.2*	*1.0*	*0.6*	*95.7*	*4.3*	*100.0*
1993-94	167.0	26.7	13.0	41.2	32.5	26.0	19.5	9.3	3.6	3.6	1.9	344.3	14.4	358.7
	46.6	7.4	3.6	11.5	9.1	7.2	5.4	2.6	1.0	1.0	0.5	96.0	4.0	100.0
1994-95	172.4	20.7	13.3	44.9	31.5	27.7	21.5	10.3	3.5	3.2	2.0	350.9	14.2	365.0
	47.2	*5.7*	*3.6*	*12.3*	*8.6*	*7.6*	*5.9*	*2.8*	*1.0*	*0.9*	*0.5*	*96.2*	*3.8*	*100.0*

Note: Other Stones exclude Marble but include Gypsum

Source: Compiled from *IRYB*, various years, Directorate of Statistics & Economics, Railway Board, Ministry of Railways, Government of India, New Delhi

Of the other bulk commodities included in the table, the relative constancy of tonnage shares of POL and fertilisers over the period may be noted, even as their actual tonnages have either nearly or more than doubled. Against the steadiness of these freight shipments, the remarkable increase of 21.9MT in cement tonnages transported implies that while in percentage terms their share has doubled, the physical order of the increase over the period is by more than three times, enabling them to occupy the third position in IR bulk shipments after 1987-88.

Railway tonnage trends in foodgrains relate in a curious manner to those in fertilisers and iron ore, and peak foodgrain movements are observed to coincide with dips in freight tonnages of the latter commodities. While fertiliser movements would logically tend to decline when incidences of drought and crop-failure in particular years caused foodgrains shipments to increase, and would thus provide partial justification to one of these related freight patterns, no such obvious argument will explain the relativity of freight trends for iron ore and foodgrains. What is actually being witnessed therefore is freight substitution either rising out of shortages of railway freight capacity or from running constraints, which will be more thoroughly considered in the subsequent chapter. A more alarming feature that can be observed vis-a-vis tonnage trends in foodgrains and fertilisers is the lateral displacement between these, implying a general tendency for drops in fertiliser movement over the 1980s to laterally precede rising foodgrains movements. Thus short supply of fertilisers might well have been the cause of lowering in local crop-yields that would necessitate shipment of foodgrains from elsewhere to meet the resulting deficits. This pattern seems to have disappeared during the 1990s, following a sharp rise in freight tonnages in fertilisers.

More insight into the role of IR vis-a-vis the economy might be gained by evaluating dips and peaks in the originating tonnages in Table 3.4 of the principal bulk commodities carried by IR, against the annual output of these commodities. Table 3.5 provides relative indication of this while showing the shares of IR in the transportation of major commodity outputs in the economy. Although coal freight has been seen to be the main constituent of IR bulk tonnages and has been increasing in importance, originating railway tonnages in coal average just under two-thirds of total coal output in the country, rising to around 68 percent by 1994-95. It is seen therefore that while railway freight in coal has increased both in relative and absolute magnitudes over the period between the 6FYP and the 8FYP [*see Table 3.4*], this has accompanied a substantial rise in coal output within the country, a third of which is not freighted by IR. As will be shown later in the IR commodity-freight analysis, the inability of IR to move adequate coal shipments to thermal power stations which precipitated the power crises of the 1970s led to an eventual shift in locational policy resulting in the establishment of pithead super-thermal power plants [STPP]. Therefore, since coal is not a commodity amenable to other modes of transportation, IR's increasing bulk-freight and technology orientation has been at least partially caused by this single circumstance. IR share in iron ore output have also generally tended to rise, although with occasional dips in absolute tonnages as seen in the mid-plan years in the previous table. In contrast, tonnage freight in POL, the other fuel commodity declined from above 60 percent to under 50 percent of total POL output over the decade, indicating that an increasing proportion of POL is now being transported by non-railway means.

Table 3.5: Shares of Major Commodity Outputs carried by Railway in India

Year	% Coal Output	% Iron Ore Output	% Cement Output	% Foodgrains Output	% Fertilisers Output	% POL Output
1980-81	56.2	60.0	51.8	14.1	54.5	62.0
1981-82	61.0	69.1	51.7	16.1	61.4	58.7
1982-83	63.1	64.2	55.0	19.3	60.7	55.8
1983-84	64.4	63.6	58.2	16.1	54.6	54.6
1984-85	62.1	63.7	57.1	14.2	54.0	54.7
1985-86	65.9	65.9	54.2	16.0	58.0	46.7
1986-87	66.0	62.2	54.1	20.2	68.1	46.4
1987-88	66.7	66.0	56.4	21.5	69.0	48.5
1988-89	65.8	66.3	58.5	14.6	66.7	49.4
1989-90	64.8	65.2	60.0	13.8	65.5	49.9
1990-91	63.8	62.8	59.2	14.4	68.7	51.5
1991-92	63.9	66.1	57.0	16.4	66.6	52.9
1992-93	66.2	70.6	56.2	15.2	67.8	51.1
1993-94	67.9	65.3*p*	56.1	14.5	71.7	50.7
1994-95*p*	67.9	69.1	50.4	10.8	71.9	52.4

Source: Compiled from *IRYB*, various years, Directorate of Statistics & Economics, Railway Board, Ministry of Railways, Government of India, New Delhi; figures for the year 1994-95 and for iron ore in 1993-94 are provisional

A commodity whose tonnages and commercial importance to IR has sharply increased since the 6FYP is cement, with tonnage freight increasing almost four-fold over the period earlier reviewed. It is seen from Table 3.5 however that while railway loadings of the commodity as a proportion of its total output tended, despite fluctuations, to rise in the mid-1980s and again towards the end of the decade, they have since undergone a definite decline. Since the increasing tonnages are not reflected in an equivalent increase in the output share, the inference would be that although IR handles considerably more cement traffic than before, cement production in the country has increased even more strongly, of which a larger and larger share travels today by road. Unlike coal or iron ore for which specific railway wagons are committed, transport of cement requires general-purpose wagons on which there are competing demands. The wagon constraints that determine this pattern will therefore need to be explored in a subsequent chapter.

With reference to foodgrains and fertiliser outputs, it may be noted that while IR freight shares in the former have tended overall to decline to relative insignificance, there has been a pronounced pickup in freight shares of the latter. Quite evidently, since fertiliser tonnages have also expanded strongly, the role of IR in stabilising food supply in the country has declined correspondingly. Among the reasons which might be ascribed here are the improvements in agriculture in previously deficit states, which have reduced the need for balancing movements in foodgrains to ensure food security for a growing population. The part of foodgrains traffic which travels on other transport modes is short-lead in nature and therefore sustains the hypothesis.

3.5.2 General Commodity Freight Trends

Despite the preponderance of bulk commodities in IR freight, it has been seen in Table 3.4 that other commodity freight continues to occupy a visible position in freight operations. Thus analysis centering around bulk commodities alone would be too limiting in securing a proper understanding of commodity freight patterns on IR. In Tables 3.6 & 3.7, analysis is extended into the set of 30 principal commodities carried by IR. Further, to add depth to the study, changes in commodity tonnages and traffic are considered over an extended 21-year period between 1973-74 and 1994-95, and evaluated against changes in computed traffic-rates. Although the data are not considered here in longitudinal form in order to limit the size of the dataset, the principal trends are clearly visible even in the gap-year analysis.

Table 3.6: IR Freight Tonnage & Traffic Trends for Thirty Selected Commodities 1973-74 to 1994-95

	TONNAGES [million metric tonnes]								*TRAFFIC [billion net tonne-km]*							
Freight Commodity	1973-1974 *MT*	%	1976-1977 *MT*	1983-1984 *MT*	1986-1987 *MT*	1989-1990 *MT*	1994-1995 *MT*	%	1973-1974 *TKm*	%	1976-1977 *TKm*	1983-1984 *TKm*	1986-1987 *TKm*	1989-1990 *TKm*	1994-1995 *TKm*	%
Coal & Coke	47.2	*29.1*	67.4	89.0	109.5	130.2	172.4	*47.2*	26.6	*24.3*	38.8	54.7	71.6	85.1	105.3	*42.2*
Iron Ore	20.1	*12.4*	26.7	24.8	31.6	35.8	42.0	*11.5*	6.2	*5.7*	9.5	8.4	11.7	13.3	15.8	*6.3*
Foodgrains	14.7	*9.0*	20.0	24.6	29.0	23.7	20.7	*5.7*	16.3	*14.9*	18.8	30.3	39.8	31.7	27.1	*10.8*
Cement	10.0	*6.2*	13.7	15.6	19.8	27.5	31.4	*8.6*	6.4	*5.8*	9.2	10.6	12.9	17.7	19.1	*7.6*
POL	10.0	*6.2*	12.4	18.0	19.9	24.3	27.7	*7.6*	6.4	*5.8*	7.6	10.7	11.7	15.7	18.2	*7.3*
Iron & Steel	9.3	*5.7*	12.7	10.2	12.3	11.9	13.3	*3.6*	9.4	*8.6*	12.7	11.7	13.4	13.3	13.6	*5.5*
Limestone & Dolomite	7.4	*4.6*	9.5	9.1	9.9	8.8	10.3	*2.8*	1.8	*1.6*	2.6	3.0	3.7	4.2	5.5	*2.2*
Fertilisers	5.3	*3.3*	7.8	8.2	14.5	17.0	21.5	*5.9*	4.0	*3.7*	7.2	8.3	15.6	17.4	19.3	*7.7*
Other Stones	4.6	*2.8*	4.7	2.7	3.5	3.3	2.9	*0.8*	1.5	*1.4*	1.5	1.0	1.2	1.1	0.9	*0.4*
Salt	2.3	*1.4*	3.0	2.7	3.2	3.3	3.2	*0.9*	2.8	*2.6*	4.0	4.1	5.4	5.2	5.0	*2.0*
Unwrought Wood	2.2	*1.4*	2.2	1.0	0.7	0.6	0.1	*0.04*	2.1	*1.9*	2.2	1.3	0.9	0.7	0.2	*0.1*
Sugarcane	1.8	*1.1*	1.4	1.4	1.1	1.3	0.7	*0.2*	0.1	*0.1*	0.1	0.1	0.1	0.1	0.1	*0.03*
Oilcake Fodder	1.6	*1.0*	2.1	1.5	1.6	2.1	2.3	*0.6*	1.3	*1.2*	1.6	1.5	1.7	2.2	2.2	*0.9*
Sugar	1.4	*0.9*	1.8	2.1	2.4	2.1	2.0	*0.5*	1.3	*1.2*	1.8	2.2	3.2	3.0	3.3	*1.3*
Manganese Ore	1.1	*0.7*	1.3	0.9	1.1	1.1	1.2	*0.3*	0.4	*0.4*	0.5	0.3	0.4	0.4	0.5	*0.2*
Tar & Bitumen	1.0	*0.6*	0.9	-	-	-	-	-	0.9	*0.8*	1.0	-	-	-	-	-
Oil Seeds	1.0	*0.6*	1.2	0.6	0.6	0.4	-	-	1.1	*1.0*	1.3	0.8	0.8	0.6	-	-
Other Metal Ores	1.0	*0.6*	1.6	1.6	1.6	1.7	1.7	*0.5*	0.7	*0.6*	1.1	0.9	0.8	0.8	0.7	*0.3*
Gypsum	0.9	*0.6*	0.8	1.0	1.0	1.3	0.6	*0.2*	1.2	*1.1*	0.9	0.9	1.2	1.2	0.6	*0.2*
Paper	0.8	*0.5*	1.0	0.7	0.6	0.5	0.2	*0.05*	1.0	*0.9*	1.2	0.9	0.9	0.7	0.3	*0.1*
Non-Oilcake Fodder	0.8	*0.5*	1.1	0.8	0.7	0.5	0.2	*0.05*	0.5	*0.4*	0.7	0.6	0.6	0.4	0.2	*0.1*
Firewood & Fuel	0.8	*0.5*	0.8	0.6	0.3	-	-	-	0.3	*0.3*	0.5	0.5	0.3	-	-	-
Gur & Jaggery	0.7	*0.5*	0.9	0.4	-	-	-	-	0.9	*0.8*	1.1	0.5	-	-	-	-
Sand	0.7	*0.4*	0.6	-	0.4	0.3	0.1	*0.03*	0.3	*0.3*	0.3	-	0.2	0.1	0.04	*0.02*
Provisions	0.6	*0.4*	0.6	0.4	0.3	0.2	-	-	0.8	*0.7*	0.7	0.5	0.5	0.4	-	-
Raw Jute	0.6	*0.4*	0.6	-	-	-	-	-	0.4	*0.4*	0.4	-	-	-	-	-
Bricks & Tiles	0.6	*0.3*	0.6	0.4	0.3	-	-	-	0.4	*0.4*	0.4	0.3	0.2	-	-	-
Bamboos	0.5	*0.3*	0.8	0.4	0.4	0.4	0.3	*0.1*	0.3	*0.3*	0.6	0.3	0.4	0.4	0.4	*0.1*
Fruit & Vegetables	0.5	*0.3*	0.8	0.4	-	-	0.2	*0.05*	0.6	*0.5*	1.2	0.6	-	-	0.3	*0.1*
Raw Cotton	0.5	*0.3*	-	-	-	-	-	-	0.6	*0.6*	-	-	-	-	-	-
Compressed Gases	-	-	-	-	-	-	0.1	*0.03*	-	-	-	-	-	-	0.04	*0.02*
Acids	-	-	-	-	-	-	0.3	*0.1*	-	-	-	-	-	-	0.1	*0.02*
Non-Ferrous Metals	-	-	-	-	-	1.0	0.9	*0.2*	-	-	-	-	-	0.7	0.6	*0.2*
Soda Ash	-	-	-	0.4	0.5	0.6	0.4	*0.1*	-	-	-	0.8	0.7	1.0	0.7	*0.3*
Caustic Soda	-	-	-	-	-	0.2	0.2	*0.1*	-	-	-	-	-	0.1	0.1	*0.03*
Wrought Timber	-	-	-	0.3	0.4	0.4	0.3	*0.1*	-			0.7	0.8	0.9	0.7	*0.3*
Edible Oils	-	-	0.6	0.5	0.5	0.2					0.8	0.9	0.8	0.4	-	-
Cement Manufactures	-	-	-	-	-	-	0.1	*0.03*	-	-	-	-	-	-	0.1	*0.02*
Electricals	-	-	-	-	0.3	0.3	-	-	-	-	-	-	0.4	0.3	-	-
Jute Manufactures	-	-	-	0.4	0.4	0.2	0.3	*0.1*	-	-	-	0.6	0.6	0.3	0.5	*0.2*
Other Freight	12.1	*7.5*	13.1	9.7	9.8	9.1	7.3	*2.0*	12.7	*11.6*	14.2	11.2	12.0	10.1	8.5	*3.4*
Total Traffic	**162.1**	***100***	**212.6**	**230.1**	**277.8**	**310.0**	**365.0**	***100***	**109.4**	***100***	**144.0**	**166.6**	**214.1**	**229.6**	**249.6**	***100***

Source: Compiled from *IRYB*, various years, Directorate of Statistics & Economics, Railway Board, Ministry of Railways, GOI, Delhi

It is noticed first of all that while commodities from the bulk group retain their place (if not their position) among the principal freight commodities, considerable change occurs lower down the scale because of several low-bulk commodities that had earlier been important having lost their erstwhile position since. While to an extent, these have been replaced by newer freight commodities, leading to inclusion of 41 commodities in the table, the tendency of IR freight traffic towards polarisation around a narrow commodity-group is clearly visible within the table. It is also noticed that traffic-polarisation is generally stronger than tonnage-polarisation, except for a distinct group of commodities relating either to the iron & steel-making industry or else to non-bulk freight. With the trend patterns noted here offering a disaggregated reflection of the trends earlier observed in Table 3.3, the first set of conclusions that emerge are that while average freighting distances for bulk-commodity loadings of coal, cement, fertilisers, POL, etc. have tended to lengthen over time, the lead of iron & steel-sector inputs such as limestone & dolomite, gypsum etc. have declined because of relatively greater dispersal in the location of steel plants. Against such trends, average leads for railway traffic in the non-bulk commodities have tended to decline much more sharply than tonnages. Since non-bulk freight has increasingly become the domain of the roadways, the overall analysis implies a progressive switch of the long-haul traffic in these high-rated commodities to the road sector.

It would be interesting to examine the possible causes of this switch. While the next four chapters will make a detailed examination of the ultimate determining role of railway freight capacity, the tariff-related causes might be ascertained from Table 3.7. The table shows average IR rates per tonne-km of commodity-freight computed as a ratio of commodity-revenues to commodity-traffic for the given years. The overall tendency for IR freight-rates to increase sharply over the 21-year period is visible clearly. However, it also becomes apparent that the proportion of rate-increase varies according to commodity, sometimes even changing the railway pricing-ratio between different commodity-pairs over the period reviewed. Three commodity subsets might be separately considered from among the commodities included in the table. These are, namely, *bulk* commodities for which IR constitutes a monopoly freight-provider; *bulk* commodities for which the freight market is at least partially contestable; and *non-bulk* commodities where the freight market is generally well contested.

It is observed that the increase in traffic-rates has been fairly substantial over the period of 21 years (at between 4-12 times, with the solitary exception of sugarcane) for most commodities included in the table. It is also seen however that the order of rate increase is generally high in the case of the first group of bulk commodities for which traffic has also increased over the period, pointing to a tendency towards monopoly pricing by IR, particularly for commodities like coal & coke, POL, iron & steel, etc., and cement to a lesser extent. Considering that base-rates for POL and iron & steel were already high, the burden of revenue carried by railway traffic in these becomes extremely significant to IR. Conversely, for a large group of commodities of the low-bulk type, the rate order of increase remains substantial, but is accompanied by a definite decrease in traffic realised, to the extent that these cease to be important freight commodities for IR towards the end of the period. It is also noticed that several among such commodities, *e.g.* raw cotton, raw jute, general provisions, etc., were once the mainstay of railway freight operations in India and gradual decline in their traffic is a pointer to the overall nature of change in the IR freight-mix.

A middle group is defined by commodities such as oilseeds, tar & bitumen products, unwrought wood, gypsum and other stones, etc., which have a bulk character, but for which traffic has declined over the interregnum. For such commodities, both base-rates and the order of rate increase have been high, leading to a migration of traffic to other transportation modes. It needs to be noted contextually that the computed traffic rates of the table average the telescopic rate structure actually offered by IR. As such, it would generally benefit the consignor to move long-lead traffic in these commodities by railway so long as the rate-telescope remained favourable. The fact that considerable traffic-loss has taken place instead indicates otherwise.

The foregoing analysis remains an approximation, in the sense that several other non-tariff factors may enter the determination of commodity-traffic levels, among which the character of the commodity, the relative distances between sources of supply and demand and so on will be extremely relevant. Considering however, the degree of polarisation in IR freight operations, another very important factor which will form the base for analysis in the next four chapters is the disaggregated (*i.e.* specialised as well as spatial) freight capacity on IR, which determines both the ability and inability of IR to cater to various classes of commodity freight. This factor, when combined with the changing tariff structure noted above, has invested the emerging roadways sector in India with the ability to successfully contest the freight market in certain commodities and to acquire substantial traffic share in these.

Table 3.7: Changes in Average IR Freight Tariff Rates per TKM for Selected Commodities 1973-74 to 1994-95

Freight Commodity	Average Rate/TKm 1973-74	Average Rate/TKm 1976-77	Average Rate/TKm 1983-84	Average Rate/TKm 1986-87	Average Rate/TKm 1989-90	Average Rate/TKm 1994-95	Total Increase in IR Tariff	*Proportion of Increase*
Coal & Coke	0.04	0.07	0.18	0.23	0.33	0.53	0.49	*12*
Iron Ore	0.07	0.09	0.19	0.22	0.26	0.50	0.43	*6*
Foodgrains	0.04	0.06	0.10	0.13	0.19	0.32	0.28	*8*
Cement	0.06	0.10	0.22	0.26	0.34	0.59	0.52	*8*
POL	0.09	0.14	0.38	0.46	0.58	0.99	0.90	*10*
Iron & Steel	0.08	0.13	0.32	0.39	0.52	0.87	0.79	*10*
Limestone & Dolomite	0.07	0.10	0.23	0.24	0.31	0.52	0.45	*6*
Fertilisers	0.06	0.08	0.18	0.20	0.27	0.35	0.29	*5*
Other Stones	0.07	0.11	0.22	0.23	0.32	0.53	0.47	*7*
Salt	0.05	0.06	0.11	0.14	0.18	0.25	0.20	*4*
Unwrought Wood	0.06	0.10	0.18	0.21	0.31	0.50	0.44	*7*
Sugarcane	0.11	0.17	0.30	0.22	0.22	0.26	0.16	*1*
Oilcake Fodder	0.04	0.07	0.13	0.17	0.23	0.45	0.41	*10*
Sugar	0.08	0.10	0.19	0.21	0.31	0.48	0.41	*5*
Manganese Ore	0.06	0.10	0.21	0.24	0.32	0.55	0.49	*8*
Tar & Bitumen	0.07	0.10	-	-	-	-	-	-
Oil Seeds	0.06	0.08	0.18	0.20	0.26	-	-	-
Other Metal Ores	0.05	0.09	0.19	0.22	0.29	0.51	0.46	*9*
Gypsum	0.05	0.07	0.16	0.19	0.28	0.50	0.45	*10*
Paper	0.07	0.11	0.20	0.24	0.34	0.51	0.44	*6*
Non-Oilcake Fodder	0.06	0.08	0.15	0.19	0.25	0.40	0.34	*6*
Firewood & Fuel	0.06	0.07	0.12	0.16	-	-	-	-
Gur & Jaggery	0.06	0.07	0.17	-	-	-	-	-
Sand	0.06	0.09	-	0.22	0.31	0.56	0.50	*8*
Provisions	0.08	0.10	0.17	0.20	0.27	-	-	-
Raw Jute	0.12	0.16	-	-	-	-	-	-
Bricks & Tiles	0.06	0.09	0.19	0.24	-	-	-	-
Bamboos	0.06	0.11	0.22	0.23	0.29	0.48	0.42	*7*
Fruit & Vegetables	0.06	0.08	0.13	-	-	0.29	0.23	*4*
Raw Cotton	0.10	-	-	-	-	-	-	-
Compressed Gases	-	-	-	-	-	0.82	0.82	-
Acids	-	-	-	-	-	0.90	0.90	-
Non-Ferrous Metals	-	-	-	-	0.35	0.54	0.54	-
Soda Ash	-	-	0.17	0.22	0.30	0.49	0.49	-
Caustic Soda	-	-	-	-	0.34	0.52	0.52	-
Wrought Timber	-	-	0.15	0.17	0.26	0.43	0.43	-
Edible Oils	-	0.10	0.21	0.24	0.31	-	-	-
Cement Manufactures	-	-	-	-	-	0.72	0.72	-
Electrical Goods	-	-	-	0.43	0.63	-	-	-
Jute Manufactures	-	-	0.26	0.31	0.41	0.63	0.63	-
Other Freight	0.08	0.11	0.22	0.25	0.33	1.61	1.53	*19*
Total Traffic	**0.06**	**0.09**	**0.19**	**0.23**	**0.32**	**0.54**	**0.48**	*8*

Source: Computed on revenue & traffic data for Thirty Principal Freight Commodities, *IRYB*, various years, Directorate of Statistics & Economics, Railway Board, Ministry of Railways, Government of India, New Delhi

Besides the rate-analysis that has just been conducted, several other features of tonnage versus traffic changes in IR commodity-freight become apparent on detailed examination of Table 3.6. It is noticed, for instance, that increasing tonnage-polarisation in major bulk commodities like coal & coke, iron ore, POL and so on is almost matched by traffic-polarisation in these categories so that average traffic leads have increased only marginally over the 21-year period. Traffic leads for other heavy commodities such as non-ferrous metal ores, gypsum, etc., as well as construction material such as sand and unwrought wood have on the other hand declined, indicating greater increase in tonnages than in traffic. To a lesser extent, this is also true for cement. Decreasing traffic leads in these commodities would point firstly to closer location of metallurgical industry to mining pitheads, and secondly to greater regional dispersal in project and other construction activity. Conversely, in the high-rated, low-bulk traffic segment, average commodity leads appear to have increased since greater polarisation is visible in terms of traffic rather than tonnages. It is also to be noted that in addition to the commodities which form this segment, traffic-polarisation in bulk movements in foodgrains, sugar, oilseeds, etc., has also been higher than tonnage-polarisation. The implication of rising leads for all such commodities is that traffic with relatively shorter freighting distance has been gradually surrendered to other modes, leaving only long to very long hauls with IR. Since railway rating of the commodities mentioned by name is subsidised on account of their essential nature, retention by IR of the long-haul traffic in these is supported both by lower average rates and by the rate-telescope. It is also noticed from both tables that IR traffic in commodities other than those listed by names has become increasingly long-lead in nature over the review period. The impetus for such polarisation evidently comes from the high base-rate and the 19-fold increase in average traffic-rate that has occurred over the period, rendering the short-haul segment of this freight market most open to contest from the roadways.

3.6 Critical Operational Constraints

The IR freight situation over the 6FYP and 7FYP periods during the 1980s has been characterised by increases in both originating tonnages as well as railway freight traffic. However, while traffic increases had been more moderate over the first five FYPs, and had thus maintained greater parity with the increase in IR freight tonnages, the gap between the two has begun to widen since the 6FYP. As has been mentioned earlier , in order to maintain the public utility nature of its operations, IR cannot refuse certain commodities that assume the position of necessity, either for consumption or production, since "under Section 27-A of the Indian Railways Act, the Central Government may direct the railways, in the public interest, to give preference to transport of such goods as may be specified and such directions are generally given in respect of low-rated commodities like coal, foodgrains, mineral ore for export, raw materials for iron and steel industries, manure, etc.[29] Thus the shift of emphasis in IR freight operations towards bulk traffic noticed through the preceding analysis has been more policy-determined than commercially-directed. Even with major tariff hikes over several recent Railway Budgets, a major portion of the range of bulk commodities freighted by IR still remain low-rated when compared to the low-bulk categories of general freight which are often highly-rated. The overall consequence of this has been disadvantageous for IR, entailing low traffic earnings compared to the increasing traffic costs it has been incurring over recent decades.

Public investment policy towards railway freight transportation in India for more than three decades has been directed more towards the management of freight demand, rather than towards the building of freighting capacity in advance of the materialisation of transportation demands. Thus the addition of railway freighting capacity stayed a step ahead of demand only uptil the end of the 3FYP. The subsequent FYPs have allowed considerable shortages to build up in freighting capacity, as a result of which the foci of infrastructure planning have shifted towards providing transportation as and when necessary. Nevertheless, an increasing tonnage trend has been maintained most major commodities hauled by the IR freight network. Without the adequate planning provisions for rolling stock acquisition, such trends have led to considerable congestion on the IR freight system, a logical consequence of which has been the diversion of commodity traffic towards other modes of transportation like the roadways. The commodity-freight mix catered to be IR has also consequently undergone a change, with more pressure coming to bear on the railways to transport preferred commodities at relatively low tariff rates, in order to cater to the needs of core PSUs and of the state-regulated public distribution system [PDS]. Consequently, the commodities which display the longest freighting leads today include core industrials like iron & steel, as well as critical inputs and essential PDS commodities like coal & coke, fertilisers, foodgrains, salt and sugar.

Freight in coal & coke has now come to occupy singular importance for IR freight operations, with strongly increasing trends in both traffic and originating tonnages. Presently, coal & coke shipments account for over 50 percent of all traffic freighted by IR, while their contribution to total IR freight earnings hover around 40 percent. However, a major part of the increase in coal-generated railway freight revenues since the 1980s has originated from frequent upward revision in tariff rates, rather than in sharp increases in the transportation of coal tonnages. On the other hand, commodity shipments of limestone and dolomite which are required in bulk by the steel plants as well as the cement industry show decreasing longterm tonnage trends as well as decreasing freight leads, indicating a shift in traffic from the IR freight network. Traditionally important freight commodities like mineral oils [POL] show irregular traffic trends, mainly owing to a slowdown in the growth of their railway freighting leads, which works to the disadvantage of IR revenues as POL freight shipments have had the highest average tariff yields. Similar irregularity in traffic trends are also being increasingly noticed now for iron & steel, which had hitherto been among the principal revenue-generating freight commodities for IR Cement and fertiliser shipments have come to occupy prominent positions in the

IR commodity-freight mix, because of the widespread demand for these commodities across the whole country. IR freight tonnages and traffic in both these commodities have consequently been increasing, showing evidence of vast expansion in freighting leads. Yet, while most of these commodities have hitherto constituted captive traffic for IR, material evidence has accumulated that IR tariffs in the highly-rated segments among these have begun to surpass the limits of what the traffic can bear, leading to the diversion of short-lead shipments wherever possible to the roadways. Trends like these are disturbing for longterm IR freight and revenue projections, and account for the consistent failure of the railways to match freight targets set by the FYPs.

Accompanied by the public-service obligation of IR to transport subsidised freight in essential PDS commodities, traffic diversions like these have imparted increasing tariff-inelasticity to IR's freight revenues. Since the principal earnings on any railway system originate from freight rather than passenger operations, operational and financial performance has consequently suffered at a time when IR has come under increasing pressure to finance its capital needs through internal resource generation and external borrowing. It would thus appear that the key to the restoration of IR freight operations to commercial health lies in the maintenance of adequate freighting capacity on the system. An examination of the constitution and technical composition of IR freighting capacity is thus made in the next chapter in terms of its principal constitutent units, namely the railway wagon and the railway wagonfleet.

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Chapter 4

FREIGHT CAPACITY & THE INDIAN RAILWAY WAGONFLEET

4.1 Capacity Factors in IR Freight Operations

The preceding analysis of IR operational performance revealed the existence of certain inefficiencies in IR freight structure which have led to traffic dominance by bulk-freight on the IR network. Bulk commodities like coal, foodgrains, cement, mineral oils [POL], iron ore and iron & steel now provide as much as 96 percent of originating tonnages and 94 percent of net tonne-km traffic to total freight operations by IR.[1] The analysis has also demonstrated that this change in IR freight composition did not occur instantaneously, but resulted from gradual diversion of low-bulk categories of traffic to alternative modes of carriage, as railways in India were compelled by efficiency considerations to progressively assume the role of a bulk-carrier. The main technical factor that has prevented outright shifts of bulk traffic away from IR is the relative economy and fuel-efficiency with which railways can transport heavy freight commodities over long leads. Although in the wake of the worldwide spiral in fuel and transportation costs following the Oil Shocks of the 1970s, this factor has also become crucial to many other categories of freight, modal shifts of general freight to the roadways have also been induced in several countries - India among them - by the setting of exorbitant tariff rates on low-bulk and break-bulk consignments, or because of the extra value added to roadfreight services by their faster transits, doorstep deliveries, etc. An investigation as to which of these factors can adequately explain the disappearance of general freight from the IR system holds considerable importance towards an assessment of the longterm infrastructural role of Indian railways. The problem will be studied in the present chapter, on the working hypothesis that the shift of high-rated freight to other transportation modes poses difficulties for IR's longterm revenues and capitalisation projects, and that long-lead low-bulk traffic will have to be lured back into the IR freight-system in order to counterpose this threat.

The phenomenal growth evident in bulk-freight operations would also suggest that a change of orientation in IR freight capacity towards the specialised carriage of bulk traffic has occurred on IR, especially over the 1980s. Adaptation of such nature would require the technological modification of track, traction, equipment and rolling stock standards, so that increasing numbers of freight vehicles became available for the carriage of heavier consignments at higher speeds over longer distances. A study of the IR wagonfleet is therefore in order, and should encompass its composition by various wagon-types, the phases of modernisation in special wagon design to adapt IR wagonfleet capacity to specialised haulage of bulk freight, and the constraints originating in such wagon acquisition policies which now impact upon the Indian wagon industry. The overall effect that all these have had on the evolution of IR freight trends shall be evaluated separately by study of wagon utilisation indices and the wagon economics of IR freight operations.

4.1.1 Components of the IR Wagonfleet

The modern railway is believed to have originated in English coalmines where the use of parallel lines of planks secured by crossties to provide a hard surface for haulage of very heavy loads had been known from the 16th century. The first railway wagons were essentially adapted from the coal wagon which ran with fixed axles on flanged rails, and thus adhered to its open-box design.[2] Except for the substitution of wood by steel, this remains the predominant form of wagon design even today. It was only after the technological evolution of swiveling bogie axles which improved the turning characteristics of rolling stock over track curves that the railway wagon could be lengthened to any appreciable degree. Nevertheless a number of other modifications of the open-box design were made periodically to adapt fixed-axle railway wagons for the carriage of special categories of freight. Thus the modern railway wagonfleet generally includes wagons on the open-top and boxcar design, the flatwagon or platform design, the tankwagon design for carriage of liquid freight, and wagons with special load discharge capabilities like the various hopper designs. Progressive lengthening of the wagon body while limiting its body weight has allowed more payload to be carried including freight with odd dimensions, while improvements in axle, brake and coupler design have improved the endurance and reliability characteristics of wagons to allow high speed freight transits.

The major design refinements in wagon technology have all been inducted from time to time into the IR wagonfleet. Thus the IR wagonfleet today forms a composite of several heterogeneous categories of wagons, each designed either for general or special freight, with the major technological thrust having been towards the improvement of bulk haulage capacity and running speeds.

4.1.2a The Standard IR Wagon

The earliest railway wagons used in India were designed on the horse-drawn wagon trucks used for coal and timber haulage in Britain, and hence were fabricated on wooden underframe support, with open or covered high-sided wooden bodies reinforced by metal strappings and knees, and ran on a wheelbase of two fixed wrought-iron axles and spoked wheels . The maximum payload that could be carried by a broad gauge [BG] railway wagon built on this design was just over 12T.[3] Although modifications of the design were made subsequently to accommodate the transportation needs of varied merchandise, the 4-wheeled truck-type wagon with fixed axles or 4-wheeler unit [FWU] is still the most ubiquitous component of the IR wagonfleet.

Steel wagons began to come into use after the turn of the century, and gradually substituted the earlier design on the British and Continental railways because of their superior construction and carrying capacity. This technological innovation developed out of the backward linkage between the railways and metallurgical industry. Despite the multitude of companies that built and ran the Indian railways, India had been among the first countries to appreciate the advantages accruing from gauge and wagon standardisation, namely, economies in running, maintenance and inventory holdings of spares. Thus from 1908 onwards, a new BG FWU wagon design employing rolled-steel structural sections and steelplate construction to increase payload capacity to 21.3T was adopted as the *standard* wagon for the Indian BG network. These CR standard wagons were equipped either with flap-doors or dropping ends, and their covered versions with vertical hinge-doors were evolved on the same basic design, in some cases further adapted with dropping flap-sections to facilitate transportation of cattle.[4]

4.1.2b Specialised IR Wagons

Periodic alterations of the basic wagon design became necessary to enable transportation of rising freight volumes of commodities ranging from sand, coal, heavy timber, sugarcane, foodgrains, mineral ores and ballast (rubble for laying railway track-beds), to oils and petroleum fuels. This led naturally to the building of a wide range of non-standard wagon platforms adapted to the specific carriage of coal and other minerals, unwrought timber, edible and volatile oils, as also water tankers, travelling cranes, ballast wagons, etc., which were built for departmental purposes. While the 4-wheeler FWU continued to be the standard wagon design, the elongated 8-wheeler bogie design was gradually introduced to meet special requirements and also to enable the haulage of bigger or bulkier freight loads.

The engineering adaptations made on the basic FWU and bogie-type wheelbase to enable the carriage of various categories of freight merit comment since they represent the technological response of the Indian railways to transportation challenges, at a time when they were still relatively secure from intermodal competition. The modifications were quite interesting. Special cattle wagons were partitioned into pens and provided with ventilators and arrangements for disposal of animal wastes, with troughs being added for feeding and drinking during transit. The special platform wagon for timber haulage was built on the open truck design with a skeletal body which adapted to unwrought timber of various shapes and sizes and prevented their dislodgment during transit. The special hopper-type wagon was designed for the carriage ballast, ores and coal and permitted their unaided gravity-discharge at unloading sites.[5] Particularly ingenious design refinements were made for freighting refrigerated or inflammable goods. Special bogie-type refrigerated vans were built with double-cased timber bodies with an insulating layer of slab cork in between, and were provided with cam-operated and spring-sealed doors for airtight closure. The special cement flooring on these vans covered a timber-boarded undersurface again insulated with cork, and was occupied centrally by an angled-steel ice bunk comprising separate steel racks for holding blocks of ice. A cheaper refrigerated design was also developed specifically for the transportation of chilled dairy cans from milk-surplus areas in

Gujarat to meet the requirements of the city of Bombay. The typical tankwagon design was evolved on the fixed-axle platform mounted with cylindrical top-loading steel tanks for the carriage of various edible and other oils. Refinements to this design were made to allow the safe carriage of petrol, by equipping the tanks with special pressure-release and vapour-return valves and a sealing flap within the manhole that prevented losses of petrol vapour. Petrol wagons were also finished with aluminium-paint or white-paint to minimise internal heating from direct exposure to the sun.[6]

The well-wagon evolved as a specific technical design for the adaptable carriage of extremely large or bulky freight articles such as heavy machinery, and became increasingly important to the infrastructural thrust of India's early FYPs. The prototype was thus designed to carry a unit payload of 132T, distributed over a 'short well'. Although fabrication of the giant wagon was entrusted to the technical skills of a Swiss engineering firm, the prototype design and specifications were prepared in India by the Central Standards Office [CSO] of the Ministry of Railways. The main girder of the well which rested on special rubber-cushioned pivots could absorb jolts and shocks through two main sub-tructures fitted on 6-wheel bogies at either end, and incorporated a hydraulic device which adjusted the main girder to required heights when passing fixed structures such as railway overbridges and tunnels with out-of-gauge loads. Although the giant prototype measured as much as 27.56m over the buffers and 17.25m between pivots, all-welded construction reduced its tare weight to a minimum. An important technical feature in the bogie design allowed the well-wagon to make right-angled turns on a turntable of only 8.23m diameter, thus enabling onsite discharge of critical heavy machinery and equipment for the multipurpose irrigation and hydroelectric projects that were taken up soon after Independence. Projects of national importance such as the Damodar Valley Project, the Bhakra-Nangal Project and the Hirakud Dam Project undertaken during the early FYPs thus greatly benefited from the use of these special wagons to convey their heavy equipment.[7]

4.2 Freight Capacity Development on the Indian Railways

Although as a major area for application for railway capital, rolling stock investments are a crucial determinant of freighting capacity on railway systems, the extent to which such investments are undertaken by nationalised railway systems is largely a matter of public policy. When transportation policies are designed to stimulate economic growth, the primary investment decision comprises two parts. While the first determines the extent to which state investment should be committed to transportation infrastructure vis-a-vis the producing sectors of the economy, the second defines the allocation of infrastructural investment made between alternative transportation modes. Developmental allocations of funds towards transportation in the Indian FYPs have displayed this segmented character, even while IR have remained their principal point of focus. Nevertheless a secondary and final component in the investment decision jointly comprises internal decisions within the transport authority - IR, in this case - regarding the allocation of development funds that have been made available between the different spheres of railway investment. Thus the allocation of railway capital towards the augmentation of wagonfleets and IR freighting capacity traverses a tortuous hierarchy of decisions through different planning levels.

4.2.1 Growth of IR Wagonfleet

The actual freighting capacity of a railway system is composed of two elements. While the number of wagons online indicates the raw physical capacity of the system, a refinement is posted by the differing levels of technology embodied in the special wagons that are on the online wagonfleet. To avoid confusion on this count, it is usual for railway systems to quote their wagonfleets in terms of standard-wagon equivalents, which in the case of IR is the 4-wheeler CR standard wagon with unit-payloading capacity of just under 22T. Again, while the online wagonfleet with its heterogeneous wagon variants defines the aggregate tonnage-freight capacity available on the system in the general sense, the extent of wagon specialisation towards the loading of specific categories of freight posts a compartmental limit to tonnages that can be transported of any individual commodity. However - no matter in which sense freighting capacity is viewed - shortfalls in rolling stock inventories can cause serious transportation bottlenecks with an impact detrimental to the overall growth of the economy. Maintenance of adequate freighting capacity in the transportation sector thus becomes imperative for economic development and can be evaluated, in the case of IR, in terms of the growth of the IR wagonfleet.

Table 4.1: The Indian Railway Wagonfleet 1950-51 to 1994-95

Year	Total Online Wagonfleet	Composition by Wagon Categories % Covered Wagons	% OHS Wagons	% OLS Wagons	% BOX/BOB Wagons	% Departmental Wagons
1950-51	205597	58.9	25.5	3.4	7.2	5.0
1955-56	240756	58.1	24.7	4.2	8.7	4.3
1960-61	307907	57.3	25.5	2.5	10.6	4.1
1965-66	370019	53.1	27.2	2.1	13.3	4.3
1968-69	381685	53.3	26.1	1.8	14.6	4.2
1969-70	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*
1970-71	383990	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*
1971-72	382725	53.3	25.5	1.8	15.1	4.3
1972-73	384283	53.1	25.7	1.7	15.6	4.1
1973-74	388366	52.8	25.8	1.7	15.6	4.1
1974-75	390968	53.7	28.3	3.1	11.4	3.5
1975-76	395250	54.0	28.0	3.0	11.5	3.5
1976-77	397773	54.1	28.1	3.0	11.4	3.4
1977-78	399971	53.8	28.4	3.1	11.3	3.4
1978-79	401885	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*
1979-80	405185	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*
1980-81	400946	53.3	28.3	3.2	11.8	3.4
1981-82	392062	52.7	28.3	3.2	12.5	3.3
1982-83	374756	52.2	28.1	3.2	13.2	3.3
1983-84	374757	52.2	28.1	3.2	13.2	3.3
1984-85	365392	52.1	27.8	3.4	13.4	3.3
1985-86	359617	51.9	28.0	3.4	13.4	3.3
1986-87	354041	51.7	28.2	3.4	13.4	3.3
1987-88	346844	51.2	28.5	3.4	13.5	3.4
1988-89	345821	50.6	28.9	3.5	13.7	3.3
1989-90	349560	49.8	29.3	3.5	14.1	3.3
1990-91	346102	49.1	29.6	3.6	14.4	3.3
1991-92	346394	47.7	30.7	3.6	14.6	3.4
1992-93	337562	46.7	31.2	3.6	14.9	3.6
1993-94	312405	44.4	32.4	3.8	15.7	3.7
1994-95	291360	41.9	33.9	3.9	16.5	3.8

Source: *IRYB*, various years, Directorate of Statistics & Economics, Railway Board, Ministry of Railways, Government of India, New Delhi *(for wagon descriptions, see sec.4.3.2)*

Table 4.1 summarises the growth of the IR wagonfleet in terms of standard FWUs over the era of planning. It had been noted earlier that the drawn-down condition of railway inventories after WWII and the partial transfer of railway assets to Pakistan Railways during the process of partition kept IR occupied over the transitional years with rebuilding wagon numbers to restore its lost freighting capacity. The institution of planning shifted the focus towards the upgradation of freighting capacity to match transportation needs in a growing economy. As such, both plan allocations and IR investment policy decisions during the early FYPs were directed to the removal of infrastructural deficiency. Sharp growth in the online wagonfleet is noticeable therefore over the period from the 1FYP uptil the end of the 3FYP, during which freight capacity increases were planned ahead of the materialisation of equivalent traffic demands. Hence online wagonfleet numbers increased by over 80 percent compared to 1950-51 levels, with average net annual acquisitions of 7032, 13430 and 12422 wagons, respectively, over the three plan periods. It had been noted however that the 3FYP period witnessed a traffic shortfall arising mainly from lack of adequate freight support from the PSUs, as a result of which the IR freight system found itself saddled with excess capacity. Net increases of the online wagonfleet during the 4FYP were therefore much more restrained at 1336 wagons annually. Over the 'plateau' period of the 1970s, the online wagonfleet thus hovered at just under the 400 lakh FWU mark, with marginal net annual acquisitions of 2321 wagons over the 5FYP period. The IR wagonfleet peaked at just over 400 lakh FWUs when the 6FYP commenced in 1980-81. Since the 6FYP, the infrastructural thrust of planning has been more towards fleet modernisation than towards expansion in wagon numbers. The upshot has been a reversal of earlier growth trends and an absolute decline in the number of wagons online. Over the 6FYP period, the average net annual decrement in the online fleet was (-)7111 wagons, with capacity shedding then declining somewhat to (-)2011 wagons over the 7FYP. Within the 8FYP period, the net annual decrement in the wagonfleet averaged as many as (-)18345 wagons over three plan-years between 1992-95. Thus in terms of wagon numbers, the IR online wagonfleet in 1994-95 stood 42 percent higher than the 1950-51 level, but had declined by about 28 percent from its all-time peak in 1980-81.

Since online fleet decrements at least partially reflect non-replacement of wornout railway wagons, a point of vital consideration while evaluating growth in IR freight capacity concerns the replacement acquisitions of wagons. Annual wagon purchase by IR serves dual purposes, namely *maintenance* of wagon inventories at prior levels as a first step, and further *augmentation* of wagon inventories as a second step through net acquisition of wagons. Thus the figures for average net annual wagon acquisitions presented above offer only a partial picture of wagon purchases made by IR. Railway policy in India till the 3FYP had been oriented towards the extraction of maximum service from existing equipment and rolling stock inventories and did not therefore witness high rates of replacement for overaged and obsolete rolling stock. Consequently, even as wagon numbers increased, efficiency declined. The principle adopted while projecting IR rolling stock requirements for the 3FYP in fact postulated retention of all locomotives and railway wagons upto the age of 45 years, posing a striking contrast to US railroad policies of the time which permitted only 4 percent inclusion in online traction-fleets of locomotives with an age of 20 years or more.[8]

While it might be argued that a policy basis was provided to the non-replacement of IR rolling stock assets by the overall constraints on investment resources and the rapid expansion of traffic, the appearance of traffic slack changed the situation dramatically after the mid-1960s. As a result, while wagon acquisitions decreased on the whole, a larger proportion of the acquisitions made each year were directed to the replacement of wagons which were long past their prime. After the focus of IR policy shifted progressively towards the modernisation of railway inventories, greater commitments of investment towards the acquisition of nonstandard equipment including periodic imports of stock and technology ruled that less money was available for financing wagon replacement. Hence negative figures for net wagon acquisitions ever since the 6FYP reflect both shortfalls in plan allocations as well as the incidental impact of the policies on railway technology. What IR have been undergoing since the start of this period might thus be termed as technological renewal at high capital cost.

The foregoing analysis has made an exposé of the real freight-capacity anomaly that has been confronting IR. The period of planning, which produced the three operational phases outlined in the previous chapter, was composed of three analogous phases in the railway infrastructural policy pertaining to the development freight capacity. In the first of these phases stretching between the 1FYP and 3FYP, a policy of rapid wagonfleet increments kept freight capacity well ahead of traffic demand and allowed rapid expansion in operations. The second phase lasting through the 1970s and spanning the 4FYP and 5FYP put a brake on capacity expansion and brought about an operational plateau. Redirection of the infrastructural thrust towards fleet modernisation commenced with the 6FYP and brought about renewed expansion in subsequent IR freight operations, but has been accompanied as shown in the preceding chapter, by freight specialisation favouring select flows of commodity-traffic, leading to surrender of other commodity freight to alternative transportation. Analysis of the growth of IR wagonfleet identifies certain issues which require further attention. It becomes necessary therefore to evaluate the degree to which technological upgradation of IR freight capacity has compensated the reduction in absolute wagon numbers. Other technological features of railway development such as gauge conversion and the improvement of track and traction also need to be evaluated in terms of their possible impact on the expansion of IR freighting capacity in terms of traffic, *i.e.* in net tonne-km terms. These issues shall now be approached.

4.2.2 Growth of IR Freighting Capacity

The importance of wagon capacity to this analysis can be gauged from the fact that while the IR wagonfleet had grown numerically by around 70 percent over the period between 1FYP and 7FYP (*see table*), the freighting capacity of the system had risen 173 percent or 7.3MT over its 1950-51 level. Expansion of this order sustained the growth of aggregate IR freighting capacity even through the period of declining wagon numbers witnessed after the mid-1970s. By 1994-95, the average carrying capacity of an IR wagon had risen by 176 percent compared to 1950-51, although the proportion of increase in the wagonfleet excluding its departmental wagons was only 73 percent. Table 4.2 summarises the growth of IR freighting capacity in both aggregate and average wagon-unit terms. While the even match maintained between the growth of wagonfleet and aggregate freighting capacity till the end of the 1950s indicated the absence of wagon upgradation to any noticeable degree, the situation changed markedly over the 3FYP when the growth rates of freighting capacity began to outpace the growth of the online wagonfleet, indicating considerable induction of upgraded railway wagons. Total freighting capacity of the online IR wagonfleet then stabilised over a temporary plateau during the 1970s and early-1980s, before another rise commenced towards the end of the 7FYP. The number of online wagons have gradually fallen, on the other hand, after peak levels were reached in the mid-1970s.

Table 4.2: Wagon Capacities on the Indian Railways
1950-51 to 1994-95

Year	BG Wagonfleet *['000]*	Average Wagon Capacity *[T]*	MG Wagonfleet *['000]*	Average Wagon Capacity *[T]*	Total IR Wagonfleet *['000]*	Total IR Freighting Capacity *[MT]*
1950-51	149	22.6	43	17.1	195	4.14
1955-56	161	22.6	64	18.0	230	4.87
1960-61	207	23.1	83	18.0	295	6.30
1965-66	257	26.4	91	18.0	354	8.52
1970-71	271	27.8	91	19.1	368	9.35
1971-72	270	28.1	90	19.1	366	9.37
1972-73	273	28.2	89	19.1	368	9.49
1973-74	279	28.6	88	19.1	372	9.74
1974-75	285	29.1	87	20.7	377	10.17
1975-76	291	29.3	86	20.9	382	13.37
1976-77	294	29.7	85	20.9	384	10.61
1977-78	296	29.9	85	21.1	386	10.74
1978-79	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*
1979-80	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*
1980-81	299	30.6	83	23.0	387	11.14
1981-82	294	31.1	80	21.5	379	10.95
1982-83	290	31.7	77	21.7	371	10.92
1983-84	284	32.5	74	22.0	362	10.95
1984-85	279	33.1	70	22.4	353	10.98
1985-86	276	33.9	68	22.3	348	10.96
1986-87	275	34.3	64	22.4	342	10.88
1987-88	272	34.5	60	22.4	335	10.77
1988-89	274	35.2	57	22.6	334	10.99
1989-90	278	36.3	57	22.7	338	11.44
1990-91	276	36.9	55	22.9	335	11.50
1991-92	278	37.9	54	23.3	335	11.84
1992-93	272	38.7	51	24.0	326	11.79
1993-94	259	39.7	40	25.0	301	11.32
1994-95	246	40.2	33	25.8	280	10.76

Source: *IRYB*, various years, Directorate of Statistics & Economics, Railway Board, Ministry of Railways, Government of India, New Delhi

Note: *Listed wagonfleet numbers exclude Departmental wagons*

While considering such capacity trends, it needs to be remembered however that the gauge composition of the wagonfleet precedes all other technical factors as a determinant of freighting capacity, since broad gauge [BG] wagons have higher payloading capacity compared to metre gauge [MG] wagons. While more will be said about gauge and other factors shortly, the growth of average BG and MG wagon capacities evident above can first be analysed in relation to the growth of the aggregate IR wagonfleet.

Till the shift in policy stress towards the modernisation of railway equipment and inventories, freight operations on IR's MG feeder networks had been important to the mainline operations on BG. A sharp increase was consequently witnessed in MG wagon numbers till the commencement of the 4FYP in 1969-70. In net-terms, *i.e.* wagon acquisition minus obsolescence, 0.43 lakh MG wagons were added to the IR wagonfleet over the period of first three FYPs and interplan years between 1950-51 and 1968-69, representing an indexed increase of 114 percent in the MG wagonfleet. Compared to the net addition of 1.19 lakh BG wagons during the same period where the indexed increase was only 80 percent, this would imply that the proportional rates of wagon acquisition over the relevant period were substantially higher for MG wagons. Thus in capacity terms, the ratio of BG-to-MG freighting capacity had declined by 1968-69 to around 3.9:1 from a starting level of 4.6:1 in 1950-51, again reflecting greater *pro rata* addition of MG wagons to the total wagonfleet. Against this however, the net BG wagonfleet increment represented the augmentation of IR freighting capacity by 3.65MT, against 1.06MT added by MG wagon acquisition. Considering the hinterland character of MG freight services in India, these figures would show that the expansion in mainline freighting capacity on IR during the initial planning period was not entirely unrelated to the anticipated expansion in feeder-freight flows, although a substantial proportion could be attributed to freight which needed to be moved exclusively along IR's mainline corridors.

The planning focus during subsequent augmentations of freighting capacity on the MG feeder networks shifted towards upgrading the carrying capacity of the MG wagon, to which little attention had been paid in the initial period. Since the average capacity of the MG wagon continued to rise subsequently without substantive increase in MG wagon numbers, this appears to have been accomplished during the replacement of obsolescent wagons implying that a shift of emphasis from feeder freight to mainline freight was beginning to occur. Although a full exploration of the planning shift would extend beyond the purposes of this brief review, the reasons underlying it would relate to anticipated change in nature of IR freight flows during the 4FYP.[9] With the memory of traffic failures during the 3FYP then still being fresh, transportation priorities for the 4FYP were reorganised around the need for industrial recovery, calling for specific augmentation of the capacity of IR to handle bulk-freight in large technological units. In retrospect, this spelt the death-knell for feeder-freight operations on the MG network and reversed the flows of IR freight traffic by progressively reducing its focus to a few select commodities, in the process also opening the huge general-freight market to open entry by the Indian roadways. These and related issues concerning the evolution of IR commodity-freight patterns will be approached again later in the present study.

On the BG network however, augmentation of the wagonfleet continued, accompanied by substantial technological upgradation of wagon capacity. As a result, while growth trends in the BG wagonfleet generally remained positive through the 1970s with net addition of 0.31 lakh wagons over the fleet level that existed at the commencement of the 4FYP, the MG wagonfleet witnessed a sharp decline in wagon numbers, with a net decrement of around (-) 9000 wagons over the same period. In terms of equivalent tonnages, BG wagon acquisition added net freighting capacity of 2.25MT to IR against the loss of 0.04MT on the MG network. The ratio of BG-to-MG freighting capacity consequently climbed to 5:1. While reductions were witnessed in both BG and MG wagonfleets during the 1980s, the decline on the BG network related primarily to IR's inability to finance wagon replacement at an adequate level, since the average carrying capacity of BG wagons continued to improve. The decline in the MG wagonfleet was however especially sharp as a consequence of the policy decision to unify the IR gauge and gradually phase out MG railway operations, thereby doing away altogether with the need for wagon replacement. The net cutback in fleet levels over the decade amounted to around (-) 0.21 lakh BG wagons and (-) 0.26 lakh MG wagons. Inspite of this, technological upgradation in the BG wagonfleet allowed the addition of 0.82MT to total BG freighting capacity while MG capacity fell by 0.52MT, allowing aggregate IR freight capacity to increase in net terms by around 0.30MT. As another consequence of the selective phasing out of MG operations, the ratio of BG-to-MG freighting capacity rose to 7.7:1 by the end of the decade, indicating the degree to which the IR traffic focus had switched over from MG to BG sections.

A curious ambivalence can thus be noticed over the planning period regarding the infrastructural character of railway freight operations and the maintenance of adequate wagon capacity for the same. This has been captured in the gauge-wise analysis of freighting capacity on the mainline and feeder networks of IR. In the planning philosophy that guided the early FYPs, the need for augmenting the capacity of the feeder network to handle the downstream traffic anticipated from augmented mainline flows of freight appears to have been acutely felt. In the spatial sense, IR freight services spread outwards to reach the transportation needs of the hinterlands, marking a change from older colonial railway patterns and the conscious use of IR as a development instrument. Freight polarisation in the opposite direction, which became a feature of transportation planning thereafter, was precipitated by traffic setbacks and industrial recession. IR specialisation and the substitution of general freight flows by special freight appears to have been initially undertaken as a temporary device in order to stimulate an industrial recovery by providing IR with guaranteed traffic flows from the PSUs. For a period of time through the 1970s, IR still struggled over maintaining equivalent capacity on both feeder and trunk networks. However as freight specialisation became institutionalised over time because of the durable nature of the railway technology that had been inducted, the importance of expanding downstream railway operations in the hinterlands gradually declined, eventually justifying the write-off of feeder capacity. Instead, the downstream freight flows of the economy gravitated to the roadways where they became subject to increasingly greater transportation costs.

While this seems to have been the broad picture, the onus would not rest entirely with the railways. During a period of capital abundance relative to the size of their existing freight operations, IR strove valiantly to expand into feeder regions and meet the infrastructural needs of the regional economy, maintaining railway technology at appropriate levels. As seen from the financial analysis in previous chapter, the malaise set in after capital support to IR had declined to levels where they had to sustain their services from their operating profits. Hence despite maintaining a surplus position through the subsequent period, IR have progressively been compelled to reduce the horizontal spread of their freight services to maintain capital and wagonfleet adequacy for technology-intensive bulk-freight operations. The results of this have told heavily on the infrastructural character of railway freight operations in India.

4.3 IR Wagonfleet Composition

The preceding analysis has offered a fleeting glimpse of the technical problems created by the simultaneous presence of different gauges on the IR network, which render BG and MG equipment inventories incompatible with each other besides creating economic separation between trunk and feeder operations. As noted previously, early railways in India had been constructed over a BG trunk network on one of the widest railway gauges of 1.6764m [5' 6"]. While this was an administrative decision made under Dalhousie, it was informed by the gauge controversies that had occurred during early railway development in Britain and by the engineering merits displayed by Brunel's 2.2m [7'] gauge on the Great Western, against the narrower 1.435m [4'8½"] gauge adopted as standard gauge on British railways.[10] The purpose behind this choice of gauge was to reduce eventual running costs on Indian trunk operations, although construction on this wider gauge necessitated higher capital outlays per track-kilometre. It is interesting also to note that construction on the 1.6764m gauge appears to have been widely preferred whenever British capital was involved in railway construction overseas, since the same gauge is found presently on railways in Spain, Portugal and Latin America whose construction was undertaken by British companies. Although the later Indian preference for the MG [1m or 3' 3⅜"] gauge arose when the branch and feeder network was under construction because of the financial stringency that occurred after the first phase of railway construction was over and the interest guarantee system had been withdrawn, it was also justified as a means for lowering railway construction costs by using a lighter railway gauge in sectors where traffic density was expected to be limited. Light railways were also specifically constructed to two narrow gauges of 0.7620m [2'6" or QNG] and 0.6096m [2' or NG] to keep engineering costs low in mountain areas and other feeder regions where traffic was expected to be exceptionally light.[11]

The decision on multigauge construction was fraught with future consequences on the composition and utilisation of railway inventories in India, since it necessitated a large volume of transhipment when freight originating on the trunk network was destined for feeder lines, and long detainments when feeder freight was being assembled for trunk operations. This made traffic transit laborious and time-consuming, while entailing additional handling costs that are avoided on through-transits.[12] Also the vast inventories of track, equipment and rolling stock maintained on low-intensity MG networks could not be deployed against shortfalls on the BG system. Gradual conversion of MG to BG at huge capital costs - the byword for which has been the UNIGAUGE scheme launched with much fanfare by IR during the 8FYP, is necessitated by the imperative of doing away with these transhipment costs and delays, but also imposes additional inventory costs of its own as new replacement needs arise for the MG equipment inventories that are rendered redundant. Differentiation between BG and MG has also posed perpetual problems for IR freight planners, since the composition of IR wagon stocks is determined by the rates of apportionment of financial resources over the MG and BG networks.

Substantial improvement in the average carrying capacity of IR wagons was observed to have accompanied the growth of BG and MG wagonfleets. Thus besides multiplying wagon numbers in order to handle the growing freight flows of the planning period, the IR wagonfleet has also diversified into several new wagon-types. Till the mid-century, nearly all commodity-freight had been carried on general-purpose railway wagons, comprising the CR *covered* boxwagon, the *open low-sided* [OLS] K gondola wagon and the KC *open high-sided* [OHS] gondola wagons. The KC open wagon design that was standard for the BG network had evolved as a 4-wheeler wagon with fixed axles, 10.31T *tare* weight (deadweight or unloaded weight), with maximum payloading capacity of 22.19T. The MG network instead employed a smaller 5.69T tare boxwagon with 18.69T payloading capacity running on the smaller MG wheelbase.[13] As a comparative yardstick, it might be noted that the US Class I Railroads already operated much heavier wagon designs of 27T tare with 77T payloading weight, and 34T tare with 109T payloading weight for special freightage of coal.[14] Subsequent upgradations in IR wagon designs, while considerably improving loading-to-tare ratios, have also been directed towards the carriage of special freight.

4.3.1 Freight Innovation and Wagon Design

It has been observed in writings on economic history that the multiple streams of specialised production that imparted an industrial character to modern civilisation only became possible after the prior development of an efficient transportation system. Thus the improvements in standards of living over the 20th-century which have arisen from the 'external' specialisation of entire communities derive historically from the great 19th century advances in transportation.[15] As methods of manufacture increased in industrial complexity, the facility of freightage became correspondingly more crucial to the transformation of finished products from one industry into intermediate material inputs for others. The imperative of minimising transportation costs at a time when product prices were also falling as a result of the economies of largescale production generated a rising need for specialisation within the transportation sector. Specialised innovations on the railways thus arose from the need to provide efficient freight carriage to various industrial sectors at lowest cost. Similar needs have guided the technical adaptations witnessed on the IR freight system.

An important means for augmenting railway freight capacity in a specifically technical sense is superior wagon design. As a part of the technical emphasis in the FYPs on raising wagon payloads, IR have favoured the bogie design which permits longer wagon-body construction using swivelling wheelbases instead of fixed axles. Simultaneous mechanical upgradation of handling facilities for special categories of traffic has also been made. The more important classes of bulk-freight have since been increasingly carried on these high-capacity wagons, even though the standard 4-wheeler boxwagon still remains the workhorse of the IR wagonfleet. The principal wagon-types in current use by IR include the standard OHS KC 4-wheeler wagon and BKC bogie wagon which have now largely been upgraded to the OHS BOX/BOXN bogie-type standard suitable for high-speed haulage of coal, iron and other bulk; the standard CRT 4-wheeler covered wagon used for conveying foodgrains and cement, which is being upgraded now to the covered high-capacity BCX/BCN bogie-type standard suitable for watertight haulage of general freight; the open hopper-type BT bogie wagon with bottom discharge facilities which is being replaced by the upgraded BOBS/BOBX bogie wagon suitable for quick discharge of both ballast and ores; the OLS K wagon which has largely been replaced by the BOY bogie wagon suitable for ore shipment; the TPGL 4-wheeler tank wagon for haulage of POL, edible oils and molasses, which is now being upgraded to the BPTN bogie-type standard; the BFR well-wagon for haulage of overdimensional or extra-heavy freight and machinery consignments; and two variants of the platform wagon, including the BRH flatwagon suitable for the transport of steel rails and bars, and the BFKI flatwagon now being used for carriage of international ISO containers on the CONCOR [Container Corporation of India] door-to-door service. As the KC and CRT wagons decline in number, IR is heading towards the eventual replacement of the 4-wheel FWU standard by the 8-wheel bogie wagon standard which permits reliable traffic transit at much higher trainspeeds.[16]

At this level of disaggregation, the changing composition of the IR wagonfleet also reveals the commodity preferences of its freight operations. Except for standard covered BCX/BCN wagons which can be used the transporting nearly all categories of general freight, all other wagons in the IR wagonfleet handle specialised traffic. Growing complexity of the wagonfleet thus preordains technical rather than spatial diversification in IR freight services by progressively tying them to the needs of captive freight.

4.3.2 IR Special Wagonfleet

Indication of change in the proportionate breakup of the IR wagonfleet under special wagon categories had been provided earlier in Table 4.1, alongside figures for the growth in the number of wagons online. Covered standard wagons still constituted more than half of the IR wagonfleet in the 1980s, although acquisition of wagons of this type had decelerated during the period reviewed. At the end of the 7FYP in 1989-90, the proportion of covered standard wagons in the IR fleet declined to less than 50 percent for the first time over nearly four decades of planning, with the trend having continued since. On the other hand, wagons of the OHS design have been in high demand for carriage of mechanically-loaded coal and other bulk-freight for which sharply increasing tonnage trends had been noted earlier. The proportion of such wagons in the IR wagonfleet rose from around a quarter to a third of total online wagons between the 1950s and the mid-

1990s. Since the average loading capacities on these wagons have been upgraded through design modifications while average trainloads have also increased following the modernisation of IR traction, inference can validly be drawn that the increases in IR bulk tonnages noted in the previous chapter are more than proportionate to the growth in OHS-type wagons. Also, with longer and heavier rakes being hauled on IR trunk routes today, it also appears likely that the actual intensity of use of railway track for freighting purposes has actually declined, even as tonnage-freight has increased.

These peculiar features in IR freight and freight-capacity patterns draw attention to the traffic impact of special wagons in the IR wagonfleet. Quite obviously, increasing returns and high traffic elasticities are at play here. Wagons utilising specialised technology designed around the transportation and handling needs of special freight improve the throughput of captive freight on the IR network as they have done elsewhere. They have thus been critical input in improving freight efficiency on the IR network. However, this improvement also has paradoxical consequences since, after the movement of traffic in rakeloads and the quickening of transits, it creates significant slack on IR track and on other sections of the IR freight network which can only be filled if adequate capital is also being committed to the expansion of other freight services.

LIST: Design Specifications of IR Special Wagons

BOX	: High sided open bogie wagons with side discharge arrangement for transportation of coal & other bulk items
BOXN	: High-sided bogie open wagon with improved components like cast-steel bogies, high tensile couplers, cartridge taper roller bearings, air brakes etc., enabling greater trailing loads, for transportation of bulk commodities like coal, iron ore, etc.
TPGL	: Tank wagons for transportation of liquid consignments like petroleum products, molasses, vegetable oils, etc
BTPN	: Upgraded tank wagons for liquid consignments like petroleum products, molasses and vegetable oils
BOBS\BOBX	: Open Hopper wagons with bottom-discharge arrangements for transportation of ballast, ores, etc.
BOY	: Low sided open bogie wagons for transportation of ores, etc.
BRH	: Flat-wagons for transportation of nails, steel bars, etc
BFU	: Well-wagons for transportation of over-dimensional and heavy machinery consignments
CA\BCA	: Wagons designed for the transportation of cattle
CRT	: Water-tight 4-wheeler covered wagons with higher load-capacity for transportation of general goods
BCX	: Water-tight covered wagons for transportation of foodgrains, cement, etc.
BCN	: Water-tight covered bogie wagons with cast-steel bogie, cartridge-taper roller bearings and air brake
BFKI	: Flat-wagons to carry containers for door-to-door service

Table 4.3: Technical Specifications of BG Special Wagons on the Indian Railways

Wagon-Type	*Wheelbase*	Gross Weight Tonnes *[T]*	Tare Weight Tonnes *[T]*	Maximum Loading Capacity *[T]*	Length over buffers *[mm]*	*Maximum Speeds* Empty *[kmph]*	Loaded *[kmph]*
BOX	*Bogie*	81.30	25.20	56.10	13716	75	75
BOXN	*Bogie*	81.28	21.47	58.81	10713	80	90
TPGL	*Fixed-axle*	31.17	11.17	20.10	8382	75	75
BTPN	*Bogie*	81.28	27	54.28	12420	*n.a*	*n.a*
BOBS	*Bogie*	91.44	30.23	61.21	11638	*M32* *NM40*	*M48* *NM56*
BOBX	*Bogie*	91.70	27.70	63.80	11596	56	56
BOY	*Bogie*	90.60	20.20	70.40	11930	65	65
BRH	*Bogie*	81.30	23.90	57.40	14998	75	75
BFU	*Bogie*	*n.a*	*n.a*	50-183	*upto* 27560	*n.a*	*n.a*
CA/BCA	*Fixed-axle*	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*
BFR	*Bogie*	81.30	23.90	57.40	14998	75	75
CRT	*Fixed-axle*	40.64	13.40	27.54	8824	75	75
BCX	*Bogie*	81.28	28.98	52.80	15710	75	75
BFKI	*Bogie*	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*

Source: Adapted from *IRYB 1983-84*, p41, and *IRYB*, other years, Directorate of Statistics & Economics, Railway Board, Ministry of Railways, Government of India, and RFFC [1993], 1(21):658, *Annexure 21-0*

A brief description of the principal special wagon-types that currently serve the IR freight network has been provided in the list, and their technical specifications in Table 4.3. The composition of the IR wagonfleet by different wagon-types reported earlier [*see Table 4.1*] can thus be related to their freight purpose and their technical characteristics including tare and loading weights. It may be noted that the introduction of special wagon designs by IR were a periodic technological response to the industrial and traffic priorities of specific FYPs. Hence, modification of the standard OHS design to adapt it to the specific carriage of coal and iron ore began during the 2FYP. The OHS BOX-type wagon was inducted into railway operations in 1959-60, and was quickly followed by the technologically-advanced BOXN design. Other open wagon hopper designs like the BOBS introduced during the 2FYP in 1957-58, and the BOBX introduced after the 3FYP in 1966-67, featured special bottom-discharge systems to facilitate quick discharge of ores at metallurgical plants as well as railway ballast.[17] The proportion of these open hopper-type wagons in the IR wagonfleet rose rapidly during the 3FYP period commensurately with the expansion in mining and metallurgical capacity. Through the 4FYP, the rise in the OHS wagonfleet was more gradual and a peak proportion of 15.6 percent of total IR wagons online was reached in 1973-74. Although the proportion slipped through the rest of the decade, it began to rise again during the 1980s so that, by 1994-95, OHS wagons represented 16.5 percent of online IR wagons. Low-sided OLS wagons have traditionally recorded a smaller presence in the IR wagonfleet and underwent proportionate decline during the early FYPs. However, introduction of the specialised BOY variant in 1973-74 for exclusive carriage of iron ore again raised their proportionate presence in the IR wagonfleet to 3.4 percent in 1984-85 and 3.9 percent in 1994-95.

Comparisons between the freighting efficiency of OHS and OLS wagon-designs can be made in terms of payloading capacities and running speeds. The comparision gives some idea of the efficiency basis for wagon specialisation. For instance, while the OLS BOY with lower tare weight of 20.2T and higher payload capacity of 70.4T appears a better choice in terms of payload-to-tare weight ratios, the more ubiquitous BOX design with the higher tare weight of 25.2T and lower payload capacity of 56.1T offers the advantage of faster transits at upto 75kmph, against 65kmph for the BOY wagon. With maximum running speeds of 90kmph, the BOXN wagon is superlative to either of these. The table also shows that the proportion of departmental wagons that cater to IR's internal freight needs has declined from as high as 5 percent of the online wagonfleet in 1950-51 to around 3 percent in 1994-95. The principal cause of this has been the phasing-out of steam traction which has greatly reduced the need for departmental shipment of coal. It is also obvious from the table that departmental freighting capacity has remained relatively stable over the period under review and has consequently declined in proportionate terms, the apparent percentage rise in departmental wagons since 1992-93 having accompanied an absolute decline in the total online wagon numbers.

Logical limits exist nevertheless in making a comparative assessment of wagonfleet proportions, since the changes in percentage of special wagons have occurred over an extended period when the total size of the online IR wagonfleet has risen and then declined. Correct interpretation of the proportions after the 1970s becomes particularly difficult because of the sharp fall in wagon numbers brought on by the decline in wagon renewals. Considering the extended life of a railway wagon as a durable capital asset, it would still be safe to say though, that the overall changes in special wagon proportions reflect the increasing presence of younger-aged and technologically superior wagon stocks, while the declining presence of standard covered wagons represents the physical obsolescence of old stock. This is borne out also by the rising trend in average wagon capacity and consequently the overall increase in IR freighting capacity observed in Table 4.2. Again because of the long-lived nature of wagon assets, IR are apparently in the throes of a capital transition from old technology to new technology. It is another matter that the choice of technology adopted has transformed the commodity-composition of railway freight while creating significant slacks within the IR system.

Evidence of system shrinkage and the existence of slacks can also be deduced from comparing gauge-wise composition of the IR wagonfleet by wagon-types. This comparison is made between the 6FYP and 8FYP periods and therefore assumes additional importance in view of the decision taken during the 6FYP to gradually phase out IR's MG and NG railway operations. Table 4.4 therefore provides a point-to-point comparison of gauge-wise IR wagonfleets between 1983-84 and 1994-95. Although downgradation of light gauge railway operations after the 6FYP has led to the disappearance of gauge-wise breakup figures for wagon-types from IR's public statistics for recent years, comparison of overall stock position between the periods provides sufficient indication that drawing down of composite MG and NG wagonfleets by 60 percent in the interregnum has been the principal reason behind the shortage of covered wagons for carrying general freight on the IR network. Conversely, since special-wagon categories are less present on MG and NG networks, their rising proportion within the IR wagonfleet is attributable as much to the decline of MG and NG wagon numbers as to increased BG acquisition. While such rising proportions explain IR's increasing orientation towards bulk-freight following the 6FYP in the 1980s and 1990s, they also partially mask a decline that has taken place in the spatial spread of IR's general freight services following the downgrading of MG feeder-freight operations.

Table 4.4: Gauge-wise Changes in IR Special Wagonfleet 1983-84 to 1994-95

	Total Wagons	% Covered Wagons	%OHS Wagons	%OLS Wagons	%Special Wagons	%Departmental Wagons
[1983-84]						
Broad-Gauge	293152	49.3	31.3	3.1	13.3	3.0
Metre-Gauge	76981	63.2	17.9	1.7	12.7	4.5
Narrow-Gauge	4623	51.7	*nil*	34.9	10.9	2.5
IR Wagonfleet	374757	52.2	28.1	3.2	13.2	3.3
[1994-95]						
Broad-Gauge	246000	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*
Metre-Gauge	33000	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*
Narrow-Gauge	1000	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*
IR Wagonfleet	280000	41.8	33.9	3.9	16.4	3.8

Source: *IRYB 1983-84* & *IRYB 1994-95*, Directorate of Statistics & Economics, Railway Board, Ministry of Railways, Government of India, New Delhi

Table 4.5: Special Wagon Stocks on IR 1983-84 to 1994-95

Wagon Type	Freight Category	Wagons 1983-84 BG	MG	Wagons 1986-87 BG	MG	Wagons 1989-90 BG	MG	Wagons 1994-95 BG	MG
BOX	Bulk-freight	51276	..	50747	..	49408	..	36618	*n.a*
BOXN	Bulk-freight	3579	..	13263	..	26225	..	42739	*n.a*
TPGL	POL	30666	4900	30649	4569	34037	4577	2435 *	*n.a*
BOBS/BOBX	Ores	2547	..e	2352	..	2431	..	2510	*n.a*
BOY	Ores	895	..	837	..	899	..	810	*n.a*
BRH	Steel	7107	..	7715	..	7661	..	*n.a*	*n.a*
BFU	Machinery	448	138	417	130	419	130	*n.a*	*n.a*
CA/BCA	Cattle	4957	1546	4015	1195	2994	1081	*n.a*	*n.a*
CRT	General	20838	..	20584	..	20373	..	*n.a*	*n.a*
BCX	General	17987	..	18947	..	18970	..	18546	*n.a*
BCN	General	...	...	...	...	...	...	15582	*n.a*
BFKI	Containers	318	8	322	8	323	8	*n.a*	*n.a*

Source: Adapted from *IRYB*, various years, Directorate of Statistics & Economics, Railway Board, Ministry of Railways, Government of India, New Delhi

*Note: *BG figures in 1994-95 are for the upgraded BTPN design. TPGL strength for the year is unavailable.*

Although Table 4.1 had shown that general-purpose covered wagons still comprise by far the largest proportion of the IR wagonfleet, thus revealing the original orientation of IR towards the transportation of general freight, the proportion of special wagons has steadily increased with the specialisation towards bulk-freight. This is evident from 3.2 percent rise in the proportion of special wagons between the periods above. Although breakup figures for 1994-95 are not carried by the public statistics, rendering gauge-wise comparison impossible, attention is still drawn to the process of internal change within IR represented in selective draw-downs of the gauge-wise wagonfleet. The character of the internal change within IR's special wagonfleet becomes much clearer from Table 4.5 where the wagon-types are sorted by freight categories.

The table reveals that the improved BOXN design is the main wagon-type being inducted into the IR wagonfleet after the policy changes of the early 1980s, and growing numbers have been acquired in the period since. Net additions of this wagon-type to the BG wagonfleet over the 11-year period between 1983-84 and 1994-95 amount to nearly 0.4 lakh units. The corresponding decrement in the fleet of OHS BOX wagons for which the BOXN wagon has been designed as a replacement is just under 0.15 lakh units. Over the same period, there has also been acquisition of over 0.15 lakh BCN covered wagons, which are eventually to replace the older BCX covered wagon. Acquisition of BCX wagons over the period has thus been correspondingly low at only 582 wagons in aggregate, and BCX fleet strength after the 7FYP period has actually fallen by 424 units. Of the older standard fixed-axle designs, the CRT wagon is seen to have maintained a fleet strength of just over 0.2 lakh units while the TPGL wagonfleet uptil the end of the 7FYP stayed at around 0.3 lakh units. The increase in the flatwagon fleet of the BRH and BFKI type over the 1980s should also be noted, although the slower rise for BFKI reflects on the slow progress of containerisation on the IR freight network. Fleet-levels of the older BOBS/BOBX wagon-type and the improved BOY variant have also remained virtually constant over the period and there has only been marginal increase in the BFU type. Fleet specialisation on IR's MG network remains confined to TPGL and CA/BCA wagons, both of which have declined in numbers.

Considering that each of these wagon-types is intended to carry a specific type of freight, the internal capacity relocation that has occurred within the IR network after the 5FYP becomes apparent. With only BOX/BOXN and TPGL/BTPN wagonfleets showing a marked increase, IR have become increasingly specialised towards the carriage of energy-freight. The fleet of BOBS/BOBX and BOY wagons which carries downstream freight flows from the mineral sector has remained constant, although the BRH wagonfleet which serves the downstream transportation needs of the steel sector has risen moderately over the period. Fleet levels of BFU wagons which serve the specialised transportation needs of heavy engineering industry have also remained stagnant. Further downstream in the economy, the fleet of CRT and BCX covered wagons that carry general freight has remained virtually stagnant over the period. The only notable addition to general freight capacity has been made by the introduction of the improved BCN covered wagon. Even so, the presence of covered wagons in the IR wagonfleet has declined overall, as noted in Table 4.1 earlier, while the progress of containerisation has been slow. Quite clearly, IR's increasing commitment towards the carriage of coal freight has reduced its ability to handle general freight.

Gradual alteration, reflecting both current traffic availability and IR current traffic priorities, has also occurred in the relative proportions of different special wagon technologies. Thus the highest proportion of IR's new acquisitions has been of BOXN special wagons which were first introduced in 1982 during the 6FYP to facilitate efficient and high-speed carriage of coal and iron ore. These have generally replaced the older BOX design which is also of older technological vintage. Similarly, while the presence of TPGL tankwagons has been sustained on both BG and MG networks by the ubiquitous need to transport POL products to every corner of the country to feed IR's principal competitors *i.e.* the roadways, the recent stress has been on the induction of the BTPN design which is of most recent vintage. Clearly IR's choices in this respect have been driven by the dependability of these traffic streams, as much as by national energy priorities, and have enabled IR to maintain freight capacity in coal, iron ore and POL traffic. Again, the sharp decline in general-freight capacity resulting from inadequate replacement of old *standard* 4-wheeler covered wagons after they have become outmoded is reinforced by non-induction of BCX and BCN wagons of newer vintage on a sufficient scale, revealing IR's reluctance to invest on a freight sector with dwindling traffic streams. The decline in IR's CA/BCA wagonfleet, being both relative and absolute, features the gradual phasing out by IR of traffic stream which was an important constituent of intergauge freight-flow across BG and MG networks.

Although the gradual innovation of special wagon designs signifies the modernisation of IR traffic operations and increased operational efficiency, it has certain pitfalls. Principal among them has been the increasing number of empty wagon-kilometres being run by IR today[18] because of capacity inflexibility on the freighting unit or railway wagon. While the incidence of empty wagon haulage adds to wagon turnaround times, frittering away the efficiency-gains from faster and higher-capacity haulage, it diminishes the ultimate gains from the induction of upgraded railway technology because of incompatibility between freighting capacity and freighting needs. This aspect will be examined further in the present chapter. Certain other technological problems that arise in association with technological specialisation have also been witnessed on IR. Whenever the mixing of wagons of different vintages occurs on IR goods-rakes, the surfeit of old twin-axled wagons equipped with plain rather than tapered bearings causes overheating of bearing blocks and locking of axles, known in railway terminology as 'hot-boxes'.[19] This problem multiplies when mixed rakes are hauled at high speed under diesel or electric traction. Wagons with hot-boxes while on the run then have to be detached from the rakes between terminals, obstructing the even flow of traffic. To circumvent such problems, the IR freight system is being compelled by the new traction technologies to run increasing numbers of modernised

BG wagons, and more recently, to run block rakes rather than mixed rakes. The technological consequence is that large units of composite freighting capacity are assembled on the rake, which cannot carry anything other than special freight and can only be handled at fixed terminal points which have mass loading and unloading facilities. Hence the flows of freight becomes increasingly one-way resulting in substantial losses of general-freight and revenue. Large sections of the IR network which have neither the line-capacity nor the handling and traction facilities to handle heavy block rakes are progressively neglected leading to virtual route-shrinkage and crowding on the mainline corridors. In sequence, IR is further compelled to shrink its freight-focus to the spasmodic flows of bulk-freight while the thinner trickle of general freight migrates to the roadways.

While this appears to be the general tenor of technical events that have influenced the trends witnessed in the IR wagonfleet, certain principal areas emerge for further empirical investigation in the present study. The first would relate to whether this course of events was *traffic-driven* and hence inevitable, leading eventually to the decline in the infrastructural importance of IR as far as the forward linkages of transportation are concerned. The next would relate to whether the events were *profit-driven* as a result of decreased infrastructural support from the state and hence required that an efficiency choice be made by IR. A third area would relate to whether the events were *technology-driven* and hence resulted from the lack of appropriate innovatory responses from the monolithic state-owned Indian railways to the emerging freight situation in the country. These fundamental questions and the issues relating to them shall be approached at different points in the investigation. The overview of the problem of IR freight capacity provided by the present section draws specific attention to the domestic wagon industry in India which, because of its position upstream of the backward linkages of the Indian railway system, provides an immediate mirror to the upstream consequences of changing freight emphasis on the railways.

4.4 Railway Technology and the Wagon Industry in India

The continuing primacy of railways on the Indian freight transportation system owes much more to the nature and economic command of the bulk commodities that IR handles than to IR's command over market-share. While between 1951 and 1995, the share of IR in internal freight transportation has declined relatively from 89 percent to 40 percent of total freight traffic,[20] its freight handling in terms of tonnages has risen rapidly because of increasing weight-to-volume and weight-to-distance ratios. Although freight demand can be quantified in its macro sense by the freight tonnages that need to be transported and the distances that need to be covered, the demand for freight services from IR in practical settings is not manifested in either form. Rather, freight consigners indent IR commercial authorities at the originating points with their requirement of the number and specification of wagons that need to be provided, and their desired delivery schedules. If this wagon capacity becomes available within a reasonable waiting time at the loading and transhipment points along the route of the consignment, transportation of the consignment is contracted.[21]

Both micro and macro manifestations of freight demand are relevant to the evaluation of IR freight operations. Viewed in a longterm infrastructural context, IR performance indices of tonnages-originating and net tonne-kilometerages have consistently pointed to the growing capacity-constraints of the system. It would not however be adequate methodologically to identify infrastructural lacunae only in terms of the existence of transportation bottlenecks at a given point of time. The problem needs to be studied in a longer dynamic timeframe since the response to infrastructural change does not occur in the short term.

In the light of the patterns of emphasis that have existed in the FYPs, growth of core industrial freight flows on the IR network are not unexpected. A critical rate exists nevertheless, at which incremental freighting capacity should be added each year if the total transportation capacity of the system is to be maintained at dynamically optimum levels. This increment is measured by the net capital addition to freighting capacity over and above the investment involved in replacing overaged assets. In micro settings available freighting capacity on the railways is determined by the availability of wagons online. Thus in growth contexts, the accurate projection of wagon-demands and adequate procurement of wagons by IR, and commensurate production and supply of wagons by industry all become individually important for the even provision of railway freighting services across different production levels in the economy. A component of this dynamic procedure that has seldom received due attention during transportation planning in India is efficient growth of the wagon industry.

As physical movers of freight, railway wagons reflect intricately the forward and backward linkages of railway development. While enhancing the resource flows for downstream production activity, they also widen the field for technological experimentation by the railways and for the application of engineering innovations to improve the freight effort. Despite this importance, anomalies prevail between the organisation of wagon and coach manufacture in India. While wagons are still supplied by several medium-sized engineering units in the private and public sector principally clustered around Calcutta, manufacture of railway coaches is undertaken at IR's own departmental establishments, namely the Integral Coach Factory [ICF] established in 1955 during the 1FYP at Chennai in Tamilnadu, and the more recent the Railway Coach Factory [RCF] established in 1988 during the 8FYP at Kapurthala in Punjab.[22] The need for coaches to be manufactured departmentally has been rooted in the high technical standards needed to ensure safe carriage for railway passengers and has generally required a higher import content. Another departmental unit of IR involved in manufacture of critical ancillaries for wagon and coach manufacture which have substituted certain imports is the Wheel and Axle Plant [WAP] established near Bangalore in Karnataka in 1977 during the 5FYP.[23] Thus while wagon production is located fairly close to the Indian steel and mineral belt, manufacture of coaches and wheelsets involves considerable freighting leads for departmental consignments of steel while moulding the character of trunk operations conducted at principal IR nodes. The three departmental plants represent huge backward-linked investments on the part of IR in order to create economies of scale for coach construction and have since led to the rapid development of coaching technology on the IR system.

A critical link in this technology chain is also provided departmentally by IR's Railway Designs & Standards Organisation [RDSO] which was formed during the 2FYP with its headquarters at Lucknow, Uttar Pradesh, in 1957. Formation of RDSO merged the resources of two older railway mechanical and structural design establishments, namely the Central Standards Office [CSO] that had been established in 1930, and the Railway Testing & Research Centre [RTRC] set up in 1952 just after planning commenced in India.[24] As its acronym would suggest, RDSO provides and tests standard engineering design specifications for railway construction and equipment, while also developing new railway technologies through departmental R&D. Hence in its conception, RDSO is the spearhead for mechanical and engineering innovation on the IR system, providing advanced design technologies for induction into IR track, rolling stock, traction and signalling. The advanced IR wagon designs examined earlier have all originated from RDSO.[25]

Because of such anomalies of organisation, while the technological economies of scale in coach manufacturing are internal to IR and flow within the respective departmental establishments, the wagon-producing units [WPUs] continue to undertake contracted fabrication of wagons with their critical inputs being manufactured elsewhere. Consequently the technological economies of scale still elude them.

4.4.1 The Historical Evolution of Wagon Manufacture

The system of awarding contracts for wagon fabrication is intimately associated with the history of railways in India. Many firms that were or are still in the business are identified with the names of British contractors who had built the Indian railways. The origins of these firms lay in the contracting methods adopted by railway companies while constructing the railway network for India during the 19th century.[26] Several contracting firms involved in laying the permanent way and its structures had subcontracted foundry-work during plate-laying and the construction of railway structures while the major routes were being laid. By doing so, they were able to put their excess capacity and engineering expertise to profitable use during slack periods, allowing retention of labour and personnel. Minor fabrication work had thus already commenced in India during the period of railway construction. An expansion in its scale occurred when major bridgeworks were being undertaken. While the main bridging contracts awarded to engineering firms in Britain directly benefited the British ferrous metal industry, an avenue was opened in India for erstwhile railway contractors to subcontract the assembly of large prefabricated iron bridge sections, thus reducing the volume-to-cost ratios for heavy metallurgical components that had to be transported from Britain. As is quite evident, it was only through subcontracting and fabrication that British engineering industry could in fact participate in railway construction far away in India. Although in this sense, the subcontracting system was backward-linked to the construction of railways, the nature of innovation it involved was mainly organisational since the backward linkage still flowed unimpeded to metalworks and engineering firms in Britain.[27]

Because of the subcontracting system, fabrication thus remained essentially of a low-technology nature since there was neither need for transfer of plant or technology.[28] Consequently, entry was open to all railway contractors who had accumulated a minimum of stores and capital. Availability of cheap labour also encouraged manual fabrication methods at piece-rates which made the direct importation of assemblies uncompetitive. Even greater economies of scale obtained where unit-sizes of assemblies were smaller, such as during the fabrication of wooden bodywork for early railway coaches and wagons. Hence while the fabricating firms grew to appreciable size, they remained contract suppliers rather than manufacturers. Subcontracting also worked to the advantage of railway and engineering companies whose responsibilities were reduced to supervision of the contracted works, and received a further boost during the period of railway cost-cutting and State construction between 1869-1882 when construction in India was undertaken departmentally by the Public Works Department [PWD].[29] The system has remained institutionalised in India till the present day in the modes by which many PWD and railway works are still executed.

Unlike in other countries including Britain, the domestic backward linkages from Indian railway construction were thus confined mainly to simple fabrication and civil works. While this limited the infrastructural impact of the railways on the evolution of Indian engineering and metallurgical industry, it also perpetuated certain other peculiarities within the railway system. Often noted among these was the pronounced preference of the Indian railways for wrought iron and riveted-steel construction, witnessed in the preponderance of metalwork at railway stations and in the earlier bridges of the IR system. Although technological justification offered for using riveted bridgeworks at the time made references to the sizes of Indian rivers to be forded,[30] this mode of bridge construction also continued to sustain the manufacture of pre-assemblies in Britain before their fabrication in India, long after the railway revolution in Britain was over. The contracting system thus considerably influenced pre-Independence bridge design in India, where some of the largest bridges constructed since have favoured ferro-concrete to girder-steel engineering, avoiding the enormous recurring costs still incurred in refitting, regirdering and repainting the old railway bridges of the IR system.[31] It emerges quite clearly therefore that while railway construction in India showed typically strong backward linkages to the metallurgical and engineering industries, little of these applied within India.

It would appear that clustered location of the wagon fabricating units around Calcutta is an inheritance from the same historical factors. Trade and industry during British rule had mainly concentrated in the port hinterland of the city, giving Calcutta its commercial dominance over other port cities during the pre-Independence period. Even after commercial setbacks over the period of WWII, nearly 40 percent or 7.06MT of the aggregate shipping tonnages of 18.35MT in India during 1947-48 accrued from Calcutta port, against 29 percent from the port at Bombay.[32] Early foreign mercantile presence had been attracted to the hinterland by its vast trade in cotton piecegoods. After the EIC presence had been consolidated into possession by the Battle of Plassey in 1757, British investment gradually switched from trade into production activities which began to yield sizeable commodity exports of opium, indigo, tea and jute. The region was well-served by natural waterways. Discovery of coal at Raniganj and iron ore and manganese deposits close by added the potential for developing ferrous metal industry within the hinterland.[33] The result was that the headworks of the Indian railways were located at Calcutta. Vastly larger shipping tonnages rising to 10.10MT in 1912-13 were being handled at the port during the period when metal structurals imported for the railways were still landed at Calcutta. In 1909, the Tata Iron & Steel Company [TISCO] founded at Sakchi, 243km from Calcutta, stepped in to close this breach by making steel for the Indian rail lines and was followed shortly after by the Indian Iron & Steel Company [IISCO] set up at Burnpur in 1918. Finally, the establishment of the Tata Engineering & Locomotive Company [TELCO] at Jamshedpur in 1945 opened the British monopoly on the supply of railway equipment and engineering materials to direct Indian competition.[34] The proximity of coal, iron & steel and engineering facilities accelerated industrial development in neighbourhood of Calcutta, allowing old foundry units to diversify into wagon fabrication in a classic manifestation of the railway-mining-metallurgical-engineering industrial linkage. Till the present day, these regional advantages account for the persisting locational pattern of the Indian wagon industry.

The move of railway subcontracting firms into wagon production however took some time to accomplish. Old modes of wagon manufacture on the Indian railways had merely involved the building of wooden trucks on imported underassemblies and wheelbases. With the growth of traffic initially being slow and no regular replacement needs having arisen, no immediate need was felt for upgrading wagon technology. Hence although the steel wagon had already been inducted on the British railways and an all-steel design approved in 1908 for use on the Indian railways, its widespread use on the Indian network had to wait until fleet depreciation rose to significant levels during WWI. Systematic manufacture of railway wagons was thus not undertaken in India before WWI. The Indian wagon industry was brought into being when the accumulated wagon shortfall led to Government notification in 1918 guaranteeing the annual purchase of a minimum number of railway wagons from domestic sources, provided their offer price did not exceed the import price of wagons.[35] The Indian Standard Wagon Company was formed immediately after this notification, and was soon joined by other enterprises.

Little progress could be made initially in the face of price-competition from British manufacturers. Thus in 1924, the government accorded approval to a Tariff Board scheme providing for protection to the nascent Indian wagon industry. With subsidies being provided under the scheme between 1924-27, the older guarantee of purchase was withdrawn since the industry had been afforded protection. On receipt of the production subsidies, it had become possible by 1927 to construct steel wagons in India at a competitive price in India, provided sufficient volumes were involved. Even so, the continuous railway orders necessary to sustain domestic wagon production were not always forthcoming, and complaints also arose that the railway companies were still needlessly directing their orders to manufacturers abroad. More serious difficulties arose after the railways announced in 1927 that they had surplus freighting capacity and would need to scale down wagon orders drastically. The Tariff Board then proposed while lifting protection subsidies, that all wagon orders should henceforth be placed with the domestic industry. In spite of the recommendation, little enhancement in wagon orders occurred and the industry continued to remain in a depressed state till Independence.[36] Ironically, the situation since then has not improved fundamentally, and the wagon industry still operates under severe constraints that originate from erratic wagon orders and consequently high levels of inventories.

4.4.2 Wagon Technology Initiatives under the Plans

At the time they were incorporated into IR, railways in India were quickly nearing technological obsolescence but still depended largely on imports for engineering, rolling stock, structural and technical requirements. Steam was the sole mode of traction, except on the suburban line at Bombay where DC electric traction had just been introduced.[37] The CR fixed-axle wagon of 1908 design vintage with a loading capacity that was barely double its tare-weight composed the standard BG freight stock, with only a limited number of bogie wagons being available for transportation of rails and special freight. Although IR had inherited an extensive network of 54,694 route-km, even its best BG trunk lines were single-track and used light 44.64kg rail with fishplate joints fastened by dog-spikes or keys on wooden sleepers at a low density of 1300 to the kilometre. Consequently, maximum axle loads on such lines were restricted to less than 16.5T which limited the capacity to handle freight. Signalling on the network was still done manually using semaphore. Track interlocking was rudimentary, and the vast majority of stations had hand-operated points with Standard I track which restricted approaching trains to speeds of under 50kmph. Telecommunication between most stations on the network was by morse code.[38] The IR system at Independence was thus overdue for technological renewal.

Planning initiated this renewal by parts, seeking to maintain a balance between the need for railway modernisation and the growth of domestic technological capability to match the rising flows of freight expected from economic expansion. As a consequence, the growth of physical stock on the IR system since 1950-51 has been tied to the development path of India's economy. Rolling stock changes over the period since provide partial evidence that the stress has been on technological renewal rather than mere expansion of numbers. In the case of traction, while the total locomotive fleet declined from 8209 to 6919 units between 1950-51 and 1994-95, its steam component fell from 99 percent to just over 5 percent. The slack was mostly taken up by progressive dieselisation of the system with 1.9 diesel traction units being added *pro rata* for every additional electric unit.[39] Technological renewal is more difficult to visualise from consolidated figures for non-tractive rolling stock, where passenger coaching units multiplied overall from 19,168 to 30,3006 units over the identical period. Similarly, the online wagonfleet has increased from 205,596 to 291,360 units after having touched peak levels of over 4 lakh units in 1980-81.[40] Nevertheless, the changes in the composition of IR wagon stock that have been examined previously reveal the technological nature of such growth.

High order of growth was also witnessed in the IR workforce from 9.14 lakh personnel to 16.02 lakh personnel over the period reviewed. With increase in the number of service points being implied by the addition of nearly 10,000 route-km and by growth in the number of railway stations from 5976 to 7056 over the period,[41] this would imply the continuance of high levels of labour-intensity in IR operations. This is in sharp contrast to the path chosen by other railway systems like the US railroads which also had a very high proportion of single-track lines but resorted instead to route development and early mechanisation in order to carry ever-increasing freight loads.[42]

4.4.3 Wagon Manufacture through the Plans

At the commencement of the 1FYP, there were four wagon producing units [WPUs] in the country, namely Indian Standard Wagon Ltd. at Burnpur, Jessop & Co. and Braithwaite & Co. at Calcutta, and Burn & Co. at Howrah - all locations in and around the same vicinity. With government deciding to leave the fabrication of wagons to the private sector while expanding wagon orders in order to rejuvenate IR, rapid proliferation took place and by the 2FYP, there were 13 WPUs operating in the private sector with total licensed production capacity of 26,000 wagons p.a. While steady wagon orders from IR over the 2FYP and the 3FYP kept the WPUs in good financial health, economic recession in the mid-1960s and consequent cuts in wagon orders after 1966-67 caused industrial turmoil, and many WPUs were ultimately faced with closure. The earliest to shut down were Saxby & Farmer, Braithwaite and Indian Standard Wagon, which were followed by Britannia Engineering and a few others over the late-1960s and early-1970s. Braithwaite, Indian Standard Wagon, Jessop, Burn & Company as well as two other WPUs that had been set up in Bihar were subsequently taken over by the government and turned into PSUs.[43] Continuing uncertainty regarding the IR demand for wagons has since then saddled the Indian wagon industry and its ancillary units with chronic excess capacity. A study of the evolution of the industry over the planning era will shed light on this position.

In 1951, total production capacity at the 4 WPUs then in existence - namely Indian Standard Wagon Ltd. and the Jessop, Burn and Braithwaite companies, was just 6000 wagons p.a., while another 3925 wagons were fabricated over the year at different departmental workshops of the railways and at other engineering firms located in West Bengal, Bihar, Maharashtra and Punjab.[44] Although the 1FYP target for wagonfleet augmentation was set at 30,000 units, actual production exceeded this by 11,966 wagons because of the replacement of overaged stock. The annual requirement of 25,000 wagons p.a. projected for the 2FYP exceeded current domestic capacity, and led to the establishment of four new WPUs in West Bengal and Maharashtra, with another engineering unit at Chennai (then Madras) being licensed to assemble 5000 imported wagons p.a.[45] Because of the addition of imports, production exceeded licensed capacity by 10 percent in the second year of 2FYP. Because of subsequent shrinkage in IR orders the position could not be sustained, so that while capacity utilisation at the end of the 2FYP had fallen short of 50 percent, the number of WPUs had also declined leaving only larger-sized WPUs in the fray.

Reduced wagon production over the 2FYP had also been caused by shortages of steel. Hence while wagon acquisition over the 3FYP inclusive of replacement allowance was projected at over 1.17 lakh units, emphasis was also laid on the induction of BOX wagons that would enhance the freighting capacity for coal, iron ore and other critical minerals. Additional production capacity was therefore created through the licensing of new WPUs to raise the aggregate production capacity of the industry to 33,500 wagons p.a. Steel supply to the WPUs also improved considerably after the outputs from the new integrated steel plants [ISPs] in the public sector came onstream.[46] Production of wagons consequently increased from the low of 7634 wagons in 1960-61 to 23,600 wagons by the end of the 3FYP, with capacity utilisation over the period rising from under 35 percent to over 66 percent. But following the industrial recession after 1966-67, production levels nose-dived to an average of just over 11,000 wagons p.a. till the end of the 1970s and capacity utilisation averaged well under 40 percent. The nadir was witnessed in 1971-72, when total production was just 7010 wagons and capacity utilisation had fallen to 24 percent. Existence of idle capacity on this scale proved the undoing of several WPUs which began to leave the wagon industry after the 4FYP. The sustained industrial crisis was precipitated when the current traffic squeeze being faced by IR caused them to prune wagon orders drastically. Even though freight realisations by IR have maintained a rise in tonnage and traffic terms through most of the period since the 3FYP, no pickup occurred in wagon orders till the end of the 7FYP.

Table 4.6: Production and Capacity-Utilisation in the Railway Wagon Industry in India 1955-56 to 1987-88

FYP & Years	Wagon Producing Units	Licensed Capacity in Wagons *p.a*	Wagons actually Produced	% Licensed Capacity Utilisation	Average Production per WPU	Average Idle Capacity per WPU
2FYP						
1955-56	10	14560	13500	92.7	1350	106
1956-57	10	14560	16019	110	1602	-146
1957-58	8	20135	16956	84.2	2120	397
1958-59	8	20135	13515	66.7	1689	828
1959-60	9	20255	10077	49.7	1120	1131
3FYP						
1960-61	11	22155	7634	34.4	694	1320
1961-62	11	26000	10530	40.5	957	1406
1962-63	15	26472	18100	68.3	1207	558
1963-64	15	26472	19300	73	1287	478
1964-65	15	35534	23600	66.4	1573	796
Annual Plans						
1965-66	15	29409	24983	85	1666	295
1966-67	15	30409	16683	55	1112	915
1967-68	16	30409	13783	45.3	861	1039
1968-69	16	29940	15248	51	953	918
4FYP						
1969-70	16	32819	13214	40.2	826	1225
1970-71	16	32819	10489	32	656	1396
1971-72	16	33869	8010	23.6	501	1616
1972-73	16	33969	9721	28.6	608	1516
1973-74	16	33869	11500	34	719	1398
5FYP						
1974-75	16	33869	9205	27.2	575	1542
1975-76	16	30625	12233	40	765	1150
1976-77	13	30625	11920	39	917	1439
1977-78	13	30600	13072	42.7	1006	1348
1978-79	13	29540	11047	37.3	850	1423
Plan Holiday						
1979-80	13	29540	12541	42.4	965	1308
6FYP						
1980-81	13	29540	13000	44	1000	1272
1981-82	14	31585	13050	41.3	932	1324
1982-83	14	31585	13561	43	969	1287
1983-84	14	31585	13996	44.3	1000	1256
1984-85	14	31585	13110	41.5	936	1320
7FYP						
1985-86	14	31585	9530	30.1	681	1575
1986-87	14	31585	18140	57.4	1296	960
1987-88	14	31585	12800	40.5	914	1342

Source: Adapted from H.L.Chandhok [1990]: *Indian Database: The Economy: Annual Time-Series Data*, vol2, The Policy Group, UM Books, New Delhi; *figures for subsequent plan years unavailable*

The positions indicated by Table 4.6 amply reveal the persisting difficulties of the Indian wagon industry arising from excess capacity. While the way out would be to increase the offtake of wagons by IR, this solution appears a far cry now after changes in planning philosophy have considerably reduced capital allocations to IR and left the onus for mobilising funds to the railways themselves.

4.4.4 Current Status and Organisation of the Indian Wagon Industry

The Indian wagon industry presently comprises 13 WPUs, of which 6 are in the public sector and 7 in the private sector. The largest number of WPUs are located in the eastern region in or around the state of West Bengal, for the historical reasons already described above. These are Braithwaite and Jessop at Calcutta, Indian Standard Wagon at Howrah, Burn Standard at Howrah and Burnpur, and Bharat Wagons at Mokameh in Bihar, all of which are old private units now run in the public sector. Texmaco is another large WPU located near Calcutta which has remained in private hands. Two WPUs are located in the northern region, namely Hindustan General Industries at Delhi, and Modern Industries at Ghaziabad, Uttar Pradesh, while another two, namely Binny Engineering and Southern Structurals, are clustered around Chennai in the southern region. The central region has a solitary WPU, namely Central India Machinery Manufacturing Company [CIMMCO] which is located at Bharatpur in the state of Madhya Pradesh.

As their locational history has also revealed, WPUs in the eastern region are favourably situated close to collieries at Raniganj, Solanpur and Asansol and near major metallurgical plants such as TISCO, IISCO and the Durgapur Steel Plant [DSP] under the Steel Authority of India Limited [SAIL]. They also lie within the largest cluster of engineering industry in eastern India. Like most other heavy industrial units, they are also strategically located close to major sources of power from the State Electricity Board [SEB], the Damodar Valley Corporation [DVC] and the National Thermal Power Corporation [NTPC], and in an area where the advantages of hiring technically proficient labour can easily be reaped. The port facility at Calcutta offers them an additional advantage unavailable to other WPUs except those at Chennai. All locational factors governing their situation therefore point towards lowest costs being incurred in procuring basic raw materials. On the same criteria, the WPUs elsewhere are located at a comparative disadvantage.

In spite of possessing such advantages and being backward-linked to the development of the IR freight system after the FYPs, it seems remarkable that the WPUs in the eastern region and the Indian wagon industry as a whole should be in such persisting distress. To understand the reasons, an exploration needs to be made of the internal economics of the wagon industry, including its production structure and its production planning processes.

4.4.4a Production Structure

The semi-finished inputs required for wagon manufacture are mostly metallurgical in nature, comprising grey iron, steel castings, wheel and axle sets, sleeper bars, spring steel, etc. As in all other heavy engineering units, coal and power are the most important accessory inputs. However the resemblance ends there. Wagon production is labour-intensive in nature and does not require sophisticated plant and equipment, since the WPUs depend principally on IR for the supply and freighting of critical materials, including technical components. An exceptional organisational feature of the Indian wagon industry is the system of contracted manufacture. Wagon-building contracts are essentially fabrication contracts in which the entire requirement of steel and most major technical components are supplied by IR to the WPUs free of cost. Although prior to the mid-1970s the WPUs undertook supply contracts rather than fabrication contracts, they were still being supplied free wheelsets by IR. Most technical inputs required by WPUs are now domestically produced, except for the cast-steel bogies imported since the 6FYP as part of the programme for modernising IR. Free inputs supplied to the WPUs under fabrication contracts include wheelsets, roller bearings, cast-steel bogies, central buffer couplers, air-brake equipment and laminated bearing springs, which are either manufactured departmentally at IR workshops or by ancillary units located close to the WPUs.

Canalisation of free-supply technical inputs to the WPUs is undertaken for economic reasons. Through IR's leverage with SAIL and with component-suppliers, procurements of steel can be made at ex-factory rather than stockyard prices while favourable prices can be negotiated for major wagon components and subassemblies, resulting also in considerable savings on the attendant taxes and duties. Because of reliable multisourcing, component-purchases can be scheduled according to wagon production schedules, thus lowering inventories. Finally, the procedure economises on component imports by ensuring that these occur only after domestic production has been full utilised.

The value of free-supply components constitutes around 65 percent of the total cost of a BOXN wagon, and proportions for other wagons do not differ very much from this. The free-supply system thus lowers working capital requirements at the WPUs, which would otherwise have had to mobilise under commercial terms. Supply of free capital inputs by IR to independent WPUs implies that wagon production is jointly organised by the buyer and the sellers, giving the wagon market a unique character where the pricing of wagons by the WPUs has to impute shadow costs for the free inputs received from IR.

As the most basic of required inputs, supply of steel is arranged centrally by IR on the basis of indents placed at Calcutta since most major WPUs are located around the city. Free supply of steel to the WPUs in the form of steelplate, structurals and flats, and hot and cold-rolled sheets comprises a major portion of IR's total requirement of steel for non-track purposes. Thus out of approximately 3.5 lakh tonnes of steel drawn annually by IR as non-track material, as much as 35 to 40 percent is routed into wagon production.[47] Timely provision of other free-supply inputs by IR in concordance with wagon production schedules also holds great importance for avoiding the stabling of incomplete wagons at the WPUs. Thus the efficiency of wagon production rests in a large part on the efficiency achieved by IR in planning the bulk procurement of inputs required for wagon manufacture in advance and in coordinating their distribution to WPUs. Quite obviously, advance planning of such nature rests on IR's advance planning of wagon requirements.

4.4.4b Production Planning and Materials Management

Planning and procurement of free supply inputs by IR is carried out under the supervision of the Railway Board. This involves initial formulation of wagon production plans for the year, as the basis for estimating input requirements. Lead times for the procurement of indigenous inputs are around 9 months, and rise to 10-12 months for imports. Hence unless wagon production plans are finalised at least a year ahead, difficulties can arise in arranging timely supply of inputs to the WPUs. Apart from physical factors, the size of the production plan also depends on the appropriation made in the Railway Budget towards current wagon-acquisition, which has only a 3-month production lead. To circumvent coordination difficulties, a tentative wagon production plan, subject to ± 30% revision depending on funds committed by the Budget, is framed in advance to raise the lead time for production planning and the procurement of technical inputs to around 12 months.

Input requirements for the financial year are estimated after debiting inventories already lying with the WPUs and input supplies outstanding against previous purchase orders or stabled wagons, if any. A margin is then added to the input estimates to cover the inputs required by wagons to be supplied before the commencement of the financial year, and to maintain buffer stocks of imported inputs at a level adequate for 3 month's production at the WPUs. Due to the very large quantities in which free-supply items are required, IR usually places parallel contracts with several suppliers. These include an escalation clause which leave it to IR's discretion to raise the supply quantity if necessary, to make up for default on the part of certain component-suppliers.

Tenders for the net requirement of indigenously-manufactured inputs are floated about 9 months prior to start of the financial year. Additional lead time of 3 months is provided for input imports to allow for opening of LOCs, potential shipment delays, ocean-transit times, port clearances and so on. Precise assessment of the future production trends of indigenous inputs helps to prevent unnecessary imports. Sporadic problems can arise nevertheless, as when precise production estimates of 20T wheelsets at Durgapur Steel Plant [DSP] could not be made, and subsequent failure on the part of DSP to meet its supply commitment created major stabling problems for the WPUs. After the changeover to 23.2T wheelsets since the 6FYP and their departmental production by WAP at Bangalore, this particular problem has eased.

Before the supply of free inputs can be undertaken by IR, annual wagon production quotas have to be allotted to different WPUs. In order to deal collectively with IR, WPUs in both public and private sectors have grouped themselves since 1973 under a joint-sector consortium called Wagon India Limited [WIL]. WIL negotiates wagon procurement levels and input-supply positions with IR and allocates wagon orders and design specifications between individual WPUs. Each WPU then has to produce the specified wagons from its quota of free-supply inputs and its own resources.

The overall supply position of free-supply inputs against the wagon production plan is closely monitored at IR and WIL. Detailed monthwise production plans for different wagon-types to be produced at each WPU are prepared by WIL, on the basis of which free-supply inputs are allocated to the concerned WPU. Monthly input quotas are jointly decided between the WPUs, WIL, the ancillary component producers and RDSO. While assigning non-departmental input quotas, consideration is given to the past performance of the ancillary, proximity of the ancillary unit to the WPU, and also to any preference that the WPU may have for a particular supplier. Where ancillary components are manufactured within the WPUs, as happens in case of Texmaco, Burn Standard and CIMMCO, the free-supply ancillary inputs required by them for wagon production are allocated internally to avoid additional transportation. If the total input quantity on offer from component suppliers exceeds the combined current requirement of the WPUs, the excess supply is allocated between WPUs in accordance with their input requirements for the subsequent month.[48] But in spite all such management procedures aiming at market coordination, mismatch in the input flows from IR to the WPUs are a common affair and many wagons have to be stabled by the WPUs in an unfinished condition.

4.5 Structural Peculiarities of the Indian Wagon Market

The production of railway wagons in India thus has certain exceptional features. Under its mode of organisation, the WPUs still undertake fabrication contracts at the instance of IR, rather than manufacture in its full industrial sense. Although this system has historical roots which were explored earlier, the shape it has acquired since has been directed by the transportation planning process. After a degree of centralisation on the Indian railways had been brought into being in the pre-Independence period by the recommendations of the Acworth Committee and by the takeover of several companies under repurchase clauses, the task of standardising railway technology had devolved upon the CSO set up in 1930.[49] Till planning started in India, the purpose of central railway institutions had been to formulate civil and mechanical standards for Indian railway engineering and to ensure that imported and indigenously-acquired railway equipment met such standards before induction. The pace of acquisition till Independence had nevertheless been slow. After nationalisation of the railways, the responsibility for funding technological renewal devolved more strongly upon the state. Facing technological limitations within the existing IR system, the FYPs thus initiated phased replacement of railway technology under a concept of macro efficiency. Since the key to this lay in the indigenous development of strategic technological capability, the plans sought to preserve economies of scale for railway R&D by creating specialist research institutions such as RTRC and later the RDSO. With the major capital costs of technological design and development thus being borne by IR's own departmental units, it was possible to develop and test new IR designs and specifications indigenously in keeping with the broader plan focus on import substitution. Greater difficulties were faced however while creating facilities for their indigenous manufacture. Consequently, capacity for the manufacture of strategic and high-technology railway inventory such as traction equipment or advanced bogie coaches had to be created from scratch by setting up departmental production units such as the Chittaranjan Locomotive Works [CLW] in 1948 near Asansol in West Bengal or later the ICF at Chennai. Again on the principle of economies of scale, it was decided that fabrication of a comparatively low-technology product such as a wagon body could be farmed out to medium private-sector engineering units where such capacity already existed, by providing their requirement of advanced critical inputs such as brake equipment or cast-steel bogies from the upstream strategic capability that was being created in the public sector.

While this arrangement had an efficiency logic of its own by minimising waste during the creation of advanced technological capability, it told differently upon the manufacturing economics of IR coaches versus wagon units. Built to high safety standards, the all-welded integral coaches were manufactured departmentally, thus involving internal costing rather than pricing principles during their acquisition by IR. The rate of acquisition of railway wagons, which were being fabricated externally, depended instead on the pricing economics of the WPUs. The dynamic behaviour of the wagon market thereafter is quite simple to understand if cognisance is taken of IR's presence in the market as a sole buyer and the presence of several WPUs as common producers and sellers of an undiifferentiated low-technology product with no alternative uses. As long as FYP funds were flowing for freight capacity expansion, expanding conditions existed in the wagon market allowing a reasonable margin of profit for existing WPUs and accommodating the entry of newer ones. No entry-barriers as such existed in terms of technological capability, since the wagon technology was supplied by IR rather than being created by the WPU. Hence the only features of the market that influenced the new entry were the locational economics of wagon production, which in ordinary situations would have ensured that the wagon industry remained in areas where it was locationally served. Initially it did, as the expanding wagon market brought many more WPUs into business in and around Calcutta. Nevertheless, their sustained presence within the market required stability and regularity in wagon orders from IR. This was not a peculiarity of the market structure but a peculiarity of the railway wagon as a product, since identical needs for maintaining stability in wagon orders had been articulated by the nascent Indian wagon industry as early as the 1920s, as noted earlier. The inevitable result of the cutbacks in IR wagon orders following the 3FYP was excess capacity, and consequently, price-competition between WPUs forcing the closure of many after the economy had been hit by deep recession. While the closures were a means for market equilibration through a rather ruthless shedding of capacity, the short-term response of the state was to take over sick WPUs and to try to put them back on their feet again with capital support. What the WPUs really needed to tackle their dire situation at the time were infusions of technological capability rather than of capital.

What role was played by the IR transportation policy in the emerging situation ? Quite clearly, the attention of the FYPs and consequently of IR policy remained on the preservation of internal technological economies of scale. As a part of its focus on PSU-led industrial revival, the 4FYP sought improvement of IR freighting capacity through technological solutions such as line conversion and the improvement of traction, necessitating the upgradation of IR wagon technology in order to improve the freighting capability for coal which was crucial to the revival of core-sector activity. Rather shortsightedly, the problems that had confronted the WPUs uptil then were ascribed to poor management rather than to poor technological capability. It became increasingly the practice to locate new public-sector production and technology units well away from the eastern steel belt, compounding the transportation bottlenecks being encountered by IR while also destroying the locational economics of wagon production. IR was able to activate this process because of the departmental nature of its production and supply of critical inputs, which allowed it to locate units as crucial as WAP far away in Karnataka, nullifying locational economies through policies like freight equalisation[50] that ensured equal transportation charges for critical industrial freight regardless of the freight leads that were involved.[51] The obvious corollary that followed was the establishment of new public-sector WPUs in areas entirely unsuited to their location, such as Delhi or Madhya Pradesh.

As long as the tendering system was being followed for wagon acquisition by IR, locational economies still exerted some influence on the offer prices of wagons and hence on the order volumes that went to each WPU. Two factors appear to have undone this. The strategic thrust on the upgradation of wagon technology to 8-wheeler BOXN standards greatly increased the critical content in wagon manufacture, including a high fraction of specialised imports such as cast-steel bogies. To maintain and optimise the flow of these, it became incumbent upon IR to canalise supplies to the WPUs giving IR a greater organisational role in the manufacture of their wagons. Since already there was an apprehension that the high prices of Indian wagon were lowering their acquisition below the rates at which freighting capacity needed to be augmented, wagon pricing came under close scrutiny by IR.[52] Both market structure and the contract system of wagon manufacture followed by IR played a role here. With the full costs of wagon manufacture never being apparent because of the presence of free-supply inputs, there was a tendency to substitute pricing principles by costing principles during such scrutiny. In this, IR tended to be guided by the experience of departmental production of integral coaches where similar high-technology inputs were also used. Consequently, what was overlooked during the costing scrutiny were the economies of scale and the high capital-intensity of coach manufacture, unlike wagon manufacture which required minimum plant and was highly labour-intensive. While on pricing grounds, the WPUs came under unjustified criticism, IR's decision to also canalise the supplies of steel further destroyed the locational economies of wagon production by ensuring that a WPU located anywhere in the country could price its wagons on labour alone, turning the wagon supply contracts into fabrication contracts. While this squared up production costs for wagons supplied from any part of the country, it also gave IR an ultimate pricing stranglehold on the wagon industry in India, while adding considerably to the leads and tonnages of departmental freight.

Under such circumstances, the tendering system became untenable since with a major part of their hidden costs being absorbed by IR during the supply of free inputs, it gave newer WPUs with updated plant a pricing advantage. Thus in an exercise of countervailing power in the monopsonistic market, the WPUs banded together under WIL institutionalising the disappearance of the economies of location from the Indian wagon industry. Certain pitfalls have continued in the present system, because of the perpetuation of the contract system for fabrication of wagons. Inefficiency on the part of IR in procuring and delivering free-supply inputs translates into production inefficiency on the part of the WPUs. Although this adds additional costs to wagon manufacture, IR does not carry the liability for these. By contrast, late procurement and supply of vital inputs to IR's own departmental production units imposes direct liability on IR costs. Given this situation, the coordination problems faced by the wagon industry in India appear to be rooted in the size of the wagon-procurement quotas fixed by IR, since it is these that are the real determinant of wagon production levels, rather than industrial costs and prices.

4.5.1 Problems of Allocative Efficiency

Vis-a-vis the markets faced by other engineering industries, the market for wagons is thus atypical. The main points of distinction are the monopsonistic nature of the market, the existence of production by quota, the bifurcation of wagon production into the high-technology manufacture of components and low-technology fabrication, and the consequent limitations on the economies of scale and location. The volume of wagon supply thus depends on total orders received from IR and the production quotas set by WIL for the WPUs.

Facing a predetermined demand situation, the principal operational objective of the WPUs becomes the minimisation of production costs, which because of the free-supply of upto 65 percent of their high-technology inputs, are essentially labour costs. It needs to be examined whether in a market possessed of such oddness, the WPUs can efficiently allocate resources, meet product specifications and price wagons economically.

Although monopsonistic, the behaviour of the market is influenced to a certain degree by the fact that as PSUs, both the *buyer* or IR and the *sellers* or public-sector WPUs are supported on public money and are consequently afforded protection by the state. On its production side, the market structure assumes a collusive oligopolistic character with cartelisation of the WPUs under WIL. Thus the wagon production targets for the WPUs are allocated exogenously by quota rather than by market forces. In such circumstances, the resource allocation decisions of the WPUs lose some of their constraints. The WPUs actually operate in a protected market, with that protection being provided directly by IR through free supply-inputs and indirectly by the guarantee of purchase on orders placed through WIL. Most interestingly, because the free-supply of inputs makes IR a participant in wagon manufacture, the market for wagons also becomes something of a *buyer-seller* cartel. In such a market situation, with imperfect market elements in both its buying and selling segments, uncertainties arising from organisational lapses, erratic order-placements, or capital shortages of any kind destroy production incentives for the WPUs. This imperfection of the wagon market directly derives from the concept of macro efficiency embodied in the FYPs. What is being dynamically optimised through the resultant market procedure is the flow of high-technology to the IR system. In practice however, the physical production of wagons cannot be optimised through the pricing mechanism because the infrastructural character of plan investment on IR technology results in autonomous rather than price-determined wagon demand on the part of IR.

Nonexistence of data on the complete cost-structure of the wagon industry becomes an impediment to the direct analysis of allocative efficiency in the WPUs. A compensation can nevertheless be made by dealing with the issue from the demand side, *i.e.* in terms of the factors that determine the IR demand for wagons. It may be noted that the size of wagon procurement orders received from IR *prima facie* determines both the cost and profit structures of wagon production, and hence also the fate of the Indian wagon industry. As production levels at the WPUs depend on advance orders received from IR and involve the assembly of technical inputs including those supplied free of cost by IR, any *post facto* revision of wagon orders resulting from IR hindsights over the 12-month lead period places the WPUs into a precarious position.

Allocation of wagon procurement orders received from IR is made among the WPUs by WIL on the basis of their licensed capacity as well as their average and best production performances over the previous 10 years. However the *installed* capacity at each WPU, which depends on actual plant, equipment and labour employment, may not conform dynamically to the capacity licensed by government. This is particularly in view of the chronic shortage of orders which has afflicted the wagon industry since the end of the 3FYP. Another factor that dynamically determines currently installed capacity at each WPU is the technological specification of wagons which are to be built. This has become increasingly important since the 6FYP, as IR wagon specifications since then have been tailored to the new BOXN standard, requiring the use of cast-steel bogies and welded construction in place of the FWU wheelsets and rivetted construction that were sought earlier. Similarly, the gradual phasing out of IR's MG operations and the non-replacement of MG wagon stock have also forced the writing-off of substantial fabrication capacity. Although the overall technology requirement at the WPUs is low, the consequent level of technological obsolescence in tooling, handling equipment and labour skills is particularly high. With the bulk of the wagon offtake by IR since then being of BOXN wagons, the capacity installed years back by the WPUs for the assembly of older wagon designs has become irrelevant.

4.5.2 Problems of Wagon Pricing

Pricing in the Indian wagon industry acquires a critical dimension, since because of the anomalies of market structure, the supply variable behaves differently from traditional price theory. This is primarily because the work contracted by IR remains confined to workmanship, *i.e.* to the conversion by the WPUs of raw materials and technical inputs procured by IR. As such, the free-supply content of a wagon becomes the dominant factor in determining its price.

Till the 4FYP, free-supply content in a wagon was confined to wheelsets, bearings and couplers. Wagon prices at the time were determined by negotiation over the initial tenders submitted by the WPUs, thus taking indirect cognisance of the comparative price offerings of different WPUs.[53] Pricing problems began to surface when low wagon orders and resulting excess capacity manoeuvred IR into a position to dictate prices and terms to the WPUs. While the revenue margins required for the WPUs to carry underutilised capacity and manpower inventories were no longer available, there was also hardly any scope for internal capital formation to modernise their plant and equipment inventories.[54] As wagon manufacture under the contract system was entirely skill-based and tied the WPUs to the use of capital inputs supplied by IR, no internal economies of scale had been created through which they could diversify into other areas of engineering manufacture by developing new product lines. While the formation of WIL was mainly intended to allow wagon prices to be fixed between IR and the wagon industry on a mutually favourable basis, the procedure adopted by IR for canalising inputs to the WPUs was intended to standardise capital costs between WPUs. Consequently the revenue margins earned by the WPUs now crystallised around their ability to lower the labour costs of wagon fabrication, without creating incentives for internal capital formation in order to raise labour productivity. Retention of labour-intensive methods of wagon fabrication without renewal of plant also made it increasingly difficult tor the WPUs to implement the new quality standards sought by IR for upgraded wagons without affecting turnover rates.

Pricing of wagons since then has been carried out on the basis of labour content, both in terms of total labour hours and labour rates using the BOXC wagon as the representative wagon-type.[55] Appropriate yardsticks for labour and labour-rate content were set up through an independent study commissioned through the National Industries Development Corporation [NIDC], which worked out the magnitudes involved on the basis of averaged actuals at the larger WPUs. With allowance for overheads and for longterm escalation, these measures were then applied uniformly across all WPUs. Following the introduction of the cast-steel design specification just before the 6FYP, the BOXN wagon soon became the standard wagon-type. Basing their proposal on existing BOXC principles IR initially offered labour-content of 3200 hours for BOXN wagons, which was unacceptable to the WPUs because of numerous manufacturing differences between the two designs and the different proportions of welding and rivetting required. The dispute had to be referred for arbitration in 1982 to the Bureau of Industrial Costs and Prices [BICP]. While new labour benchmarks were approved after detailed study by the BICP of the manufacturing parameters at major WPUs, IR continues to contend that the BICP rates are too high, basing its assessment on conditions at its departmental manufacturing units.[56]

4.5.3 Changing Face of the Indian Wagon Industry

Technological shifts within the wagon construction process that have arisen from the modernisation of wagon design have necessitated a change in the nature and skill-level of the labour embodied in a wagon. The additional industrial costs that arise from this are not directly captured by the labour-hour content of wagon manufacture, and there is no alternative way in which the WPUs can fully absorb such costs since they engage in undiversified production. While technological backwardness within the wagon industry limits the possibilities for increasing labour productivity and thereby keep the labour content of wagon manufacture unduly high, the uncertainties in wagon demand that have been consistently encountered by the WPUs leave them little justification for initiating a technological modernisation plan.

It would appear therefore that the present organisation of wagon manufacture in India has been too focused on short-term production planning and quota assignment to allow the creation of longterm technological economies of scale that have been a prominent part of the traditional backward linkage of engineering industry with the railways. Had positive thinking developed among the WPUs and IR, the benefits from such backward linkages could conceivably have flowed to both of them. Two features of the present market organisation appear to impede this. One is the inability of IR to shed the departmental mindset of the 19th century railways displayed by adherence to the contract system as a substitute for direct market interaction with engineering industry. The second is the metamorphosis that transportation planning in its infrastructural sense has undergone to fit the short-term contexts of wagon production planning. At the root of both problems lies the overall shortage of capital allocations which have afflicted IR since the 3FYP. In their absence, IR have been increasingly forced to resort to cost cutting as a means for internal resource generation, sacrificing the longterm infrastructural development of the wagon industry and hence their own development of freighting capacity. The cartelisation of the wagon industry through the creation of WIL has been an exercise in countervailing power. While protecting the WPUs in the short term, WIL restricts open competition between them which would have allowed locational economies to come into play that are the forerunners of technological economies in engineering industry. Meanwhile, the system negotiated between WIL and IR in order to standardise input costs becomes the basis for doing away with transportation and locational advantages and kills the technological initiative that could rescue the Indian wagon industry.

The situation of the wagon industry has not changed materially even after the 6FYP decision to focus exclusively on BG renewal. After an initial pickup, wagon orders again crashed towards the end of the plan and remained depressed thereafter until the early-1990s. A crash again occurred soon after the 8FYP got underway. While the cause of these reductions in wagon orders lie again in the shortage of capital funds for railway development, which since the 6FYP have had to be raised increasingly through market borrowing, IR have routinely maintained since the 3FYP, while slashing wagon orders, that wagonfleet levels are adequate to lift existing freight. Since the burden of inventorising unclaimed wagons consequently falls on the WPUs and further reduces their effective capacity-utilisation, this claim of fleet adequacy has been increasingly questioned by the wagon industry, on the grounds that the decreasing projections of wagon requirements made over successive FYPs imply that not even wagon replacements are being met. There are also frequent complaints from several quarters, including major clients of IR in the coal and cement sectors, about the inability of IR to provide wagons as required. It is believed as a consequence, that despite the immense growth in freight demand over the planning era, wagon availability on the IR network has not increased materially from the levels that existed at the end of the 3FYP, creating a tremendous infrastructural bottleneck for the economy.

Table 4.7: Trends in Wagon Production and IR Wagonfleet over the Planning Period 1950-51 to 1994-95

Period	*Years*	IR Online Wagonfleet by Period	Wagons Production by Period	Net Addition of Wagons by Period	*Difference [Net Addition - Production]*
1950-51	*1950-51*	205596	-	-	-
1FYP	*1951-52 to 1955-56*	240756	13500	35160	*-21660*
2FYP	*1956-57 to 1960-61*	307907	64201	67151	*-2950*
3FYP	*1961-62 to 1965-66*	370019	96513	62112	*34401*
Annual Plans	*1966-67 to 1968-69*	381685	45714	11666	*34048*
4FYP	*1969-70 to 1973-74*	388366	52934	6681	*46253*
5FYP	*1974-75 to 1978-79*	401885	57477	13519	*43958*
Plan Holiday	*1979-80*	405185	23588	3300	*20288*
6FYP	*1980-81 to 1984-85*	365392	66717	-39793	*106510*
7FYP	*1985-86 to 1989-90*	349661	65770	-15731	*81501*
Interplan	*1990-91 to 1991-92*	346394	50200	-3267	*n.a*
8FYP*[part]*	*1992-93 to 1996-97*	291360	*n.a*	-55034	*n.a*

Source: Computed from Tables 4.2 and 4.6 above

Table 4.7 illustrates the slowdown in wagon acquisitions that has occurred over the planning era. At the commencement of the period, capacity installed for the indigenous production of wagons was woefully short of wagon demand, so that uptil the 3FYP the balance of wagons required by IR were still being imported. Because of the proliferation of WPUs and the addition of a substantial amount of capacity over the early FYPs, wagon production rose to substantial levels during the 3FYP obviating the need for wagon imports. Since domestic production exceeded the net wagon addition to the IR wagonfleet during the 3FYP, over 35 percent of indigenous production went into the replacement of overaged stock. Through the 4FYP and 5FYP, ever increasing proportions of indigenous production were absorbed in wagon replacement so that only about 13 percent of domestic wagon production during the 4FYP and only 24 percent during the 5FYP represented net augmentation of the wagonfleet. After the conclusion of the 1970s, there was a total reversal in trend so that indigenous wagon production levels were inadequate even to cover wagon replacement needs, leading to massive shedding of wagon stock. Although, as seen earlier, this was at least partly the result of the decision during the 6FYP to modernise the IR wagonfleet and to phase out MG freight stock, the contention of the wagon industry that the present level of wagon orders by IR are inadequate even to maintain current freighting capacity appears to be well taken. While it had been seen earlier that the decline in wagon numbers has been more than compensated by the increase in tonnage freighting capacity of the IR wagonfleet, the gain in tonnage terms is not an exact substitute for the draw-down in wagon numbers since it is specialised towards the carriage of bulk-freight. In truth therefore, there has been a steep erosion in IR's ability to meet freight demands in their micro sense and to provide wagons of the right specification in desired numbers to regular consigners of freight. It also appears likely that the loss of IR market share in general freight is the inevitable result of such a trend.

It is not surprising therefore to find the wagon industry in India facing such dire straits. A few larger WPUs such as Texmaco of CIMMCO had seen the writing on the wall in good time and diversified into other product lines to utilise idle capacity. Texmaco today produces a wide range textile machinery, boilers and pressure vessels, road rollers, steel structurals, and mill machinery, etc.[57] Most public sector WPUs were at a gross disadvantage because of capital shortages similar to those that have afflicted IR. Large WPUs like Burn Standard, with separate units at Howrah and Burnpur, also suffer the brunt of inventorisation losses because of their large production volumes.[58] As many as 323 unfinished wagons had to be stabled in 1985 because of the cancellation of orders by IR and non-supply of the requisite technical inputs.[59] Among the worst sufferers are the ancillary industries which have very little capital to spare and depend almost entirely on the WPUs for job-work. It has been estimated that upto 1.5 lakh workers employed in the WPUs and ancillaries in West Bengal have been adversely affected.[60] Thus instability in IR wagon orders has lain deep at the root of industrial recession in the state.

At the end of the 7FYP, the Planning Commission and the Railway Board volunteered to make amends, committing IR to the placement of advance orders spread over three consecutive years, amounting to four-fifths of the total estimated procurement of wagons . The procurement target for the 8FYP was also raised to around 1.5 lakh FWUs in accordance with the projection of freight movement.[61] This decision however had no visible effect on the frequent downscaling of wagon orders, so that the final procurement of wagons over the 8FYP fell short by about 55,000 units, with merely 9000 wagons being acquired during 1994-95 and 14,370 in 1995-96 against more than 25,000 in the first year of the 8FYP. Apprehension about potential traffic bottlenecks arising from the dearth of wagons caused another spurt in wagon orders to 30,000 units in the last year of the 8FYP, but even this was downsized later to 23,000 wagons.[62] This typical sequence has in fact characterised the placement of wagon orders throughout most of the planning period.

Only of late has there been indirect admission by IR of the true nature and extent of freight capacity shortages that exist on the IR network. To increase the availability of wagons to major railway clients users without having to mobilise new capital funds, IR first launched the Own Your Wagon [OYW] scheme towards the end of the 6FYP in 1985.[63] The scheme anticipated that railway clients might be persuaded to lease-finance the acquisition of BOX or BCN covered wagons suitable for the carriage of general freight on the guarantee of assured fulfilment of wagon needs as and when indented by the client and an accompanying freight rebate. The scheme however soon fell through because of the lack of client interest. The OYW scheme as relaunched in 1992 substituted the payment of 14.5 percent p.a. as leasing charges in place of the freight rebate on general wagons supplied by clients as full rakes and allowed for the payment of lumpsum freight charges by clients who supplied their own special wagons.[64] The new scheme also proposed concessional rates for return consignments mobilised by the owners, in principle conceding the wagon owner the right to run an independent one-way freight service on the payment of reduced charges to IR.[65] There was some response to this scheme in 1996-97 when major producers of cement, fertilisers and petroleum resorted to the OYW scheme to procure around 5000 wagons after they had been hit by acute wagon shortages. While leasing schemes could potentially bail out the Indian wagon industry from its present straits by allowing wagon orders to be received from a wider clientele, a lot would depend on the willingness of major IR clients to commit funds to the leasing of entire wagon rakes.

Several important issues are thus thrown up by the exploration of the wagon industry in India. Many of the travails faced by WPUs arise from their being in a protected market without being assured of wagon orders on a sufficient scale. The structure of this market is neither conducive to short-term productive efficiency nor to longterm internal capital formation within the wagon industry. Although the major WPUs have been operating for a period of 50 years or more, none of them can be said to have shown evidence of having gained from the backward linkage with the railways. Rather, the financial stringency that has hit IR ever since the downsizing of FYP grants has migrated into the uncertainties faced by the WPUs since the late-1960s. Uncertainties of this kind have further limited the creation of technological economies of scale in the Indian wagon industry. Since the vicissitudes of the industry have arisen from inability or reluctance on the part of IR to make realistic projections of fleet replacement and acquisition demands since the 3FYP, the process by which such projections are made will be explored in the next chapter. The larger issue about the effect that wagon shortages have had on the efficiency of IR's freight operations is the subject of more immediate attention.

4.6 Freight Efficiency & the Utilisation of IR Wagons

Along with passenger transfers, transportation involves the shifting of freight-flows, the volumes of which are indicators as well as determinants of economic development. Although passenger transportation also has infrastructural features when it is associated with the movement of migrant or commuting labour, by far the most important infrastructural dimension of transportation relates to the movement of freight. Besides ordinary trade consignments that enter the general-freight flow in piecemeal units, large industrial and manufacturing establishments depend on the cyclic supply of railway wagons to feed their production processes and to carry away distributive flows. Hence the slowing down or speeding up of transportation has tremendous infrastructural implications. In practice, the speed at which freight flows is jointly by the freight consigners and transporters. Client establishments can be prompt or slow when loading or receiving consignments, depending on speed of their industrial operations, managerial ability and work organisation. Conversely, the speed or slowness with which the consignment is able to pass between origin and destination determines the pace at which production and distributive activity may be conducted by the client.

4.6.1 Running Efficiency of IR Wagons

A conceptual measure of the efficiency of use of the IR wagonfleet can be devised around the average lead distance covered by a railway wagon over normal hours of use per day. In railway statistics, this is represented in ratio-terms by the wagon-kilometres run per wagon-day, where the wagon-day is analogous to the man-day concept used in labour economics. Although there is an efficiency-limit on the hours over which a mechanical asset may be utilised without inducing undue wear and tear, the duration of the average wagon-day may show secular increase if more traffic begins to materialise than was previously available. Freight shortages can on the other hand effectively restrict the duration of the wagon-day. When gauging the efficiency with which railway wagons are being utilised, it is important also to assess whether the hours over which a wagon is in daily use are actually being spent on track, or at railway sidings and marshalling yards. Hence the wagon-day statistic measures the actual running hours of use per wagon. Congestion factors such as the unavailability of track or traction can also limit the wagon-day. Under present conditions, the length of the wagon-day for the average IR wagon is around 4.8hrs,[66] having risen since the 1970s because of increased bulkfreight-handling efficiency as well as the general growth of traffic demand. Over the fixed duration of a wagon-day, the efficiency of a running wagon measured in wagon-km depends on the running speeds of freight trains and the nature of impediments encountered on transit corridors during the wagon run. As a composite statistic, the ratio of wagon-km run per wagon-day thus describes wagon utilisation efficiency in both its aspects, namely the effective duration for which a wagon is available for daily running, and the average kilometre-distance covered during its daily run.

Table 4.8 reveals that the average run of a standard BG wagon per wagon-day on the IR network has more than doubled from the once-lowly 62.3km at the commencement of the planning period to 138.5km mid-way through the 8FYP, placing IR quite favourably between the 1993 achievements of 45.9km on SNCF and 158.2km on the Japanese Railways.(*see ch2*) However the path along which this increase has been achieved has seldom been smooth. Consequently, periods of sharp improvement from the starting average to 74.5km and 76.9km levels are noticed between the 1FYP and 2FYP respectively, and again in the rise from 73.4km at the commencement of the 6FYP eventually to 138.5km at the end of the review period, while a hiatus appears over the 20-year duration spanning the 1960s and 1970s. The initial efficiency setbacks occurred through the 3FYP, when non-materialisation of adequate freight led to traffic slack and wagon underutilisation. After the crisis had deepened while excess wagon capacity was being worked off during the mid-1960s, the 4FYP set the road to recovery through plan-induced buoyancy in freight traffic. The aberrant performance of the Indian freight sector following the combined externalities of the first oil crisis and the Railway Strike of 1974 also precipitated a steep descent in wagon-running efficiency to 67.2km in 1973-74. Traffic uncertainty continued through the second oil crisis into the starting years of the 6FYP, before recovery was made. Another smart increase in wagon-running efficiency from the 90.8km level occurred following the commencement of the 7FYP, but running-efficiency figures had clustered around

110km at the close of the decade and did not surpass this till the 8FYP commenced in 1992-93.

Table 4.8: Efficiency of Wagon Utilisation on the Indian Railways 1950-51 to 1994-95

Year	[Annualised] Net Tonne-km perTonne of Wagon Capacity BG	MG	Wagon-km per Wagon-day BG	MG	Net Tonne-km per Wagon-day BG	MG
1950-51	11833	9021	62.3	50.2	710	304
1955-56	14790	8497	74.5	45.9	885	332
1960-61	16558	10125	76.9	51.6	998	405
1965-66	15567	12255	73.2	60.1	940	510
1970-71	15117	12583	73.4	58.4	908	524
1971-72	15626	13003	74.1	58.8	935	540
1970-71	15717	13225	74.4	60.0	953	552
1973-74	13950	11574	67.2	50.8	837	482
1974-75	15186	11876	70.3	53.7	907	528
1975-76	16412	12313	76.8	56.4	982	545
1976-77	16754	12843	81.2	58.1	1019	570
1977-78	17259	12764	81.9	57.5	1045	570
1978-79	*n.a.*	*n.a.*	75.9	52.7	976	543
1979-80	*n.a.*	*n.a.*	73.3	49.7	972	534
1980-81	16285	11013	73.4	58.4	986	522
1981-82	18366	12227	83.7	56.4	1112	538
1982-83	18455	13091	86.4	47.3	1123	576
1983-84	18349	13068	88.7	47.9	1112	577
1984-85	18942	12567	90.8	50.3	1150	565
1985-86	21165	15197	97.8	58.8	1296	677
1986-87	23326	15878	106.6	64.4	1420	703
1987-88	24084	16649	109.9	64.6	1449	731
1988-89	24107	17330	113.0	66.3	1453	763
1989-90	23617	18478	112.1	68.2	1428	810
1990-91	23418	18629	110.5	69.7	1407	810
1991-92	23940	19806	113.2	70.6	1439	855
1992-93	24184	18786	116.4	71.2	1457	824
1993-94	25009	18098	125.0	64.5	1506	773
1994-95	25358	16414	138.5	59.0	1590	684

Source: *IRYB*, various years, Directorate of Statistics & Economics, Railway Board, Ministry of Railways, Government of India, New Delhi
Note: *Computations are for standard FWU units*

In the face of uncertain traffic trends, the extent of improvement in IR wagon-running efficiency might be considered remarkable, with wagon utilisation during the 1980s apparently picking up where the 1950s had left off. But the earlier analysis of factors like train running speeds and track-utilisation intensity (*see ch3*), and of changes in IR freight traffic and wagonfleet composition would colour such interpretation. It should be recalled therefore that both traffic complexion as well as the extent of wagon specialisation on IR have undergone vast change between the 1950s and the 1980s, with bulk-freight having now become virtually the sole constituent of IR freight. Because of the larger loading-unit sizes involved, bulk traffic has a natural tendency to run in full trainloads over longer lead-distances. Thus in standard circumstances, the average BG wagon today is likely to be of the BOXN design carrying a full wagonload of mechanically-loaded coal in a block rake made up of other similar coal wagons, and to be traversing a longer lead between the coal pithead and a cement, steel or power plant. While this metamorphosis has increased the running efficiency of IR wagons for the same technical reasons which have made railways across the world efficient carriers of bulk-freight in full trainloads (*cf.*SNCF *see ch2*), it also implies the withering away of other IR freight operations and severe circumscription of the infrastructural role of railways in a nation that has been witnessing sharp escalation in transportation needs. Ultimately, the technical metamorphosis has also told on the financial health of IR because of the loss of their high-rated traffic segments. The focus on bulk traffic since the 1980s has been part of deliberate planning policy. Having been induced through radical changes in wagonfleet composition, it has brought about radical improvements in wagon efficiency. However its costs in infrastructural terms remain uncertain.

Related efficiency-analysis can also be made of tonnage-loading on IR wagons, taking due note of the increasing wagonfleet specialisation which has raised aggregate IR freighting capacity even as wagon numbers declined. The appropriate measure of freight efficiency in this context is provided by the ratio that IR net tonne-kilometre traffic bears to freighting capacity available on the IR wagonfleet. When assessed comparatively in per-wagon terms, the statistic evaluates the efficiency-gains in tonnage and traffic realisation against every tonne of carrying capacity available on the IR wagonfleet. The traffic lead factor stays implicitly present, as the ratio of net tonne-km to originating tonnages in aggregate terms would define average traffic leads. Since the wagon-efficiency index in this case is formulated relative to each tonne of available wagon capacity, it remains neutral to longterm upgradations in wagon design.

It was noted above that while running-efficiency of the IR wagonfleet increased phenomenally over the planning period, it traversed through three distinct growth phases. Prior analysis of IR operational trends over the period [*see ch2*] had also shown that although the initial growth of traffic leads reflected freight response on the part of IR to the expansion of the national market, subsequent changes were dictated increasingly by the rising tonnages of specified bulk-freight. Such trends would also have significant bearing on the interpretation of traffic-efficiency gains realised per tonne of wagon capacity by IR, because of the freight specialisation that has occurred within the IR wagonfleet. Thus while rising traffic realisation in *pro rata* terms could alternately reflect fuller utilisation of IR freighting capacity or increasing journey leads, a bias towards seemingly high ratio values would be inbuilt by higher wagon capacity and bulk-freight specialisation. The average net tonne-kilometre run per tonne of originating freight has increased considerably over the planning period. However as noticed in the table, the trend defined in terms of tonne-km realisations vis-a-vis the increased loading capacity of the IR wagonfleet is not one of uniform rise, but reflects more or less the pattern noted for wagon-efficiency per wagon-day, which showed efficiency increases in the 1950s and again from the 1980s, with a hiatus in between. However the rate of escalation in tonne-km realisations has been markedly higher - at least uptil the 1980s - because of increasing average leads, and only thereafter represents a true gain in loading-efficiency.

The trends could be explained as follows. During the first two FYPs and for some time into the 3FYP, IR made substantial gains in wagon loading-efficiency because of the rise in traffic during the period of capacity-led growth. Since continuation of such traffic trends depended on the continued growth of PSU-based traffic, which did not realise the growth targets of the 3FYP, slippages occurred in wagon-loading efficiency because of the materialisation of excess freighting capacity. Instead of waiting for traffic to revive, the policy reaction was however to shift into a demand-management regime which scaled increases in freight capacity to prior growth achieved in traffic - under the possible rationale of maintaining wagon-loading efficiency and the commercial position of IR. Although the objective in itself was unexceptionable, the means adopted to achieve it negated the all-round developmental role that IR had played hitherto, because of the reduction in traffic focus to specific freight which could offer fuller wagon-loading, fuller trainloads and secure freight turnovers. This revision in planning policy, which coloured the thinking behind the 4FYP and appeared to take full effect over the 5FYP, led to the capture of other freight by the roadways during the plateau period of the 1970s, coincident with the decline in wagon efficiency. As an ultimate solution to both commmercial problems and transportation bottlenecks, the decision was taken to specialise IR freighting capacity towards the carriage of bulk-freight. Over the 1980s and after, IR returned better operational results as well as improved wagon-loading efficiency mainly on account of the reduced freight-mix and specialised wagonfleet. But the increase in wagon specialisation also reduced IR capability to handle general freight and thus involved further passive surrender of this category of traffic to alternate transport modes. As such, while the improved wagon efficiency statistics of the later period vouch for the improvement in technical viability of IR operations, they veil the narrowing of IR's infrastructural role. Although the process of economic development and market expansion continues today, the railways in India are thus less inclined to influence its magnitude and direction, except through the direct forward linkages of the few bulk-freight commodities that they now carry.

Another factor in the specialisation of the IR wagonfleet as earlier noted, is the gradual phasing out of MG freight operations. Recalling that the entire feeder network for BG trunklines had historically been built on this reduced gauge, reduction of freighting capacity on the MG network through the drawing down of its wagon and traction fleets would be likely to affect traffic viability on the network, particularly if railway policy dictated a simultaneous shift towards longer-lead traffic involving combined MG and BG haulage. Traffic shortfalls of this nature would be revealed in MG wagon-efficiency statistics.

Considering the MG wagon efficiency trends in the table associatively with the MG wagonfleet positions noted earlier [*see Table 4.2*], major departures from BG wagon-efficiency trends are seen over the planning period. Over the 1FYP and 2FYP when the MG wagonfleet grew at a higher incremental rate than the BG wagonfleet, MG wagon efficiency declined while BG efficiency rose. This divergence of trends would reflect the expansion of IR feeder operations over the initial planning phase, since traffic on the MG network did not necessarily materialise in efficient full-wagonloads because of its feeder character and its very different freight-mix. It might therefore be said that market expansion during the period of capacity-led freight planning was commensurate with the objectives of regional development even while it imposed social burdens on IR. Increased net tonne-km realisations followed the initial phase of wagonfleet development, revealing a trend towards subsequent traffic growth. The traffic failures of the 3FYP period mainly pertained to non-materialisation of PSU (*i.e.* bulk) traffic, which basically affected BG wagon efficiency. Such trends might therefore have warranted the continuation of the MG emphasis for feeder operations, because of the lower break-even for MG freight operations in low traffic-density conditions. However this did not occur. Instead, since the main IR losses had been incurred on BG operations, the subsequent FYPs sought to restrict the freighting capacity for non-bulk traffic while concentrating exclusively on increasing the efficiency of BG bulk-handling. Since this was succeeded by the net contraction of IR's MG freight services, it in fact further destroyed the viability of the MG freight network while also negating IR's infrastructural role.

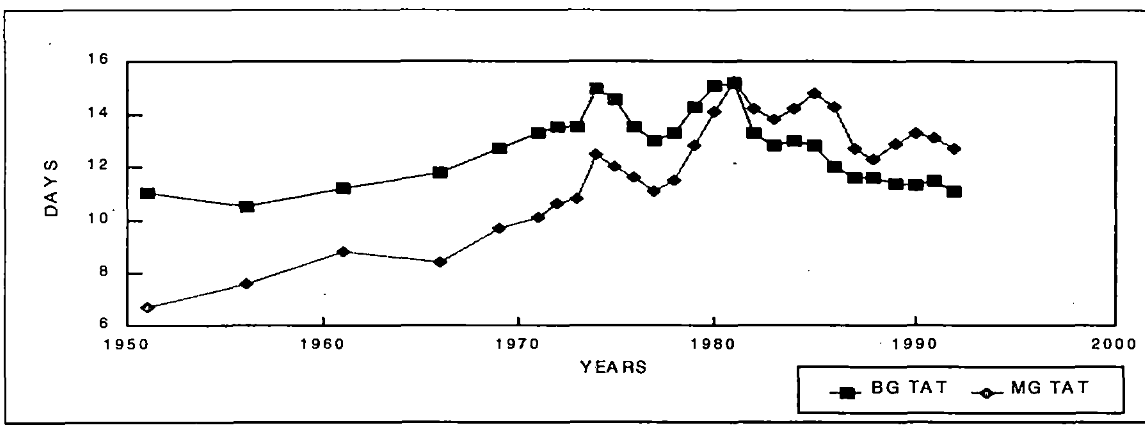
4.6.2 Efficiency of Wagon Turnaround

Another wagon-related measure of efficiency widely used to provide indication of the speed and efficiency of railway freight handling operations centres around the concept of *wagon turnaround.* Both at originating and terminal points, a railway wagon is subject to loading, unloading and transhipment of consignments, the speed of which along with the duration of the freighting journey determines the ultimate length of time before the wagon can set out again as part of a new rake. Thus the wagon turnaround time [TAT] measure assesses overall efficiency in railway freight operations, and subsumes *running* efficiency which depends on marshalling expertise, journey leads, track availability and average trainspeeds, and *handling* efficiency which depends on availability of adequate terminal space, manpower and freight handling equipment. Mechanisation of freight loading and unloading processes through use of conveyors, forklifts, etc., as widely adopted by advanced railway systems, or through wagon-design improvements on the open hopper system [OHS] which permit the quick discharge of coal and ore consignments, all contribute to the quickening of freight handling operations, but pose a tradeoff between the high capital costs of new facilities and the reductions in the unskilled workforce and savings on handling times that would ensue. While mechanisation at each existing railway terminal is unviable, it becomes a more viable option when the associated capital costs do not directly devolve upon the railways, such as at external terminals on private sidings built to handle the full-trainload consignments of major railway clients.

The importance of TAT as an indicator of wagon efficiency arises *a priori* from the desirability of loaded consignments being delivered within a reasonable time without being subjected to avoidable delays in movement. That increasing journey leads imply rising wagon TAT is foregone. However, close association of rising average journey leads on IR with the spatial growth of economic activity requires that *pure* efficiency indicators such as TAT be viewed from the development perspective also, beside their technical implications about the pace of IR wagon movements. The decisive role is played in this case by changes in the commodity-composition of IR freight. Since spatial multiplication of regional producing nodes which resulted in the compaction of economic activity (*see ch.3*) would also induce declining journey leads and shorter wagon turnarounds for a railway freight system that catered to a well diversified commodity-mix, increases in TAT under such idealised circumstances would be attributable only to equipment deficiencies and to operational inefficiency in the freighting activity. In more general circumstances, other factors coming into play would include the nature and quality of traction and track which ultimately determine the speed of freight transits, the extent of railway network congestion caused by parallel passenger operations, and the changes in freight composition induced by a shift to bulk-freight and full trainloads accompanied by the elimination of traffic smalls - all characteristically important for IR.

Fig 4.1 reveals the broad trends in BG and MG wagon turnarounds on IR over the planning period. Although the common pattern of both is of rising TAT uptil the end of the 1970s followed by a fall after 1980, the more noteworthy feature appears to be the positional switchover between BG and MG TATs with reference to that same year. BG turnarounds thus remain consistently higher than those for MG till the end of the 5FYP, whereupon, following the switchover, they undergo steeper and steadier declines than MG TAT until the end of the study period. Obvious underlying reasons would relate the switchover to bulk-freight trends during the late-1970s and 1980s which also implied directional change in IR freight traffic, and to the eventual downgrading of MG operations by IR. Reminder would be needed in this connection that the MG network was originally developed as a system of feeder lines to serve the main trunk operations of the railways in India. MG route-kilometerage, currently at 19,210km, constitutes less than a third of the IR network and is substantially lower than the BG route-kilometerage of 39,612km.[67] Freight journey leads are also generally lower on MG since they largely associate with auxiliary operations branching to and from the main BG route system. Even though these operations involve the additional component of intergauge transhipments, shorter wagon turnarounds on the MG network were still maintained in the initial period primarily because of the shorter leads that each MG wagon had to move. Hence the rise in MG wagon TATs over the planning period to levels that eventually exceeded those for BG indicates the greater technological inefficiency now afflicting freight operations on the MG network where wagons and technical facilities have undergone virtually no upgradation since the end of the 5FYP. As earlier seen, this has been part of a official policy package which recommends the capital-intensive alternative of gauge-conversion and adoption of the UNIGAUGE in order to improve BG freight efficiency, at heavy efficiency-cost to MG freight operations. With the available capacity to move general freight on the BG network also having been brought down by high levels of specialisation in the BG wagonfleet, a mismatch between freight availability in the regions served by IR's MG services and downstream BG freighting capacity has resulted, thus destroying the very feeder character for which the MG network had originally been designed.

***Figure* 4.1: Trends in BG and MG Wagon Turnaround on the IR Network 1950-51 to 1991-92**



Viewed from this perspective, a marked divide emerges between IR transportation planning approaches before and after the 6FYP, the change having largely been the outcome of the policy exercise on intermodal transportation planning that preceded the 6FYP. During the prior phase, wagon TAT increased for both BG and MG following the spatial dispersion of economic activity through the process of development and parallel expansion of BG and MG operations accompanied by spatial and technological upgradation of the IR network. Evidence of the rise in TAT being as representative of spreading development as of reduced wagon efficiency exists till at least the end of 5FYP in the concurrent increase of average freight leads from just 458km in 1947 to well over 700km by the end of the 1970s (*see ch.2*) - the increase deriving from the expansion of economic hinterlands as well as from the new need to freight bulk materials all over the country. The sharp increase exhibited by MG TAT however warrants independent consideration. While upgradation and modernisation of BG operations have remained key policy objectives over the entire planning period, it would appear that the continuous resource crunch faced by IR since the 3FYP selectively curtailed investment on MG rolling-stock renewals and upgradation of MG tracks and terminals till the point that freight-efficiency on the MG network began to decline at a much sharper rate than it did on the BG network. The resultant traffic instability made MG operations less relevant to freight efforts as a whole, as IR began to turn increasingly towards assured flows of BG freight. Eventually these sustained trends fuelled the argument for phasing out MG operations, as the conscious move towards bulk-traffic on the BG network escalated freight adaptation and the demand for modernised wagons which require longer-lead operation to run efficiently. While the overall decline in BG TAT after the 1970s can be attributed to the improvement of railway technology, the converse would hold for IR's MG operations. Reasoning on these lines would also tie in with the changing wagon acquisition trends observed earlier which have proved to be the undoing of the Indian wagon industry.

It would be useful also to collate the TAT patterns with the operational trends of IR freight over the FYPs that had been taken note of earlier. With augmentation of the transportation infrastructure leading to widening of the production and consumption base of the economy over the first three FYPs, the rise in wagon turnarounds initially matched rising freight leads. Till the 3FYP, simultaneous increases in the IR wagonfleet on both BG and MG networks occurred ahead of the actual manifestation of traffic demand. Since the upstream and downstream linkages emanating from the expansion of IR infrastructure provided spatially distributed freight gains, the initial rise evident in BG and MG TATs is not wholly inconsistent with the context of an expanding economy. However, as the recessionary phase set in after the 3FYP, the excess capacity created previously took toll of operational efficiency in IR freight movements. The setback to average IR freight leads from nonmaterialisation of adequate bulk traffic during the 3FYP also had a spillover effect on wagon TATs which remained sluggish around the time. When freight buoyancy during the 4FYP partially overcame the recession with the recovery of bulk-freight also working towards raising average IR traffic leads, prevailing physical shortages of rolling stock combined to increase BG TATs substantially from 13.5 days to 15 days, and MG TATs from 10.6 days to 12.5 days between 1971-72 and 1973-74. IR freight efficiency was however sharply affected by the twin oil crises and the Railway Strike of 1974 as originating tonnages alternately fell, rose and then fell again, the intermediate increase being caused by commencement of the 5FYP which improved traffic realisation temporarily. Although average freight leads grew almost continuously, wagon-efficiency responded to the traffic upswing with a reduction in turnarounds on both gauges. Such improvements however proved shortlived as wagon TATs again began to climb after the second oil crisis to reach alltime-high levels of 15.2 days on BG and 15.3 days on MG in 1980-81 with the start of the 6FYP, accompanying a sharp rise in average freight lead to 754km, the highest over three planning decades.

The possible underpinnings for this uncertain turn of events during the 1970s lay in a shift in the composition of freight traffic arising from the inability of IR to meet the wagon demands of non-bulk traffic because of fleet shortfalls. Freight policy shifts that occurred over the 1980s then increased wagon-efficiency and brought about declines in wagon TAT with those for BG being most marked, because they took conscious stock of *de facto* changes in the railway freight complexion as a consequence of the oil crises, which were institutionalised in the new policy on intermodal transport coordination recommended in 1980 by the National Transport Policy Committee [NTPC]. To meet the projected policy target of carrying 435-468 billion tonne-km of freight by the end of the century, IR was now required to concentrate on increasing the operational efficiency of BG freight operations. Thus while BG TATs declined sharply with the new focus on special categories of traffic that originated in full trainloads and were carried on block rakes to drastically shorten the time expended in marshalling and terminal operations, efficiency on the MG network failed to recover after the 6FYP. It may also be noted that while cyclicity in average freight leads and wagon turnarounds was absent during the prior phase, it has been a notable feature in IR freight patterns since the first oil shock. While freight policy changes since the 6FYP have partially stabilised the amplitude of cycles in BG wagon-efficiency, the cycles in MG wagon-efficiency continue unabated.

4.6.3 Tractive & Loading Efficiency on IR

Other indicators of the efficiency of railway asset-utilisation such as average freight trainspeeds and trainloads, which are intimately associated with the running-efficiency of railway freight operations, shed light on certain interesting aspects of wagon turnarounds on IR. Both indicators relate to the efficiency of traction, since improvements in the power of tractive units allow both train running speeds as well as the haulage capacity of rakes to be progressively raised. Figures for average railway freight trainspeeds however subsume halting delays and hence may vary considerably from the maximum speeds achieved on freight-hauls, if running-efficiency is low. With the gradual phasing out of steam traction over the planning period, the importance of diesel and electric traction has grown enormously - electrification of 12,266km of track having been completed by 1995 and 57 percent of BG gross tonne-km freight traffic now being accounted for by the electrified BG high-density network [HDN].[68] Thus while the average speeds of steam-hauled freight trains have declined continuously over the planning period from a high of 15.8kmph in 1956, as evident from Table 4.9, average overall speeds of BG freight trains over all tractive modes have risen from 17.4kmph in 1950-51 to 23.6kmph in 1994-95, reflecting the change in the composition of IR traction.

Table 4.9: Average Train Running Speeds by Traction and Gauge on the IR Freight Network 1950-51 to 1994-95

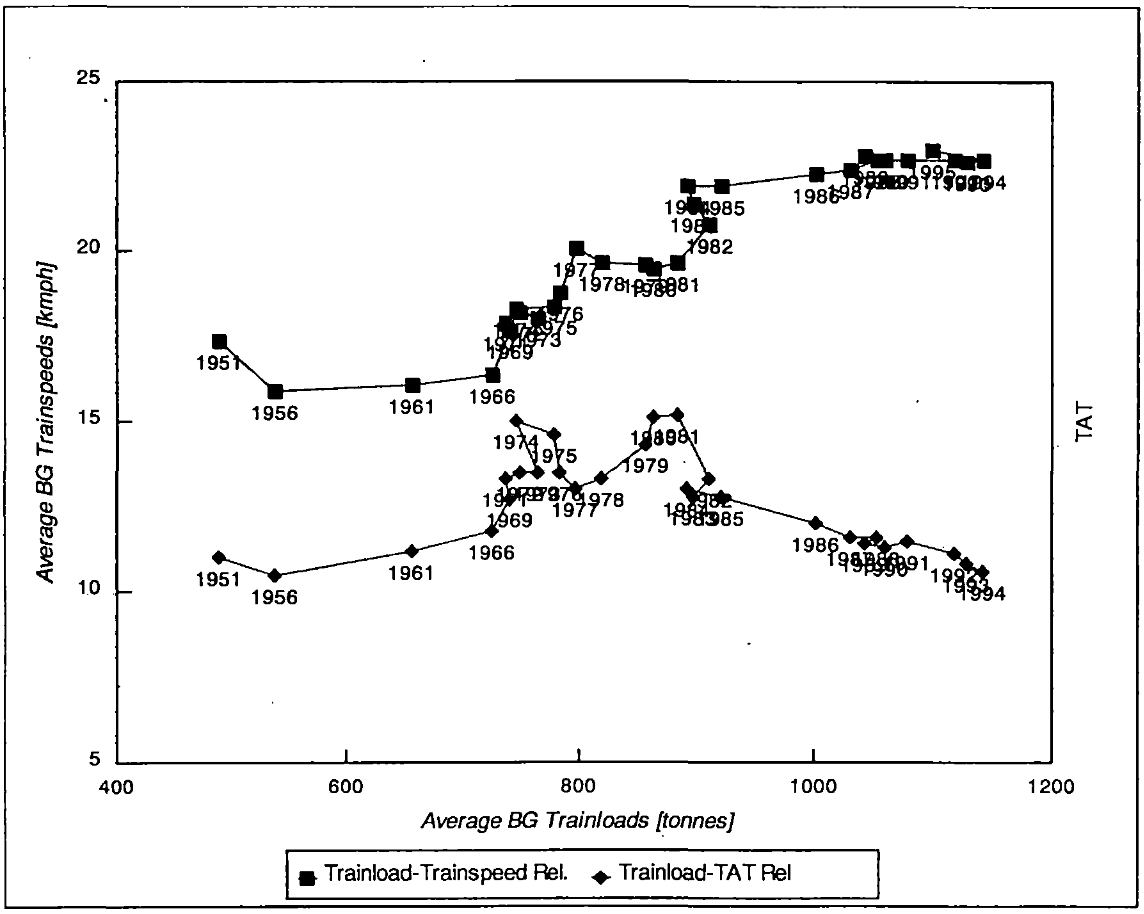
Year	BG Net Trainload *[Tonnes]*	MG Net Trainload *[Tonnes]*	BG Steam Traction *[kmph]*	BG Diesel Traction *[kmph]*	BG Electric Traction *[kmph]*	Average BG Train Speeds *[kmph]*	Average MG Train Speeds *[kmph]*
1950-51	489	185	17.1	-	20.8	17.4	15.0
1955-56	537	246	15.8	13.9	19.8	15.9	13.6
1960-61	656	298	15.6	22.2	19.5	16.1	13.7
1965-66	725	347	13.0	23.7	23.4	16.4	14.0
1968-69	739	362	12.1	22.9	25.5	17.7	14.9
1970-71	737	378	12.0	22.9	25.2	17.9	14.7
1971-72	748	391	11.8	22.8	24.2	18.2	14.9
1972-73	763	403	11.7	22.0	23.5	18.0	15.2
1973-74	745	408	11.8	22.2	22.5	18.3	15.5
1974-75	778	422	12.0	22.1	22.4	18.4	15.2
1975-76	782	413	11.9	22.1	23.5	18.8	14.9
1976-77	796	413	11.9	23.1	25.2	20.1	15.2
1977-78	818	423	11.5	22.2	24.7	19.7	15.0
1978-79	857	451	11.2	21.5	23.9	19.6	14.8
1979-80	863	467	10.8	21.1	23.4	19.5	14.8
1980-81	884	487	10.2	21.3	22.8	19.7	15.1
1981-82	911	508	9.6	22.5	23.1	20.8	16.1
1982-83	898	520	9.6	22.6	23.1	21.4	16.5
1983-84	892	539	9.5	22.7	23.7	21.9	17.0
1984-85	922	523	9.7	22.8	23.2	21.9	16.9
1985-86	1001	539	10.4	22.7	23.2	22.3	16.7
1986-87	1031	520	10.0	22.6	22.8	22.4	17.0
1987-88	1053	544	9.6	22.9	23.2	22.7	17.3
1988-89	1042	553	9.6	22.9	23.4	22.8	17.5
1989-90	1060	576	9.2	22.9	22.9	22.7	17.5
1990-91	1079	562	10.1	22.6	23.1	22.7	17.6
1991-92	1119	585	10.1	22.6	22.9	22.7	17.8
1992-93	1128	574	-	22.6	22.6	22.6	18.0
1993-94	1142	599	-	22.3	23.1	22.7	18.2
1994-95	1100	576	-	22.4	23.6	23.0	19.1

Source: *IRYB*, various years, Directorate of Statistics & Economics, Railway Board, Ministry of Railways, Government of India, New Delhi

Commencing with the 2FYP, the main technological thrust of IR towards electrification and traction improvement carried strongly into the 3FYP, by the end of which the average running speeds of electrified BG freight trains had risen from 19.8kmph to 23.4kmph and those for diesel-hauled trains from 13.9kmph to 23.7kmph. This increase in average trainspeeds was accompanied also by the raising of average BG net freight trainloads from 537T to 725T between 1955-56 and 1965-66. Running inefficiencies and traffic uncertainties in the subsequent period caused trainspeeds to hover uncertainly around these levels during the 1970s with overall BG trainspeeds being much lower, except in the single year 1976-77 when diesel, electric and overall BG freight trainspeeds recorded a sharp rise. Electrification has however bypassed MG, since of the total IR running-track network, the 19 percent which has has been electrified comprises 5 out of 7 major trunk routes connecting Mumbai, Calcutta, New Delhi and Chennai.[69] Changes in IR traffic composition over the 1980s have sustained rather than materially improved BG trainspeeds, indicating that technological improvements in traction have been geared towards raising average trainloads rather than average trainspeeds. Evidence of this is drawn from average BG net trainloads which increased from just around 800T in the late 1970s to well over 1000T by the end of the 1980s.

Another factor highly relevant to determination of average trainspeeds and overall IR freighting efficiency is the average payload transported on each freight rake. Comparison of net average trainloads with the average trainspeeds realised by IR on BG freight operations provides several interesting insights into other technical factors that ultimately reflect upon wagon TATs. It may be noted that while the average speeds of BG freight trains had already risen to 20kmph by the mid-1970s, they have since only increased marginally, with occasional dips. The attainment of higher freight trainspeeds could be attributed to progressive dieselisation and electrification on IR's BG routes as well as to increased freight handling efficiency, since they follow the reduction of halting delays as reflected in the associated TAT trends. Average IR trainloads have however also increased because of expansion in freighting capacity through wagon specialisation over the planning period. A comparative assessment is thus called for. Analysis of the interactivity of upgraded BG traction and wagon technology may be made from the crossplot of average BG trainloads, trainspeeds and BG wagon TAT over the planning period presented in Fig 4.2 below.

***Figure* 4.2: Crossrelation of Tractive-Efficiency and Wagon-Efficiency Trends on the BG Freight Network 1950-51 to 1994-95**



During the 1FYP when steam traction still dominated IR operations, average trainspeeds tended to decline as the net BG rake loads carried by IR increased. The focus on core industrialisation during the early planning phase and the consequent freight dominance of short-lead traffic routed from mining areas to the core industries helped in maintaining a low TAT despite the increase in freight tonnages till the end of the 3FYP. Since steam-based traction had not proved adequate to meet the mass transit needs of commodities like coal, a technological thrust towards the upgradation of tractive power was necessitated by the mid-1960s which increased BG trainspeeds much more sharply than trainloads. Nevertheless freight handling efficiency remained low, causing BG TAT to rise considerably as heavier trainloads were carried over the 1970s. The sharp increases in TAT during the two oil crises apparently arose from the need to transport vaster amounts of coal on IR's main trunk routes without realising adequate traffic on the return journey. Commodity substitution consequently occurred on BG freight operations, assisted by increasing specialisation of the IR wagonfleet. With the commercial performance of IR becoming progressively dependent on the realisation of bulk-freight, wild oscillations took place both in average BG trainspeeds and TAT uptil the end of the 6FYP. The apparent improvement in TAT thereafter was attained against sharply increasing average trainloads, without commensurate enhancement in average trainspeeds. It thus becomes quite obvious that the improved BG freight-handling efficiency embodied by the recent decline in TAT has not been achieved through major reduction in halting and other delays which would also have simultaneously raised the average running speeds achieved by BG freight trains, but rather through the increased trainloads freighted on specialised wagon rakes.This is in keeping with the inferences drawn earlier from the analysis of freighting capacity trends and wagon specialisation on IR's BG network.

Although the increase in wagon-utilisation efficiency achieved by IR over the planning decades in terms of tonnages transported and transit times has been fairly credible, it has been at the cost of rising haulage of empty special wagons. Reflection of the rising incidence of empty haulage is found in the fall in the net load of the goods trains.[70] Although the proportion of loaded wagon-km to total wagon-km has remained more or less stationary of the initial plan years, empty wagon-kms constituted nearly 34 percent of the wagon-km on BG and 30 percent on MG by 1976-77, owing to dynamic changes in the IR freight traffic pattern and in the composition of the specialised IR wagonfleet that carries this traffic. For instance, if coal is shipped to Punjab in the open wagons, it is not suitable to transport the ffodgrains that the region can offer for outward loading. To meet the demand for foodgrains loading, covered wagons are despatched to reach such commodities to the deficit areas. As a consequence, the open wagons return empty to the origin to be loaded once again with commodities suitable to be carried in open wagons and thus increasing the TAT.[71] Although the percentage of empty wagons online has increased only marginally to 34.9 in 1983-84,[72] it is evident from Table 4.9 that after a steady increase in the net load of the freight trains till 1981-82, there has been a sharp dip in the net load in the two years that followed recovering thereafter. But the 6FYP and the 7FYP witnessed a variability in the net loads indicating variations in the incidence in empty haulage.

4.7 Freight Capacity & the Transportation Infrastructure

While phased acquisition of rolling stock by IR over the period of each FYP constitutes a crucial link in matching the provision of freight service to the new demands for freight movement generated by the process of market expansion and planned economic development, the character and composition of railway wagon stock determine the units in which IR freight services can be provided and also the nature and quality of freight service available to each economic sector. Concurrently, the demand for wagons for freight movements is determined by the changing magnitude and composition of production and consumption demands within the economy, which in turn decide the magnitude and direction of commodity freight movement in the economy. Transportation bottlenecks can thus cause drastic demand and supply mismatches in the economic system, and lead to a slackening of the production impetus imparted by each FYP, because of shortage in the required freighting capacity and the consequent building up of inventories which can disrupt the country-wide flows of resources and outputs that generate balanced economic development. In further extension of this chain, either of the above circumstances can have crippling impacts on the Indian WPUs and on the operational performance of IR as a whole.

During the early phases of the planning era, planners in India had laid blanket emphasis on the augmentation of transportation infrastructure, in confidence that this would eventually lead to accelerated industrial growth. Towards this end, the planning effort also sought to expand basic industries like steel, chemicals industries, fuel and power and also establish the required machine-building capacity, so that the future requirements of industrialisation would be met within the relatively short period of one decade, mainly from the country's own internal resources.[73] It was also anticipated that the feedback signals emanating from the economy would require progressive investment on railway infrastructure, including upgraded railway technology and wagons, as well as phasing out of lumpy investment on the expansion of system capacity. However, the suggested approach began to show signs of coordination failure when the desired phasing of major industrial and infrastructure projects could not be achieved within the short time-horizon prescribed for this anticipated 'decade of development'. While the principal source for coordination failure were sectoral mismatches within the Indian economy, visible structural lacunae also appeared in the transportation infrastructure calling for serious thought to be given to the need for intermodal integration.

As diagnosed by the 9FYP review of past economic performance, the continuous decline in IR's freight share has primarily resulted from the inability of the railway system to grow proportionately with the increasing traffic demands of the Indian economy. The review also recognises that the resource constraints of the Government of India have been the principal reason for the under-funding of the state-owned railway system throughout the planning era, leading to chronic under-supply of IR freight services. Faced with the resulting capacity constraints, IR has been forced to narrow its freight focus to less contestable sectors of the freight market by specialising in bulk movements of materials for the core sector of the economy. While IR has been able to retain a major share of this captive freight market, it has been constantly losing ground in the high-rated non-bulk freight segment which caters to economic sectors that have historically shown intrinsically higher rates of growth.[74] Over the long period, this change in the IR freight policy stance has induced continuous slack within the Indian wagon industry, driving the WPUs to the brink of economic ruin.

Skewing of railway tariff policies in order to raise internal capital resources while cross-subsidising loss-making preferential freight and passenger operations, has led in recent years to unwarranted escalation in IR freight-tariff rates, beyond what the traffic will bear. While on the one hand, the privately-owned roadways sector has been able to aggressively contest the freight markets which are being progressively vacated by IR as a result of freight capacity constraints, the policies for deregulating the roadways adopted since the 1980s to compensate for the gradual phasing out of MG operations by IR have also rewarded private operators by liberal issuance of national permits, low licence charges and road taxes, as well as cheap bank finance and subsidised diesel costs, unduly increasing their ability to contest in the country's freight markets.[75] In such scenarios, the new IR tariff policies are proving suicidal, since they have even begun to drive away long-distance bulk-freight traffic into the hands of the roadways.

Thus a study of the crucial determinants of freighting capacity on the IR system acquires critical importance in the present context. The next chapter accordingly undertakes an analytical review of a gamut of related policy issues, including the planning needs of IR and the associated tariff and transport coordination policies enunciated in the reports of numerous expert committees constituted since Independence to suggest better ways of matching railway freight capacity to the projected freighting needs of the Indian economy. This is followed by an econometric exercise that seeks to identify the principal factors that have guided the decisions of IR managers on the addition of wagon capacity to the railway network.

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Chapter 5

DETERMINANTS OF RAILWAY FREIGHT CAPACITY IN INDIA

5.1 The Policy Determinants

The preceding chapters, which were largely descriptive in content, have sought to lay a comprehensive foundation for more rigorous analysis of railway freight operations in India. In doing so, two considerations have emerged which are important in the bearing they have on the discussion to follow. Firstly, the problems afflicting freight operations of IR are seen to have changed over time as a natural consequence both of growth of the economy and of Indian industry, and the overall evolution of Indian transport infrastructure and of competing segments within it. Since neither of these developments has been short term - as indeed no infrastructural variable is, a period of sufficient duration has to be considered in order to make such changes visible. Secondly, the differential performance of railways in India through all three post-Independence phases cannot entirely be explained in terms of supply-side efficiency of railway operations alone, since freight demand conditions generated by the evolution of the economy have a lot to do with determining the successes and failures of IR, especially over the long 'plateau' phase. This is further established on the strength of the analysis made earlier of selected world railway systems, whose experience in more recent decades has been at least partially similar to IR in respect of the common problem of rising inroads from freight competition and changing traffic composition.

With these considerations firmly in mind, it is now proposed to embark on an empirical analysis of IR freight operations as they have evolved over the planning period. The two empirical sides to freight performance are again freight demand and supply. However, since the initiative has slowly but ineffably swung away from the railways in India with the rise in demand and supply for road transport, the aspect that needs first consideration is whether IR has been able to enter into competition head-on, given the freight dominance that it had enjoyed earlier, or whether it has - in a manner of speaking - 'retired from the field'. The relevance of this question lies in the fact that if current freight trends can be ascribed to the former event, the railways have been provably outcompeted in both quantum and quality of service, while if on the other hand the latter attribute holds, the declining presence of IR in certain traffic segments will appear to have been a matter of design rather than an accident. Thus the crux of the issue is the role of transport policy in India.

Analysis of IR wagonfleets made in the immediately preceding chapter has brought out their changing composition and increasing specialisation, over time, to the needs of bulk freight and long lead traffic. Why this change took place requires an examination of railway policy, and in its larger element, of intermodal transport policy in India. The present chapter shall undertake this, through a review of statements of transport policy in India made at different points of time, and their reflection on the plan allocations made to IR. It is anticipated that where transport policy is more or less a statement of intent, fund commitments by Government are a manifestation of that intent and can fruitfully be studied as such. However, instead of diffusing its attention over all areas of railway investment, subsequent discussion shall build around the evolution of IR freight capacity, represented by the IR wagonfleet and its component wagon-types. After studying freight capacity in this systematic manner, it will be possible to draw conclusions about whether changes in IR freight capacity constitute a policy response to major economic trends, or whether they have a more *ad hoc* character.

This accomplished, it will be possible to move on, through two subsequent chapters, to examination of the major consequences of IR and national transport policy on railway freight operations. Inevitably, the analysis at that stage will become more disaggregated, and hence both variants of the process, *i.e.* disaggregation over time and disaggregation over space shall be considered. The quantitative methodology employed by the empirical analysis in all three chapters will be drawn from standard econometric procedures and techniques. The third empirical chapter, namely chapter 7, shall in addition formulate a complete freight-adjustment model for IR, after it has been verified that IR freight trends are more the product of shortages of freight capacity, than of freight demand constraints. Analysis of freight trends in the proposed manner shall then open for discussion, the larger issue of the place and viability of railway freight in overall transportation infrastructure in India, which the final chapter shall attempt to address in the light of the comparative experience of railways the world over.

5.1.1 The Components of Government Transportation Policy

The rationale for long-term government intervention in the planning of transportation infrastructure emerges from the larger role of government in framing policies conducive to the balanced development of a country's regions and economic sectors. The immensity of transportation projects and the low returns to capital invested in such projects have seldom made them viable for private enterprise. As a consequence, investments in transportation projects are largely financed and/or regulated by government. The major economic decisions relating to transportation availability therefore vest with government and its policies are expected to be directed towards achieving high operational efficiency within the envelope of social and financial cost constraints. While government policy is likely to emphasise the public utility aspect in transportation, it is necessary that investment also be made towards expansion of networks and augmentation of capacities, in addition to maintenance of existing operational levels. Failures to maintain existing networks owing to resource scarcity amount to 'negative investment', *i.e.* disinvestment, on the part of the government.[1] Thus the general health of transportation sectors is largely dependent on the degree of cogency and comprehensiveness achieved by transport policy.

The main spheres of influence of government transport policy, subject to variation between time, modes and countries, are control of quality and quantity of services, control of organisation within the transportation sector and control of its resource allocation processes.[2] Efficiency of resource allocation determines the operability of controls in the other spheres and hence recent attention has been focused on raising investment efficiency in transportation. Investment in transportation infrastructure may be financed by either private or public capital, depending on which mode of transportation is being considered. In the LDCs, where capital is generally scarce, judicious planning of transport investment becomes imperative and may be considered now by way of its components

The first component in investment planning is the decision on the magnitude of fund allotments to transportation infrastructure vis-a-vis other economic sectors, this being governed once again by the decisions of government on whether primarily to foster the development of sectors which create demand for transportation services and then raise transportation capacity accordingly, or whether to build transportation infrastructure and capacity as a first step, and wait for sectoral transportation demands to rise to levels commensurate with capacity in the long run. The traffic-adjustment policies involved in either case thus relate to time, and where the former alternative requires that short-term investment adjust to short-run transportation demand, the latter calls for long-term investment to be adjusted against expectations of rising transportation demands over the longer timeframe.

The second component in investment planning of transportation infrastructure is the decision on the proportion of fund allocations between alternative transportation modes, and as seen earlier, differs from country to country depending upon size, geographical features and settlement density, with the railways gaining importance wherever settlement density is high.. On the other hand, where spatial size is too small to guarantee railway volumes, or where there is large and empty geographical space that has to be filled, investment on roadways is generally deemed more important. Even so, developed countries can as a rule afford to invest more on both surface modes and other advanced modes of transportation like airways, when compared to the LDCs.

The third component in investment planning of transportation is the decision on internal fund allocations within specified modes of transport, which ultimately determine the quality and quantum of services provided. The study shall presently attempt to identify the major spheres of investment within railway systems, primary segments of which are railway construction works and network-expansion; augmentation of stocks of mobile capital assets or rolling stock comprising railway locomotives, coaches and wagons; and technological stock like signalling, marshalling and traffic-handling equipment. Maintenance and upgradation of operational railway capability through track renewal and through conversion, maintenance and modernisation works on existing railway stock and improvements in managerial and communication (*i.e.* information-flow) techniques form an adjunct to these.

As outlined earlier, the first phase in railway investment primarily comprises 'sunk costs' involving heavy outlays on laying track and installing equipment prior to commencement of railway operations. Intensive utilisation of railway stocks thereafter requires phased additional investment for maintenance and for the replacement of overaged and wornout capital assets. Phasing-in of investments on upgradation of signalling and marshalling equipment, track renewal, electrification and gauge conversion, all of which come under the generic description of 'railway modernisation' is, on many railway systems, also part of comprehensive transport policy. Advanced railway systems in the world have also laid stress on networked computerisation as a way of improving the efficiency of handling highly dispersed operations, an innovation that necessarily involves significant outlays of expenditure. 'Phasing' aspects therefore spell out the time-relations that govern railway investment as a long-run infrastructural variable, and the need for having an overall system of time-capacity management which constitutes transportation planning. The crux is limited availability of capital resources on the vast scale required. Thus in the face of capital shortages, a cogent national transport policy that subsumes all three components of investment planning is required to phase capital outlays in order that highest benefits may be reaped for transport operations and for the economy as a whole.

5.1.2a Transport Committees & Commissions in post-1947 India

There has been no dearth of commissions and committees to evaluate the performance of railways in pre-Independence India, at a time when railways represented the Indian transportation infrastructure almost in entirety. A few of these, such as the Mackay Committee and Acworth Committee [IRC], had been mentioned earlier as charged with the responsibility of planning and coordinating railway development in the country, the IRC also framing the Railway Convention of 1924 which led to separation of railway finances from the general finances of government, and the institution of the annual Railway Budget. Other committees such as Railway Finance Committee [1921] and the Inchcape Committee [1923] generally had more limited terms of reference, such as streamlining budgeting and administration. Since competition *per se* did not exist for the Indian railway companies because of limited presence of waterways and absence of highways in the country, the concept of intermodal coordination of transport did not develop quite as naturally as it did in Britain or France. Till Independence, therefore, the task of government vis-a-vis transportation in India was confined to maintaining the operability of existing railway services, without much need for technological input or expansion, despite the Mackay Committee's enthusiastic endorsement at the turn of the century of a 100,000km railway network being necessary for the country.

The Indian Railway Enquiry Committee [IREC] (also known as the Kunzru Committee] was constituted in 1947 to examine the future organisation for railways for independent India, and its recommendations paved the way for nationalisation of the many company railways then in existence, after the Railway Convention of 1949 relating to perpetual dividend liabilities had been adopted. One recommendation of the IREC that however was never followed up related to the setting up of a Statutory Central Railway Authority (also recommended in the Government of India Act [1935] as a Federal Authority), and control over IR still vests firmly with the Railway Board, which is charged with both policy-formulation and policy-implementation.[3]

Infrastructural development in post-Independence India commenced with a series of thrusts in certain segments of the overall transportation infrastructure through successive FYPs. Certain vulnerabilities within the economy because of non-coordination within the network became visible within the first planning decade, and were sought to be addressed by the Committee on Transport Policy and Coordination [CTPC] set up in 1959, in what was the first government attempt to coordinate transportation in the country. The terms under which the Committee operated allowed it to examine and project the sequence of long-term transportation demands that had been generated by institution of planned industrialisation, so as to provide guidelines to the Planning Commission on the need perceived for phasing allocations to the transportation sector, including the modal splits required in Plan outlays. However the CTPC Report[4] took nearly seven years to formulate and was only submitted in 1966, by which time the railway crises of the 3FYP had already arrived to nullify some of the initial optimism regarding transportation trends. With the entire economy going into a tailspin in the mid-1960s, economic reasons for which will be examined at length in the following chapter, traffic uncertainty continued to assail the foundations of transportation planning in India resulting in drastic scaling-down of

Government outlays towards it. Secondly, the need for diversifying modal transportation facilities began to acquire visible importance with stress being laid now on the expansion of roadways and the production of commercial vehicles, not the least because these would be based on larger involvement of the private sector, without taxing the exchequer to as considerable an extent. Hidden within this also was recognition that the downstream development of industry engendered by planning had generated new commodity flows, the distribution of which could not always be provided for by railways. Meanwhile problems had also arisen in the allocations of transportation capacity made by IR to different freight categories, since while excess capacity prevailed in bulk-sector freight facilities throughout most of the 1960s, a freight squeeze appeared at the other end. While the cause of the overall crisis has become clearer with hindsight and rests explicitly in the buildup of PSU inventories and consequential cutback in public-sector spending and production, the simpler prognosis of the time was that capacity in general had exceeded transportation demand and justified reduced fund allocations towards transport.

The traffic uptrend that emerged with the refurbished 4FYP launched in 1969-70 temporarily allayed transport planners' worries, as buoyancy was restored to the economy. However a chain of economic setbacks including war and the effects of the worldwide Oil Crises led again to seesawing traffic trends over the entire 1970s as the economy restructured to the new energy regime, and saw gaps and excesses in transportation capacity emerge again. By the end of the decade and the 5FYP, it was abundantly clear that the old foundations of transportation policy in India had been rendered out-of-date both by revised energy equations and by changes in the cost structure of Indian industry.

The appropriate response for IR was to innovate, especially by inducting modernised technology, lack of which had significantly contributed to steady weakening of its operating position. With a large technological backlog already in existence because of the plan squeeze during the late-1960s and 1970s, this would by no means be easy unless new means of raising railway capital were found. An Expert Group on the Capital Structure of Indian Railways was accordingly constituted by the Planning Commission preparatory to the 6FYP to explore the capital requirement for meeting the technological challenges and alternative means to raise it, and quickly submitted its report in 1978. The need for a comprehensive revision of transportation policy with particular emphasis on intermodal infrastructure, which had also become simultaneously apparent, was entrusted to the National Transport Policy Committee [NTPC] set up the same year to advise the Planning Commission in this respect.

A major task accomplished by the Expert Group related to outlining the need to enhance the internal provisions made by IR against asset depreciation that are incorporated in the Depreciation Reserve Fund [DRF]. This was deemed to be as essential as meeting dividend payments to government from the perspective of internal resource mobilisation. Another aspect in the Group's recommendations that merits contemporary attention relates to the financial overburden being carried by IR on account of its having to make additional contributions from its operating surpluses to the revenues of government, over and above its perpetual dividend liability. In the view of the Group Report, annulment of this requirement could effectively provide relief to IR and raise internal capitalisation at a time when budgetary support was consistently dwindling.[5] A different perception within the Finance Ministry led to rejection of the recommendation, on grounds articulated in the dissenting note attached to the Group recommendations by its Member (Finance). A reading of this note is fairly indicative of the mindset of the Ministry, since the grounds cited include prior endorsement of the surplus payment practice by previous Railway Conventions, and most importantly, the plea that with financial arrangements of the Government of India having been made all along under expectation of certain revenues, a departure from past practice would not be well-advised.[6]

The primary objective assigned to the NTPC was on the other hand to formulate integrated transportation policy for the country that would allow complementary development in all modes of surface transportation around an optimum intermodal freight-mix. The focus besides this was on comprehensive long range planning of the entire gamut of transport operations in the light of current and expected development trends in the economy. The significance of the perspective plan devised by the NTPC lay in its association, for the first time, of growing demand for transportation services with sectoral growth in the economy, and in its renewal of the argument that the creation of infrastructural capacity should precede demand, since the income elasticities of transportation demand exceed unity[7] and since evidence from the first planning decade showed that in ideal circumstances, transportation requirements in the country tended to increase at a much higher rate than the rate of growth of economic sectors and national income.[8] The NTPC noted also that transportation demand derived intrinsically from the demand for mobility of labour services and commodities, which found reflection in the originating traffic of passengers and freight. Efficient use of transportation was thus deemed capable of developing backward rural regions in the country via agricultural growth and industrialisation, which enjoined that IR therefore should ensure an adequate supply of services based on 'realistic appraisal of traffic demand.'[9]

It was recognised however that investments on transportation involve a risk element arising from possible traffic inadequacy, or from supply-side weaknesses such as technological obsolescence of railway facilities to the point where they are rendered incapable of meeting even existing traffic demand. Either case could lead to either nonmaterialisation or nonrealisation of adequate traffic, adversely affecting the returns on investments made in future transportation capacity and on maintaining existing capital assets. Additional risk factors arose also because of the long gestation lags involved in the planning and implementation of transportation projects. The NTPC further recognised that while creation of transportation infrastructure should in principle precede traffic demand, policy of this kind will always be subject to the quality of administration, education and the 'people's propensity to grow'.[10] On the other hand, inadequacies in transportation infrastructure could become potential impediments to economic development and hence shortfalls in capacity should not be allowed to exist. Creation of large-scale transportation capacity ahead of traffic demand also determined the 'lumpiness' in the investment involved.

The most important components of the NTPC Report were the alternative transport demand projections arrived at by the Committee. Three major issues that the NTPC attempted to identify via these projections were the total magnitude of investment required by the Indian transportation sector, the intermodal distribution of such allocations over different transportation modes, and the determination of tariffs commensurate with the returns expected on the investments to be made. Addressing these conclusions, the Report proposed significant increases in the allocation of financial resources in order that 'net capacity' might grow at a 'critical rate' that kept pace with economic development.[11] Constrained capacity might lead to lopsidedness in development and an unrealistic intermodal mix. Accurate assessments of transport demand and the intermodal costs of transportation were therefore twin prerequisites to the development of an optimum intermodal mix where alternative transportation modes performed as complements rather than as substitutes. Traffic forecasts over a long time horizon formed the core of the NTPC's exercise at formulating comprehensive transport policy, and the methodologies adopted to arrive at these are briefly outlined below.

Besides projecting traffic demand volumes, the Report also commented on pricing mechanisms for transportation infrastructure that could be adopted by a controlled economy like India. While short run marginal cost [SRMC] pricing has been the general consensus in the transport pricing literature examined earlier, the NTPC contended however that traffic earnings should be made to cover the projected returns on investment in addition to short-run operating costs, depending on the quantum of funds invested by government. On the basis of this principle, the Report suggested a rational pricing policy with tariffs being set above short run operating costs and maintenance costs, and the additional revenue accruals forming a common pool resource for the exchequer. Alternative transportation modes could then draw from the common pool for their incremental investments.[12]

The NTPC Report formed a virtual watershed for infrastructural development in India since it radically changed government perceptions on the relative placement of IR and of transportation infrastructure in general within the economic priorities of the country. The immediate task for IR after submission of the NTPC Report was to constitute the Railway Reforms Committee to advise on technological and other reorientations within the administrative and operating structures of IR, the outcomes of which have already been alluded to elsewhere. The combined exercise of the NTPC and the RRC had already been preceded in part by the Expert Group on the Capital Structure of Indian Railways in 1978 when it had first mooted the need for raising capitalisation of the railways in India to cope with the growing challenge of technological change, but the key to an ultimate solution lay in restoring the profitability of IR operations. While technological upgradation would partially assist this by raising efficiency and lowering costs, the major contribution could only come from rationalisation of railway tariffs.

5.1.2b Railway Rates & Tariff Commissions

An important policy determinant of the profitability of railway freight operations is the power to set and regulate rates. The need for regulation springs theoretically from allowing a monopoly to operate a public utility service and instituting control over the exercise of its pricing powers. As seen earlier from railway history, regulatory mechanisms were thus instituted at some time or the other on most major world railways, even though the trend in recent years has been for deregulation after transport monopolies collapsed under the competitive assault of the roadways. With no move towards privatisation till date, the monopoly character of the railways in India has remained entrenched through much of their existence, and it needs to be seen whether this has had carryover effects on the pricing of freight services by IR.

No comprehensive modalities or guidelines for railway rate setting existed before Independence partly because of the company structure adopted for railways in India, and partly because of the obligation of government to make up revenue shortfalls to the railway companies. After the takeover of private equity and the institution of state railways under the Railways Act of 1890, rate-setting remained at the sole discretion of government and the provision for a rate-regulatory Railway Commission built into the Act was never invoked. The Act itself remained a particularly long-lived piece of legislation and its provisions held sway for a hundred years till its repeal in 1989. Following the Acworth Committee recommendations however and after adoption of the Separation Convention in 1924, a Railway Rates Advisory Committee was constituted in 1926 to deal with disputes arising between freight consigners and the company railways, and functioned till Independence. Scope for fundamental alteration of railway rate-structure did not however vest with this Committee which could only address the cases referred to it by Government.[13]

Following Independence, the original Acworth Committee recommendation was followed up temporarily by constituting the Railway Rates Tribunal [RRT] by amendment of the Railways Act in 1949, which broadened the powers of rate regulation and adjudication of the advisory body.[14] Besides being empowered to adjudicate undue preference, unreasonable rate-setting and unfair charging, the RRT could thus also reclassify any commodity to a higher rate class on application by government. The power of reclassification was an immediate casualty of the review made of the provisions of the RRT by the Railway Freight Structure Enquiry Committee [RFSEC] eight years later. While expanding jurisdiction, the RFSEC decided against conferment of further mandatory rate-making powers to the body, since this would deter the mobilisation of resources from the railway revenues which accrued to government. It however envisaged an informal regulatory role for the tribunal which would resemble that of the Interstate Commerce Commission [ICC] in relation to the US railroads.[15] This recommendation proved unacceptable and the new Railways Act brought in 1989 in replacement of the Railways Act [1890] went so far as to include an explicit provision that no jurisdiction may vest with the RRT in respect of setting and reclassification of freight classes or fixation of rates and fares.[16] It emerges therefore that the power to set their own rates without interference has been assiduously protected by the Indian railways, both before and after Independence, creating a piquant situation where, while rate-setting by major world railways has undergone considerable deregulation after worldwide changeovers in market attitudes, in India these have never been regulated at all.[17]

Periodic revisions of the IR freight-tariff structure have thus largely been left to the competence[18] of the Railway Budget presented to Parliament every year. Three Expert Committees have however been constituted at different times since Independence to examine vexed issues relating to public-utility pricing and rating principles to be followed by IR.. While consolidating the annual revisions made in railway rates, these committees have also formulated long-term guidelines for framing tariffs, giving due consideration to the rise in input costs and the need for internal mobilisation of capital resources by IR. The first of these bodies was the RFSEC constituted in 1955 under the chairmanship of A.Ramaswami Mudaliar, which examined freight pricing during the landmark 2FYP.

The Rail Tariff Enquiry Committee [RTEC] headed by H.K.Paranjape and constituted in 1977 worked concurrently with the NTPC and reexamined the entire tariff structure of IR including both coaching and wagon services. By this time, the folly of tailoring railway investment by the external availability of funds had been well acknowledged and the climate existed for expanding IR's internal effort. The principle of rate-setting adopted by the RTEC strove accordingly to maintain tariff uniformity across the country as far as practicable, and to partially relieve IR of its social burdens by ensuring that railway revenue would cover the fully distributed costs of operation.[19] Viewing transport subsidies in effect as resources denied to the railways, the RTEC noted that with four-fifths of IR freight being composed of bulk commocities and 91 percent of passengers travelling by Second Class, it had become inevitable that these categories bear the burden of tariff hikes since the possibilities of further cross-subsidisation from higher-rated traffic sectors had been exhausted.[20] The IR follow-up to the RTEC report, orchestrated through the RRC, was to raise tariffs across the board on freight as well as passenger segments by hiking standard mileage rates. By 1993, when tariff options had become non-viable, resort was made to more indirect stratagems of raising revenues such as multiplying commodity classifications, redesignating all BG trains with average speeds of 55kmph and above as the more expensive 'Superfast' class of trains, and creating the new Sleeper Class on mail and express trains.[21] On the freight front, the RTEC pricing principles introduced prohibitive rates for traffic in the parcel and smalls categories and raised minimum chargeable distance as a means of discouragement, since traffic in this class is more expensive to handle than long-lead freight in full rakeloads.

In their departure from older principles of public utility rate-making which had guided IR after nationalisation, the RTEC recommendations were expected to induce commercial orientation in IR operations. However with the concepts of railway costing in India being nebulous and relatively undeveloped, the restriction of railway costs that should have been the principal means of raising operating efficiency failed to materialise. While basic restructuring of IR rates in accordance with the RTEC recommendations had already been implemented by 1983 during the 6FYP, *ad hoc* revisions involving reclassification of commodities were made thereafter in 9 out of 10 years uptil 1993-94,[22] the sole objective being to shore up IR revenues and generate operating surplus. The relativity of the rate-schedules designed by the RTEC was thus inevitably destroyed by these frequent revisions, while the arbitrary manner of increasing rates without making reference to costs or to what the traffic was willing to bear drove a large segment of high-valued commodity-freight away to the roadways, in a vicious circle of revenue shortfalls and further tariff-hikes. The RTEC had also targeted a high 10 percent rate of return p.a. on railway capital-at-charge before dividend payment, which in the absence of adequate budgetary support for railway investment, contributed to the upward spiral that railway rates have experienced ever since.[23]

Investigation of IR pricing and operations was conducted most recently between 1991 and 1993, after the launching of economic reforms in India, by the Railway Fare & Freight Committee [RFFC] constituted under the chairmanship of D.M.Nanjundappa. The Committee was thus given especially broad terms of reference and examined the gamut of fare and freight structure and ancillary matters concerning IR, against expectations of traffic, operating costs and technological upgradation and the broad parameters of the national transport policy.[24] The reference made to the Committee thus extended into traffic costing, special traffic under postal and military categories, parcel charges, and subsidiary multimodal container services such as those being provided by the Container Corporation of India [CONCOR], a railway PSU. In its exercise, the RFFC stepped contextually into the larger areas of railway productivity and efficiency, and the main report accordingly runs into 900 pages, accompanied by appendices and summaries of seminars and special studies.

The stance adopted by the RFFC on the question of railway pricing was one of bringing IR finances back to a state of health by the reiterated need for IR tariffs to cover fully distributed costs of operation. However it did not recommend allround increase in tariffs thereby bypassing the vital issues of reducing these costs through restructuring of railway management, and by raising railway productivity through the infusion of efficient technology. The RFFC report was thus able to take note of the bottlenecks which have been responsible for long-term decline in the freight position of IR.The tariff positions which had developed and were inherited by the RFFC had amounted to monopoly pricing by IR of committed traffic in order to cross-subsidise its low-density operations. However while constant raising of freight rates was capable of leading to long-term stagnation in traffic, the rate of return required on railway capital-at-charge would have to rise to an improbable 16 percent p.a. for IR to be able to meet its requirement of new investment and replacement arrears through internal effort,[25] making some amount of tariff escalation inevitable. The freight structure recommended by the RFFC was therefore based on removal of subsidies on low-density freight and passenger traffic, while lowering rate classifications on general commodities that were being overcharged in terms of their *pro rata* costs of haulage. The latter measure was recommended to recover freight traffic that had been surrendered to the roadways and to restore vitality to IR freight operations, which in the RFFC's words had suffered because "continuous increase in the railway freight rates and classifications during the last decade has taken away whatever chance IR had in retaining this category of traffic."[26]

The method of differential freight pricing that has always been followed by the railways in India is *rate classification*, which is analogous to the scheduling of rates on other railway systems. Among the radical measures that the RFFC recommended was reduction in the horizontal spread of rate-classes on 113 major commodities which contributed 98 percent of IR's freight revenues from 60 categories to 14, by elimination of all sub-classifications within them, and by abolishing exempted traffic categories like grains and pulses.[27] As a tariff measure for improving railway efficiency, it was recommended instead that new class rates with a sharpened telescopic taper be introduced for all full trainload traffic with lead of over 250km, to favour the long-lead haulage of full rakes.[28] Another recommendation made with similar bearing was that of eliminating the 'Smalls' classification in rate schedules, so that the smallest scale on offer henceforth would be the wagonload rate scale. With IR rate scheduling set to undergo a metamorphosis with the RFFC's recommendations, stress was laid on reformulating the 'minimum weight' loading requirements to suit 8-wheeler BOXN and BCN wagons, which should progressively become the *standard* wagon unit on IR.[29] The RFFC also felt concerned about the high proportion of empty wagon-km being run by these upgraded wagons and hence recommended that specific rate rebates might be offered to consignments travelling with the direction of empties, and to consigners willing to load 'damageable' consignments like cement, fertilisers, foodgrains, oilseeds, salt, etc., on open wagons which ran the highest proportion of empty wagon-km. In a departure from the orthodox rate-scheduling method, special lumpsum or negotiable contractual rates available to major consigners were also envisaged offering upto 50 percent rebate on standard scheduled rates, without prior financial concurrence being needed from the Railway Board.[30] In a recommendation that sought to expand divisional autonomy within IR, it was proposed that authority to contract such arrangements should vest in the Zonal Railways.

Besides being radical, these new tariff proposals of the RFFC duplicated similar developments occurring in many world railways through the 1980s and 1990s, including several of those studied in Chapter 2. What they were not accompanied by was a comprehensive proposal for privatisation or corporatisation of IR, which would have been necessary to duplicate the world developments in their entirety. Instead, as a departmental undertaking, IR remained tied to the apron-strings of government, with no loosening being made during the recent process of economic reforms in the country. The common complaint from major IR clients including the PSUs concerned several non-pecuniary aspects of freight services such as delays, corruption and pilferage, etc., as well as arbitrary charging in wharfage and demurrage penalties. The review made by RFFC of these pricing anomalies ultimately reopens the issue of instituting informal controls over IR rates by reiterating the 1957 recommendation of the RFSEC for a nonstatutory 'bureau' on the lines of the US Interstate Commerce Commission. The RFFC in fact observed in this respect, that no instance existed of the Government of India ever having made a reference on tariff setting or freight classification before the Railway Rates Tribunal [RRT] over the 33 years of the RRT's existence, despite such reference being statutorily admissible.[31] Use of the statutory provision would have allowed railway clients to join issue with IR on its monopoly tariff-setting and would have restored railway competitiveness, but would also have proved inconvenient to governmental preoccupation with raising revenue from a tariff-base rather than through improvements in railway turnover. Hence the recommendation still hangs fire at a time when other RFFC recommendations have largely been accepted in phases.

5.1.3 Projections of Transportation Demand

With the longterm character of infrastructural investment and the gestation lag before suitable returns begin to accrue, the projection of future demand remains vital to formulation of infrastructural investment plans. Planning in the freight sector is confronted by more imponderable problems rooted in the complex interaction of the two groups of economic factors that ultimately determine transportation demand and supply. Principal supply factors include for instance the degree of investment in alternative transportation modes which may prove complementary or competitive in their eventual nature, thus bringing the intermodal allocation of investment into reckoning. The materialisation of transportation demands adequate to this depends however on the flow of upstream and downstream investments into the economic sectors which constitute the clientele for transportation services. As such, the projection of transportation demand has an assumptional character resting on fulfilment of spatially and secularly interlinked investment plans. It is also important that the projection forward extends over a sufficient length of time so that coalescence of different sectoral demands within the economy into resultant transportation flows is rendered visible.

In India particularly, projection of demand for railway freight transportation is rendered considerably more difficult because of juxtapositioning of public and private sectors within transportation with the overall process of economic development. Since the future volume of private investment in the roadways can at best be a 'guesstimate' which depends partially on growth conditions within the economy, partially on the presence or lack of railway investment, and partially on the degree of parallel investment in the state-sector road networks, estimates of the eventual configuration that transportation demand will have can vary widely from each other depending on the assumptions and methodology used. Traffic projections made in India have to be considered in this light.

Even though the first exercises in integrated transportation planning commenced with the work of the CTPC during the 3FYP period, it has taken some time for any degree of consensus to evolve around the future outlines of transportation demand, because of the problems just alluded to. Serious exercises in railway traffic projection only commenced in the late-1970s, well after successive oil shocks had permanently altered the cost economics of alternative transport and pointed out glaring bottlenecks in the transportation infrastructure. The critical review in this section briefly explores the projection exercises since.

Emerging freight-structure trends and the policy onus they placed on Indian transportation planning are well covered in the NTPC Report and are therefore reviewed at length here. The major observation from such trends was of the advance made by the roadways in India, with respective intermodal shares of railways versus roadways having declined from 74:26 for freight traffic and 89:11 for passenger traffic in 1950-51, to levels of 40:60 and 67:33 for the same by the 1970s.[32] While pointing apparently to reduced competitive importance of IR, the change in ratios also concealed a polarisation of railway operations around bulk freight, with the remainder of incremental transportation demand in the country flowing to the roadways by default because of inability on the part of IR to invest in the creation of adequate railway capacity. Two important areas critically examined in the NTPC study were the efficiency of energy-use in alternative modes of transportation, and the nature of lagged demand responses within the infrastructure-economy linkage which affected freight flows in the country and their commodity-composition. The NTPC Report consequently recommended an intermodal mix that would optimise traffic and restore complementarity between road and rail transportation, albeit by increasing the depth and circumscribing the range of IR freight operations to provide an adequate foothold to the former.

Transport projections in the NTPC study were arrived at through a transport-gravity model, whereby regional output levels (*i.e.* commodity supply) were forecast on a "share and shift" method that subsumed base-year regional production shares as well as the expected shift in industrial locations. Breakdowns of regional final demands for commodities for the projection were obtained after factoring in regional growth in *per capita* incomes and population.[33] Given these estimates of commodity supplies and demands, potential interregional freight movements were estimated on the principle of *gravity-flow*, or flow from regions with highest surplus production to regions with highest unfulfilled demand. Use of this particular projective model had the intrinsic advantage of keeping all transport parameters as endogenous and of generating predictions of freight by distance-slab. The NTPC estimated from these that 50.9 percent (355.76MT) of IR originating tonnages in the year 2000-2001 would have a traffic lead of over 500km, compared to 50.2 percent (149.07MT) for the traffic distance-slab estimate for 1982-83.[34] While the professed purpose of the NTPC freight forecasts becomes clear from these computations, revealing that the basis of these estimates was a freight-structure that was subsequently to remain unaltered, the overall optimism in the NTPC traffic projections has been belied by the actual freight performance of IR in the period since.

Several other traffic projections more directly focused on railway freight made in the period just preceding or subsequent to the NTPC projection include estimates by the Indian Railways Corporate Plan [IRCP 1976], the Tata Economic Consultancy Services [TECS] and the Operations Research Group [ORG] around the same period, the Energy Policy Working Group [EPWG 1979], the Rail Tariff Enquiry Committee [RTEC 1980], the Railway Reforms Committee [RRC 1983], the Indian Railways Corporate Plan [IRCP 1987], the Working Group on Railway Programmes for 8FYP [WGRP 1989] and the Railways Fare & Freight Committee Task Force [RFFC 1993]. The alternative IR freight projections for the turn of the century arrived at by these expert groups, which are summarised in Table 5.1, show marked variation over a range between 250-970 billion net tonne-km of traffic with a consensual level of just over or just under 400 billion net tonne-km in five of the alternative estimates. What is also of note in the table is the apparent downscaling of traffic estimates over time. Thus early estimates with a forward projection period of 25 years or more such as IRCP [1976] assume much more resilience in railway freight traffic in the 1980s and 1990s than has actually transpired. Although the NTPC estimate downscales this, the sequence of estimates by RTEC, RRC, IRCP [1986], WGRP and eventually the RFFC Task Force turn increasingly pessimistic following the demonstration of failure on the part of IR to retain an adequate proportion of the evolving traffic flow.

***Figure* 5.1: Expert-Group Projections of IR Freight Level by the Year 2000**

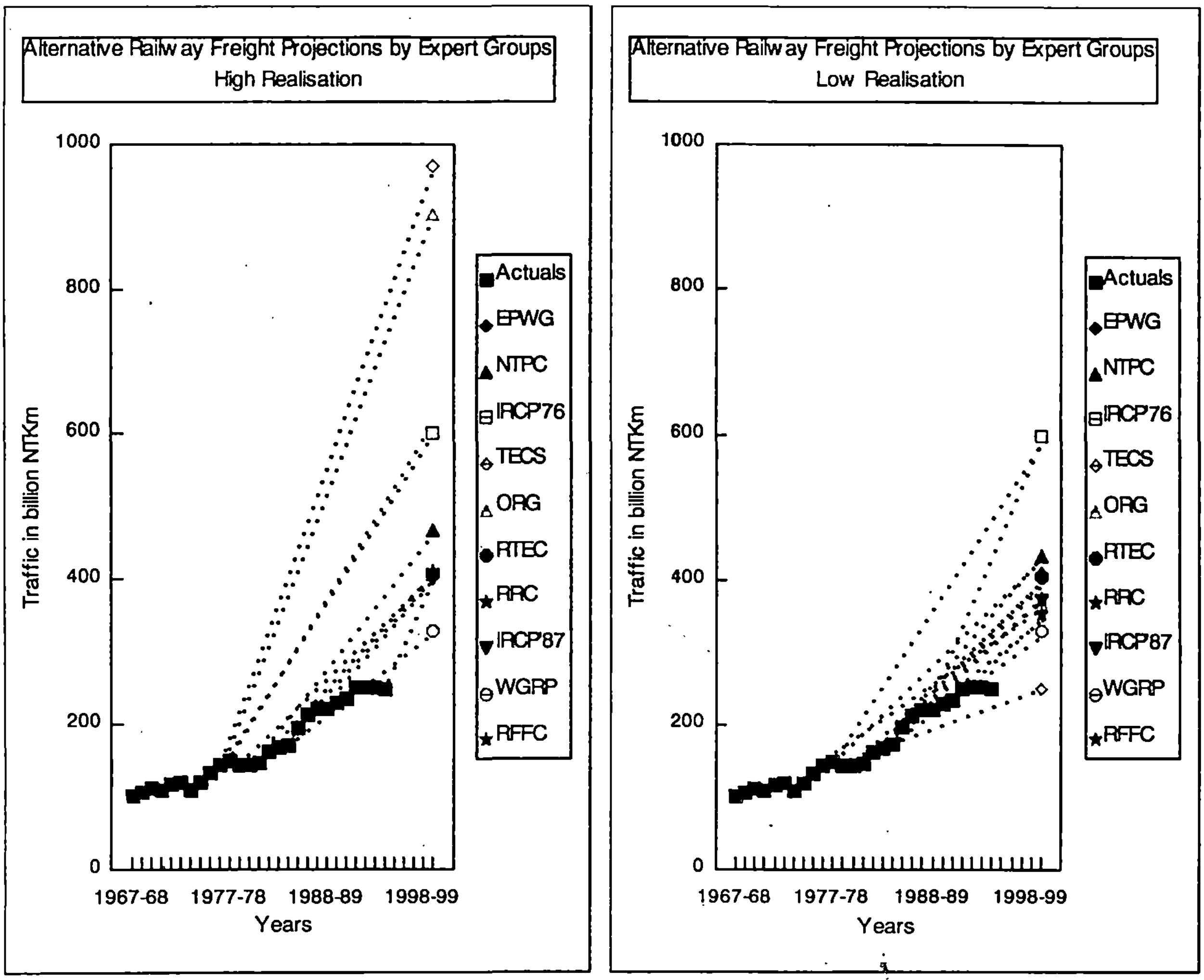


Table 5.1: Alternative Projections of IR Freight Traffic for the Year 2000

Year	*Policy Group*	*Traffic Projection [bill tonne-km]*	
	Energy Policy Working Group [EPWG]	410	
1976	Indian Railways Corporate Plan 1976 [IRCP'76]	600	
	Tata Economic Consultancy Services [TECS]	250-970	
	Operations Research Group [ORG]	368-903	
1980	National Transport Policy Committee [NTPC]	435-468	
1980	Rail Tariff Enquiry Committee [RTEC]	406	
1983	Railway Reforms Committee [RRC]	375-413	
1987	Indian Railways Corporate Plan 1987 [IRCP'87]	374-400	
1989	Working Group on Railway Programmes for 8FYP [WGRP]	330	**for 8FYP-end*
1993	RFFC Task Force	353-408	**for 2001-2002*

Source: adapted from RFFC [1993]: *Railway Fare & Freight Committee Report,* 1(6):133, Table 6.1

The two commissioned private-sector studies of railway traffic demand by TECS and ORG prove interesting from this standpoint. Although criticised by later statutory committees such as the RFFC as having pitched their estimates unrealistically high, the two studies envisage multiple expectation scenarios ranging from optimistic to pessimistic depending on the degree to which the assumptions that complement traffic generation are fulfilled. Thus while the low-growth scenarios pertain to the estimation of *restricted demand* because of capacity restraints on IR freight operations, the high-growth scenarios in either study estimate *fully unconstrained demand,* with all complementary expectations having been fulfilled. The wide range of difference between pessimistic and optimistic estimates and the fact that actual IR freight performance is closer to the former than to the latter would imply that considerable restraint operates on the development of freight flows in India because of lacunae in the IR infrastructure, and that the pickup in railway capital investments since the 6FYP has been insufficient to undo this.

Problems in planning and projecting transportation infrastructures arise when possible chain effects are overlooked, whereby the provision of transportation services generates increasing *per capita* incomes and consumption demands, satisfaction of which requires further multiplication in services. It becomes necessary therefore that the projections of transportation demand which guide the planning process should be accurate and should amply capture dynamic evolution within the economy over time. The accuracy of the projections will depend on the nature of forecasts of different macroeconomic variables that are capable of affecting transportation demand. Commonly-used methodologies for projecting traffic demand besides the gravity model used by the NTPC, include time-trend analysis, regression analysis and transport-coefficient modelling. Each of these methods works under specific equational frameworks which project transportation demand on the average growth rates of agricultural, industrial and mining sectors within the economy and the annual rate of growth of GDP, and broadly indicate the traffic volumes that would be generated as a result of projected economic growth if current locational and distribution policies are sustained through time. The assumptional structure as exemplified in the equational frameworks is however rigid since it leaves little or no scope for evolutionary transportation demands being incorporated in future periods. The traffic forecasts made in the NTPC Report have therefore been candidly termed 'broad prognostications of magnitude, based on specified assumptions and trends'.[35]

Besides assumptional rigidity, another flaw commonly present in projective methodology is marked variation between estimates depending on the method used. Projections using trend methods for instance estimate the railway shares of freight by extending past-trend lines into the next few decades. IR experience with freight operations show continuing decline in railway traffic share for at least a decade following the 3FYP, which automatically depresses the projection for the subsequent period when the past-trend method of traffic projection is used. On the other hand, regression-modelling of the relationship of transport traffic with indices of industrial and agricultural production during the 1970s projects a future rise in the railway share in freight as a follow-up to growth of the economy. Such disparities in projective estimates are often baffling, and can grossly influence the formulation of policy in the short run, leading eventually to demand-supply imbalance.

Despite these contentious issues, projected intermodal allocation of traffic estimated by the NTPC, based on combined analysis of past trends, resource costs (including imputed costs for scarce inputs like energy), traffic breakeven points and increases in POL prices, was 72:28 between rail and road freight for the turn of the present century, representing a rise of 9 percent in the railway share compared to the years which immediately preceded the Report. Subject to implementation of appropriate investment and pricing policies by government, the corresponding shares for passenger traffic were put at 60:40.[36] These projections were later refined in the report of the Steering Committee on Perspective Planning for Transport Development submitted to the Planning Commission in 1988, using detailed results from a Rail India Technical & Engineering Services [RITES] study which had projected total freight traffic on all modes to reach a level of 643 billion net tonne-km by the year 2000. Of this, IR was again expected to retain the intermodal share of 72 percent, or 463 billion net tonne-km.[37] In outright contrast, internal estimates by IR spread over the period of five years since, such as IRCP [1987] and RFFC [1993], project IR freight share at much lower levels of 400-408 billion net tonne-km by the turn of the century, even under the most optimistic scenarios. The fact that actual traffic performance by IR in 1994-95 was just 249.6 billion net tonne-km on total freight loadings of 364.96MT, [*see ch 3*] and that IR loading performance of 429.30MT in 1997-98 accounted for a mere 40 percent of intermodal tonnage freight leaves little scope for such projections to be realised.

5.1.4 Policy Implications for IR

Among the several traffic projections made over the past two decades which have just been considered, the NTPC projection would hold special place as part of the comprehensive enunciation of national transport policy which accompanied the rejuvenation of IR through fresh capital investment beginning with the 6FYP. The RFFC later commented that there appeared to be no explanation for the sudden and sharp reduction in plan allocations to transportation in general and to IR in particular that had taken place between 1966-79,[38] and squarely blamed this for the serious transport bottlenecks that had arisen in the country during the plateau period and after. Replacement-capital needs for meeting the technological backlog that existed even at the end of the 7FYP were estimated at a phenomenal Rs.17,512 crore, comprising Rs.4876 crore for rolling stock, Rs.7825 crore for track renewal, Rs.1430 crore for signalling and safety, Rs.2525 crore for machinery and workshops and Rs.1136 crore for bridge and electrical works.[39]

A major component of policy content in the NTPC Report, of which special note must now be taken, related to the composition of IR freight anticipated in the future projection. It had earlier been seen that the policy statement, implemented in parts over the 6FYP and 7FYP, led to important changes in direction for IR, including a gradual write-off of steam traction and MG operations, and reorientation of traffic capacity towards the needs of bulk freight. Whether these write-offs represented an entirely technological adaptation by IR to emerging traffic trends, or a surrender to continuing consequences of the resource crunch has considerable bearing on the current traffic position of IR, and it will hence be interesting to apply hindsight in examining the roots of the policy change later in this chapter .

To round off the present discussion, it may be noted that the NTPC Report, using data for 27 years commencing from the 1FYP, had estimated the then-current traffic density on IR's BG operations at 86.4 percent of total railway freight tonne-km and 76 percent of passenger-km.[40] Considering that the BG network constituted 51 percent of total IR routes at the time, the overwhelming importance that BG operations held in total traffic realisation by IR would become easily apparent. Moreover, freight traffic on IR was spatially concentrated on the so-called 'golden quadrilateral' of route-sectors linking the four metropolises of Bombay (Mumbai), Calcutta, Delhi and Madras (Chennai), which comprised 25 percent of total IR route-km but accounted for 75 percent of railway freight movements and 55 percent of passenger traffic. In further expostulation of the need for policy change, the NTPC Report further stated that while carriage by road proved economical on short traffic hauls with leads of upto 300-350 km, railway transportation held a definite cost advantage for traffic leads beyond that. However the tendency for high-rated freight like cotton goods, perishables, etc. to move by road even at leads of just over 350km was noted as depriving IR of a valuable component of transport revenues.[41] Projections of total freight traffic by all modes equalled 550 billion tonne-km by the year 2000 out of which IR was projected to singly carry 463 billion tonne-km. Analysis in the previous chapters has shown however that while the present freight tonnages carried by IR do not diverge so dramatically from the tonnages implied by the NTPC estimate, the major loss to IR has been of its share of traffic in net tonne-km terms.

Considering the level of renewal arrears just stated, it is not unlikely that the losses in traffic sustained by IR were at least partly the result of capital inadequacy and consequent capacity shortage. The next section shall therefore examine capital investment in IR over the planning period.

5.2 The Capital Determinants

As seen in the literature on *non-market* or *public* goods, as also in the comparative history of railway development over the long timeframe, the issue of capital finance remains a critical area both as an instrument as well as a determinant of transportation policy. In India, the institution of planning, which coincides almost exactly with the takeover and nationalisation of the old railway companies, forms a watershed as far as railway finance is concerned. While capitalisation stress in the prior period had been laid primarily on the mobilisation of private capital - either through guaranteed company investments or through direct borrowing by the state, the trickle that capital flows had been reduced to from their grand scale during the first phase of railway development meant that more dependable sources of funding would have to be assured if IR were to meet the transportation requirements for fulfilment of national economic aspirations in independent India. As such, the option exercised by the sovereign Indian state - and not only within railway planning - was to go in for public provision of all infrastructural services in keeping with the public utility school of thought. A study of Indian railway finance through the modus of the FYPs therefore holds considerable importance, and is attempted in this section.

5.2.1 Railway Capitalisation during the Plans

Railway capital is generally drawn from three principal sources, namely, capital from the *general exchequer*; capital from *internal sources;* and capital from *market borrowings.*[42] Although all three means have been commonly adopted to mobilise railway finance in India, their relative importance as components within total railway capital has changed over time. Capital drawn from the general exchequer, which represents outlays from government revenue surpluses towards the provision of railway capital, is the equivalent of participation by the state in railway equity. While this source of funding first came to the fore after the Separation Convention of Railway and Government Budgets under recommendations of the IRC (Acworth Committee), the commitments of government to new railway capital remained marginal till Independence, since the purpose of such provision till then was to ensure the maintenance of operational levels by the railway companies. However, with the commencement of planning, state capital grants soon became the principal means of financing the large autonomous injections made into IR capital-at-charge, against which dividend earnings with perpetual liability were to accrue to the exchequer. In more recent times, reduction in the level of government commitments has laid the onus on IR to find other means of outsourcing capital requirements. Although like any other commercial enterprise, the railways too can conceivably reinvest operating surpluses into capital accumulation, in practice the potential mobilisation from internal sources remains limited because of the traditionally low returns that accrue to infrastructural investment. A similar limitation also restricts the potential of market borrowings because of lower returns when these are invested in railway capital.

As such, provision of budgetary support to IR has been an affirmation of the public utility character of its operations and has remained an important means of financing the expansion of services. Nevertheless, with restriction on the level of budgetary capital over time, greater pressure has come to bear on other capital sources as means of funding railway plans. While the compulsion to raise resources internally might in this sense be welcomed as a positive move towards improving the operating efficiency of IR, in practice this pressure has been revenue-expanding rather than cost-reducing, leading to several upward revisions of IR tariffs during and after the 1980s. At the same time, the recourse to market borrowing which has been made through bond finance, particularly since the Indian Railway Finance Corporation [IRFC] was incorporated in 1986, is indicative of a return to the older modes of railway financing prevailing in the past which had relied considerably on mobilisation of capital from private sources. While the capital raised in such cases has to be repaid with interest instead of remaining at the permanent charge of railways, the costs of debt repayment incurred are obviously much higher than mere dividend payments and can only be sustained if the operating revenues therefrom show considerable elasticity. As a means for raising railway capital, the later advent of leasing (equity) schemes like OYW for railway rolling stock and BOLT for new railway lines and facilities marks the turning of a full circle to the principles of Indian railway finance in the 19th century, minus the sweetener of an interest guarantee.

In nominal terms, Railway Plan outlays in India have increased nearly thirty-fold between the 1FYP and 8FYP, emphasising the importance which has vested with IR as prime mover of the economy. However, adjustments for effective inflation in the value of the rupee and allowance for the considerable outgo now made to railway maintenance and replacement because of the expansion of railway capital-at-charge would imply that the real rate of growth of railway capital is considerably lower. A bird's-eye view of the growth and distributional pattern of railway plan outlays between the 1FYP and the early years of the 8FYP is provided in Tables 5.2*(a & b)* and 5.3*(a & b),* which reveal essential features of state finance as it applies to IR. It may be noted in connection that plan finance does not signify the collective entirety of IR expenditure but rather its *development* component. The operational component of IR expenditure which is represented in the annual Railway Budget may have capital content within it if a modicum of surpluses are expected to be earned; in other cases, it is basically a statement of operational costs (labour, inputs, etc.) against operational revenues. Because of the low margins within which infrastructural services have to operate, railway budget appropriations to capital are usually very limited and thus the plan allocation from general revenues of the Government of India has generally been the dominant constituent of new railway capital.

The major capital heads on which railway capital outlays are traditionally made, *i.e.* route & track expansion and network maintenance, rolling stock and other railway inventories, and amenities for railway personnel and passengers which involve civil construction, are seen to be well reflected in IR plan outlays. In addition however, a head of capital expenditure that has attained fairly credible levels throughout most of the Indian plan experience is railway investment, implying investments by IR in its auxiliaries such as Indian Railway Construction Corporation [IRCON], Rail India Technical & Economic Services [RITES], and the various metropolitan transportation projects. Because of changes in the mode of railway finance after the 7FYP, a new component within capital investment is *leasing,* which is sourced from market lending by the IRFC and partially from OYW and BOLT schemes. In broad terms therefore, capital outlays by IR can be broken down for different plans or years over these components.

Quite obviously the most intensive capital demand on railway finance emanates from the track and equipment heads, particularly because railways, as a transportation service, have a distinct spatial distribution within

Table 5.2a: IR Expenditure against Capital Allocations under the Indian Five-Year Plans

[in Rs.crore]

Expenditure Head	1st FYP 1951-56	2nd FYP 1956-61	3rd FYP 1961-66	Interregnum 1966-69	4th FYP 1969-74	5th FYP 1974-78	Rolling Plan 1978-80	6th FYP 1980-85	7th FYP 1985-90
Route Expansion	33.35	77.83	211.95	56.21	66.58	76.96	75.72	324.31	915.52
Track & Network Renewals	68.03	186.28	243.15	104.77	184.67	178.54	148.65	1202.82	3832.97
Line Doubling	-	-	-	-	-	-	53.91	285.40	823.43
Gauge Conversion	-	-	-	-	-	-	64.58	308.70	271.98
Electrification Projects	-	52.89	80.71	36.14	70.04	78.81	41.41	422.61	961.13
Total Route & Track	**101.38**	**317.00**	**535.81**	**197.12**	**321.29**	**334.31**	**384.27**	**2543.84**	**6805.03**
Terminal & Handling Facilities	68.10	190.89	358.26	160.59	285.85	282.61	84.25	329.86	1272.32
Workshop & Maintenance	14.06	76.37	90.38	42.02	69.03	100.85	79.15	683.06	1586.94
Total Maintenance & Handling	**82.16**	**267.26**	**448.64**	**202.61**	**354.88**	**383.46**	**163.40**	**1012.92**	**2859.26**
Rolling-Stock & Inventories	**228.02**	**401.27**	**622.75**	**335.02**	**674.75**	**685.61**	**584.45**	**2527.63**	**3328.25**
Staff & Passenger Amenities	**13.24**	**63.89**	**75.66**	**37.02**	**66.19**	**54.91**	**45.51**	**127.70**	**312.27**
Investment in Roadways	-	5.34	7.65	4.71	13.16	32.49	37.10	84.88	-
Investment in Railway PSUs	-	-	-	-	-	0.20	0.20	3.00	251.46
Total Investments	-	**5.34**	**7.65**	**4.71**	**13.16**	**32.69**	**37.30**	**87.88**	**251.46**
Total	424.80	1054.76	1690.51	776.48	1430.27	1493.78	1214.93	6299.97	13556.27
Other Credits	-	-10.93	-4.66	-13.77	-10.61	-1.85	-	-	-
TOTAL + CREDITS	**424.80**	**1043.83**	**1685.85**	**762.71**	**1419.66**	**1491.93**	**1214.93**	**6299.97**	**13556.27**
Metro Transport Projects	-	-	-	-	8.66	33.29	36.89	285.48	-
Bonds	-	-	-	-	-	-	-	-	-
TOTAL PLAN OUTLAY	**424.80**	**1043.83**	**1685.85**	**762.71**	**1428.32**	**1525.22**	**1251.82**	**6585.45**	**13556.27**
IRFC Investment in Rolling Stock									

(b) ***Percentage to Total Plan Outlay***

Expenditure Head	1st FYP 1951-56	2nd FYP 1956-61	3rd FYP 1961-66	Interregnum 1966-69	4th FYP 1969-74	5th FYP 1974-78	Rolling Plan 1978-80	6th FYP 1980-85	7th FYP 1985-90
Route Expansion	*7.85*	*7.46*	*12.57*	*7.37*	*4.66*	*5.05*	*6.05*	*4.92*	*6.75*
Track & Network Renewals	*16.01*	*17.85*	*14.42*	*13.74*	*12.93*	*11.71*	*11.87*	*18.26*	*28.27*
Line Doubling	-	-	-	-	-	-	*4.31*	*4.33*	*6.07*
Gauge Conversion	-	-	-	-	-	-	*5.16*	*4.69*	*2.01*
Electrification Projects	-	*5.07*	*4.79*	*4.74*	*4.90*	*5.17*	*3.31*	*6.42*	*7.09*
Total Route & Track	***23.87***	***30.37***	***31.78***	***25.84***	***22.49***	***21.92***	***30.70***	***38.63***	***50.20***
Terminal & Handling Facilities	*16.03*	*18.29*	*21.25*	*21.06*	*20.01*	*18.53*	*6.73*	*5.01*	*9.39*
Workshop & Maintenance	*3.31*	*7.32*	*5.36*	*5.51*	*4.83*	*6.61*	*6.32*	*10.37*	*11.71*
Total Maintenance & Handling	***19.34***	***25.60***	***26.61***	***26.56***	***24.85***	***25.14***	***13.05***	***15.38***	***21.09***
Rolling-Stock & Inventories	***53.68***	***38.44***	***36.94***	***43.92***	***47.24***	***44.95***	***46.69***	***38.38***	***24.55***
Staff & Passenger Amenities	***3.12***	***6.12***	***4.49***	***4.85***	***4.63***	***3.60***	***3.64***	***1.94***	***2.30***
Investment in Roadways	-	*0.51*	*0.45*	*0.62*	*0.92*	*2.13*	*2.96*	*1.29*	-
Investment in Railway PSUs	-	-	-	-	-	*0.01*	*0.02*	*0.05*	*1.85*
Total Investments	-	***0.51***	***0.45***	***0.62***	***0.92***	***2.14***	***2.98***	***1.33***	***1.85***
Total	*100.00*	*101.05*	*100.28*	*101.81*	*100.14*	*97.94*	*97.05*	*95.66*	*100.00*
Other Credits	-	*-1.05*	*-0.28*	*-1.81*	*-0.74*	*-0.12*	-	-	-
TOTAL+ CREDITS	***100.00***	***100.00***	***100.00***	***100.00***	***99.39***	***97.82***	***97.05***	***95.66***	***100.00***
Metro Transport Projects	-	-	-	-	*0.61*	*2.18*	*2.95*	*4.34*	-
Bonds	-	-	-	-	-	-	-	-	-
TOTAL PLAN OUTLAY	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***
IRFC Investment in IR Rolling Stock	-	-	-	-	-	-	-	-	-

Source: Adapted from *RFFC [1993]: Railway Fare & Freight Committee Report,* 1(3):71-72, Annexure 3R

Table 5.3a: Annual Allocations to Railway Plan Expenditure (1985-1994)

[in Rs.crore]

Expenditure Head	1985-86	1986-87	1987-88	1988-89	1989-90	Interregnum 1990-91	8th Plan 1991-92	1992-93RE	1993-94BE
Route Expansion	77.99	127.56	187.72	254.04	268.21	289.25	267.10	238.98	200
Track & Network Renewals	548.74	629.12	834.57	870.35	950.19	970.80	1163.59	1083.42	1090
Line Doubling	74.61	99.01	170.36	219.37	260.08	274.30	283.38	170.10	220
Gauge Conversion	31.26	43.91	53.01	57.18	86.62	86.40	27.39	541.44	810
Electrification Projects	167.19	177.19	196.05	184.84	235.86	233.27	230.75	235.00	280
Total Route & Track	**899.79**	**1076.79**	**1441.71**	**1585.78**	**1800.96**	**1854.02**	**1972.21**	**2268.94**	**2600**
Terminal & Handling Facilities	121.36	201.61	283.95	317.32	348.08	337.83	332.33	281.90	325
Workshop & Maintenance	164.88	244.24	316.05	402.45	459.32	377.86	295.32	420.01	445
Total Maintenance & Handling	**286.24**	**445.85**	**600.00**	**719.77**	**807.40**	**715.69**	**627.65**	**701.91**	**770**
Rolling Stock & Inventories	**635.53**	**988.59**	**436.17**	**589.84**	**678.12**	**855.68**	**820.02**	**1454.88**	**1940**
Staff & Passenger Amenities	**33.48**	**51.47**	**70.94**	**69.16**	**87.22**	**80.60**	**85.59**	**100.10**	**120**
Investment in Roadways	-	-	-	-	-	-	-	-	-
Investment in Railway PSUs	1.47	50.00	50.15	64.84	85.00	80.33	115.00	52.00	-
Total Investments	**1.47**	**50.00**	**50.15**	**64.84**	**85.00**	**80.33**	**115.00**	**52.00**	-
Total	1856.51	2612.70	2598.97	3029.39	3458.70	3586.32	3620.47	4577.83	5430
Other Credits	-	-	-	-	-	-	-	-	-
TOTAL + CREDITS	**1856.51**	**2612.70**	**2598.97**	**3029.39**	**3458.70**	**3586.32**	**3620.47**	**4577.83**	**5430**
Metro Transport Projects	85.07	84.36	99.90	99.97	103.54	135.46	169.49	170.00	170
Bonds	-	-	720.00	800.00	1000.00	1092.14	1503.31	962.17	900
TOTAL PLAN OUTLAY	**1941.58**	**2697.06**	**3418.87**	**3929.36**	**4562.24**	**4813.92**	**5293.27**	**5710.00**	**6500**
IRFC Investment in IR Rolling Stock	-	-	43.98	61.66	85.36	-	-	-	-

(b) *Percentage to Total Plan Outlay*

Expenditure Head	1985-86	1986-87	1987-88	1988-89	1989-90	*Interregnum* 1990-91	*8th Plan* 1991-92	1992-93RE	1993-94BE
Route Expansion	*4.02*	*4.73*	*5.49*	*6.47*	*5.88*	*6.01*	*5.05*	*4.19*	*3.08*
Track & Network Renewals	*28.26*	*23.33*	*24.41*	*22.15*	*20.83*	*20.17*	*21.98*	*18.97*	*16.77*
Doubling	*3.84*	*3.67*	*4.98*	*5.58*	*5.70*	*5.70*	*5.35*	*2.98*	*3.38*
Gauge Conversion	*1.61*	*1.63*	*1.55*	*1.46*	*1.90*	*1.79*	*0.52*	*9.48*	*12.46*
Electrification Projects	*8.61*	*6.57*	*5.73*	*4.70*	*5.17*	*4.85*	*4.36*	*4.12*	*4.31*
Total Route & Track	***46.34***	***39.92***	***42.17***	***40.36***	***39.48***	***38.51***	***37.26***	***39.74***	***40.00***
Terminal & Handling Facilities	*6.25*	*7.48*	*8.31*	*8.08*	*7.63*	*7.02*	*6.28*	*4.94*	*5.00*
Workshop & Maintenance	*8.49*	*9.06*	*9.24*	*10.24*	*10.07*	*7.85*	*5.58*	*7.36*	*6.85*
Total Maintenance & Handling	***14.74***	***16.53***	***17.55***	***18.32***	***17.70***	***14.87***	***11.86***	***12.29***	***11.85***
Rolling Stock & Inventories	***32.73***	***36.65***	***12.76***	***15.01***	***14.86***	***17.78***	***15.49***	***25.48***	***29.85***
Staff & Passenger Amenities	***1.72***	***1.91***	***2.07***	***1.76***	***1.91***	***1.67***	***1.62***	***1.75***	***1.85***
Investment in Roadways	-	-	-	-	-	-	-	-	-
Investment in Railway PSUs	*0.08*	*1.85*	*1.47*	*1.65*	*1.86*	*1.67*	*2.17*	*0.91*	-
Total Investments	***0.08***	***1.85***	***1.47***	***1.65***	***1.86***	***1.67***	***2.17***	***0.91***	-
Total	*95.62*	*96.87*	*76.02*	*77.10*	*75.81*	*74.50*	*68.40*	*80.17*	*83.54*
Other Credits									
TOTAL + CREDITS	***95.62***	***96.87***	***76.02***	***77.10***	***75.81***	***74.50***	***68.40***	***80.17***	***83.54***
Metro Transport Projects	*4.38*	*3.13*	*2.92*	*2.54*	*2.27*	*2.81*	*3.20*	*2.98*	*2.62*
Bonds	-	-	*21.06*	*20.36*	*21.92*	*22.69*	*28.40*	*16.85*	*13.85*
TOTAL PLAN OUTLAY	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***
IRFC Investment in IR Rolling Stock	-	-	*1.29*	*1.57*	*1.87*	-	-	-	-

Source: Adapted from *RFFC [1993]: Railway Fare & Freight Committee Report,* 1(3):71-72, Annexure 3R their capital needs. Curbs on funding therefore drastically affect transportation capacity on railway networks and thus their levels of operational efficiency. This is in fact a marked peculiarity of railways as opposed to other means of transportation, since both the transport vehicle as well as the path on which it is propelled place heavy capital demands on the same outlay - the essential argument for locating railways in the public sector. While the means to capital adequacy are, obviously, profitable operations in the long-run, questions of *sunk capital*, etc., complicate the picture and impart a lumpiness to railway investment. Although growing trends in IR plan outlays attest to the importance of railway transportation in India, a study of the long-term behaviour of investment magnitudes defines critical capital determinants of freight capacity.

As seen in the tables, outlays on route & track and rolling stock & inventories have always constituted the bulk of railway capital investment, ranging at levels between 65-70 percent of total railway plan outlays throughout the planning period. The ratio between the two has however fluctuated, with increases in the proportion of the former in the late 1970s and after being a reflection of transport policy changes that favoured line doubling and gauge conversion as a means of focusing IR freight operations towards bulk traffic on the BG network. A natural consequence of the shift in stress within an overall situation of capital shortage has been reduced rolling stock acquisitions during FYPs where route & track expenditure has been particularly high. Another point clearly relating to this is the build-up of alternating backlogs in either track or rolling stock renewal-related expenditure because of plan focus on the other head, which necessitates refocusing of the plan-stress after some interval of time. Quite evidently, such alternating behaviour relates to the materialisation of traffic bottlenecks either because existing rolling stock inventories are inadequate to service the railway route network, or because track inadequacies reduce the efficiency of utilisation of existing rolling stock. As would be anticipated, such bottlenecks emerge through the 1960s and 1970s, with spillover effects in the subsequent plans.

The true extent of such backlogs is in fact understated by the extent of plan allocations after the 1970s because of the policy decision to phase out MG operations on IR, substantially reducing the backlog investments to be made in one fell swoop as it were. However, if consideration is given to the fact that IR's BG routes and stocks would as a consequence of this have to supplant MG operations, the apparent increases in quantum and proportion of plan outlays on these heads during and after the 6FYP would appear quite inadequate and would point to truncation of traffic as a consequence rather than as a cause of insufficient capitalisation. This is borne out also in the pattern of subsectoral allocations made towards route technology involving line doubling, gauge conversion and electrification since the same period. While each of these increases potential utilisation of the BG network, the associated allocations would appear to have been on the low side considering that BG freight would eventually have to make up for route and traffic losses on the MG network. It has been critically noted elsewhere that the UNIGAUGE policy has remained a perennial 'caprice' of the Railway Ministry,[43] with periodic rise in allocations towards it telling ultimately as a 'throwforward' on other railway development programmes - most seriously on electrification targets, double-tracking and the construction of new lines.[44] A conceptual problem also relates to the traffic effect of such policy changes. While electrification and double-tracking involve very little gestation lag in raising traffic-handling capacity on busy trunk lines, the alternative of gauge conversion or the building of new lines may cause a hiatus before adequate traffic materialises. Gauge conversion in itself cannot increase railway traffic, particularly if requisite downstream investments on the raw material and industrial base of the economy have not been simultaneously planned.[45] Under present prescriptions, construction of new lines now has to have yield-adequacy of a recommended 12 percent returns on capital invested, which at current tariff rates against costs of rolling stock acquisition and IR operating ratios, can only be sustained by a few areas in the country such as those rich in minerals.[46] From such perspectives, policy shifts of this nature from fleet consolidation to upgradation of line capacity impose both immediate direct costs and opportunity costs on IR.

It is most noteworthy of the period after the 6FYP that physical allocations under the two major capital heads have been raised substantially, indicating realisation on the part of the planners that IR transportation capacity had been placed under tremendous inventory and technology squeezes in the prior period. The serial increase of these allocations from levels of around Rs.1000 crore in the 4FYP and 5FYP to Rs.5071.47 crore (6FYP) and Rs.10133.28 crore (7FYP) - the magnitude in real terms being sufficient to outweigh inflation - is both an indicator of the new resolve to wipe out the backlog, at least on BG, and to allow massive infusion of new railway technology while doing so. Not as much emphasis appears to have been placed however after the early plans on increasing physical and spatial capacity of the IR network, so that the proportion of outlays on route expansion and maintenance & handling do not again touch the high levels recorded during the 3FYP when the thrust had been on building capacity ahead of demand. The larger size of annual railway plans during and after the 7FYP period would nonetheless attest to physical growth of railway capital stock, albeit increasingly through exercise of the more expensive option of market borrowing (bond finance and leasing) which have imposed heavy interest and repayment obligations on subsequent IR revenues. As such, the proportion of capital funds sourced from general and internal revenues never substantially cross four-fifths of the total plan requirements in the later period and have tended to decline in more recent years.

Metropolitan railway transportation, even after being separated from IR zonal suburban operations, is also funded out of the Railway Plan appropriation. Since the lines, routes and inventories on this account are committed and unavailable for other use, plan investments on metro projects do not add to general freight or passenger-handling capacity on IR. The growing involvement of IR - directly or indirectly- in suburban and inner-city passenger operations, coupled with the substantial operating losses incurred against hidden subsidies on them, thus imposes a drain on IR capital realisations, leading to a call in recent years for delinking of IR's inter-city operations from suburban transport so that more realistic pricing policies can be adopted.[47]

Overall, the tables show the extent and phases of emergence of the resource crunch which has affected railway planning in India. It will be noticed that the traffic trends commented upon in Chapter 3 follow the patterns of IR plan investment, especially after the 3FYP, with the 'plateau' phase of IR operations being closely coincident with the investment slowdown between 1965 and 1980 during which a massive backlog of rolling stock and track replacement gradually built up. Although the position appears to have eased somewhat since the 6FYP, it is to be noted that the pickup in investment is associated with a planning shift towards bulk freight and the BG network. As a result a substantial portion of the then existing MG capacity has had to be written off since. The change in policy has however also induced a change in traffic handled by IR because the BG routes that now carry the bulk of traffic are spatially separated from the MG feeder region and are moreover not equipped with equivalent rolling stock and wagons.

As to the reasons for the resource crunch, several causes might be ascribed, primary among which is the high cost of technology induction on the BG network. However, larger issues are also at play here. While the 1FYP, for instance, was largely an infrastructural plan and thus allowed the transportation sector to claim the highest percentage share of investments made, the subsequent direction of economic policy in India made direct participation of the state in economic activity its primary plank. With proliferation of public sector units, plan support to transportation infrastructure dwindled accordingly, partly also because of the inability of IR to raise its revenues and its internal generation of resources. Therefore the reliance on market borrowing in the later plans represents both a realisation of the extent to which development of IR has been circumscribed by the resource crunch, and an admission that substantial state funding is not likely to be forthcoming within the foreseeable future. The option for IR in these circumstances was either to raise internal surpluses or to avail of capital credit. From a longer perspective, these alternatives were really no alternative at all. Whether raised directly (through internal investment) or indirectly (through bond finance), the higher rates of railway investment in the 1980s and the 1990s eventually had to be financed through commitments from IR revenues and increased tariffs, without collateral gains in traffic and reduction in costs. Loan capital therefore appears to be an extremely short-term means of viably raising capital funding for the IR. Since the observations just made are of compelling importance in judging the present predicament and financial future of IR, it will be useful to probe them further.

5.2.2 Capital Financing Modes

Tables 5.4*(a)* & *(b)* examine financing aspects of railway plans between 1FYP and 8FYP. It is seen very clearly that IR mobilisation from internal revenues stood at a credible 66 percent of the Railway Plan during the 1FYP period, although in absence of any pronounced technological takeoff, IR capital requirements during the plan period were low at Rs.422 crore. Integrated transportation planning in India began in earnest from the 2FYP, during which internal sourcing of capital resources dwindled immediately to 45 percent of the railway plan despite increasing substantially in absolute terms from Rs.280 crore to Rs.467 crore. The balance of funding required was provided by government from the general budget and rose further to 68 percent in the 3FYP. Thereafter, however, capital support from general revenue did not show much absolute progress until the 6FYP, while its apparently high proportionate share was attributable to extremely low internal resource generation of well below 30 percent during the 1970s rather than to any remarkable change in government policy. A reversion to high-growth governmental funding only occurred in the 1980s with the commencement of the 6FYP, as a matching outlay to increased internal mobilisation by IR. Midway through the 7FYP, after it became difficult for government to finance the large capital outlays made by the Plan to IR, recourse was made for the first time after Independence to market borrowing, which hovered below or just around Rs.1000 crore p.a. in the three closing years of the Plan. After another plan-holiday between 1990-92, the 8FYP began with a substantial increase in the annual plan outlay, partially met through increased budgetary support. The 8FYP period is of special interest because of the launching of economic reforms in India, accompanied by the downscaling of government tax mobilisation and opening up of several avenues for investment by the private sector. Bond finance since 1987-88 had been raised for IR by the IRFC. Through most of the 8FYP years however, the quantum of bond finance remained low and shrank appreciably from 7FYP proportions. With budgetary support also having been diluted, the brunt of the capital financing effort fell on IR's internal resources which were accordingly raised through the mechanism of upward tariff revision, supported by direct capital leasing through the OYW scheme commencing from 1994-95 to supplement market borrowing, and the BOLT scheme for capital projects commencing from 1996-97. While the two schemes represent financial innovation on the part of IR, the gross capital mobilised by them over the 8FYP was just Rs.596 crore or just 1.8 percent of the total plan outlay - considerably lower than had been anticipated.

Table 5.4: Budgetary Support to IR Capital Expenditure

PLAN	Internal IR Mobilisation *[Rs.crore]*	%	Bond Finance *[Rs.crore]*	%	Total Internal & Extra-Budgetary Mobilisation *[Rs.crore]*	%	Government Budgetary Support *[Rs.crore]*	%	Total IR Capital Finance *[Rs.crore]*
1st FYP	280	*66*	-	-	280	*66*	142	*34*	422
2nd FYP	467	*45*	-	-	467	*45*	576	*55*	1043
3rd FYP	545	*32*	-	-	545	*32*	1140	*68*	1685
1968-69	320	*42*	-	-	320	*42*	442	*58*	762
4th FYP	397	*28*	-	-	397	*28*	1031	*72*	1428
5th FYP	384	*25*	-	-	384	*25*	1141	*75*	1525
1978-80	316	*25*	-	-	316	*25*	935	*75*	1251
6th FYP	2783	*42*	-	-	2783	*42*	3802	*58*	6585
7th FYP	7089	*43*	2520	*15*	9609	*58*	6940	*42*	16549
1990-92	4225	*41*	2595	*26*	6820	*67*	3388	*33*	10208
8th FYP	18830	*58*	6161	*17*	24991	*77*	7311	*23*	32268
					(b) Annual Plan Outlays during & after the 7th Plan				
1985-86	1065	*55*	-	-	1065	*55*	877	*45*	1942
1986-87	1318	*49*	-	-	1318	*49*	1379	*51*	2697
1987-88	1331	*39*	720	*21*	2051	*60*	1368	*40*	3419
1988-89	1586	*41*	800	*20*	2386	*61*	1543	*39*	3929
1989-90	1789	*39*	1000	*22*	2789	*61*	1773	*39*	4562
1990-91	2091	*43*	1092	*23*	3183	*66*	1632	*34*	4815
1991-92	2134	*40*	1503	*27*	3637	*67*	1756	*33*	5393
1992-93	2548	*41*	1025	*17*	3573	*58*	2589	*42*	6162
1993-94	4030	*69*	856	*15*	4886	*83*	974	*17*	5860
1994-95	3582	*65*	779	*14*	4361	*80*	1145	*21*	5472
1995-96	4208	*65*	1118	*15*	5326	82	1138	*18*	6464
1996-97	4462	50	2383	*24*	6845	82	1465	18	8310

Source: Compiled from GOI [1998]: *Status Paper on Indian Railways*, Ministry of Railways, Government of India, New Delhi, pp7-8

As noted earlier, tariff setting is by far the most controversial area in railway literature because of its bearing on the nature of railway monopoly and railway pricing. This position originates both from social utility considerations and from the standard infrastructural pricing principles of 'second-best' pricing, or pricing according to 'what the market can bear'. Thus the mechanism of tariff revision which has increasingly been adopted by IR as an almost desperate means of circumventing the capital crunch has to be explored in this light. Summary investigation of the recent fallouts of tariff revision on IR is therefore in order.

Table 5.5 below examines the crossrelation between IR traffic and revenue trends between 1979-92. Average tariff rates realised per tonne-km traffic, which can be computed as a simple quotient of trend values for any given year, have increased more than three-fold over the period from 09.6 paise in 1979-80 to 37.1 paise in 1991-92 against a less than two-fold traffic increment, showing that a considerable proportion of IR's improved revenue performance through the 1980s and 1990s originates from tariff increases. Since the traffic increment per year can also be easily computed, the incremental revenue earned each year can be split up into traffic-related and tariff-related components.

Gross as well as break-up trends in incremental revenue generally show sharp increase through most of the period considered. Provided that such increases are attributable to operational improvement (attraction of more traffic by IR), they would be considered creditable. If on the other hand, they more or less emanate from frequent hikes in railway tariff rates and are moreover unaccompanied by parallel effort towards reducing railway costs, they would tend in the long run to be offset by traffic losses on the overrated freight segment and hence would be subject to diminishing returns. That IR has had to resort so frequently to monopoly pricing of its freight services is the result of budgetary pressure on it to increase internal resource mobilisation to fund its own capital outlays. But the high proportions assumed by tariff-related incremental revenues through most of the 1980s and 1990s becomes sufficient cause for concern. Conversely, the ostensibly healthy revenue trends over the period are not backed by the order of traffic gains which would have rendered them stable. The adverse fallout of severe tariff hikes in the year 1982-83 and between 1985-88 becomes immediately apparent. On the first occasion, traffic increment fell from a buoyant 16.60 billion net tonne-km in the preceding year to just 3.53 billion net tonne-km and remained depressed until 1985-86, when the 7FYP commenced. The sharp hike in IR capital outlays made over that FYP was however being increasingly financed from tariff-related internal revenue generation, leading to a severe traffic slump in the mid-plan years. It is also noticed from the table that improvements in traffic realisation have only occured over years when average tariffs remained relatively stable, pointing out the negative portents of unpredictable pricing behaviour. While it had been noted elsewhere in this chapter that IR tariff-setting is strictly the preserve of specifically-empowered tariff committees rather than of the annual Railway Budget exercises, increasing departure is being made from this practice over recent years. The reasons for this course of events are self-evident, and contribute significantly both to losses of general traffic and increasing proportions of bulk traffic on IR. Tariff volatility and capital shortages together have reduced the ability of IR to attract high-rated traffic which has consequently switched over to the roadways. At the other end of the commodity spectrum, tariff hikes and pressures for revenue mobilisation have steeply increased transportation costs for higher-rated bulk traffic such as iron & steel and POL which cannot shift over to other transportation modes, the spillover of such increases leading to cascading costs throughout the economy.

Table 5.5 : Traffic & Tariff Origins of Incremental IR Revenues

Year	Total Traffic *million NTKm*	Traffic Increment	Tariff-rate Realised *Paise/TKm*	Freight Earnings *Rs.crore*	Freight Increment *Rs.crore*	Revenue Increment from: Δ Traffic Earnings *Rs.crore*	Revenue Increment from: Δ Tariff Earnings *Rs.crore*	*% Traffic-related Increase*	*% Tariff-related Increase*	*Traffic* ELASTICITY OF EARNINGS	*Tariff* ELASTICITY OF EARNINGS
1979-80	144559	-	9.6	1394.1	-	-	-	-	-	-	-
1980-81	147652	3093	10.5	1550.9	156.8	29.8	127.0	*19.02*	*80.98*	***5.26***	***1.26***
1981-82	164253	16601	13.7	2250.3	699.4	174.4	525.0	*24.93*	*75.07*	***4.01***	***1.48***
1982-83	167781	3528	17.1	2865.9	615.6	48.3	567.3	*7.85*	*92.15*	***12.74***	***1.11***
1983-84	168849	1068	19.2	3234.3	368.4	18.2	350.2	*4.95*	*95.05*	***20.19***	***1.06***
1984-85	172632	3783	20.1	3465.0	230.7	72.5	158.2	*31.41*	*68.59*	***3.18***	***1.49***
1985-86	196600	23968	21.5	4232.2	767.2	481.1	286.1	*62.71*	*37.29*	***1.59***	***3.05***
1986-87	214096	17496	23.3	4990.7	758.5	376.6	381.9	*49.66*	*50.34*	***2.01***	***2.16***
1987-88	222528	8432	26.2	5839.2	848.5	196.6	651.9	*23.16*	*76.84*	***4.32***	***1.35***
1988-89	222374	-154	27.9	6196.7	357.5	-4.0	361.5	*-1.13*	*101.13*	***-88.47***	***0.99***
1989-90	229602	7228	32.5	7460.8	1264.1	201.4	1062.7	*15.93*	*84.07*	***6.28***	***1.23***
1990-91	235785	6183	35.0	8247	786.2	200.9	585.3	*25.56*	*74.44*	***3.91***	***1.38***
1991-92	250238	14453	37.1	9293.1	1046.1	505.5	540.6	*48.32*	*51.68*	***2.07***	***2.05***

Source: RFFC [1993]: Railway Fare & Freight Committee Report, 1(10):240, Annexure 10A, with additional computations

Although the proclivity to raise IR revenues through tariff rather than traffic means is witnessed throughout the 1980s and after, the computed traffic and tariff elasticities of IR revenues in the table show that much larger revenue increments can be drawn against traffic increases rather than tariff increases, with decrements in traffic also causing a sharp downward revenue swing as in 1988-89. Although in the table, composition of IR freight for the given years remains transparent, variability patterns in the elasticity coefficients provide some indication of the compositional change, with variability being observably higher in case of the traffic-elasticity coefficients. Since it is the traffic (*i.e.* net tonne-km) variable that is being considered within these, sharp traffic increases may reflect both rising tonnages and/or rising traffic leads, depending on whether the traffic increment is in the bulk or non-bulk freight segment. The crossrelationship between traffic increments and traffic-elasticities in the table would suggest that high elasticity coefficients occur over years where there has been pickup in the higher-rated non-bulk traffic. Conversely, traffic-elasticity of revenues is lower in years where the traffic increment has been fairly substantial, implying that incremental traffic in those years has been drawn both from longer leads as well as higher bulk-traffic loading.

Overall, the elasticity analysis indicates tariff increase as a principal cause for shifting freight composition on IR. Two other observations might also be noted. Firstly, tariff hikes during annual railway budgets appear to have frequently been made to compensate IR for traffic shortfalls incurred in the preceding year through shiftovers of non-bulk freight and lowered loadings of bulk freight, implying an extremely short-term pricing strategy. Secondly, because of the lag between movements of bulk raw materials and downstream production in the economy, tariff increases have tended to impact on the economy during periods when production of non-bulk commodities has been on the rise, leaving IR little scope to augment revenues through higher traffic realisation from this segment, despite the higher traffic-elasticities associated with such years. IR tariff policy over the period thus appears to be killing the proverbial goose with the golden eggs, while overtly appearing to aid IR's resource mobilisation effort.

5.3 The Capacity Determinants

The preceding discussion establishes that the transportation crisis in India owes its genesis to slowdown of plan investment in IR during the mid-1960s and 1970s, and subsequent cuts in the extent of state support to the railway plans even after investment picked up again from the 1980s. While sluggishness in railway development has been compensated in part by development of roadways, it had been shown earlier that road and rail transportation services are not pure substitutes for each other. Major differences between the two result from differences in optimum leads and loads and differences in breakeven points. Thus, despite the integrated statement of policy made in the NTPC Report which has sought to restore intermodal complementarity to transportation in India by restricting the operational role of IR to bulk haulage of BG freight, several potential areas for intermodal skirmishing are created by the high costs and high tariffs that attach to railway transportation, progressively rendering it uncompetitive in the transportation of high-rated low-bulk freight that had been the primary source of IR operating profits in the past.

Table 5.6: Transportation Sector Outlays over the Five-Year Plans

[brackets % shares]

Plan Period	Duration	Outlay on Railways *(Rs.crore)*	Total Transport Outlay *(Rs.crore)*	Total Plan Outlay *(Rs.crore)*	***Ratio of Rail: Non-Rail Transport Outlay***
1st FYP	1951-56	217 *(11.1)*	434 *(22.1)*	1960	*1.00*
2nd FYP	1956-61	723 *(15.5)*	1100 *(23.5)*	4672	*1.92*
3rd FYP	1961-66	1326 *(15.5)*	1983 *(23.1)*	8577	*2.02*
4th FYP	1969-74	934 *(5.9)*	2522 *(16.0)*	15779	*0.59*
5th FYP	1974-78	1523 *(6.0)*	4078 *(14.1)*	28991*	*0.74*
6th FYP	1980-85	6585 *(5.2)*	12412 *(12.7)*	97500*	*0.70*
7th FYP	1985-90	16715 *(6.9)*	22971 *(12.8)*	180000*	*1.18*
8th FYP	1992-97	27202 *(6.3)*	53966 *(12.4)*	434100	*1.02*

**including DRF component*

Source: Adapted from *IRYB*, various years, Directorate of Statistics & Economics, Railway Board, Ministry of Railways, Government of India, New Delhi, and FYP documents

Transportation bottlenecks became evident in the country during the industrial recession that occurred while the 3FYP was nearing a close, and have at least in part been linked to the subsequent slowdown in the economy and deceleration in industrial development. Evidence in the literature on the industrial economy substantiates the lack of headway between 1965-66 and 1975-76, as an aberration from the high-growth period between 1950-51 and 1964-65, and the rising-growth period after 1975. Averaged trend rates of growth of production for three industrial sectors, namely mining & quarrying, manufacturing and electricity, are observed to have declined from 6.7 percent p.a. between 1951-65 to 4.7 percent p.a. between 1966-85.[48] The worst-affected period, in terms of non-fulfilment of targeted rates of growth, was the 4FYP which has consequently been described as both the most overtargeted and most underachieved plan.[49] Various causes have been ascribed for the long and drawn-out recession which began in 1965-66. Prominent observers show some concurrence in their identification of causal factors like slowed rates of public investment and infrastructural constraints; disproportionate development of capital-goods industries relative to consumer-goods industries; inherent inefficiency in Indian industry as shown by low use of capacity, high prices, poor quality of output, and technological backwardness; and slowdown in import substitution and indifferent foreign trade policy in India, as having contributed to the recession.[50] Infrastructural bottlenecks arising from underinvestment have however been accorded highest significance in explanations of the industrial recession between the 1965-76, since infrastructure-sectors like railways and power disproportionately bore the brunt of the slowdown in net public investment - the share of infrastructure (railways, electricity, mining, etc.) in total public investment declining from 36 percent in the early 1960s to 29 percent over the recessionary decade.[51] Table 5.6 summarises manifestations of the infrastructural slowdown over the plans in terms of outlays made to the transportation sector.

Indication of declining infrastructural priority accorded by Indian planners to railway transportation is also evident from continuous decline in the IR share of total plan-outlays following the prominent infrastructural thrust of the 2FYP. The lowest IR share of barely 5.9 percent coincides with the 4FYP, during which marked shift of priorities towards the roadways was also indicated. Other evidence also suggests that actual IR capital expenditure has fallen far short of targeted outlays in real terms through almost every FYP, resulting in the carrying-forward of projects. This recurrent problem has surfaced partly because later Indian FYPs have lacked the planning foresight to anticipate that initial increases in *per capita* income arising from transport expansion require further augmentation of infrastructural facilities over time for economic development to be sustained into the long term. In the present case, the fallouts of poorly-sustained Indian infrastructure are felt by all economic sectors in the country. Insufficiency in railway wagonfleet numbers to cater to the rising demand for freight services, along with the generally low priority given to the creation of advance transportation capacity leaves an onus on freight demand to adjust itself to freight supply over the long term, through alarming curtailments of traffic.

5.3.1 The Roots of Freight Capacity Inadequacy

The foregoing discussion has already investigated the infrastructural linkages of the persistent economic slowdown experienced by India between 1965-76, which relate particularly to the transportation of freight. It is thus hypothesised that the industrial recession was at least partly the result of inability on the part of the transportation system in the country to provide swift, efficient and cost-effective transit to industrial inputs and manufactures on the required scale, and that shortages in freight-carrying capacity during the period resulted from planning pessimism in providing capital support to IR, leading eventually to relative unresponsiveness of freight capacity to trends in industrial and aggregate economic indicators such as GDP. It may be noted in passing that while the basic quantitative dimensions of demand for railway freight services are the freight tonnages to be carried and the total distances to be covered, user-demand for railway freight services is manifested as the wagon requirement for delivering particular shipments of goods to predefined destinations within a specified period of time. Fulfilment of user-demands depends on IR's ability to provide railway wagons to meet the stated delivery schedule. Since capitalisation needs for providing wagons in adequate numbers generally draw support from transportation-sector appropriations in the FYPs, the Plans as such present both a quinquennial review of transportation needs in the economy as well as a five-year timeframe for their fulfilment.

A useful study can thus be made of various railway transport indicators in this five-year setting, with the objective of tracing relationships which emerged during the recessionary period and later precipitated major freight policy redirection on IR during the 1980s. As just noted, the most important change in the transport policy frame was wrought by the NTPC Report, which recommended among other things, that IR reorient itself towards the carriage of BG bulk consignments over long leads and decided the induction of specialised wagons and upgraded technology accordingly. However, with hindsight, it may also be observed that the NTPC projections of traffic and freight-mix noted earlier were made on IR traffic trends through the plateau period, when a large proportion of low-bulk and general goods traffic shifted to the roadways for no better reason than IR's inability to provide wagons in sufficient number. It would seem pertinent therefore to retrace ground covered in the NTPC Report and make an econometric evaluation of the railway transportation situation over the recessionary period. Since it was this experience which moulded later intermodal freight policy in India, the exercise would also provide a review the appropriateness of policy changes, in view of later inflexibilities in IR freight capacity which have prevented the railways from meeting the freight targets projected by different expert committees.

5.3.2 Freight Capacity Modelling

Theoretically the railways, as an integral part of infrastructure, could counter unforeseen freight situations by building freight capacity ahead of demand. A change in tonne-km traffic would thus induce them to go in for either one-period capacity adjustment, *i.e. instantaneous adjustment*, or for capacity adjustment with a time-lag, *i.e. lagged adjustment.* Of the two processes, the latter would seem more applicable to IR, for two reasons. Firstly, IR investment decisions have largely depended on plan allocations made every five years. Hence an instantaneous adjustment that involves unforeseen investment cannot be made autonomously. Secondly, changes in freight traffic composition which entail subsequent modification in the railway wagonfleet can be brought about only after wagon-production lags have been accounted for.

Thus the investigative methodology adopted in this section seeks to establish the lagged capacity relationships that determine wagon output and IR wagonfleet in India, via an Almon polynomial distributed-lag model developed over the original database of the NTPC[1980] study, supplemented by other pertinent railway statistics for the period. The projections from this model are then tested against the future freight experience. Essentially, the relationships being modelled pertain to a restricted demand situation, with IR responses being determined primarily by the level of capital-appropriations for railway hardware, and the allocation of a certain component within these to acquisitions of freight stock. Since a lag structure of five years is suggested by the FYP context, analysis is made of distributed changes in the wagon stock resulting from changes in freight hauled. Prior to analysis of modelling results, the modelling procedure is briefly outlined below.

The Almon model[52] offers an alternative to the Koyck approach to the distributed lag model. Basing itself on Weierstrass' Theorem, the Almon procedure assumes that lag-coefficients b_i for a finite distributed lag can be approximated by a polynomial of suitable degree in 'i', the length of the lag. The lagged estimating equations in linear form for the Almon polynomial five-year lag model are:

$$\hat{Y}_t = \hat{\beta}_0 X_t + \hat{\beta}_1 X_{t-1} + \hat{\beta}_2 X_{t-2} + \hat{\beta}_3 X_{t-3} + \hat{\beta}_4 X_{t-4} \quad \dots \quad (5.1)$$

where the regressand Y_t is, alternatively, wagon output and wagonfleet, with X_{t-j} as the chosen regressor, *(j=0,1,2,3,4)*. The two alternative semi-log forms of the lagged estimating equations are:

$$\log \hat{Y}_t = \hat{\beta}_0 X_t + \hat{\beta}_1 X_{t-1} + \hat{\beta}_2 X_{t-2} + \hat{\beta}_3 X_{t-3} + \hat{\beta}_4 X_{t-4} \quad \dots \quad (5.2)$$

and

$$\hat{Y}_t = \hat{\beta}_0 \log X_t + \hat{\beta}_1 \log X_{t-1} + \hat{\beta}_2 \log X_{t-2} + \hat{\beta}_3 \log X_{t-3} + \hat{\beta}_4 \log X_{t-4} \quad \dots \quad (5.3)$$

with regressors and regressands as above.

Double-log forms were also experimented with, but it was found that nonlinearities in the data are best taken care of by either one of the semi-log fits, as applies to the regressand being considered. Thus in semi-log analysis, the dependent variable in the first 'log-lin' form *(equation 5.2)* is assumed to be lognormally distributed for an explanatory variable with linear specifications, and the converse is assumed for the second 'lin-log' form *(equation 5.3)*. Lognormal forms are found particularly useful for modelling skewed series with a long, almost asymptotic RHS tail. When applied for example to the regressand wagon output in the log-lin equation, the lognormally distributed output values imply that output log-values are normally distributed. Valid economic justification also exists for applying the lognormal form to lag analysis of wagon output. Since wagon outputs are necessarily positive and entail indivisible production costs, output fluctuations are more frequent at the lower end than at the high end. Hence wagon output series is positively skewed.

The Almon *Approximation Polynomial*, which follows from Weierstrass' Theorem, defines a system of lag-weights (here called the 'β-system') as linear combinations of polynomial coefficients α_i in the 'α-system', with *i* as the degree of the polynomial approximation. The weights of the 'β-system' can be written as:

$$\begin{aligned}
\hat{\beta}_0 &= f(0) = (\hat{\alpha}_0)\\
\hat{\beta}_1 &= f(1) = (\hat{\alpha}_0+\hat{\alpha}_1+\hat{\alpha}_2+\hat{\alpha}_3)\\
\hat{\beta}_2 &= f(2) = (\hat{\alpha}_0 + 2\hat{\alpha}_1+ 4\hat{\alpha}_2+ 8\hat{\alpha}_3)\\
\hat{\beta}_3 &= f(3) = (\hat{\alpha}_0 + 3\hat{\alpha}_1+ 9\hat{\alpha}_2+ 27\hat{\alpha}_3)\\
\hat{\beta}_4 &= f(4) = (\hat{\alpha}_0 + 4\hat{\alpha}_1+ 16\hat{\alpha}_2+ 64\hat{\alpha}_3)
\end{aligned} \qquad \text{....} \quad (5.4)$$

where

$$f(z) \approx \alpha_0+\alpha_1 z^1+\alpha_2 z^2+\alpha_3 z^3 \qquad \text{....} \quad (5.5)$$

is the assumed Approximation Polynomial of cubic degree required for a five-yearly distributed lag. Under the model assumption that the degree of the polynomial is less than the length of the maximum lag, four α's are thus generated that define the five required β-coefficients.

5.3.2*(i)* Model Estimation Procedures

OLS is applied to the transformed model where Y_t is regressed on the constructed variables 'W_i' and not on the original X variables, to estimate the form

$$Y_t = \alpha_0 W_0 + \alpha_1 W_1 + \alpha_2 W_2 + \alpha_3 W_3 + u_t \qquad \text{....} \quad (5.6)$$

The W's in the estimating equation above are linear combinations of lagged X's according to the scheme below:

$$\begin{aligned}
W_0 &= X_t + X_{t-1} + X_{t-2} + X_{t-3} + X_{t-4}\\
W_1 &= X_{t-1} + 2\,X_{t-2} + 3\,X_{t-3} + 4\,X_{t-4}\\
W_2 &= X_{t-1} + 4\,X_{t-2} + 9\,X_{t-3} + 16\,X_{t-4}\\
W_3 &= X_{t-1} + 8\,X_{t-2} + 27\,X_{t-3} + 64\,X_{t-4}
\end{aligned} \qquad \text{....} \quad (5.7)$$

After the W-transformation, the lagged function can be written as

$$\begin{aligned}
Y_t = {} & \alpha_0 X_1 + (\alpha_0 + \alpha_1 + \alpha_2 + \alpha_3)\,X_{t-1}\\
& + (\alpha_0 + 2\alpha_1 + 4\alpha_2 + 8\alpha_3)\,X_{t-2}\\
& + (\alpha_0 + 3\alpha_1 + 9\alpha_2 + 27\alpha_3)\,X_{t-3}\\
& + (\alpha_0 + 4\alpha_1 + 16\,\alpha_2 + 64\,\alpha_3)\,X_{t-4} + u_t
\end{aligned} \qquad \text{....} \quad (5.8)$$

Rewriting,

$$\begin{aligned}Y_t = {} & \alpha_0(X_t + X_{t-1} + X_{t-2} + X_{t-3} + X_{t-4}) \\ & +\alpha_1(X_{t-1} + 2X_{t-2} + 3X_{t-3} + 4X_{t-4}) \\ & +\alpha_2(X_{t-1} + 4X_{t-2} + 9X_{t-3} + 16X_{t-4}) \\ & +\alpha_3(X_{t-1} + 8X_{t-2} + 27X_{t-3} + 64X_{t-4}) + u_t\end{aligned}$$

or,

$$Y_t = \alpha_0 W_0 + \alpha_1 W_1 + \alpha_2 W_2 + \alpha_3 W_3 + u_t \qquad \text{....} \qquad (5.9)$$

which is the estimating equation after W-transformation.

Intercept suppression has necessarily to be made in estimating polynomial coefficients since the polynomial approximation is made on the assumption of proportionality, the implication being that we regress on the actual W-variables rather than their deviations. The estimates of α_i thus obtained have all the desirable statistical properties provided the stochastic disturbance term u satisfies the assumptions of the classical linear regression model. Once the α-coefficients have been estimated, the original lag-coefficients or β_i's can be estimated from the α-system mentioned earlier. Comparison of R^2 for linear and log-linear fit provides assessment of which variables are linearly related to the regressands wagon output and wagonfleet, and which are not. Computed t-values provide a necessary test of significance.

For α-coefficients, t-values are defined by the ratio $\hat{\alpha}_i$/s.e.($\hat{\alpha}_i$) and for β-coefficients, by $\hat{\beta}_i$/s.e.($\hat{\beta}_i$). In the case of estimated α_i, comparison of computed t's with theoretical values of t under the chosen level of significance and given degrees of freedom (df) provide a two-tailed test of significance for the polynomial coefficients, and in the case of the estimated $\hat{\beta}_i$, for the distributed-lag coefficients, under the null hypothesis that the coefficient being so considered is not significantly different from zero. Significance testing of the α-coefficients provides a first-order test of the degree of the approximation polynomial, in this case the cubic approximation of f(z). In case of computed $\hat{\beta}_i$'s, the t-test provides a test of the order of the fitted lag. In the absence of an autoregressive lag-structure, the Durbin-Watson d-test can be used for detecting auto-correlation. The adjusted R^2 is also computed, which is independent of the number of α_i's estimated.

5.3.2*(ii)* Modelling Results

Using timeseries data for the sample period between 1960-61 and 1976-77 which is covered by the NTPC freight study, the estimating equations above were estimated by the OLS technique. The regression results are given in Tables 5.10 to 5.17. Each column in these tables contains the estimated coefficients for the regressor considered with their respective t-ratios. A summary is provided in Tables 5.8 and 5.9 below of the regression results obtained under linear and semi-log estimation from modelling wagon output and IR wagonfleet trends on the augmented NTPC dataset using the polynomial distributed lag procedure. Details of the intermediate results from the estimating procedure and computed values of the lag-coefficients, along with the dataset are provided in Tables 5.10 to 5.17 in the chapter-appendix. While the values for R^2 and adjusted $\bar{R}^2$ (the *coefficient of determination* adjusted for df) given in Tables 5.8 & 5.9 indicate the explanatory strength of respective railway variables as determinants of IR freight capacity, the relevant Durbin-Watson d-statistic provides an evaluation of serial correlation characteristics in the data . Inconsistent values of R^2 and R^2 have arisen in a few isolated cases because of the intercept suppression that is necessitated by the Almon lag-estimation procedure.

Table 5.7: Lag Modelling of IR Freight Capacity Adjustment: The Augmented NTPC Dataset

Year	Wagon Fleet [lakhs]	**Net Wagon Additions [lakhs]	**Wagon Repla-cements [lakhs]	*Empty Wagon Km [mill]	*TAT [days]	*NTKM/ Route Km	Rail Tonne Km [mill]	Road Tonne Km [mill]	All Tonne Km [mill]	Rail Pass. PKM [mill]	All Pass. PKM [mill]	GDP	IND	AG	TP [mill]	PCI [Rs.p.a.]
1960-61	3.08	-	-	30.4	11.2	2.76	87.7	87.7	122.7	77.6	57	140.7	28.7	67.5	439	305.6
1961-62	3.19	0.111	0.008	31.1	11.5	2.31	91.2	91.2	131.2	81.9	59	146.1	31.0	68.1	448	309.2
1962-63	3.31	0.120	0.072	30.7	11.2	3.08	100.7	100.7	144.7	84.0	65	149.9	33.8	66.4	458	308.2
1963-64	3.44	0.130	0.130	31.3	11.0	3.25	106.8	106.8	154.3	88.6	69	158.0	36.9	68.1	468	318.3
1964-65	3.58	0.140	0.176	31.8	11.9	3.15	106.9	106.9	157.9	92.9	76	170.1	39.7	74.4	479	335.1
1965-66	3.70	0.120	0.225	31.5	11.8	3.4	116.9	116.9	171.9	96.3	95	162.7	41.0	63.8	489	311.0
1966-67	3.76	0.060	0.275	31.0	12.3	3.41	116.7	116.7	173.5	102.1	106	164.5	41.6	63.0	500	307.4
1967-68	3.78	0.020	0.192	31.6	12.6	3.49	118.9	118.9	177.9	107.2	124	177.9	43.0	72.8	512	325.4
1968-69	3.82	0.040	0.136	30.9	12.7	3.59	125.2	125.2	189.2	106.9	140	182.9	45.1	73.4	523	327.0
1969-70	3.84	0.020	0.145	31.6	12.6	3.66	127.4	127.4	192.4	113.4	156	194.6	49.0	78.1	535	340.6
1970-71	3.84	-0.000	0.149	30.9	13.3	3.61	127.4	127.4	193.4	118.1	169	205.9	50.2	84.5	547	343.0
1971-72	3.82	-0.015	0.127	31.6	13.5	3.71	133.3	133.3	199.3	125.3	190	208.2	50.8	82.8	559	349.0
1972-73	3.84	0.016	0.070	30.3	13.5	3.81	136.5	136.5	203.5	133.5	196	206.0	52.7	76.8	571	337.1
1973-74	3.88	0.040	0.068	29.3	15.0	3.42	122.4	122.4	189.4	135.6	208	216.5	53.7	83.7	583	349.1
1974-75	3.91	0.030	0.092	28.6	14.6	3.77	134.3	134.3	205.3	126.3	219	216.7	54.8	80.4	595	343.2
1975-76	3.95	0.043	0.070	29.8	13.5	4.17	148.2	148.2	221.2	148.8	225	221.1	56.0	84.6	606	365.9
1976-77	3.98	0.027	0.097	29.9	13.0	4.35	156.8	156.8	232.8	163.8	235	229.6	58.4	87.9	618	362.3

Source: Compiled from NTPC [1980]; *columns marked [*] added from* Rao & Sriraman [1985]; *columns marked [**] on net wagon additions and wagon replacements are computed within the data*

The dataset for the regression comprised timeseries in the following variables:

WAGONUNITS	=	wagonfleet in standardised BOX wagons
NETADDITIONS	=	annual additions to rolling-stock (excluding traction and coaching)
REPLACEMENTS	=	annual fleet renewals
EWAGONKM	=	journey kilometres on account of wagons running empty
TAT	=	turnaround time of wagons
NTKM/RKM	=	track-utilisation intensity in terms of net tonnages carried per route-kilometre
RAILTKM	=	rail freight traffic in tonne-km
RDTKM	=	road freight traffic in tonne-km
ALLTKM	=	total freight traffic in tonne-km
RAILPKM	=	rail passenger traffic
ALLPKM	=	total passenger traffic
GDP	=	Gross Domestic Product
IND	=	aggregate industrial output
AG	=	aggregate agricultural output
TP	=	total population
PCI	=	per capita income

some of which are the transportation and development indicators used by the NTPC study while most others are added railway variables which reflect the trend of IR freight and passenger operations. Wagon production trends are also added to the NTPC dataset. Inclusion of timeseries on specific economic variables allows an examination of whether a match had been maintained over the period of study between IR freight capacity and the development needs of the economy.

The results of lag-regression were encouraging on several counts. The coefficient of determination or regression coefficient was found to be large for most data relationships and the parameter estimates were statistically significant at the 5 percent level with few exceptions. While the signs of the lag coefficients were not always internally consistent, most lag-relationships did not exhibit serial correlation. Major multicollinearity problems were not encountered in most cases. The few instances of serial correlation were presumably the result of exclusion of other variables in the lagged regressions which were run on a single regressor and single regressand to simplify modelling and parametric estimation. A more rigorous modelling procedure which included multiple lagged regressors could conceivably eliminate this problem while extending the results of the present investigation.

Table 5.8: IR Freight Capacity Model under Linear & Semilog Estimation: R^2 & Adjusted $\bar{R}^2$ Values & Serial Correlation Characteristics for Wagon Output

Regressand: Wagon Output: Table of R^2 & Adjusted $\bar{R}^2$ Values & Durbin-Watson *d*-statistic

	Linear Estimates			Semilog Estimates		
	D-W d	Adj. $\bar{R}^2$	R^2	R^2	Adj. $\bar{R}^2$	*D-W d*
WAGONUNITS	*1.003038*	0.934	0.956	0.975	0.962	*3.212047*
NETADDITIONS	*1.001753*	0.551	0.701	-10.022	-15.534	*1.346535*
REPLACEMENTS	*1.011403*	0.151	0.434	-0.941	-1.911	*1.540457*
EWAGONKM	*1.009578*	0.080	0.387	0.365	0.048	*1.001632*
TAT	*1.010697*	-0.182	0.212	0.515	0.272	*1.621815*
NTKM/RKM	*1.007382*	0.465	0.644	0.832	0.748	*2.229619*
RAILTKM	*1.010209*	0.397	0.598	0.770	0.655	*2.057832*
RDTKM	*1.007884*	0.463	0.642	0.925	0.887	*2.312275*
ALLTKM	*1.009288*	0.439	0.626	0.812	0.719	*2.036578*
RAILPKM	*1.007452*	-1.154	-0.436	0.635	0.452	*1.553119*
ALLPKM	*1.011135*	-1.432	-0.621	0.918	0.877	*3.090632*
GDP	*1.007948*	-1.017	-0.344	0.614	0.421	*1.487814*
IND	*1.007189*	0.307	0.538	0.732	0.598	*1.531073*
AG	*1.008078*	-0.709	-0.139	0.527	0.290	*1.572672*
TP	*1.013282*	-0.221	0.186	0.574	0.362	*2.101179*
PCI	*1.007171*	-0.620	-0.080	0.275	-0.088	*1.332724*

Table 5.9: IR Freight Capacity Model under Linear & Semilog Estimation: R^2 & Adjusted $\bar{R}^2$ Values & Serial Correlation Characteristics for Wagonfleet

Regressand: Wagon Output : Table of R^2 & Adjusted $\bar{R}^2$ Values & Durbin-Watson *d*-statistic

	Linear Estimates			Semilog Estimates		
	D-W d	Adj. $\bar{R}^2$	R^2	R^2	Adj. $\bar{R}^2$	*D-W d*
RAILTKM	*2.945167*	0.334	-0.501	0.930	0.907	*2.357344*
TAT	*1.511661*	1.969	-1.727	0.810	0.747	*1.693891*
WAGONOUTPUT	*1.386219*	199.283	-149.712	-29.752	39.336	*1.807870*
ALLTKM	*2.834123*	0.189	-0.392	0.935	0.914	*2.312912*
GDP	*1.179840*	12.787	-9.840	0.701	0.602	*1.000932*
ND	*1.917056*	5.125	-4.094	0.784	0.713	*1.001442*
*NETADDITIONS	*3.805418*	0.993	0.995	0.994	0.992	*3.592057*
*REPLACEMENTS	*2.367691*	0.625	0.719	0.888	0.851	*2.498294*

**on WagonFleet*

Theoretical values of the *t*-statistic at 9*df* are 2.262 at 5% level of significance and 1.833 at 10% level. Reviewing results of the polynomial fit, it can be seen that the cubic form of the approximation polynomial is only justified for the regressor WAGONUNITS in Table 5.12, and for the reversed regressands NETADDITIONS and REPLACEMENTS in Table 5.13 with WAGONFLEET as the regressor. In other cases, the α-significances decay beyond $\hat{\alpha}_0$, thus indicating that the first-order test of the degree of the approximation polynomial is invalid beyond the simple proportional relationship between regressand and regressor.

Both R^2 and $\bar{R}^2$ serve as indicators of the goodness of polynomial fit. In the case of net additions and replacements, linear fits are indicated, while for wagon units, rail and road tonne-kilometerages and total passenger kilometres, the log-lin fits yield higher $R^2/\bar{R}^2$. All acceptable fits for the regressand wagon units are lin-log, so also for the regression of replacements on wagonfleet; only for net additions is the regression on the wagonfleet of lin-lin type. The lin-log fits relate absolute change in the regressand to relative changes (or growth) in the regressor, whereas the log-lin fit relates relative changes in the regressand to absolute changes in the regressor. Obvious multicollinearity, expressed in high $R^2/\bar{R}^2$ and low α-significances, is explicit for the regressors NTKM, RDTKM, RAILTKM, ALLTKM, GDP, IND, AG and TP, in Table 5.12, and once again for GDP and partially for TAT in Table 5.13.

Theoretical *t*-values for β-significances remain identical, although, as in α-significances, the degree of significance is often found to be stronger than 5% or 10% percent for good fits. The order of lags is however less than five or skips intermediate time periods if significances are taken into account, except when net wagon additions are regressed on wagon units. Under statistical hypotheses, a low β-significance for a particular time period may also be the result of some degree of multicollinearity which vitiates estimation of the periodic response without negating its existence.

Taking only significant lag-coefficients into account and eliminating all regressions where multicollinearity seems to be explicitly present on the thumb-rule test of high $R^2/\bar{R}^2$ and high standard errors of coefficient estimates, the following regression results held good over the period of the study:

i) The rate of growth of railway wagon production and acquisition was determined by the current size of the IR wagonfleet, scaled downwards by wagonfleet inventory levels over the immediately preceding lag-period. Quite obviously, high initial levels of wagon acquisition at the commencement of each plan were thus quickly succeeded by a slowdown, so that the resulting patterns of wagon production remained cyclical.

ii) The level of wagon output was determined primarily by current net addition to railway rolling stock (exclusive of traction and coaching units) and less so by replacement-acquisition of wagons. In such circumstances, a replacement backlog became inevitable if current financing of net wagon acquisitions remained low over successive plan years.

iii) The rate of wagon output and acquisition was inversely scaled by IR freight traffic levels achieved at the commencement of the plan horizon, implying the prevalence of traffic pessimism whenever traffic realisation appeared to be fairly high at the commencement of any plan.

iv) The rate of wagon acquisition by IR was also inversely related to the rate at which freight traffic on the roadways had grown over the course of the plan, so that lower *pro rata* fleet augmentation targets were set by each successive plan as a response to growing roadways competition.

v) The rate at which IR wagonfleets were augmented was influenced by current IR passenger traffic realisations, as a consequence of which IR wagon acquisition underwent a slowdown following the growth of passenger traffic volumes.

vi) Current levels of IR wagonfleet inventories were tagged to the rate of freight traffic growth at the commencement of each plan. A failure of freight traffic to maintain its earlier momentum over the plan appreciably slowed the rates of subsequent wagonfleet augmentation.

vii) Current wagonfleet requirements for IR were decided after mid-plan review of the growth of wagon turnaround, so that IR wagon acquisitions became a short-period adjustment device for circumventing immediate bottlenecks to achieve current traffic targets, rather than a longterm transport development device.

viii) Current IR wagonfleet levels were pessimistically scaled by the rate at which freight traffic had previously grown, with sustained increase in traffic over the previous period being expected to be followed by traffic decline in the immediate future.

ix) Net IR wagon acquisition levels in any current year were part of a lagged adjustment in wagonfleet inventory levels spread over a large number of preceding years, with readjustment being made to the initial projection of the required wagonfleet during mid-plan and end-plan years.

x) Wagon replacements by IR were a current adjustment to the growth trends of wagonfleet inventories in the immediately preceding period. Higher adjustment to take care of the mounting replacement backlog was undertaken in alternate lag-years, whenever traffic growth was found to have remained consistent over successive years.

Summarising, the determinants of the level of wagon output in India over the period of study were found to be the rate of growth of wagonfleet, the levels of rolling-stock acquisition and replacement by IR, the rates of growth of rail and road freight traffic and, inversely, the level of passenger traffic within the lag structures implied above. Wagonfleet levels were found to be determined on the other hand by the growth rates of railway freight traffic, wagon turnaround and total freight traffic, with the expectation of some incursion from road-transport operators, and were not significantly related to the growth rates achieved by industry and GDP in India. It is this latter lack of responsiveness that substantiates the existence of transportation bottlenecks, which were observed by many commentators[53] to be contributing to the recessionary trends that prevailed in the Indian economy over the study period.

5.3.3 Freight Policy Consequences

Before going into an evaluation of the policy impact of this freight situation, it becomes necessary to briefly reenter the scenario of post-Independence transportation planning, taking note of railway plan objectives and their relationship for IR capital investment decisions. The main transportation objective during each FYP was to carry the traffic forecast for the plan period. While IR concentrated mainly on the replacement of overaged railway assets during the 1FYP, railway development was accelerated considerably by the 2FYP, although transportation demand at times still outstripped IR freight capacity. The objective of the 3FYP was to accordingly develop sufficient infrastructural strength so that IR freighting capacity would not become a bottleneck to the industrial development of the country. While the main thrust continued to be the augmentation of IR asset stocks, a start was provided to the process of technological upgradation through the induction of modern traction and signalling equipment. By the end of the 3FYP, IR freighting capacity on given sections of the BG network was observed to have risen to levels slightly ahead of demand, particularly for streams of programmed BG traffic in coal, ores, heavy industrial raw materials and finished steel, where the PSU production targets had not been realised. On the MG network, freighting capacity maintained an overall balance with transportation demand. Thus during the interplan years between 1966-69, transportation and capital planning on IR began to shift its focus to meeting more immediate freight demands, while staying within sight of the longterm objective of adding freight capacity to meet the needs in the future. A major redirection of these objectives during the 4FYP was embodied in the planning shift from routine augmentation of IR capacity to maintain its parity with freight demand, to upgrading the technological efficiency of IR freight handling through railway modernisation. Because of the pervasive resource shortages of the time, the financial requirements for the modernisation plan resulted in a cutback on wagon acquisition and thus on the physical rate of growth of IR freight capacity.

Although the volume of IR freight traffic had increased appreciably over the first three FYPs in line with growth trends in the national economy, the rate of growth of freight operations slowed down thereafter. Thus while IR freight handling increased by 6 percent in terms of originating tonnages and by 6.5 percent in traffic terms over the duration of the 3FYP, subsequent freight tonnages over the next decade tended to stagnate around the 200MT mark reached in 1965-66. The slow rise in traffic upto 1972-73 mainly reflected the augmentation of freight leads arising from IR's growing specialisation in bulk-traffic. Hidden from view behind this specialisation was the running down of IR's ageing fleet of general-purpose wagons because of low replacement rates and negligible acquisition. Another consequence of increasing wagon specialisation was the loss of freighting elasticity by IR increasing its vulnerability to PSU production shortfalls. Thus the 1973-74 freight setback was principally caused by stagnation in producer-goods production, most notably in coal, cement and steel, which restricted the freight volumes available for transit, besides the unforeseen event of the Railway Strike. Thus, while upto 1965-66 IR freight increased at a rate distinctly faster than the expansion of the economy, growth of freight during the recessionary period from 1966-67 to 1974-75 was distinctly slower, imposing a drag on economic growth. Only after 1975 did IR freight traffic begin to recover.

Given this historical experience, credence is imparted to the regression findings, emphasising the analytical utility of the lag-fitment exercise. The regression relation of wagon output to wagonfleet over the recessionary period establishes that whenever existing rolling stock proved adequate for meeting current haulage needs, IR was reluctant to invest in wagon capacity in the succeeding year, despite the need foir advance planning of freight capacity to preclude the formation of transportation bottlenecks. Sluggish industrial growth and the failure of IR to achieve its slated freight targets over the period relevant to the NTPC study greatly contributed to cyclic wagonfleet augmentation. Since the semilog regressions relate wagon output and IR wagonfleet nonlinearly to other growth rates in the economy, the high degrees of serial correlation found therein are accounted for by the autocorrelated influence of low industrial growth rates and consequent slowness in the growth of producer goods demand, as well as by tardy rates of fleet replenishment which led to the growth of roadways competition in the shorthaul non-producer goods segment. Cross-dependence between IR's capital investment decisions and the public investment decision embodied in each FYP is also revealed by the lag-analysis. Wagon acquisition decisions by IR are taken only after emerging traffic trends and roadways competition have been closely monitored, and hence tend to cluster in the transitional years of each planning horizon instead of being evenly spaced. The resulting cyclicity in the growth of freighting capacity has adverse impact on the subsequent growth rates of the economy.

Thus the *increasing returns* scenarios that characterise the building of infrastructure have largely vanished from IR, and each spurt in freight demand calls for substantial outlay of new funds on building transportation capacity. In the absence of adequate advance capacity development by IR which would have provided it with a competitive buffer, competition from the roadways is strong since capital investment in these has shorter gestation. Over the years, this investment mismatch has been siphoning a growing proportion of non-bulkfreight traffic away from IR and has significantly affected its market share. Negative coefficients in the regression of IR wagon acquisitions on roadways freight traffic also assert that the growth of roadways has had an adverse impact on railway rolling-stock investments, and consequently on IR's acquisition and

Figure 5.2: Wagon Fleet regressed on Rail Tonne-Kilometerage
Almon Distributed-Lag Weights

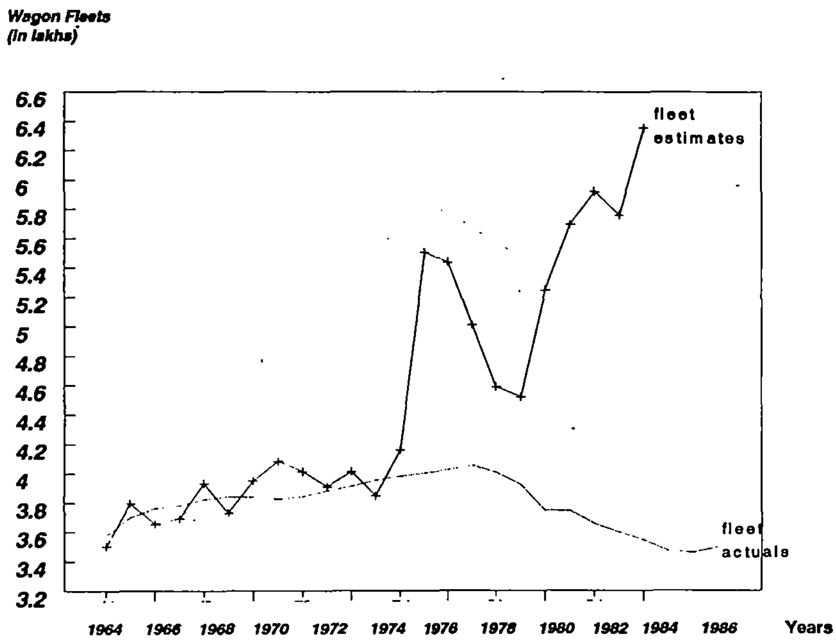
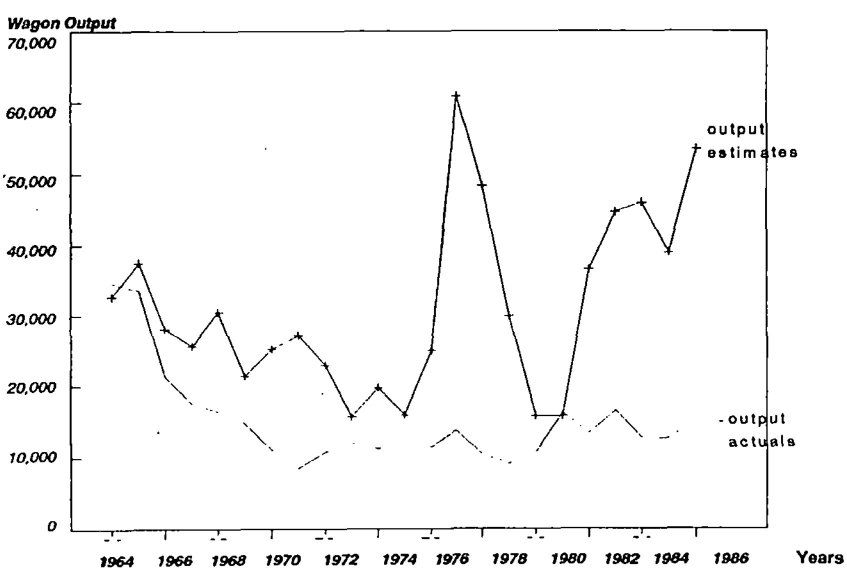


Figure 5.3: Wagon Output regressed on Rail Tonne-Kilometerage
Almon Distributed-Lag Weights



deployment of freight wagons. Comparing the economics of freight between railways and roadways, both NTPC[1980] and RTEC [1980][54] concede that the latter derive competitive advantage from greater flexibility in their capital structure and mode of organisation and have been able to offer serious competition to IR in contestable freight segments. Thus while IR has been gaining bulkfreight over the years, it has surrendered a substantial proportion of the more profitable general freight segment to the roadways.

Viewing IR freight transportation trends beyond the timeframe of the NTPC study, further specialisation is noted. Bulkfreight now constitutes around 90 percent of revenue-earning tonnages on IR, while other freight has been steadily surrrended[55] Because of this changing freight-mix, traffic growth on IR has continually outstripped the growth of freighting tonnages because of the rising proportion of longhaul freight. In spite of this apparently high order of freight specialisation, studies of freighting capacities vis-a-vis producer-goods volumes shows that IR's bulk haulage capacity has not grown apace with the potential availability of bulkfreight traffic,[56] clearly indicating that capacity constraints have limited producer-goods operations as well, constraining potential growth rates of the Indian economy. With plan allocations to IR undergoing continuous decline in proportionate terms over the years since the 3FYP, a slowdown has consequently been induced in engineering industry[57] accompanied by rising slack in the wagon industry.

Evidence of this is carried in Fig 5.2 and 5.3. These depict plots generated for IR wagonfleet and wagon output relation by applying lag-coefficients from their estimated regression relationships with IR freight traffic over the study period. It is seen from both figures that regression estimates are a reasonable approximation to actuals, particularly for wagonfleets, over the timeframe used by the NTPC study, but diverge dramatically when the projection is extended into the succeeding decades. It may be recalled that freighting capacities over the beginning of the study period were still heavily influenced by the high-growth philosophy of the 3FYP, although significant slack developed in subsequent years.

With the planning thrust in the post-3FYP period consequently being directed towards railway modernisation, rather than towards blanket expansions of wagonfleet and running track, the patterns of growth in IR freighting capacity underwent inevitable revision. If the momentum of the early-1960s had been sustained, and freight capacity had been created ahead of freight demand, wagonfleet requirements by the 7FYP period would have amounted to nearly 6.4 lakh FWUs [*4-wheeler units*]. Actual IR wagonfleets are only around half of this for the relevant years. Such sluggishness in the growth of freight capacity contributed to the cyclic pattern of wagon production evident in Fig 5.3. Recessionary slowdowns in freight traffic realisation curtailed the procurement of new wagons uptil 1971. The recovery that followed scaled up wagon production thereafter, until the end of the 5FYP. But spillover shortfalls in freighting capacity slowed the recovery in IR freight realisation, also causing the slumps in lag-estimates of wagon output observed at end-plan years. The post-1975 industrial recovery, when carried into the lagged estimation procedure, should have seen wagon output rise to nearly 60,000 wagons p.a., if unrestricted wagonfleet requirements had been fully met and freight capacity had been created ahead of demand. However, actual wagon outputs over the relevant period stagnated at well below 20,000 wagons p.a. While a part of the observed gap between the distributed-lag estimates of wagonfleet requirements and wagonfleet actuals has been filled by wagon modernisation and by the phasing out MG freighting capacity in favour of BG, it is unlikely that the gap has been fully covered. It remains to be noted that the persisting gap is indicative of the resource-shortages that have afflicted IR not only by limiting the expansion of freighting capacity, but also by cutting the rate of capital investment on track development and other modernisation measures which would have allowed a wagonfleet of over 6.4 lakhs to be online.

The lag-analysis has contributed to an understanding of the underlying causes. The root of the infrastructural problem lies in the failure of public policy to adequately capitalise railway plans. Investment constraints force IR to scale haulage capacity to the past trends in railway tonnages rather than to total anticipated freight movements in the country as a whole. Over extended periods of time, this reinforces further slackening in the growth rates of IR freight operations, opening avenues for roadways competition to enter, especially in selected traffic sectors such as the lucrative 'other goods' segment. The relation between IR freight capacity and GDP becomes progressively weaker as the transportation bottleneck becomes constrictive. Tremendous capital and freighting inefficiency is created by capacity mismatch between the road and railway sectors adding to high cost levels in the Indian economy, despite the energy considerations which dictate that progressively larger proportionate shares of overland freight should be transported on the railways. For a reversal of this situation, competitiveness has to be returned to IR through rapid wagonfleet augmentation which can once again widen the spectrum of its freight services and restore increasing returns to railway infrastructure in India.

5.4 Critical Evaluation of IR Freight Policy

Strong evidence has emerged from the distributed-lag analysis that structural inconsistencies such as adhesion to backward focus and an incremental approach to railway freight capacity planning in India[58] have gradually eroded the competitiveness of IR freight services in the transport market. The narrowing of IR's freight focus to a few bulk commodities and to a few high-density traffic corridors is as much the consequence of the inability of IR to make capital investment on the required scale for maintaining an adequate and diversified wagonfleet, as of the technological advantages that accrue from freight specialisation. Decisions on the acquisitions of new railway wagons, as the lag analysis has shown, are no longer been guided by the manifestations of new traffic demands in the Indian economy. As pointed out in the 9FYP document, the decline in IR's freight share from 89% in 1951 to 40% in 1995 has thus been inevitable, because of the failure of railway freight operations to grow annually at a rate that matches the recent growth rates of the economy.[59] The resulting slack in the freight market has thus spurred the acquisition of new freight capacity by the roadways.

In principle, the increasing acquisition of specialised wagons by IR reflects the larger choice of a new railway technology that is geared towards improving the efficiency of IR freight operations. Specialised wagons are an important constituent of IR's new freight focus on moving faster and heavier trains drawing uni-product rakeloads. While this technological decision is conceptually sound in terms of improving freight handling efficiency, it represents the engineering view of railway efficiency and is not necessarily prudent from the viewpoint of the economics of transportation. Since expanding transportation demands of the economy reflect the expansion of the country's economic space, extension of new railway technologies to cover IR's huge route network would involve prohibitive capital costs which could only be funded through a programme of massive external investment on the railways. With the attitudes of the state towards meeting the new public investment needs of the IR infrastructure having been decidedly lukewarm since the end of the 3FYP, the new railway technologies are being applied only on limited HDC sections of the IR network, where congestion costs have begun to adversely affect the speed of traffic handling and movement. [*see Map* 2] But despite their limited spatial focus, these new high-cost railway technologies have magnified the resource squeeze on many other critical segments of railway operation including replacement and renewal, reflecting problems of moral hazard and adverse project selection closely associated with the whims of IR's bureaucratic and political masters.

Since the 6FYP, IR has been asked to meet its need for new railway capital mainly from internally generates resources. Increasing stress is accordingly being laid by IR on frequent tariff rationalisations, so that the annual Railway Budgets can show operating surpluses to finance its capital needs. Even then, the internal resource flow has been too meagre to match IR's need for project funds, as a result of which its short-term funding needs after the 6FYP are being met through increased market borrowing. The new burden of debt servicing costs that has consequently been added further erodes IR's capacity for new capital investment, perpetuating a vicious circle. During the 1990s, railway debates in India thus moved towards the possibility of restoring IR to financial health through organisational and managerial restructuring. At the heart of such debates, were concurrent organisational reforms being carried on many major railway systems across the world, involving the unbundling of monolithic railway service organisations into more compact and more efficient entities, and also the alternative of either corporatising or privatising the railways. These debates thus shifted the focus towards the possibility of rationalising the costs of railway operation, providing a counterpoint in the debate within India on how IR's capital needs should best be met.

As noticed during the planning review, the central focus of Indian railway planning in the era following the 3FYP has been on technological upgradation of the IR network, through route-improvements like electrification, line-doubling and gauge conversion, as well as the acquisition of specialised freight capacity. Although the large fund outlays on such IR development projects have involved a new dose of 'sunk capital', the proportion of routes that have been upgraded pales into relative insignificance when compared to the size of the entire IR network. Consequently, a shrinkage of the railway freight-base has inevitably occurred, with IR having to concentrate on the movement of its captive long-lead bulk traffic which mainly serves the core sectors of the economy. As several reviews have since noted, this narrowing in the freight focus has made IR freight performance rather vulnerable to the productivity cycles of the core sectors and also to the locational shifts in core-sector activity which have occurred over time.[60] The non-core segment of the freight market catering to low-bulk and piecemeal traffic has thus been rendered contestable, with the roadways gaining advantage both from flexibility and convenience-of-service, as well as from IR rate-setting strategies which have priced IR freight services out of this segment of the market. Meanwhile, freight specialisation by IR has also led to congestion on the HDCs where large investments had been made on upgraded railway technology, leading to route saturation and falling freight productivity. The visible results of such phenomena are well reflected in freight cyclicity and longterm change in IR's commodity freight-base, which will be examined closely in the next chapter.

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Table 5.10: IR Freight Capacity Model: Linear Estimation
α-system for Wagon Output

Regressand: Wagon Output :	Table of Polynomial Coefficients & α-significances			
Linear Estimates	W_0 $\hat{\alpha}_0$	W_1 $\hat{\alpha}_1$	W_2 $\hat{a}_2$	W_3 $\hat{a}_3$
WAGONUNITS	1.300 **	-4.389 **	2.543 **	-0.389 **
t-comp	*6.269392*	*-3.78654*	*3.244224*	*-3.00430*
NETADDITIONS	1.961 **	-2.618	1.038	-0.117
t-comp	*3.351395*	*-1.24171*	*0.773650*	*-0.53996*
REPLACEMENTS	1.259 **	-2.087	0.984	-0.139
t-comp	*2.739332*	*-1.06613*	*0.766805*	*-0.65604*
EWAGONKM	0.040	-0.062	0.034	-0.006
t-comp	*1.293659*	*-0.46571*	*0.385320*	*-0.40801*
TAT	0.012	-0.087	0.012	0.005
t-comp	*0.331675*	*-0.65675*	*0.135389*	*0.315231*
NTKM/RKM	0.034	0.341	-0.186	0.020
t-comp	*0.418734*	*1.43511*	*-1.34757*	*0.941979*
RAILTKM	0.005 *	-0.003	0.004	-0.001
t-comp	*1.842129*	*-0.3715*	*0.691228*	*-1.14883*
RDTKM	0.022 *	-0.056	0.032	-0.005
t-comp	*2.111971*	*-1.17372*	*1.026834*	*-1.00458*
ALLTKM	0.003	-0.003	0.003	-0.001
t-comp	*1.547519*	*-0.39131*	*0.609363*	*-0.93433*
RAILPKM	0.004	-0.003	0.003 *	-0.001
t-comp	*0.512877*	*-0.11306*	*0.186881*	*-0.28517*
ALLPKM	0.005	-0.013	0.006	-0.001
t-comp	*0.949427*	*-0.38223*	*0.256403*	*-0.19959*
GDP	0.001	0.003	-0.003	0.001
t-comp	*0.308478*	*0.200546*	*-0.30306*	*0.321837*
IND	0.037 *	-0.095	0.056	-0.009
t-comp	*2.140138*	*-1.20247*	*1.076854*	*-1.07400*
AG	-0.002	0.005	-0.003	0.001
t-comp	*-0.44802*	*0.332092*	*-0.33463*	*0.374541*
TP	0.059	-0.068	-0.020	0.010
t-comp	*1.469847*	*-0.35888*	*-0.16104*	*0.480021*
PCI	-0.001	0.005	-0.003	0.001
t-comp	*-0.38205*	*0.581053*	*-0.58488*	*0.576311*

Table 5.11: IR Freight Capacity Model: Linear Estimation
α-system for Wagonfleet

Regressand: Wagonfleet :	Table of Polynomial Coefficients & α-significances			
Linear Estimates	W_0 $\hat{\alpha}_0$	W_1 $\hat{\alpha}_1$	W_2 $\hat{\alpha}_2$	W_3 $\hat{\alpha}_3$
RAILTKM	0.013 **	-0.005	0.012	-0.004
t-comp	*2.238909*	*-0.2268*	*0.95786*	*-1.68874*
TAT	0.120	-0.214	0.056	0.002
t-comp	*1.421423*	*-0.69437*	*0.275594*	*0.046444*
WAGONOUTPUT	12.018	-9.321	-2.000	1.124
t-comp	*1.053096*	*-0.18923*	*-0.06198*	*0.212483*
ALLTKM	0.009 *	-0.004	0.010	-0.003
t-comp	*1.913467*	*-0.22267*	*0.91829*	*-1.60172*
GDP	0.018	-0.007	-0.002	0.001
t-comp	*1.059633*	*-0.12729*	*-0.05146*	*0.098246*
IND	0.177 **	-0.435	0.268	-0.045
t-comp	*2.438426*	*-1.32682*	*1.23572*	*-1.26037*
€NETADDITIONS	0.902 **	-3.051 **	1.698 **	-0.249 **
t-comp	*24.08986*	*-14.5731*	*11.99008*	*-10.6640*
€REPLACEMENTS	-0.568 *	3.625 **	-2.285 **	0.352 *
t-comp	*-2.17572*	*2.483807*	*-2.31534*	*2.158154*

€Reversed regression on Wagonfleet

Note: *Theoretical t-values at 9df are $t_{(0.05, 9)}$ = 2.262 at 95% confidence (**) and $t_{(0.1, 9)}$ = 1.833 at 90% confidence (**)*

Table 5.12: IR Freight Capacity Model: Semilog Estimation
α-system for Wagon Output

Regressand: Wagon Output :	Table of Polynomial Coefficients & α-significances			
Semilog Estimates	W_0 $\hat{\alpha}_0$	W_1 $\hat{\alpha}_1$	W_2 α_2	W_3 α_3
WAGONUNITS	2.039 **	-7.541 **	4.510 **	-0.703 **
t-comp	*5.844883*	*-3.86487*	*3.418121*	*-3.22968*
NETADDITIONS	-5.596	7.046	-1.405	-0.100
t-comp	*-0.70770*	*0.2473*	*-0.07754*	*-0.03420*
REPLACEMENTS	-1.299	-2.364	2.882	-0.620
t-comp	*-0.68600*	*-0.29310*	*0.545287*	*-0.71232*
EWAGONKM	0.081	-0.145	0.090	-0.006
t-comp	*1.139514*	*-0.48059*	*0.445660*	*-0.40801*
TAT	-0.021	-0.053	-0.004	0.007
t-comp	*-0.33685*	*-0.22783*	*-0.02632*	*0.265920*
NTKM/RKM	0.086	0.219	-0.156	0.018
t-comp	*0.695003*	*0.60285*	*-0.73949*	*0.546078*
RAILTKM	0.005	-0.005	0.003	-0.001
t-comp	*1.211675*	*-0.33285*	*0.28092*	*-0.41539*
RDTKM	0.028 **	-0.043	0.006	0.001
t-comp	*2.675336*	*-0.88801*	*0.202756*	*0.145904*
ALLTKM	0.004	-0.005	0.002	0.000
t-comp	*1.282447*	*-0.40970*	*0.209125*	*-0.20212*
RAILPKM	0.002	-0.014	0.009	-0.001
t-comp	*0.214909*	*-0.57334*	*0.4955*	*-0.43503*
ALLPKM	-0.006 *	0.014	-0.010	0.002
t-comp	*-2.18676*	*0.830785*	*-0.78419*	*0.831258*
GDP	-0.003	0.005	-0.003	0.001
t-comp	*-0.54826*	*0.23304*	*-0.22703*	*0.247386*
IND	0.028	-0.110	0.065	-0.010
t-comp	*0.946636*	*-0.82447*	*0.73177*	*-0.68463*
AG	0.008	0.006	-0.003	0.001
t-comp	*-1.08417*	*0.23861*	*-0.17977*	*0.223197*
TP	0.055	-0.072	-0.027	0.013
t-comp	*0.854594*	*-0.23767*	*-0.13502*	*0.380922*
PCI	-0.003	0.008	-0.005	0.001
t-comp	*-0.59951*	*0.52155*	*-0.52783*	*0.539083*

Table 5.13: IR Freight Capacity Model: Semilog Estimation
α-system for Wagonfleet

Regressand: Wagonfleet :	Table of Polynomial Coefficients & α-significances			
Semilog Estimates	W_0 $\hat{\alpha}_0$	W_1 $\hat{\alpha}_1$	W_2 α_2	W_3 α_3
RAILTKM	0.626	-1.131	0.430	-0.029
t-comp	*1.622709*	*-0.89563*	*0.53484*	*-0.21657*
TAT	0.433	1.176	-0.499	0.045
t-comp	*0.625162*	*0.46835*	*-0.30335*	*0.162062*
WAGONOUTPUT	-4.260	5.224	-0.922	-0.079
t-comp	*-2.07789*	*0.57323*	*-0.15347*	*-0.07990*
ALLTKM	0.992 *	-1.499	0.458	-0.020
t-comp	*2.114291*	*-0.90812*	*0.435381*	*-0.11688*
GDP	0.311	-0.168	0.075	-0.005
t-comp	*0.935283*	*-0.16012*	*0.11247*	*-0.04125*
IND	2.610	-7.161	4.474	-0.734
t-comp	*1.637769*	*-0.9784*	*0.92637*	*-0.92436*
€NETADDITIONS	7.385 **	-24.844 **	13.774 **	-2.017 **
t-comp	*22.04139*	*-13.2785*	*10.90329*	*-9.68313*
€REPLACEMENTS	-5.729 **	33.577 **	-20.938 **	3.212 **
t-comp	*-2.64421*	*2.77535*	*-2.5632*	*2.384414*

€Reversed regression on Wagonfleet

Note: *Theoretical* t*-values at 9df are* $t_{(0.05,\,9)} = 2.262$ *at 95% confidence* (**) *and* $t_{(0.1,\,9)} = 1.833$ *at 90% confidence* (**)

Table 5.14: IR Freight Capacity Model: Linear Estimation
β-system for **Wagon Output**

Regressand: Wagon Output : Table of Computed Lag Coefficients & β-significances

Linear Estimates	X_t $\hat{\beta}_0$	X_{t-1} β_1	X_{t-2} β_2	X_{t-3} β_3	X_{t-4} β_4
WAGONUNITS	1.300 **	-0.935 **	-0.417	0.522	-0.450
t-comp	*6.269392*	*-2.97298*	*-0.22474*	*0.035185*	*-0.05078*
NETADDITIONS	1.961 **	0.263	-0.062	0.280	0.587
t-comp	*3.351395*	*0.466044*	*-0.4005*	*0.53689*	*1.501794*
REPLACEMENTS	1.259 **	0.017	-0.088	0.112	-0.213
t-comp	*2.739332*	*0.034186*	*-0.5119*	*0.225334*	*-0.51548*
EWAGONKM	0.040	0.007	0.005	0.000	-0.047
t-comp	*1.293659*	*0.197764*	*0.40076*	*-0.00405*	*-1.37111*
TAT	0.012	-0.059	-0.077 **	-0.014	0.157 *
t-comp	*0.331675*	*-1.42568*	*-3.7678*	*-0.39375*	*2.046561*
NTKM/RKM	0.034	0.209 **	0.134* *	-0.070	-0.281**
t-comp	*0.418734*	*3.270844*	*4.9980*	*-1.29983*	*-4.02804*
RAILTKM	0.005 *	0.004	0.005 **	0.001	-0.014 **
t-comp	*1.842129*	*1.805612*	*4.40662*	*0.398261*	*-4.27770*
RDTKM	0.022 *	-0.007	-0.002	0.005	-0.018 *
t-comp	*2.111971*	*-0.51938*	*-0.3827*	*0.372707*	*-1.90729*
ALLTKM	0.003	0.002	0.003 **	0.001	-0.009 **
t-comp	*1.547519*	*1.194682*	*3.0405*	*0.345625*	*-4.09235*
RAILPKM	0.004	0.003	0.004	0.001	-0.012
t-comp	*0.512877*	*0.580384*	*0.9357*	*0.099832*	*-0.75431*
ALLPKM	0.005	-0.002	-0.003	0.000	0.000
t-comp	*0.949427*	*-0.27133*	*-0.581*	*-0.00724*	*-0.02392*
GDP	0.001	0.002	0.000	-0.002	-0.001
t-comp	*0.308478*	*0.477930*	*-0.095*	*-0.49255*	*-0.10376*
IND	0.037	-0.011	-0.001	0.009	-0.035
t-comp	*2.140138*	*-0.51467*	*-0.2245*	*0.436798*	*-2.14394*
AG	-0.002	0.000	0.000	0.000	0.005
t-comp	*-0.44802*	*0.050566*	*-0.1035*	*-0.00667*	*0.884500*
TP	0.059	-0.019	-0.078	-0.058	0.098
t-comp	*1.469847*	*-0.35323*	*-2.980*	*-1.12688*	*1.665708*
PCI	-0.001	0.001	0.000	-0.001	0.001
t-comp	*-0.38205*	*0.551678*	*0.1834*	*-0.40542*	*0.355827*

Table 5.15: IR Freight Capacity Model: Linear Estimation
β-system for **Wagonfleet**

Regressand: Wagonfleet : Table of Computed Lag Coefficients & β-significances

Linear Estimates	X_t $\hat{\beta}_0$	X_{t-1} β_1	X_{t-2} β_2	X_{t-3} β_3	X_{t-4} β_4
RAILTKM	0.013	0.018	0.025	0.013	-0.040
t-comp	*2.238909*	*3.168843*	*6.02107*	*2.368388*	*-4.95731*
TAT	0.120	-0.037	-0.071	0.028	0.267
t-comp	*1.421423*	*-0.38292*	*-0.87213*	*0.323832*	*1.497408*
WAGONOUTPUT	12.018	1.821	-5.632	-3.593	14.682
t-comp	*1.053096*	*0.14352*	*-0.9978*	*-0.29385*	*1.662893*
ALLTKM	0.009	0.013	0.019	0.010	-0.032
t-comp	*1.913467*	*2.65841*	*5.59243*	*2.100419*	*-6.06952*
GDP	0.018	0.009	0.000	-0.005	-0.004
t-comp	*1.059633*	*0.58425*	*0.02797*	*-0.31941*	*-0.19353*
IND	0.177	-0.035	0.018	0.066	-0.165
t-comp	*2.438426*	*-0.41297*	*0.45566*	*0.78549*	*-2.45069*
€NETADDITIONS	0.902	-0.701	-0.404	0.297	-0.094
t-comp	*24.08986*	*-12.3331*	*-22.801*	*5.41009*	*-2.85720*
€REPLACEMENTS	-0.568	1.124	0.355	-0.764	-0.125
t-comp	*-2.17572*	*2.83661*	*2.87284*	*-1.99982*	*-0.54812*

€Reversed regression on Wagonfleet

Note: *Theoretical* t-values at 9*df are* $t_{(0.05,\,9)} = 2.262$ *at 95% confidence* (**) *and* $t_{(0.1,\,9)} = 1.833$ *at 90% confidence* (**)

Table 5.16: IR Freight Capacity Model: Semilog Estimation
β-system for **Wagon Output**

Regressand: Wagon Output : Table of Computed Lag Coefficients & β-significances

Semilog Estimates	X_t $\hat{\beta}_0$	X_{t-1} $\hat{\beta}_1$	X_{t-2} $\hat{\beta}_2$	X_{t-3} $\hat{\beta}_3$	X_{t-4} $\hat{\beta}_4$
WAGONUNITS	2.039 **	-1.695**	-0.631 **	1.012	-0.988
t-comp	*5.844883*	*-3.20068*	*-3.27421*	*0.656791*	*-1.07353*
NETADDITIONS	-5.596	-0.056	2.072 **	0.184	-6.320 **
t-comp	*-0.70770*	*-0.00730*	*6.81648*	*0.18116*	*-8.28171*
REPLACEMENTS	-1.299	-1.400	0.545 **	0.819	-4.297 **
t-comp	*-0.6860*	*-0.66547*	*2.24615*	*1.1578*	*-7.3224*
EWAGONKM	0.081	0.009	0.017	0.003	-0.047
t-comp	*1.13951*	*0.11779*	*0.90852*	*0.0559*	*-1.00632*
TAT	-0.021	-0.071	-0.087 **	-0.028	0.150
t-comp	*-0.33685*	*-0.99337*	*-3.5607*	*-0.62595*	*1.62455*
NTKM/RKM	0.086	0.167	0.043	-0.177	-0.385 **
t-comp	*-0.695003*	*1.70409*	*0.89598*	*-1.83046*	*-3.09172*
RAILTKM	0.005	0.002	0.001	-0.003	-0.013
t-comp	*1.211675*	*0.594025*	*0.45668*	*-0.7967*	*-2.3206*
ALLTKM	0.004	0.001	-0.001	-0.003	-0.006
t-comp	*1.28245*	*0.1949*	*-0.6829*	*-0.8254*	*-1.52823*
RAILPKM	0.002	-0.005	-0.002	0.001	-0.003
t-comp	*0.21491*	*-0.75218*	*-0.57064*	*0.19486*	*-0.23910*
ALLPKM	-0.006 *	0.000	-0.002	-0.003	0.009
t-comp	*-2.18676*	*0.07911*	*-0.5732*	*-0.3141*	*1.244045*
GDP	-0.003	-0.001	-0.001	-0.001	0.002
t-comp	*-0.5483*	*-0.0373*	*-0.5444*	*-0.271*	*0.46534*
IND	0.028	-0.028	-0.013	0.010	-0.017
t-comp	*0.94664*	*-0.7906*	*-1.3008*	*0.3191*	*-0.6679*
AG	-0.008	-0.005	-0.003	-0.001	0.006
t-comp	*-1.0842*	*-0.70145*	*-1.2634*	*-0.1448*	*1.1868*
TP	0.055	-0.031	-0.096 **	-0.065	0.139 *
t-comp	*0.8546*	*-0.4933*	*-3.1258*	*-1.05435*	*2.0042*
PCI	-0.003	0.001	-0.001	-0.002	0.002
t-comp	*-0.59351*	*0.20266*	*-0.6193*	*-0.85006*	*0.7993*

Table 5.17: IR Freight Capacity Model: Semilog Estimation
β-system for **Wagonfleet**

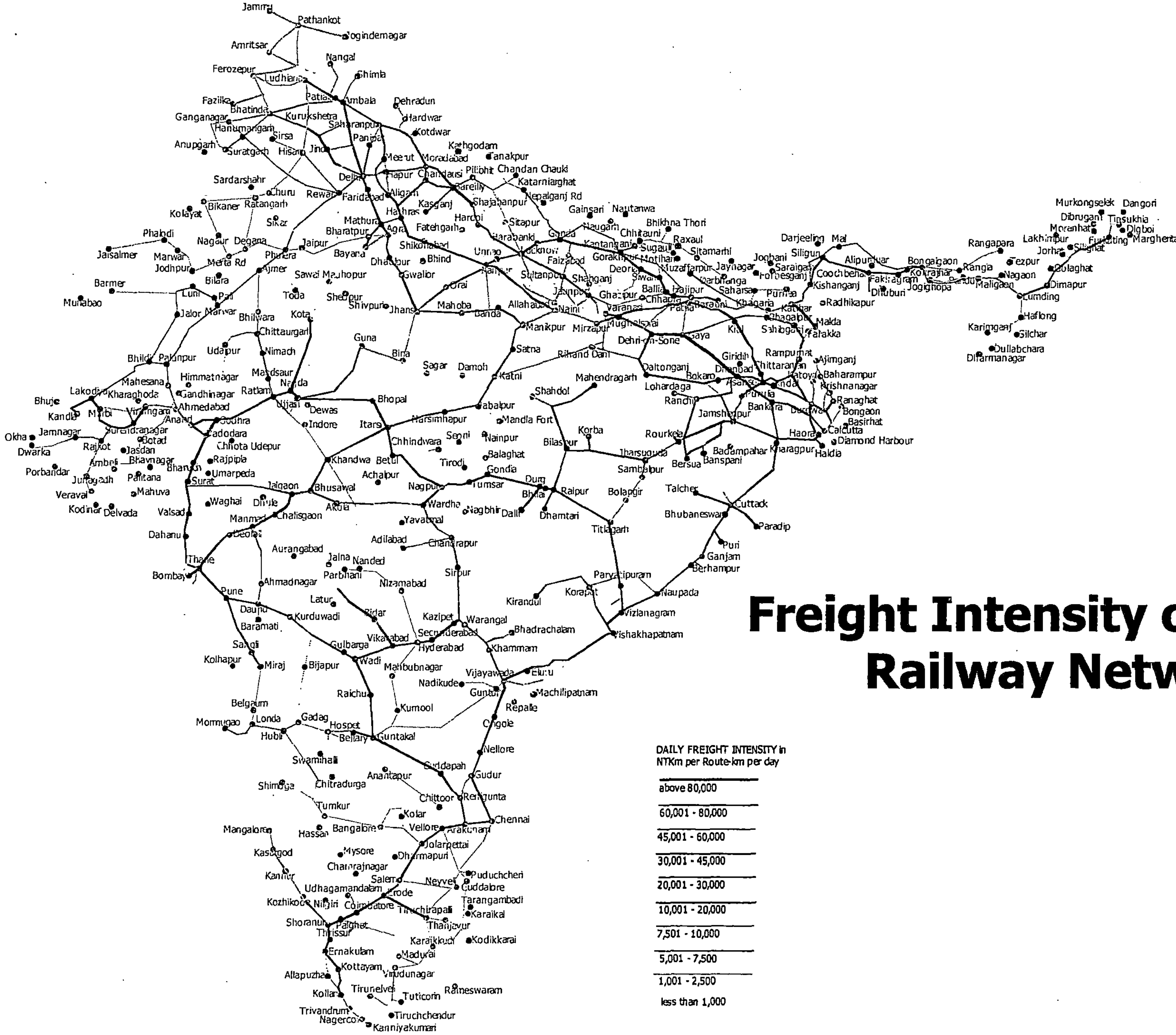
Regressand: Wagonfleet : Table of Computed Lag Coefficients & β-significances

Semilog Estimates	X_t $\hat{\beta}_0$	X_{t-1} $\hat{\beta}_1$	X_{t-2} $\hat{\beta}_2$	X_{t-3} $\hat{\beta}_3$	X_{t-4} $\hat{\beta}_4$
RAILTKM	0.626	-0.104	-0.146	0.327	1.142 **
t-comp	*1.62271*	*-0.30023*	*-0.56822*	*0.958771*	*2.65830*
TAT	0.433	1.155	1.149 *	0.685	0.034
t-comp	*0.625162*	*1.50104*	*1.85793*	*0.999715*	*0.026286*
WAGONOUTPUT	-4.260 *	-0.038	1.868	0.982	-3.169 *
t-comp	*-2.07789*	*-0.01551*	*1.60612*	*0.416249*	*-1.88624*
ALLTKM	0.992 *	-0.069	-0.334	0.074	1.035 **
t-comp	*2.11291*	*-0.15543*	*-1.03196*	*0.164734*	*2.396469*
GDP	0.311	0.214	0.241	0.363	0.554
t-comp	*0.935293*	*0.714508*	*1.13532*	*1.206475*	*1.651336*
IND	2.610	-0.812	0.311	1.573	-1.429
t-comp	*1.637769*	*-0.42618*	*0.36986*	*0.857685*	*-1.07510*
€NETADDITIONS	7.385 **	-5.702 **	-3.343 **	2.359 **	-0.696 **
t-comp	*22.04139*	*-11.2172*	*-21.3201*	*4.835229*	*-2.43558*
€REPLACEMENTS	-5.729 **	10.122 **	3.366 **	-6.727 *	-0.886
t-comp	*-2.64421*	*3.07929*	*3.31919*	*-2.13190*	*-0.47898*

€Reversed regression on Wagonfleet

Note: *Theoretical* t-values at 9*df are* $t_{(0.05,\,9)}$ *= 2.262 at 95% confidence (**) and* $t_{(0.1,\,9)}$ *= 1.833 at 90% confidence (**)*

Freight Intensity on Indian Railway Network



Chapter 6

COMMODITY- INTERDEPENDENCE IN RAILWAY FREIGHT OPERATIONS

6.1 Commodity-Freight Trends on IR

The importance of railways within the infrastructure for freight transportation in India derives largely from the regional spread of resource locations and industrial and agricultural production patterns across the country, and from the particular stress laid over successive FYPs on raising the production of such vital commodities as foodgrains, coal, POL, cement, fertilisers, steel, etc., all of which require bulk-freightage for their distribution across the country. Although in proportionate terms, the overall railway share in freight traffic has declined steadily over the planning period with corresponding expansion in road operations, the physical volume of freight conveyed by IR has witnessed manifold increase since 1950-51, both in terms of originating tonnages and tonne-kilometres traversed. However as noted earlier, the fact that average leads of such traffic have also increased significantly from just 458km in 1947 to well over 700km through most of the 1980s and 1990s also reflects IR's growing specialisation in the handling of longhaul movements in bulk-freight. In consequence, railway freight traffic has almost invariably presented larger increases in tonne-km terms, than in terms of originating tonnages, implying that while tonnage traffic has risen steadily, the same tonnages today are being carried over significantly longer distances than they were in the past.

It is fairly obvious that where such trends exist, underlying adaptations will also have occurred in the freight-mix transported by IR, and that it will be these changes, in fact, which determine the overall character of changes in average traffic leads. It will therefore be the purpose of this chapter to examine freight traffic trends on IR at a disaggregated level, by analysing their gauge and commodity composition as these have evolved over the planning era. Special attention will also be devoted to the phenomenon of railway freight cyclicity, which has been peculiarly characteristic of IR freight performance over the planning era. The root of these phenomena, as earlier mentioned, lies in changes in gaugewise freight capacity arising from increasing specialisation within the IR wagonfleet, which has been the principal reason why IR has been able to sustain its presence in the BG bulk-freight commodity segment of the Indian freight market, while being gradually displaced from the general freight segments once catered to by combined trunk and feeder operations on the BG and MG freight network.

6.1.1 Evolution of the IR Freight-Mix over the Plans

Integrated planning of freight transportation in accordance with national development priorities and industrialisation programmes commenced during the 1FYP and sustained its momentum through the 2FYP and 3FYP. As far as the overall relevance of IR to national planning was concerned, the period thus marked the definitive beginning of a new era for railways in India. Hitherto, the operations of the railways had been organised around small zonal companies whose freight volumes and traffic composition were determined more by commercial considerations than by social obligations, in the sense that they catered to all traffic forthcoming at commercial rates irrespective of its commodity-character, and entered into open competition for the same. The first departure from prior practice was signalled by the nationalisation of railway companies, which ensured common objectives for railway operations. The second departure, following from the institution of planning in India, ensured a longterm character for these objectives dovetailed within the overall frame of national development perspectives. Although a phase of heavy capital expenditure was entailed by these transformed priorities, the nature of transportation planning uptil the 3FYP postulated freight capacity expansions at levels capable of handling the downstream traffic expected to materialise from core-sector investment under the FYPs. Integration of freight capacity with anticipated economic development was achieved at two points: firstly, the projected capacity had to be sufficient to handle the immediate transportation requirements of bulk raw materials and bulk finished products from heavy industries such as iron & steel, etc., while secondly, freight-adequacy had to be maintained for the transportation of future commodity streams that would be generated by the supply of core inputs to general industry. Because of the nature of the economic transformation being contemplated in the FYPs, freight-adequacy on IR especially required that freight capacity be projected around a steadily increasing proportion of bulk materials in the railway freight-mix. This transportation scenario held as long as targets were achieved, and was therefore more or less representative of the first planning decade.

From the 1960s, the first aberrations appeared when the freight streams generated by the core sector of the economy proved too limited to match the 3FYP freight targets. Whether this situation resulted from the miscalculation of freight trends, or followed plan failures in the core sector would warrant deeper discussion. It needs to be remembered that where the 2FYP created vast material transportation requirements for construction of core steel-sector projects like the ISPs at Durgapur and Rourkela, as also for several giant power and irrigation projects like those at the Damodar Valley Corporation [DVC], Bhakra-Nangal, Tungabhadra, Hirakud, Rihand,[1] and so on, freight targets for the 3FYP anticipated that downstream production flows would emanate from the heavy industry that had been created over the previous plans. As a result, freight failure during the 3FYP appears to have sprung up mainly from nonmaterialisation of downstream bulk traffic in the anticipated quantities, because of the combination of foreign exchange difficulties, construction delays, and cost overruns in the heavy industry projects initiated by the 2FYP.[2] Further evidence of this is also obtained from comparison of average IR freight leads over the first three plans. While these rose over the 1950s from 513km in 1950-51 to 604km by 1960-61, the next four years of the 3FYP saw average freight leads hovering at just around or under 600km, even as tonnages and traffic-km steadily climbed.*[see ch3, Table 3.3]* This would indicate that tonnage increases during the 3FYP came mainly from the low-bulk and short-lead categories of traffic, while heavy industry and mining failed to provide IR with the levels of bulk traffic anticipated by planners. Another factor behind the lowering of traffic leads was the circumstantial need that arose to freight greater quantities of imported foodgrains to tide over the succession of indifferent harvests that occurred during the period, causing the growth rates of foodgrain production in India to fall well behind the growth rate of population.[3] Although such unanticipated freight demands may well have led to volumetric increase in the freight transported by IR, they would also have displaced other categories of bulk freight, accounting for the failure of IR to achieve 3FYP tonnage targets.

The 3FYP period thus showed that certain vulnerabilities in the Indian transportation network still persisted despite the Planning Commission having made its first essay at national transport coordination through the Committee on Transport Policy and Coordination [CTPC] constituted in 1959. The purpose behind the CTPC report, submission of which coincided with the aborted start of the 4FYP in 1965-66,[4] had evidently been to project the transportation requirements of the plans more accurately, which depended in turn on compilation of accurate databases of economic and statistical indicators which would permit short-term adjustments in freight supply and demand to be made within the intermodal structure of the Indian transportation system. For such flexibility to be practicable, longrun projections of intermodal freight demand were formulated uptil 1975-76, and the anticipated freighting capacity required in each transportation mode was projected for each planning phase to keep pace with the anticipated growth of freight demand in the economy arising from continuous and cumulative development. Slow rates of growth however continued to persist in the economy, along with agricultural uncertainty, through the subsequent Annual Plan period - particularly in core sectors like coal and steel. These in fact derailed the immediate development planning exercise, while also restricting the freight tonnages available to IR. Traffic uncertainties prevailed until the reversal of the agricultural downtrend by the exceptionally good harvest of 1967-68, which also restored buoyancy to the economy permitting resumption of the 4FYP exercise. An uptrend in IR freight was accordingly anticipated and did materialise to an extent that surpassed planners' expectations, leading to launching of the refurbished 4FYP in exceptionally favourable circumstances. IR freight expectations had in fact already been reversed by the recovery in bulk categories of traffic in 1967-68, which raised average freight leads for the first time in six years to the new high of 623km. Optimism on this count caused IR to scale up traffic estimates and revise rolling-stock acquisitions upward to 16,000 wagons, against earlier assessment of the requirement at 10,000 wagons,[5] and also sharply increased IR capital allocations towards route electrification and modernisation of signalling and telecom equipment with the purpose of improving freight transit times substantially.

Despite this buoyancy all around, the 4FYP was soon assailed by prewar and wartime uncertainties aroused by the Bangladesh crisis,[6] and was then completely dislocated in 1973-74 by heavy cost cascades induced by the first Oil Shock, that necessitated all-embracing reformulation of freight economics across the world as well as in India. As earlier noted, this 'plateau' period was undistinguished by any major gain in IR freight tonnages, although average freight leads rose to 699km even as tonnages oscillated wildly till the conclusion of the plan. In terms of the freight-mix handled by IR, such a mixture of trends would reflect retention of traffic share in bulk freight, which could not be transported in any case by means other than the railways, and alternating swings in IR realisations of low-bulk freight. Because economic uncertainty and high rates of inflation also characterised this period, freight downswings in low-bulk traffic reflected indifferent production trends in the originating industries more than any shift of these traffic categories to the roadways.

Another infrastructural characteristic of the economic crisis induced by the first Oil Shock related specifically to the carriage of coal freight by IR. In India as in the UK, both of which till then had no major identified petroleum reserves, the crushing economic pressures caused by the rise in world oil prices induced a wave of oil-replacement technology giving a new lease of life to the coal mining sector, as well as providing a fillip to offshore petroleum exploration which led eventually to the location of significant petroleum reserves in the North Sea (UK) and Bombay High (India). Raisings of coal in India thus rose from only 55.2MT in 1960-61 and 76.3MT in 1970-71 to 263.46MT in 1996-97.[7] Because of the urgent need to develop short-run power capacity in India without making recourse to oil-fired technology, the policy stress veered towards thermal alternatives which demanded that vast quantities of coal be freighted by IR. On the other hand, the slow augmentation of freighting capacity in the 1960s had left IR with very little capacity-margin to handle this suddenly manifested traffic demand. While the high priority accorded to coal transportation from mining pitheads to thermal power plants resulted ultimately in the displacement of other traffic categories from IR because of consequent wagon shortages, availability of wagons during the 4FYP was still not adequate to maintain power generation at desired levels. A vicious circle accordingly ensued, with IR being unable to transport required quantities of coal to maintain power generation, power supply being consequently inadequate to maintain fast electric railway traction, and the inability of IR to transport electrified coal-rakes aggravating the overall shortage of coal at the power plants. Subsidiary impacts also followed from the substitution of electrified rakes by diesel traction which substantially raised IR fuel costs, and from power disruptions that badly affected industrial production across the Indian economy. The ultimate consequence of the revised fuel economics following the first oil shock was the raising of freight tariffs by IR, the sharper increase in tariff rates for non-subsidised low-bulk freight encouraging its subsequent migration to other modes of transport. It becomes quite obvious from the foregoing analysis that the seeds of the eventual IR freight policy turnaround towards the carriage of bulk freight and the specialisation of IR freightage capacity towards this task had already been sown by the end of the 4FYP, even though actual policy reformulation occurred at the beginning of the 1980s.

The 5FYP accordingly directed that IR improve its bulk handling capabilities and the railways consequently allocated a much higher percentage of plan funds towards this end, spending mainly on the acquisition of modernised wagons and traction. Allocations on rolling-stock also jumped sharply in absolute terms from Rs.587.47 crore to Rs.782.28 crore between 4FYP and 5FYP, the changed freight-mix with a higher component of bulk freight providing some indication of the degree to which IR capacity adaptation had occurred over the 1970s. Several additional hurdles to freight efficiency had however been counterposed by modernisation of IR signalling and communication equipment during the 4FYP under the CTPC recommendations, in the absence of adequate and supportive handling facilities for its optimum utilisation. Elaborating on these inadequacies, the Draft 5FYP document listed loading and unloading difficulties that created impediments to the movement of block-rakes and unduly detained railway wagons at freight terminals; marshalling difficulties that arose from the incompatibility of coupling arrangements between upgraded and traditional IR wagons; periodic power shortages; as well as the physical scarcity of covered wagons which were essential to the movement of foodgrains, fertilisers, cement and other general freight categories. Along with rising railway costs and shifts in traffic patterns, these were held collectively responsible for the slow growth manifested by IR traffic and freight revenues in the immediately preceding period.[8]

The submission of the NTPC report on integrated transportation for India coincided with the launching of the 6FYP. Acknowledging the content of the report, the 6FYP conceded that it would be difficult to precisely match the growth of transportation services with growing transportation demand in the economy, and accordingly endorsed the funneling of infrastructural investment into the transportation sector in large indivisible units that would prevent the recurrence of transportation bottlenecks which had plagued economic performance over the 4FYP and 6FYP.[9] It was noted that these bottlenecks had occurred because insufficient resilience existed on the IR system to cope with sudden and unforeseen freight fluctuations and alterations of traffic patterns. Besides the physical enhancement of IR's freight capacity, the 6FYP thus laid new emphasis on improving railway productivity through better utilisation of IR assets, recommending operational modernisation through the running of heavier and more efficient freight operations with a focus on traffic containerisation and the running of full trainloads.[10] The 6FYP projected an increase of over 40 percent in IR tonnage traffic over the plan, after taking account of changes in traffic leads that would accrue from the relocation of major thermal power projects to mining pitheads as well as the changing regional patterns of production. Since more than four-fifths of this tonnage increase was anticipated to come from core traffic segments such as coal, cement, iron ore and iron & steel, this meant that IR would have to continue to meet the specialised freighting needs of the core economic sectors. Hence, while it was also deemed desirable that IR develop adequate general freight capacity to cover all medium and long-haul freight segments in a longterm perspective, the constraints being experienced in traffic acquisition and plan finance led to the recommendation that piecemeal or 'smalls' traffic in the medium and short-distance segments be left to the roadways sector as an interim measure.[11] A need for greater intermodal coordination was stressed, so that the available IR wagonfleet could be utilised preferentially for the haulage of long-lead freight traffic. In view of this exigency, the 6FYP allowed the deregulation of roadways through liberalisation of the national permit system for roadways freight operators.

Against targeted levels of 5-6 percent p.a, IR freight operations grew by 3.1 percent p.a. in tonnage terms and 3 percent p.a. over the 6FYP period. Seven bulk commodities, namely coal, iron & steel, iron ore exports, foodgrains, POL, cement and fertilisers were found to contribute 80 percent of IR's total originating traffic and 75 percent of total IR freight traffic. Noting that two-thirds of IR freight traffic and half of IR passenger traffic was now being moved along the corridors which connected the 'golden quadrilateral', the 7FYP attributed the growing congestion of IR's HDC routes to longterm alterations in the spatial distribution of economic activity and in the patterns of freight movement.[12] For the spatial rebalancing of IR operations, more importance was accorded by the 7FYP to the development of alternative routes than to addition of freighting capacity to saturated IR routes. On routes other than these, a more cautious approach was suggested, which included the optimisation of freight operations on the IR's long-neglected MG network. In part, this reflected the NTPC's adverse observations on IR's expensive programme of gauge conversions.[13] Grave note was also taken of the growing backlog in the replacement of obsolete and overaged IR assets because of the diversion of physical and financial resources to new IR projects. Observing that railway transportation capacity had frequently lagged behind desired levels of adequacy because of past underinvestment on the IR network, and had led to repression of freight demands in the economy, the 7FYP review pointed out pertinently that nearly half of the IR plan outlay was absorbed in the maintenance of capacity on the system rather than in capacity enhancement, leading to correspondingly high capital needs.[14] In view of the long life of railway assets, increased emphasis was accordingly laid on technological modernisation of the railway infrastructure during the phased process of asset replacement. In physical terms, the 7FYP anticipated an increase of 91MT in IR tonnage freight, against which increased freight realisation over the plan amounted to 70MT in 1989-90.[15] The shortfall was mainly because of short offer of bulk commodities like coal, foodgrains and iron & steel, which could not be adequately made up by reassignment of IR freighting capacity to other commodity freight. It was thus observed that hardly any slack existed on the IR system because of the location-specific nature of railway assets, and that IR plans would have to adopt a systems approach under which freight capacity expansion would have to focus on the development of alternate routes and new traffic regions so as to reduce the overall transport coefficients of the Indian economy.[16]

6.1.2 IR Traffic Performance in the Post-Reform Period

As observed in more recent reviews, railway planning in India has also been severely constrained by the lack of a coherent policy on multimodal transportation. Although certain manifestations of the current crisis, which are visible in the overcrowding of passenger services and congestion pressure on the HDCs from rising volumes of freight traffic have been frequent subjects of comment, the existence of corresponding slack in other parts of the IR network in terms of poorly utilised track, rolling stock, personnel and other physical forms of IR infrastructure has been less noticed. However, hidden slacks of this genre are particularly in the context of IR's fading presence in the general freight market, since vide the Railway Budget in 1997-

98, IR freight revenues contribute Rs.19822 crore or over 70 percent of IR gross revenue earnings of Rs.27855 crores.[17]

Traffic growth in IR's freight operations over the 8FYP was projected at 5 percent p.a, against the annual growth rate of 5.6 percent projected for the national economy over this duration. However, during the period between 1991-94 which coincided with the introduction of structural reforms in the Indian economy, revenue-earning freight tonnages stagnated between 350MT to 358MT, until increased agricultural and industrial production stimulated them to reach the level of 410MT of originating freight in 1996-97, relatively close to the original 8FYP projection of 418.4MT. Commencing in 1997-98, the 9FYP projected this to rise at the rate of 5 percent p.a. to the level of 525MT by the end of the plan.[18] Recurring anomalies in such FYP projections of anticipated IR freight traffic are attributable to the lack of reliable projective data on railway freight offers. Subsequent inadequacies in freight demand frequently put IR freight revenues under severe stress and create pressure for the escalations of IR tariffs in order to make up the revenue shortfall and to finance the internal resource demands of the plans. In the long term, such tariff escalations have served to drive more freight traffic away from IR Thus the steep hike in railway rates and fares in the Railway Budget for 1992-93, which was admittedly the result of the mismatch between IR freight revenue targets and realisations, was also responsible for the subsequent non-realisation of the freight levels targeted by the 8FYP.

In 1980, at the time of commencement of the 6FYP, the NTPC had projected an ultimate modal split of 72:28 in long-distance freight traffic between IR and the roadways at the turn of the century. Subsequent freight performance by IR has not matched these expectations, and the 9FYP review was compelled to acknowledge that the modal share of IR in total freight movements had undergone substantial decline over the planning era, dwindling from 89 percent in 1951 to only 40 percent in 1995. Despite the more energy-efficient and environment-friendly transportation alternative provided to the country by the railways, this freight leeway has been compensated by unplanned expansions in the roadways sector, particularly after deregulation of the roadways and the rapid erosion of IR's erstwhile freight monopolies. Entry of the roadways into the contested freight segments has involved spiralling energy costs as well as rapid increase in atmospherical pollution. The system of administered prices for POL products, particularly for diesel, has contributed until recently to the mushrooming growth of this sector, driven also by the same easy lease-financing market that has increased the demand for the automobile in India.

6.1.3 The Emergence of Intermodal Competition

Apart from the factors just reviewed which have affected freight performance by IR, it is also of critical consequence that the nascent roadways sector in India was able to draw a considerable volume of non-bulk freight away from IR over the planning period, reducing thereby the overall IR share in total freight traffic. The outline of roadways development in India at the commencement of this study had noted that the phenomenal rise in the number of roadfreight vehicles from 82 thousand to 1.61 million between 1950-51 and 1991-92 was accompanied by near-quintupling of the road network within four decades from the institution of planning. While the contribution made by the FYPs towards this growth was limited almost entirely to construction of 1.9 million km of trunk and feeder roads, institutional sharing of the vehicular costs of roadways development through liberal lease-financing of vehicle acquisition led to gradual emergence of the private sector as a major operator on the Indian freight market. Although a large part of the resultant growth in roadfreight capacity was absorbed by the new production streams generated within the economy, it was inevitable that a point would be reached after which the two transportation modes came into serious competition with each other. Such a point appears to have occurred within the second planning decade. Thus over eight years following the 3FYP, the traffic volumes carried by roadfreight had almost doubled from 34 billion tonne-km in 1965-66 to around 65 billion tonne-km in 1973-74. Further corroboration of freight competition is offered by the tonnage trends of revenue-earning IR traffic. Thus while originating tonnages in eight bulk commodities, namely coal, iron & steel, mineral ores, stones, cement, fertilisers, foodgrains and POL, rose from 124.7MT in 1965-66 to 136.4MT in 1971-72, non-bulk tonnages were bid away from IR by the roadways over the period and physically declined from 37.3MT to 33.7MT.[19] The process of traffic polarisation was further accelerated by technological specialisation within IR, as a result of which bulk tonnages climbed to 350.9MT or 96.2 percent of total IR tonnages in 1994-95 against the decline of non-bulk tonnages to just 14.2MT or 3.8 percent. [*cf. ch3, Table 3.4*] The extent of polarisation is made clear by comparing traffic situations across time. While downstream development within the Indian economy has led to expanded production of non-bulk commodities, most of this traffic has been handed over to the roadways sector. Despite offering a competitive rate structure, physical tonnages of non-bulk freight on IR have dropped by over 23MT between the end of the 3FYP and the commencement of the 9FYP. As non-bulk freight also constitutes the most profitable freight segment, the financial gains from traffic specialisation by IR have accrued entirely to the roadways as IR has gradually withdrawn from the competition.

With the narrowing of IR freight services, they have become increasingly tied to the transportation needs of the eight bulk commodities listed above. The share of these commodities in revenue-earning freight tonnages had risen from 58 percent in 1950-51 to over 91 percent in 1989-90. Some commodities - particularly coal, cement, steel and POL - have also traditionally figured as a backward linkage in the non-revenue freight carried by railways by virtue of their being railway important inputs. However, the proportion of non-revenue tonnages in total IR originating freight had already fallen from the high level of 21 percent in 1950-51 to 13.5 percent in 1971-72, mainly because of the lowering of IR coal demands resulting from gradual phasing out of steam traction. It was anticipated during the 4FYP that non-revenue tonnages could be further reduced by the electrification and dieselisation of IR routes during subsequent plans, thus reducing the need for transporting coal to meet the internal demands of traction. Nevertheless, two-thirds of actual non-revenue originating tonnages and nearly 90 percent of non-revenue traffic through the 1970s still comprised coal for traction purposes. Incidentally, coal also accounted for a third of total (*revenue* plus *non-revenue*) freight traffic carried by IR both in terms of originating tonnages as well as tonne-km traffic.[20]

6.1.4 IR Response to Freight Competition

Non-bulk tonnages have invariably registered slower growth rates on IR, their overall physical increase between 1FYP and 4FYP (1971-72) being a mere 3.1MT. Their proportionate share in IR's revenue-earning freight declined from 42 percent to 20 percent over this 20-year period, contributing to the dwindling of railway profits from this high-rated freight segment. Despite offering competitive rates, railway services in India are in any case not in a position to compete directly with the roadways on speed, safety, handling economy and reliability of the freight service extended to high-valued non-bulk traffic. Certain inherent railway freighting constraints arising from limited tracklength and route alignments, restricted availability of railway wagons, and the legal liability to lift all forms of traffic without showing undue preference towards given consignors or given freight consignments have also affected the magnitude of IR responses to intermodal competition. The Preferential Traffic Schedule adopted by IR in fact accords highest traffic priority to consignments belonging to government and to the defense services, as also to essential bulk commodities and strategic industrial raw materials of agricultural and mineral origin.[21] Constraints on IR transportation capacity have also emerged as a result of heavy concentration of freight traffic at a few selected terminals and along busy arterial routes of the so-called High Density Corridor [HDC] - some 10 percent of the freight terminals on the IR system already generating as much as 90 percent of originating freight by the late-1970s.[22]

Successive IR plans have attempted to surmount such constraints through progressive electrification and dieselisation of routes and other technological measures aimed towards increasing the efficiency of utilisation of railway track, wagons and traction, although even technology has failed to offer easy solutions to the problem of recovering freight share for the railways. Since the 1980s however, IR has also occasionally opted for piecemeal measures aimed at recovery of high-rated non-bulk traffic. The strategies so far included in this effort have been the development of a freight-marketing and sales organisation, special running of fast and superfast goods rakes, and consolidation of small parcel loads or traffic smalls into more economic wagonloads and trainloads through introduction of container services by its corporate subsidiary CONCOR [Container Corporation of India] and by the 'freight forwarders' scheme which allows third-party consolidation and consignment of freight to selected IR terminals. Other competitive measures include the adoption of special station-to-station rates for particular freight classes, along with more regularised commitment of wagons in adequate numbers and augmentation of terminal facilities, etc. While no physical recovery of traffic share from the roadways appears to have resulted, initiatives like these at least partially arrested further erosion of traffic share in the profitable categories. The resumed outflow of non-bulk freight to other transportation modes during and after the 6FYP are therefore as much the result of tariff pressures as of traffic constraints.

In sum, the evolution of freight operations in India after the institution of development planning provides strong evidence of polarisation of IR freight services towards the freighting needs of a selected group of bulk commodities. It may be wondered whether this polarisation has been achieved accidentally or through planning intent. Although railway tonnage-tariffs in bulk categories tend to be much lower than other tariff rates, the share of these selected bulk commodities in revenue-earning originating tonnages has increased from 58 percent to nearly 90 percent over the planning period. In spite of traffic polarisation, IR has constantly opted for technological strategies that attract more traffic in bulk categories. Through such means it has consolidated its monopolistic grip over captive traffic, while forcing other freight to leave the railways.

6.2 IR Wagon-loading Trends

The freight flows of an economy are a spatial manifestation of the resource allocation process. Limitations and constraints in the growth of these flows and their directional balance are indicative of the health of the economy which requires these transportation services. Hence freight flow data subsume the sectoral linkages and bottlenecks of an economy. Longitudinal data of credible length are available for wagon loadings of some of IR's freight commodities, which can be utilised to explore the underlying intersectoral relationships. These are presented below in Tables 6.1*a* and 6.2*a*. It may be noted that the wagon-loading series include both originating and transhipment loadings of commodities over the entire IR system. Thus a number of factors that influence the character of railway freight operations are implicitly present in the data. *Ceteris paribus*, the increasing average freight leads observed for most IR freight commodities would imply that the same originating consignments are being carried for progressively longer freighting distances in terms of tonne-kilometres. Transhipment loadings would undergo a decline in such a context. However transhipment loadings on IR are also a relic of the dual gauge system that exists on Indian railways. Where commodity leads are large and the concerned commodity has an all-India distributional character, transhipment of the commodity consignment is often necessary for to reach it to regions not covered by the BG network. Another characteristic implicit within the wagon loading dataset captures the freight impact of the gradual phase-out of MG operations and gauge conversion by IR. Extension of the BG network reduces the need for transhipment and extends commodity leads because of the uninterrupted flow paths offered to long-haul traffic. On the other hand, the crowding of railway freight services by long-haul traffic displaces the short-haul commodity flows that were the mainstay of MG feeder services from the extended network

6.2.1 Commodity-loading Trends: *A Visual Preview*

Because of the consolidated character of data available, the BG and MG wagon loading datasets for IR reproduced in the tables have a certain degree of overlap because of the unavoidable inclusion of freight transhipments along with loadings of originating freight for both IR gauges. Although transhipments may also occur in small measure within a single gauge network, particularly for parcel categories of traffic, the major part of transhipment loadings on IR conducted at notified break-of-gauge points and are inter-gauge in nature because of distinctness between the respective transport domains of the BG and MG networks. Transhipment as such can occur from BG to MG or vice-versa as the need arises. However with rising BG leads and the secular decline of MG operations over the planning period, it is mainly in the latter direction that transhipment still takes place. The volume of freight transhipment in 1991-92 thus amounted to only 5.6 percent of total originating freight, nearly two-thirds of which was transhipped from MG to BG.[23] It may be noted contextually that the gross tonnage-terms in which many of IR's targets and performance statistics are presented also subsume freight transhipment since they include freight loadings at break-of-gauge points as originating tonnage.[24] Overall, however, intergauge transhipments on IR have declined in volume over the 35-year period of study because of factors like bulk-freight specialisation and expanding traffic leads, and because of the extent of gauge-conversion that has occurred over the FYPs to bring efficiency to long-haul freight operations. Another equally contributory factor to the reduction of transhipment has been the rising proportion of upgraded and specialised wagons in the IR fleet, which has in fact reduced IR's capability to cater to heterogeneous commodity-freight. In general, wagon loadings in later periods reflect growing proportions of originating loadings vis-a-vis transhipments, and with increases over time in the average freight-capacity per wagon, unit wagon loadings in more recent periods also imply higher tonnage equivalents.

Table 6.1*a*: Railway Wagon Loadings of Commodities (1955-56 to 1988-89)
BROAD GAUGE ORIGINATING & TRANSHIPMENT LOADINGS
[Thousand wagons: 4-Wheeler Equivalents]

Year	GPulses	OSeeds	Tea	RCott	CottMf	RJute	JuteMf	SCane	Sugar	CCoke	MnOre	OMOre	IOre	ISteel	Cement	Total BG Loadings
1955-56	346.6	68.6	14.3	40.9	25.5	54.3	11.3	79.3	51.6	955.6	64.6	8.7	180.3	168.4	149.6	2219.6
1956-57	357.6	68.1	14.7	40.4	23.1	73.0	9.1	96.9	60.0	1021.6	78.5	16.6	195.4	187.7	160.1	2402.8
1957-58	418.2	66.1	12.1	37.5	20.9	73.6	8.7	84.3	64.2	1069.4	85.2	16.9	214.6	231.2	188.0	2590.9
1958-59	445.9	62.2	11.4	33.4	15.0	74.2	7.6	48.0	54.4	1187.9	47.5	10.6	237.9	248.8	176.5	2661.3
1959-60	468.9	62.2	13.5	31.0	15.0	74.5	8.2	61.9	53.9	1195.6	54.7	12.5	362.3	275.6	211.3	2901.1
1960-61	454.9	59.1	13.4	30.4	13.3	56.1	7.6	65.5	55.5	1336.8	57.7	12.4	446.4	310.2	213.0	3132.3
1961-62	430.2	55.8	12.8	22.6	11.2	62.5	6.2	60.7	59.0	1442.7	59.7	16.7	509.0	344.9	206.1	3300.1
1962-63	427.2	59.6	13.2	23.5	10.8	76.3	7.5	48.9	67.0	1639.7	58.8	30.5	623.9	406.5	209.0	3702.4
1963-64	506.3	63.9	11.3	22.4	9.9	75.1	7.1	38.0	59.4	1771.3	52.1	30.6	650.4	466.4	226.5	3990.7
1964-65	462.3	51.2	10.4	19.6	5.5	60.0	7.9	39.7	54.5	1731.9	62.7	35.1	653.4	481.8	249.0	3925.0
1965-66	488.6	56.2	13.7	26.0	5.6	76.7	8.7	34.6	58.4	1983.5	65.4	39.2	747.8	453.6	283.2	4341.2
1966-67	574.8	52.2	13.1	25.4	5.2	74.8	7.4	22.2	62.5	1978.2	55.5	41.4	778.3	415.5	286.8	4393.3
1967-68	523.6	48.0	12.0	24.4	5.2	98.2	8.8	23.7	41.1	2026.5	51.2	45.4	813.0	394.8	302.3	4418.2
1968-69	564.2	59.9	16.8	26.3	5.6	66.8	9.9	25.2	30.9	2174.7	49.8	55.2	904.2	423.8	320.1	4733.4
1969-70	532.5	53.9	10.4	25.5	5.3	75.0	10.4	36.7	37.7	2274.2	52.5	61.2	930.1	423.8	375.4	4904.6
1970-71	537.3	46.3	11.8	19.9	4.7	69.9	13.3	36.3	51.2	2102.8	49.2	60.2	942.1	401.9	387.1	4734.0
1971-72	542.2	44.4	16.9	25.3	5.2	71.8	16.2	22.2	48.8	2178.1	48.6	54.9	926.0	414.1	387.2	4801.9
1972-73	527.9	49.7	8.6	22.0	5.2	51.3	17.9	20.3	47.0	2247.3	47.6	52.8	952.8	448.1	368.1	4866.6
1973-74	503.1	37.4	9.8	23.7	4.1	48.3	14.6	19.8	51.9	2089.9	32.2	41.3	905.7	409.5	347.7	4539.0
1974-75	475.6	36.5	8.9	17.0	3.6	37.2	12.9	17.5	57.5	2410.9	40.8	46.0	974.4	427.2	325.3	4891.3
1975-76	558.2	45.2	5.4	19.4	3.6	45.2	21.0	19.0	74.3	2726.4	46.5	53.0	1128.3	461.4	418.2	5625.1
1976-77	656.3	46.3	5.1	10.8	1.7	41.9	14.6	16.4	65.1	2853.1	42.8	58.1	1178.6	534.7	492.8	6018.3
1977-78	626.4	29.4	3.8	12.4	1.7	36.7	12.7	16.9	52.7	2945.3	41.0	51.2	1192.3	490.1	465.2	5977.8
1978-79	550.5	29.9	3.3	15.6	1.2	30.2	12.1	21.0	53.1	2732.1	40.3	52.2	1192.7	471.1	412.7	5618.0
1979-80	604.0	30.7	2.5	17.4	0.6	29.7	16.4	9.1	39.6	2669.9	38.8	56.7	1120.1	443.3	312.1	5390.9
1980-81	616.6	25.0	3.5	18.2	0.5	21.5	20.0	11.2	52.4	2736.6	39.0	54.5	1178.0	450.7	303.2	5530.9
1981-82	747.9	23.1	1.9	10.2	0.6	14.7	16.5	10.6	52.3	3220.8	38.8	57.7	1238.0	511.8	339.2	6284.1
1982-83	866.4	20.4	1.4	12.2	0.3	19.0	18.3	11.7	59.4	3530.7	35.7	61.3	1221.3	492.1	417.9	6768.1
1983-84	876.4	18.6	1.4	9.0	0.3	11.5	14.6	7.5	67.6	3810.0	31.8	63.1	1124.0	426.3	516.4	6978.5
1984-85	748.9	19.5	0.6	7.2	0.2	6.7	15.0	4.0	62.7	3928.7	35.4	69.0	1223.9	439.4	583.3	7144.5
1985-86	857.2	21.7	1.3	11.5	0.3	7.8	15.7	2.5	107.9	4337.7	39.9	71.4	1305.4	471.7	631.4	7883.4
1986-87	1003.7	20.0	3.5	14.5	0.3	8.1	14.0	3.1	80.8	4582.1	38.7	74.0	1390.8	495.4	697.7	8426.7
1987-88	1024.8	12.0	3.5	8.4	0.1	6.4	7.6	3.7	79.7	4920.8	37.6	73.9	1384.2	501.3	780.9	8844.9
1988-89	873.5	9.0	1.6	7.0	0.3	5.7	9.6	3.1	62.8	5273.5	43.1	80.7	1465.7	501.5	936.5	9273.6
1989-90	822.5	11.4	5.1	6.3	0.5	2.6	7.8	3.0	71.0	5474.3	44.7	79.3	1596.0	497.2	1009.1	9630.8

Source: Compiled from various years *Basic Statistics Relating to the Indian Economy*, Central Statistical Organisation, Ministry of Planning, Government of India

Commodity Code:

GPulses = gram & pulses
OSeeds = raw jute
Tea = manufactured tea
RCott = raw cotton
CottMf = cotton manufactures
RJute = raw jute
JuteMf = jute manufactures
SCane = sugarcane
Sugar = manufactured sugar
CCoke = coal & coke
MnOre = manganese ore
OMOre = other metallurgical ores
IOre = iron ore
ISteel = iron & steel
Cement = cement

Table 6.1*b*: Inter-Commodity Correlation Matrix
BG WAGON LOADINGS

	GPulses	OSeeds	Tea	RCott	CottMf	RJute	JuteMf	SCane	Sugar	CCoke	MnOre	OMOre	IOre	ISteel	Cement
GPulses	*1*														
OSeeds	*-0.879*	*1*													
Tea	*-0.773*	*0.870*	*1*												
RCott	*-0.814*	*0.894*	*0.831*	*1*											
CottMf	*-0.726*	*0.820*	*0.707*	*0.902*	*1*										
RJute	*-0.820*	*0.900*	*0.884*	*0.791*	*0.624*	*1*									
JuteMf	*0.300*	*-0.435*	*-0.532*	*-0.363*	*-0.475*	*-0.454*	*1*								
SCane	*-0.775*	*0.843*	*0.723*	*0.881*	*0.959*	*0.676*	*-0.501*	*1*							
Sugar	*0.520*	*-0.385*	*-0.424*	*-0.365*	*-0.171*	*-0.490*	*0.052*	*-0.223*	*1*						
CCoke	*0.934*	*-0.927*	*-0.788*	*-0.873*	*-0.763*	*-0.860*	*0.285*	*-0.814*	*0.502*	*1*					
MnOre	*-0.675*	*0.780*	*0.716*	*0.778*	*0.820*	*0.681*	*-0.555*	*0.871*	*-0.127*	*-0.667*	*1*				
OMOre	*0.829*	*-0.847*	*-0.696*	*-0.850*	*-0.878*	*-0.696*	*0.462*	*-0.888*	*0.266*	*0.896*	*-0.696*	*1*			
IOre	*0.831*	*-0.907*	*-0.782*	*-0.922*	*-0.928*	*-0.779*	*0.491*	*-0.930*	*0.298*	*0.911*	*-0.785*	*0.956*	*1*		
ISteel	*0.659*	*-0.695*	*-0.624*	*-0.873*	*-0.929*	*-0.537*	*0.366*	*-0.876*	*0.202*	*0.707*	*-0.672*	*0.815*	*0.877*	*1*	
Cement	*0.842*	*-0.829*	*-0.645*	*-0.781*	*-0.656*	*-0.753*	*0.149*	*-0.710*	*0.479*	*0.956*	*-0.547*	*0.843*	*0.837*	*0.617*	*1*

Table 6.2a: Railway Wagon Loadings of Commodities (1955-56 to 1988-89)

METRE GAUGE ORIGINATING & TRANSHIPMENT LOADINGS

[Thousand wagons: 4-Wheeler Equivalents]

Year	GPulses	OSeeds	Tea	RCott	CottMf	RJute	JuteMf	SCane	Sugar	CCoke	MnOre	OMOre	IOre	ISteel	Cement	Total MG Loadings
1955-56	280.8	75.4	19.1	29.2	16.0	40.9	6.1	189.1	66.5	208.3	19.2	8.2	26.0	33.9	113.1	1131.8
1956-57	307.4	83.0	22.9	26.9	11.8	61.1	6.1	220.2	75.8	221.4	22.7	7.9	36.0	44.0	107.1	1254.3
1957-58	393.7	81.9	22.9	30.4	10.3	71.2	7.5	215.0	84.4	250.1	23.3	17.5	44.9	53.0	126.6	1432.7
1958-59	403.9	81.5	22.4	25.2	5.7	72.2	7.8	178.3	75.2	279.0	18.0	17.0	55.7	51.6	129.6	1423.1
1959-60	405.9	74.4	22.1	22.2	4.7	73.5	7.8	216.1	74.9	277.0	21.9	19.7	68.4	52.1	160.6	1501.3
1960-61	381.8	72.7	19.4	21.8	2.5	59.8	6.8	227.3	72.7	254.3	20.8	22.3	75.1	63.6	188.1	1489.0
1961-62	373.1	59.1	21.3	16.9	2.8	66.0	6.0	232.0	70.8	262.6	15.8	23.5	69.4	72.1	193.0	1484.4
1962-63	365.2	65.4	19.1	19.8	3.0	74.4	6.5	201.7	76.3	283.6	15.9	24.4	70.2	80.9	175.9	1482.3
1963-64	406.9	72.1	17.7	18.6	2.8	68.4	5.2	135.2	65.3	308.6	12.8	18.4	99.8	83.7	186.8	1502.3
1964-65	398.3	57.6	15.4	16.6	1.5	50.6	6.9	185.3	58.9	273.4	18.4	9.8	114.4	81.3	205.7	1494.1
1965-66	395.5	59.2	16.1	24.1	1.4	63.8	7.0	209.3	66.1	325.7	12.2	10.9	123.9	87.7	214.5	1617.4
1966-67	400.6	50.6	20.5	23.0	1.0	54.7	6.1	151.4	68.2	331.7	11.6	11.0	97.8	74.8	205.6	1508.6
1967-68	361.5	49.0	19.9	23.6	0.8	68.8	6.9	79.0	46.0	356.0	12.2	8.1	88.2	62.4	226.7	1409.1
1968-69	375.5	61.3	20.3	24.1	1.1	48.4	7.5	118.0	35.3	338.4	15.1	11.4	84.8	59.3	230.1	1430.6
1969-70	369.3	54.6	21.7	24.4	1.4	51.6	6.8	154.2	45.0	390.8	15.8	13.0	76.5	60.7	263.4	1549.2
1970-71	326.3	47.4	18.1	29.7	1.1	55.6	8.1	178.3	49.9	340.9	18.2	12.0	78.6	54.8	295.6	1514.6
1971-72	320.4	42.0	27.2	24.3	1.3	57.5	8.5	105.7	49.5	329.9	15.2	12.8	94.6	59.4	285.6	1433.9
1972-73	300.7	50.1	19.0	21.0	0.9	47.7	8.1	84.4	42.9	312.4	15.1	10.4	80.5	59.7	260.0	1312.9
1973-74	266.8	39.4	19.4	20.0	1.0	37.4	9.3	103.5	42.9	255.2	16.6	8.3	66.2	51.3	237.6	1174.9
1974-75	232.6	36.9	16.7	14.6	0.3	29.6	8.1	99.4	45.6	309.9	19.9	9.6	72.8	43.3	201.3	1140.6
1975-76	254.2	36.8	8.3	14.1	0.2	43.7	11.3	80.7	53.3	342.4	13.4	9.7	93.4	34.8	243.5	1239.8
1976-77	341.5	39.5	8.7	13.9	0.2	36.1	8.8	78.5	44.8	321.8	14.3	10.9	65.6	42.3	288.9	1315.8
1977-78	316.9	32.6	7.4	9.7	0.6	34.9	5.8	80.2	41.6	326.6	9.5	8.8	37.6	37.4	287.7	1237.3
1978-79	262.4	30.8	6.8	12.8	1.3	31.9	5.4	102.2	38.5	285.6	12.0	9.6	24.5	34.0	272.0	1129.8
1979-80	256.3	34.2	6.2	13.9	0.3	30.6	6.1	66.4	28.5	222.7	12.8	8.5	26.0	35.2	201.1	948.8
1980-81	226.5	29.2	6.6	12.7	0.4	23.1	6.7	57.5	31.4	191.5	11.0	8.1	31.1	29.4	196.8	862.0
1981-82	264.3	26.5	4.4	6.7	0.3	18.0	7.8	65.1	22.2	202.8	7.9	8.5	27.5	26.7	203.1	891.8
1982-83	311.9	24.7	2.6	7.6	0.5	15.7	6.0	82.5	27.4	226.6	7.8	7.3	23.2	24.5	192.3	960.6
1983-84	315.5	19.7	1.2	5.3	0.4	8.4	4.3	81.6	32.9	251.2	8.7	9.1	17.8	16.6	236.8	1009.5
1984-85	284.1	21.0	0.7	4.7	0.3	4.0	2.7	40.4	29.5	206.9	13.9	6.1	16.6	18.2	199.3	848.4
1985-86	304.3	19.9	0.1	5.9	0.4	6.0	2.2	57.6	34.7	193.5	10.6	8.4	26.2	14.8	201.3	885.9
1986-87	382.5	18.1	0.1	8.0	0.6	4.8	1.4	57.5	39.0	207.0	6.2	10.9	40.3	13.1	223.5	1013.0
1987-88	379.1	13.8	0.2	5.9	0.1	3.0	1.1	71.3	39.0	201.7	8.5	10.8	32.2	12.9	269.3	1048.9
1988-89	318.9	9.6	0.3	4.2	0.1	3.5	1.5	67.0	29.3	236.5	7.6	7.8	29.2	9.8	308.4	1033.7
1989-90	298.6	11.8	0.2	3.7	0.1	2.2	0.7	65.5	29.1	193.7	10.0	3.9	38.4	7.0	315.1	980.0

Source: Compiled from various years *Basic Statistics Relating to the Indian Economy*, Central Statistical Organisation, Ministry of Planning, Government of India

Commodity Code:

GPulses = gram & pulses
OSeeds = raw jute
Tea = manufactured tea
RCott = raw cotton
CottMf = cotton manufactures
RJute = raw jute
JuteMf = jute manufactures
SCane = sugarcane
Sugar = manufactured sugar
CCoke = coal & coke
MnOre = manganese ore
OMOre = other metallurgical ores
IOre = iron ore
ISteel = iron & steel
Cement = cement

Table 6.2b: Inter-Commodity Correlation Matrix

MG WAGON LOADINGS

	GPulses	OSeeds	Tea	RCott	CottMf	RJute	JuteMf	SCane	Sugar	CCoke	MnOre	OMOre	IOre	ISteel	Cement
GPulses	*1*														
OSeeds	*0.497*	*1*													
Tea	*0.392*	*0.862*	*1*												
RCott	*0.366*	*0.867*	*0.921*	*1*											
CottMf	*0.140*	*0.696*	*0.478*	*0.592*	*1*										
RJute	*0.515*	*0.900*	*0.907*	*0.862*	*0.421*	*1*									
JuteMf	*-0.089*	*0.521*	*0.644*	*0.615*	*0.131*	*0.640*	*1*								
SCane	*0.556*	*0.862*	*0.744*	*0.740*	*0.618*	*0.791*	*0.339*	*1*							
Sugar	*0.585*	*0.876*	*0.746*	*0.729*	*0.643*	*0.832*	*0.352*	*0.895*	*1*						
CCoke	*0.300*	*0.339*	*0.565*	*0.517*	*-0.179*	*0.589*	*0.585*	*0.229*	*0.260*	*1*					
MnOre	*0.180*	*0.808*	*0.771*	*0.757*	*0.625*	*0.689*	*0.528*	*0.744*	*0.724*	*0.222*	*1*				
OMOre	*0.598*	*0.626*	*0.551*	*0.429*	*0.212*	*0.681*	*0.250*	*0.693*	*0.716*	*0.238*	*0.453*	*1*			
IOre	*0.484*	*0.471*	*0.640*	*0.555*	*-0.122*	*0.672*	*0.528*	*0.432*	*0.472*	*0.739*	*0.326*	*0.365*	*1*		
ISteel	*0.534*	*0.738*	*0.809*	*0.719*	*0.148*	*0.876*	*0.561*	*0.686*	*0.674*	*0.640*	*0.503*	*0.600*	*0.839*	*1*	
Cement	*-0.175*	*-0.661*	*-0.379*	*-0.409*	*-0.717*	*-0.413*	*-0.178*	*-0.538*	*-0.595*	*0.297*	*-0.523*	*-0.343*	*0.076*	*-0.245*	*1*

Wagon loadings in the dataset are actually truer indicators of the magnitude of freight-handling operations on IR, since unlike tonnage-based railway indicators, they are not subject to upward biases over time on account of the higher proportions that IR bulk-freight handling has assumed. The point is important enough to merit further explanation. In the changing freight scenario of the railways in India, complacency about IR freight performance might easily develop around the visible uptrends in originating tonnages and net tonne-km [*see ch3*] that are often cited by railway authorities. But the overwhelming freight dominance acquired by a few bulk commodities during the planning period innately colours traffic assessments that are made in these terms, because identical tonnage and traffic levels at points widely separated in time can easily conceal the displacements made of low-bulk freight in order to accommodate these commodities. The truth of the matter may well be that identical tonnage handling in a changing freight scenario progressively involves a lowered quantum of wagon loadings if these represent loadings of bulk freight in replacement of lighter freight commodities. Again, identical net tonne-km levels, which in any case can also mask the secular increase in freighting leads, are further biased when bulk specialisation occurs.

The spatial and sectoral character of IR freight-flows also becomes manifest when crossgauge comparisons are made within the dataset. Because of locational confinement of the MG network to specified regions of the country, distinct differences may be observed between BG and MG freight-loading patterns, with presence or absence of heavy industrial raw materials and products in the regional railway freight-mix reflecting the level of development in the region served. In face of the overall constraint on IR freight capacity, the relatively less-developed regions served by MG freight operations appear to retain the older preindustrial freight configuration of the colonial railways with a higher presence of agricultural traffic, which regions served largely by BG operations have been forced to shed because of the swing to bulk freight. Sectoral input-output relations also appear between wagon loadings on both BG and MG networks, with increases in bulk raw material loadings on the former being matched further downstream by rising trends in the loading of heavy industrial products. A similar but converse association governs loadings of commodity inputs and outputs sourced from agriculture, which are seen to have been better retained by the MG network while being lost from the former. Visual insight into this phenomenon is provided in the grouped dataplots for freight-flows under the three sorted sectoral categories of mining & heavy industrials [*Fig 6.1a*], agricultural products and industrial raw material [*Fig 6.1b*], and light industrials [*Fig 6.1c*]. Aggregate [AG] wagon loadings for the third category show generally decreasing trends over the 35-year longitudinal timeframe, while the bulk category of mining & heavy industrials shows a phenomenal increase, indicating how the producer-goods segment of the economy has progressively become the principal client of IR, and how freight loadings in the mining category have come to dominate all IR freight-flows. More specific analyses of these spatial and sectoral freight patterns are however left to the next chapter.

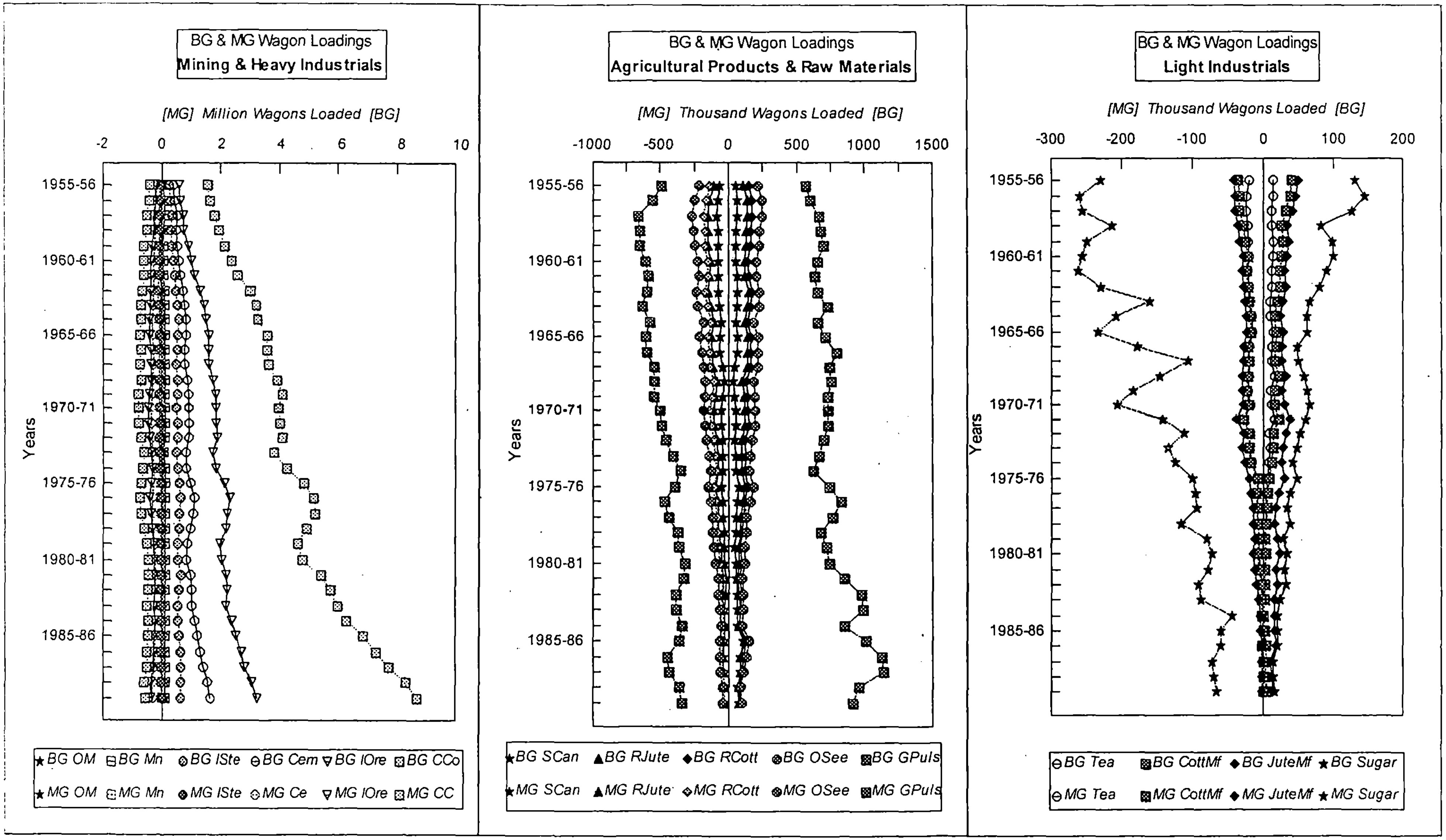
6.2.1a Mining & Heavy Industrials

Along with iron & steel and cement as finished products, commodities included in the mining & heavy industrials category in the dataplots comprise the ore-group made up of iron, manganese and other metallurgical ores as well as coal & coke - all of which hold special importance as inputs for the steel sector. With the single exception of manganese ore, wagon loadings for the group show pronounced upward time trends on the BG network. It may be noted also that the major part of BG bulk loadings in this commodity group is made up of coal & coke, iron ore, cement and iron & steel, in declining order. However, except for coal traffic which had attained freight dominance even at the commencement of the 2FYP when it comprised 43.1 percent of the BG loadings in the dataset, it is seen that the uptrend in loadings of the other three commodities is more recent and can in fact be ascribed to the developmental thrust provided by the Indian FYPs. However while coal & coke, iron ore, cement and iron & steel collectively comprised 65.5 percent of BG loadings in 1955-56, they reached a level of 89.1 percent by the end of the 7FYP, with individual proportions of 56.8 percent, 16.6 percent, 10.5 percent and 5.2 percent in BG wagon loadings. The most phenomenal increase is observed for BG loadings of iron ore where the proportion has more than doubled, indicating the degree to which the BG freight operations of IR have come to depend on traffic to and from the steel sector.

An observation might also be made in relation to the loadings of coal & coke. While at one time the railways were major consumers of coal for traction, their in-house consumption contributing coal tonnage of 19.5MT to non-revenue earning traffic at the beginning of the 3FYP, this had fallen by 1981-82 to 3MT,[25] and after

Figure 6.1 : Commodity Freight Trends on Indian Railways [1955-56 to 1989-90]
SECTORAL ANALYSIS

Fig 6.1a: Mining & Heavy Industrials | Fig 6.1b: Agricultural Products & Raw Materials | Fig 6.1c: Light Industrials



the virtual phasing out of steam traction has declined to just 0.60MT in 1994-95.[26] Thus while IR alone consumed more than a third of the total coal produced by Indian coalfields at the commencement of this period, its proportion today is not even 0.01 percent. The implication, accordingly, is that while iron ore loadings have risen phenomenally because of the development of the steel sector, the rise in coal & coke traffic has been nearly as phenomenal because of the conversion of sizeable non-revenue loadings of coal by IR for traction purposes into general loadings for downstream industry. After these factors are considered, the extent to which IR freight operations have become polarised around heavy industrials becomes pretty obvious.

Another prominent feature of IR bulk loadings apparent in the dataplot is that the same relative ordering of four major bulk commodities is also preserved by MG freight operations even though the quantum of loadings involved here is smaller. Because of this, the principal direction of transhipment is seen to be from BG to MG, since upstream or originating MG loadings alone cannot explain the huge number of BG wagons loaded. Rather, while the main traffic in the bulk commodities originates on the BG network, a part of it is transhipped onto MG for distribution purposes, and while certain other commodities are loaded as originating freight on MG return journeys, they do not necessarily tranship onto BG. Thus the older feeder role of the MG freight network has been progressively negated.

As has happened in most other countries during a certain phase in their development, the growth of bulk traffic on IR is intimately tied up with the growth of metallurgical industry in India, which while being the second-largest user of coking coal (including imports) in the country, also accounts for traffic in several other bulk commodities including mineral traffic in iron and manganese ores, as well as in limestone & dolomite which is not present in the dataset. By implication from this backward linkage, IR bulk traffic operations form the raw material artery of the Indian iron & steel industry which, after the power sector, accounts for the principal part of total IR freight tonnages and traffic. Over time and with transport policy changes, the linkages of IR freight operations to the Indian steel plants have become progressively closer. However unlike iron ore loadings which increased sharply over the 1980s, loadings of finished iron & steel remain relatively flat, reflecting the rise of iron ore exports during this period as mining capacity has outrun the domestic capacity for steel production.

The process by which this state of affairs has come about deserves special comment because of the serious reflection it has on the dimensions of the infrastructural crisis in India. While the major part in steelmaking capacity in India has come from the introduction of the highly capital-intensive blast furnace [BF] technology at 5 public-sector integrated steel plants [ISPs] that were established at Rourkela, Durgapur, Bhilai, Bokaro and Vishakhapatnam under the FYPs, domestic downstream demands for steel quickly outstripped domestic production, leading to a situation where imports of finished steel rose to 1.9MT in 1995-96 against iron ore production of 65.9MT, even as excess capacity still prevailed in the steel sector.[27] The primary reason for this vertical mismatch was the inability of IR to freight adequate quantities of imported anthracitic and coking coals to the ISPs for the beneficiation processes required to lower ash-content in the Indian coal used in blast furnaces. This combination of circumstances adversely affected the revenues of SAIL which controls the ISPs, and reduced the enthusiasm for new BF and open-hearth based steel plants, especially after political pressures led to the ISPs at Bhilai and Vishakhapatnam being located well outside the ore-belt (the Vishakhapatnam ISP in fact being port-based to dispense with the need for transporting inputs overland). Since the 7FYP, the planning thrust on creating domestic steel capacity has therefore been towards mini-steel plants [MSPs] using electric arc furnace [EAF] technology, in which the private sector is an eligible participant. Once again however, optimum utilisation of this new steelmaking capacity would have rested on IR's ability to freight adequate quantities of coal to the power plants. Rather than taking further chances on this, the national electricity policy was suitably modified to accommodate the establishment of pithead power plants in the Central sector, so that instead of infrastructural limits being posted by the amount of coal & coke freighted by IR, new limits could be set by the amount of electricity flowing along the national grid. From this perspective, the evolution of IR freight operations has differed markedly from that in other industrial countries, even though it resembles other major railway systems in its strong infrastructural linkage to metallurgical industry.

The fourth major bulk commodity in IR freight loadings, *i.e.* cement, is interesting because of the high presence it records in freight operations on both railway gauges. The need for transporting cement over long leads arises from the presence of basic construction demand in all regions of the country, while production of the commodity is localised in a few limestone-rich areas. Since most of the output from regional cement units is absorbed by local demand from within the region, transportation of cement to regions lacking mineral reserves and cement production facilities has to be made from a few states like Madhya Pradesh where settlement rates are low and production surpluses exist. Cement nevertheless is a difficult commodity to transport without the protection of covered wagons and intersects in this respect with other high-rated general freight. Increased IR loadings of cement are therefore liable to eat into the freighting capacity available for transporting general freight in both railway gauges, while also coming up against shortages in wagons of the desired type because of specialisation of the IR wagonfleet around the special wagons required for handling coal, iron ore, etc. The results can be paradoxical. Cement, with its long reverse leads, higher rates and full trainloads, and spatially well-dispersed freight demand becomes an important traffic category from the perspective of IR's revenues. However following IR's recent exercises at raising internal resources through the escalation of tariffs, cement traffic has become so sluggish - both on account of overpricing of the freight service and dearth of covered wagons - that IR in its recent Railway Budget has been compelled to offer a 10 percent discount on rates to the industry for freighting cement in non-specified or open wagons, in order to retain cement within its freight-mix and reduce the incidence of empty wagon-haulage.[28]

6.2.1b Agricultural Products & Raw Materials

Freight commodities under the second group, which are all sourced from the agricultural sector, comprise wagon loadings of grams & pulses and oilseeds in the category of foods, and raw cotton, raw jute and sugarcane in the raw material category. The position of grams & pulses is important to the purposes of the study. Although foodgrains constitute a principal part of IR freight movements under social objectives and are also accorded rate preference in this respect, loading figures for cereals like rice and wheat were unavailable. Hence, the freight patterns of grams & pulses can yield a partial picture of the impact of social constraints on IR freight operations, which is probably even more magnified in the case of cereals. To a lesser extent, this is also true for oilseeds and sugarcane, although these have to be freighted to mills for conversion before they become foods fit for public consumption. Edible oils thereafter become a constituent of higher-rated packaged freight. Although sugarcane resembles oilseeds in these characteristics, it is freighted over shorter leads to mills located in growing areas for industrial conversion to sugar and ultimately yields an unbranded freight product.

The two fibre commodities have been important traditional constituents in railway freight since the inception of freight services in India, and provided the backbone for industrialisation in the pre-Independence years. Railway movements of these commodities have influenced the location of industry in diverse ways. Weaving and cotton cultivation, once widespread in pre-industrial India, have gradually tended to concentrate on the West Coast because of the high productivity of cashcrops on its black cotton soils. Carriage leads in the raw fibre have consequently declined over time because of the location of textile industry close to growing areas. In the case of jute fibre, both cultivation and manufacturing were localised on the East Coast for natural reasons. However the carriage leads of the finished manufactures, which are part of the third group, have tended to expand because of high crosscountry demands for cotton textiles and gunny cloth.

From visual inspection it is clear that freight loadings of grams & pulses continue to retain importance in IR freight. This bears accord with the historical freight and rate priorities given to foodgrains transportation in a country where railways became the principal means of preventing the recurrence of famines. Evidence also obtains of the transference of grams & pulses loadings to the BG network as IR's MG operations were gradually circumscribed. Such evidence is not observed for the other commodities, except to a limited degree for oilseeds loadings. In more general terms, the presence of agricultural commodities and raw materials in IR freight traffic has declined steadily in proportional importance, except when these have been favoured by adequate wagon commitment and special rate concessions, and by freighting leads that run in reverse to the general traffic trend. Although grams and pulses are not distributed to consumers via India's PDS [public distribution] system, the position would hold even more strongly for government cereal stocks that are freighted almost entirely by railway to food-deficit states .

The decline of IR's feeder freight services following the downsizing of MG operations can also be taken visual note of. Freight operations on the MG network have been noticeably dominated by agro-commodities, which today have nearly vanished from IR freight. While the logic for this shift has evidently arisen within the development planning process which has placed a high premium on industrial freight, it has also meant that the spread of railway freighting services has retreated to the principal industrial corridors of the country. In view of the spatial character of transportation infrastructure in India where the MG network has served regions not attended to by BG freight, loss of MG freight loadings by IR has meant yet another gain for the Indian roadways, while also distorting the regional basis of equity in economic development. The rise in heavy industrial freight which has offset this freight-loss has also not accrued to the less-served regions, bringing about further inequities in regional development.

6.2.1c Light Industrials

Commodities in this category, which were all prominent industrial constituents of railway freight in the pre-Independence period, include jute and cotton manufactures as well as sugar and tea. Because of widespread demand, they have traditionally been freighted by IR over long leads from their localised points of manufacture. Of the four commodities, only sugar is accorded rate priority as an essential commodity and hence has been an important constituent in both BG and MG freight till recently. Along with grams & pulses, retention of this commodity has also been better on the MG network because of widespread demand and the rate priorities offered for PDS loadings. Wagon loadings of jute manufactures have also maintained a presence in BG freight because of widespread use of jute for packaging. On the other hand, the highly-rated freight loadings of tea and cotton manufactures have virtually disappeared. Recent railway traffic leads in these commodities have been remarkably high, indicating that except for very long-haul consignments, these have shifted over to the roadways.

6.2.2 Freight Adaptation & the IR Commodity-freight Mix

In the overall situation of freight restriction, there is considerable complexity in the manner in which IR's commodity flows have related to each other. The position is best summarised by considering the backward and forward linkages of railway freight flows. Against the mining outputs which feed raw materials to heavy industry, heavy producer-goods outputs are also fully catered to by IR since in most cases, the lead directions are also suitable. Saturation of the freight sectors served by these dominant commodities causes displacements elsewhere. The primary direction of freight displacement is witnessed in the industrial sector where light industrials have gradually been elbowed out of the IR freight-mix by heavy industrials because of the dearth of appropriate freighting capacity. The light industrial sector has strong backward linkages with the agricultural sector, and commodities such as textile manufactures and sugar have drawn considerable raw material support in the past from railway freight operations. Thus with the withdrawal of both forward and backward freight support, downstream growth in this economic sector is adversely affected. Considering that production targets for the heavy industrial sector have been set under the FYPs on the assumption of appropriate downstream growth, the mismatch between light and heavy industrials leads to coordination failures and to the accumulation of producer-goods inventories in a process somewhat reminiscent of Metzlerian cycles.[29] Thus even if IR freight operations are not the direct source of macroeconomic disequilibrium, they aggravate it by introducing downstream production cycles in the economy.

More complexity is added to the evolutionary patterns of freight by longterm economic development and consequent traffic change. Thus the freight patterns of commodities observed above have evolved around the achievement of foodgrains self-sufficiency during the 1970s. Despite this landmark, internal food surpluses originating in the northern breadbasket region still have to be freighted by railway to feed the rest of the country, and at times of agricultural adversity, these have also been supplemented by foodgrain imports carried over reversed leads from the major Indian ports. In spite of the progress of Indian agriculture, wide divergence in agroclimatic conditions over the Indian landmass ensures regional specialisation in production of agricultural commodities. Hence balancing movements of freight in critical agricultural commodities must still take place from surplus to deficit regions. Instead being further reduced therefore, the average lead of IR freight movements of foodgrains has climbed steadily to over 1300km in 1994-95,[30] and the increasing wagon loadings of grams & pulses in the dataset provide partial evidence of this.

The escalations in IR wagon-loadings observed over the 35-year period are nevertheless stronger for industrial commodities than for commodity freight in the agricultural group. An economic underpinning for this evolving

Table 6.3a: Commodity-influence on Gauge-wise IR Freight Loadings
OLS & Cochrane-Orcutt Adjusted Multiple Regression Results

	COMMODITY COEFFICIENTS															
	$\hat{b}_0$	$\hat{b}_1$	$\hat{b}_2$	$\hat{b}_3$	$\hat{b}_4$	$\hat{b}_5$	$\hat{b}_6$	$\hat{b}_7$	$\hat{b}_8$	$\hat{b}_9$	$\hat{b}_{10}$	$\hat{b}_{11}$	$\hat{b}_{12}$	$\hat{b}_{13}$	$\hat{b}_{14}$	$\hat{b}_{15}$
	Constant	GPulses	OSeed	Tea	RCott	CottMf	RJute	JuteMf	SCane	Sugar	CCoke	MnOre	OMOre	IOre	ISteel	Cement
ALLGAUGE ON BROADGAUGE [AG/BG]																
OLS $\hat{b}_i$	**672.38**	**1.49**	**7.84**	**8.07**	**-0.30**	**-33.54**	**4.60**	**-1.11**	**5.81**	**0.83**	**0.81**	**1.66**	**-1.47**	**0.70**	**1.69**	**2.20**
$t(\hat{b})$	2.74 *	6.77 **	2.75 *	1.50	-0.06	-3.29 **	3.41 **	-0.20	2.55 *	0.75	7.39 **	0.65	-0.57	3.10 **	3.32 **	8.30 **
C-O $\hat{b}_i$	**648.40**	**1.46**	**7.27**	**8.01**	**0.43**	**-43.11**	**5.36**	**0.70**	**8.27**	**1.03**	**0.83**	**0.54**	**-1.71**	**0.61**	**1.76**	**2.26**
$t(\hat{b})$	2.77 *	7.10 **	2.82 **	1.63	0.09	-3.92 **	3.61 **	0.14	3.37 **	1.02 *	7.63 **	0.22	-0.75 *	3.03 **	4.02 **	9.87 **
Change	*-23.98*	*-0.03*	*-0.57*	*-0.06*	*0.73*	*-9.57*	*0.76*	*1.81*	*2.46*	*0.20*	*0.02*	*-1.12*	*-0.24*	*-0.09*	*0.07*	*0.06*
ALLGAUGE ON METREGAUGE [AG/MG]																
OLS $\hat{b}_i$	**6965.47**	**3.94**	**-17.52**	**-31.08**	**-2.74**	**-26.36**	**-5.43**	**-169.08**	**-1.58**	**-3.94**	**-0.10**	**-23.14**	**17.54**	**17.55**	**-31.01**	**7.69**
$t(\hat{b})$	6.63 **	1.52	-0.95	-1.14	-0.10	-0.38	-0.39	-3.02 **	-0.52	-0.27	-0.04	-0.63	0.61	2.70 *	-2.95 *	2.76 *
C-O $\hat{b}_i$	**7244.25**	**2.45**	**-24.25**	**-45.09**	**9.33**	**145.11**	**-16.43**	**-164.91**	**-1.87**	**-15.67**	**1.33**	**-36.71**	**54.14**	**24.04**	**-24.85**	**7.41**
$t(\hat{b})$	8.14 **	1.10	-1.56	-1.93	0.41	1.78	-1.35	-3.50 **	-0.74	-1.21	0.59	-1.19	1.99	4.07 **	-2.73 *	3.14 **
Change	*278.77*	*-1.49*	*-6.73*	*-14.01*	*12.07*	*171.47*	*-10.99*	*4.17*	*-0.29*	*-11.74*	*1.43*	*-13.57*	*36.60*	*6.49*	*6.16*	*-0.28*
BROADGAUGE ON ALLGAUGE [BG/AG]																
OLS $\hat{b}_i$	**-109.43**	**0.74**	**-1.31**	**-0.83**	**-0.35**	**9.41**	**-1.10**	**-0.15**	**-0.12**	**0.73**	**1.09**	**1.77**	**1.03**	**1.17**	**0.28**	**0.32**
$t(\hat{b})$	-0.55	5.99 **	-1.25	-0.40	-0.16	2.68 *	-1.82	-0.05	-0.38	1.36	15.90 **	1.19	0.60	5.75 *	0.85	2.31 *
C-O $\hat{b}_i$	**-95.57**	**0.70**	**-1.72**	**-0.91**	**0.97**	**14.94**	**-1.44**	**-0.87**	**-0.12**	**0.64**	**1.08**	**0.20**	**1.19**	**1.17**	**0.55**	**0.34**
$t(\hat{b})$	-0.54	6.29 **	-1.81	-0.49	0.47	3.89 **	-2.55 *	-0.36	-0.42	1.35	17.60 **	0.13	0.79	6.46 **	1.79	2.77 *
Change	*13.86*	*-0.04*	*-0.41*	*-0.09*	*1.32*	*5.53*	*-0.34*	*-0.73*	*0.00*	*-0.09*	*-0.01*	*-1.57*	*0.16*	*-0.00*	*0.27*	*0.02*
BROADGAUGE ON METREGAUGE [BG/MG]																
OLS $\hat{b}_i$	**6965.47**	**2.94**	**-18.52**	**-32.08**	**-3.74**	**-27.36**	**-6.43**	**-170.08**	**-2.58**	**-4.94**	**-1.10**	**-24.14**	**16.54**	**16.55**	**-32.01**	**6.69**
$t(\hat{b})$	6.63 **	1.14	-1.00	-1.17	-0.14	-0.40	-0.46	-3.04 **	-0.86	-0.34	-0.42	-0.66	0.57	2.55 *	-3.04 **	2.40 *
C-O $\hat{b}_i$	**7245.58**	**1.44**	**-25.22**	**-46.12**	**8.35**	**144.15**	**-17.43**	**-165.98**	**-2.87**	**-16.66**	**0.33**	**-37.71**	**53.06**	**23.03**	**-25.83**	**6.41**
$t(\hat{b})$	8.14 **	0.65	-1.63	-1.98	0.36	1.77	-1.43	-3.52 **	-1.13	-1.28	0.15	-1.22	1.95	3.90 **	-2.84 *	2.72 *
Change	*280.11*	*-1.50*	*-6.71*	*-14.04*	*12.09*	*171.51*	*-11.00*	*4.10*	*-0.29*	*-11.72*	*1.43*	*-13.57*	*36.52*	*6.48*	*6.18*	*-0.28*
METREGAUGE ON ALLGAUGE [MG/AG]																
OLS $\hat{b}_i$	**109.43**	**0.26**	**2.31**	**1.83**	**1.35**	**-8.41**	**2.10**	**1.15**	**1.12**	**0.27**	**-0.09**	**-0.77**	**-0.03**	**-0.17**	**0.72**	**0.68**
$t(\hat{b})$	0.55	2.07	2.21 *	0.88	0.61	-2.40 *	3.48 **	0.42	3.52 **	0.50	-1.32	-0.52	-0.02	-0.82	2.21 *	4.81 **
C-O $\hat{b}_i$	**54.01**	**0.29**	**2.73**	**1.53**	**0.41**	**-12.73**	**2.51**	**2.13**	**1.16**	**0.35**	**-0.08**	**0.56**	**-0.54**	**-0.13**	**0.46**	**0.66**
$t(\hat{b})$	0.32	2,58 *	2.90 **	0.82	0.20	-3.85 **	4.24 **	0.94	4.22 **	0.80	-1.28	0.36	-0.39	-0.72	1.62	5.66 **
Change	*-55.42*	*0.03*	*0.42*	*-0.30*	*-0.94*	*-4.32*	*0.41*	*0.98*	*0.04*	*0.08*	*0.01*	*1.33*	*-0.51*	*0.04*	*-0.26*	*-0.01*
METREGAUGE ON BROADGAUGE [MG/BG]																
OLS $\hat{b}_i$	**672.38**	**0.49**	**6.84**	**7.07**	**-1.30**	**-34.54**	**3.60**	**-2.11**	**4.81**	**-0.17**	**-0.19**	**0.66**	**-2.47**	**-0.30**	**0.69**	**1.20**
$t(\hat{b})$	2.74 *	2.22 *	2.40 *	1.32	-0.27	-3.39 **	2.67 *	-0.39	2.11 *	-0.15	-1.76	0.26	-0.96	-1.34	1.35	4.53 **
C-O $\hat{b}_i$	**648.40**	**0.46**	**6.27**	**7.01**	**-0.57**	**-44.11**	**4.36**	**-0.30**	**7.27**	**0.03**	**-0.17**	**-0.46**	**-2.71**	**-0.39**	**0.76**	**1.26**
$t(\hat{b})$	2.77 *	2.24 *	2.44 *	1.43	-0.12	-4.01 **	2.93 **	-0.06	2.96 **	0.03	-1.55	-0.19	-1.19	-1.94	1.73	5.50 **
Change	*-23.98*	*-0.03*	*-0.57*	*-0.06*	*0.73*	*-9.57*	*0.76*	*1.81*	*2.46*	*0.20*	*0.02*	*-1.12*	*-0.24*	*-0.09*	*0.07*	*0.06*

*Note: Significances of computed regression coefficients are indicated at 95% confidence by * and at 99% confidence by ***
Theoretical t-values are $t_{19,\,0.05}$ = 2.09 at 95% confidence and $t_{19,\,0.01}$ = 2.86 at 99% confidence for OLS, with 19df. For the C-O regression, the corresponding values are $t_{18,\,0.05}$ = 2.10 and $t_{18,\,0.01}$ = 2.18 with 18df
Changes in commodity-coefficients as a result of applying the C-O correction are indicated for each regression set ..

Table 6.3*b*: Intercommodity Relationships in IR Freight Operations
Significant Freight Coefficients and 95% ConfidenceBands

COMMODITY COEFFICIENTS

ALLGAUGE ON BROADGAUGE [AG/BG]

	$\hat{b}_0$ Constant	$\hat{b}_1$ GPulses	$\hat{b}_2$ OSeed	$\hat{b}_3$ Tea	$\hat{b}_4$ RCott	$\hat{b}_5$ CottMf	$\hat{b}_6$ RJute	$\hat{b}_7$ JuteMf	$\hat{b}_8$ SCane	$\hat{b}_9$ Sugar	$\hat{b}_{10}$ CCoke	$\hat{b}_{11}$ MnOre	$\hat{b}_{12}$ OMOre	$\hat{b}_{13}$ IOre	$\hat{b}_{14}$ ISteel	$\hat{b}_{15}$ Cement
OLS (-)	*666.64*	*-12.68*	*2.08*	...	...	*-26.66*	*-2.53*	...	*0.48*	...	*-14.66*	...	...	*-5.79*	*-5.27*	*-15.18*
$\hat{b}_i$	**672.38**	**1.49**	**7.84**	...	...	**-33.54**	**4.60**	...	**5.81**	...	**0.81**	...	...	**0.70**	**1.69**	**2.20**
(+)	*678.12*	*15.66*	*13.61*	...	...	*-40.43*	*11.73*	...	*11.14*	...	*16.27*	...	...	*7.18*	*8.65*	*19.58*
C-O (-)	*642.59*	*-13.46*	*1.34*	...	...	*-34.87*	*-2.22*	...	*1.19*	*-1.13*	*-15.20*	...	*-0.13*	*-5.76*	*-6.68*	*-18.48*
$\hat{b}_i$	**648.40**	**1.46**	**7.27**	...	...	**-43.11**	**5.36**	...	**8.27**	**1.03**	**0.83**	...	**-1.71**	**0.61**	**1.76**	**2.26**
(+)	*654.21*	*16.38*	*13.21*	...	...	*-51.35*	*12.94*	...	*15.36*	*3.18*	*16.86*	...	*-3.29*	*6.97*	*10.20*	*23.00*

ALLGAUGE ON METREGAUGE [AG/MG]

	$\hat{b}_0$ Constant	$\hat{b}_1$ GPulses	$\hat{b}_2$ OSeed	$\hat{b}_3$ Tea	$\hat{b}_4$ RCott	$\hat{b}_5$ CottMf	$\hat{b}_6$ RJute	$\hat{b}_7$ JuteMf	$\hat{b}_8$ SCane	$\hat{b}_9$ Sugar	$\hat{b}_{10}$ CCoke	$\hat{b}_{11}$ MnOre	$\hat{b}_{12}$ OMOre	$\hat{b}_{13}$ IOre	$\hat{b}_{14}$ ISteel	$\hat{b}_{15}$ Cement
OLS (-)	*6951.59*	...	...	...	...	...	...	*-162.76*	...	...	...	...	...	*11.89*	*-24.83*	*1.92*
$\hat{b}_i$	**6965.47**	...	...	...	...	...	...	**-169.08**	...	...	...	...	...	**17.55**	**-31.01**	**7.69**
(+)	*6979.35*	...	...	...	...	...	...	*-175.41*	...	...	...	...	...	*23.21*	*-37.18*	*13.47*
C-O (-)	*7227.14*	...	...	...	...	...	...	*-157.57*	...	...	...	...	...	*15.48*	*-19.10*	*0.81*
$\hat{b}_i$	**7244.25**	...	...	...	...	...	...	**-164.91**	...	...	...	...	...	**24.04**	**-24.85**	**7.41**
(+)	*7261.35*	...	...	...	...	...	...	*-172.26*	...	...	...	...	...	*32.60*	*-30.59*	*14.01*

BROADGAUGE ON ALLGAUGE [BG/AG]

	$\hat{b}_0$ Constant	$\hat{b}_1$ GPulses	$\hat{b}_2$ OSeed	$\hat{b}_3$ Tea	$\hat{b}_4$ RCott	$\hat{b}_5$ CottMf	$\hat{b}_6$ RJute	$\hat{b}_7$ JuteMf	$\hat{b}_8$ SCane	$\hat{b}_9$ Sugar	$\hat{b}_{10}$ CCoke	$\hat{b}_{11}$ MnOre	$\hat{b}_{12}$ OMOre	$\hat{b}_{13}$ IOre	$\hat{b}_{14}$ ISteel	$\hat{b}_{15}$ Cement
OLS (-)		*-11.80*	...	...	...	*3.79*	...	...	...	...	*-32.18*	...	...	*-10.87*	...	*-4.52*
$\hat{b}_i$		**0.74**	...	...	...	**9.41**	...	...	...	...	**1.09**	...	...	**1.17**	...	**0.32**
(+)		*13.28*	...	...	...	*15.02*	...	...	...	...	*34.36*	...	...	*13.20*	...	*5.17*
C-O (-)		*-12.52*	...	...	...	*6.77*	*3.91*	...	...	...	*-35.89*	...	...	*-12.40*	...	*-5.47*
$\hat{b}_i$		**0.70**	...	...	...	**14.94**	**-1.44**	...	...	...	**1.08**	...	...	**1.17**	...	**0.34**
(+)		*13.93*	...	...	...	*23.12*	*-6.80*	...	...	...	*38.05*	...	...	*14.73*	...	*6.16*

BROAD GAUGE ON METREGAUGE [BG/MG]

	$\hat{b}_0$ Constant	$\hat{b}_1$ GPulses	$\hat{b}_2$ OSeed	$\hat{b}_3$ Tea	$\hat{b}_4$ RCott	$\hat{b}_5$ CottMf	$\hat{b}_6$ RJute	$\hat{b}_7$ JuteMf	$\hat{b}_8$ SCane	$\hat{b}_9$ Sugar	$\hat{b}_{10}$ CCoke	$\hat{b}_{11}$ MnOre	$\hat{b}_{12}$ OMOre	$\hat{b}_{13}$ IOre	$\hat{b}_{14}$ ISteel	$\hat{b}_{15}$ Cement
OLS (-)	*6951.59*	...	...	...	...	...	...	*-163.72*	...	...	...	...	...	*11.21*	*-25.64*	*1.67*
$\hat{b}_i$	**6965.47**	...	...	...	...	...	...	**-170.08**	...	...	...	...	...	**16.55**	**-32.01**	**6.69**
(+)	*6979.35*	...	...	...	...	...	...	*-176.44*	...	...	...	...	...	*21.89*	*-38.38*	*11.72*
C-O (-)	*7228.48*	...	...	...	...	...	...	*-158.59*	...	...	...	...	...	*14.83*	*-19.86*	*0.70*
$\hat{b}_i$	**7245.58**	...	...	...	...	...	...	**-165.98**	...	...	...	...	...	**23.03**	**-25.83**	**6.41**
(+)	*7262.68*	...	...	...	...	...	...	*-173.37*	...	...	...	...	...	*31.22*	*-31.80*	*12.12*

METREGAUGE ON ALLGAUGE [MG/AG]

	$\hat{b}_0$ Constant	$\hat{b}_1$ GPulses	$\hat{b}_2$ OSeed	$\hat{b}_3$ Tea	$\hat{b}_4$ RCott	$\hat{b}_5$ CottMf	$\hat{b}_6$ RJute	$\hat{b}_7$ JuteMf	$\hat{b}_8$ SCane	$\hat{b}_9$ Sugar	$\hat{b}_{10}$ CCoke	$\hat{b}_{11}$ MnOre	$\hat{b}_{12}$ OMOre	$\hat{b}_{13}$ IOre	$\hat{b}_{14}$ ISteel	$\hat{b}_{15}$ Cement
OLS (-)	...	...	*-2.31*	...	...	*-3.39*	*-5.18*	...	*-6.26*	...	...	...	...	...	*-3.90*	*-9.40*
$\hat{b}_i$	...	...	**2.31**	...	...	**-8.41**	**2.10**	...	**1.12**	...	...	...	...	...	**0.72**	**0.68**
(+)	...	...	*6.94*	...	...	*-13.43*	*9.38*	...	*8.50*	...	...	...	...	...	*5.34*	*10.75*
C-O (-)	...	*-5.13*	*-3.36*	...	...	*-4.65*	*-6.40*	...	*-7.71*	...	...	...	...	...	...	*-11.22*
$\hat{b}_i$	...	**0.29**	**2.73**	...	...	**-12.73**	**2.51**	...	**1.16**	...	...	...	...	...	...	**0.66**
(+)	...	*5.70*	*8.83*	...	...	*-20.81*	*11.41*	...	*10.03*	...	...	...	...	...	...	*12.55*

METREGAUGE ON BROADGAUGE [MG/BG]

	$\hat{b}_0$ Constant	$\hat{b}_1$ GPulses	$\hat{b}_2$ OSeed	$\hat{b}_3$ Tea	$\hat{b}_4$ RCott	$\hat{b}_5$ CottMf	$\hat{b}_6$ RJute	$\hat{b}_7$ JuteMf	$\hat{b}_8$ SCane	$\hat{b}_9$ Sugar	$\hat{b}_{10}$ CCoke	$\hat{b}_{11}$ MnOre	$\hat{b}_{12}$ OMOre	$\hat{b}_{13}$ IOre	$\hat{b}_{14}$ ISteel	$\hat{b}_{15}$ Cement
OLS (-)	*666.64*	*-4.17*	*1.82*	...	...	*-27.45*	*-1.98*	...	*0.40*	...	...	...	...	...	...	*-8.28*
$\hat{b}_i$	**672.38**	**0.49**	**6.84**	...	...	**-34.54**	**3.60**	...	**4.81**	...	...	...	...	...	...	**1.20**
(+)	*678.12*	*5.15*	*11.87*	...	...	*-41.64*	*9.18*	...	*9.22*	...	...	...	...	...	...	*10.69*
C-O (-)	*642.59*	*-4.25*	*1.16*	...	...	*-35.68*	*-1.80*	...	*1.05*	...	...	...	...	...	...	*-10.30*
$\hat{b}_i$	**648.40**	**0.46**	**6.27**	...	...	**-44.11**	**4.36**	...	**7.27**	...	...	...	...	...	...	**1.26**
(+)	*654.21*	*5.17*	*11.39*	...	...	*-52.54*	*10.53*	...	*13.50*	...	...	...	...	...	...	*12.83*

Note: Positive (+) and negative (-) probability limits are defined for freight coefficients at 95% confidence by $\{\hat{b}_i \pm s.e.(\hat{b}_i)t_{0.025}\}$

Table 6.3c: Intercommodity Relationships in IR Freight Operations
Significant Freight Coefficients and 99% Confidence Bands

	COMMODITY COEFFICIENTS															
	$\hat{b}_0$ Constant	$\hat{b}_1$ GPulses	$\hat{b}_2$ OSeed	$\hat{b}_3$ Tea	$\hat{b}_4$ RCott	$\hat{b}_5$ CottMf	$\hat{b}_6$ RJute	$\hat{b}_7$ JuteMf	$\hat{b}_8$ SCane	$\hat{b}_9$ Sugar	$\hat{b}_{10}$ CCoke	$\hat{b}_{11}$ MnOre	$\hat{b}_{12}$ OMOre	$\hat{b}_{13}$ IOre	$\hat{b}_{14}$ ISteel	$\hat{b}_{15}$ Cement
ALLGAUGE ON BROADGAUGE [AG/BG]																
OLS *(-)*	...	*-17.88*	...	...	...	*-24.13*	*-5.15*	...	...	...	*-20.33*	...	...	*-8.17*	*-7.83*	*-21.56*
,	...	**1.49**	...	...	...	**-33.54**	**4.60**	...	...	...	**0.81**	...	...	**0.70**	**1.69**	**2.20**
(+)	...	*20.86*	...	...	...	*-42.96*	*14.35*	...	...	...	*21.94*	...	...	*9.56*	*11.20*	*25.96*
C-O *(-)*	...	*-18.98*	*-0.86*	...	...	*-31.83*	*-5.02*	...	*-1.43*	...	*-21.13*	...	...	*-8.11*	*-9.81*	*-26.15*
,	...	**1.46**	**7.27**	...	...	**-43.11**	**5.36**	...	**8.27**	...	**0.83**	...	...	**0.61**	**1.76**	**2.26**
(+)	...	*21.90*	*15.40*	...	...	*-54.39*	*15.74*	...	*17.98*	...	*22.80*	...	...	*9.33*	*13.32*	*30.67*
ALLGAUGE ON METREGAUGE [AG/MG]																
OLS *(-)*	*6946.50*	...	...	...	...	...	...	*-160.44*	...	...	...	...	...	...	...	...
,	**6965.47**	...	...	...	...	...	...	**-169.08**	...	...	...	...	...	...	...	...
(+)	*6984.44*	...	...	...	...	...	...	*-177.73*	...	...	...	...	...	...	...	...
C-O *(-)*	*7220.81*	...	...	...	...	...	...	*-154.85*	...	...	...	...	...	*12.31*	...	*-1.64*
,	**7244.25**	...	...	...	...	...	...	**-164.91**	...	...	...	...	...	**24.04**	...	**7.41**
(+)	*7267.68*	...	...	...	...	...	...	*-174.98*	...	...	...	...	...	*35.77*	...	*16.45*
BROADGAUGE ON ALLGAUGE [BG/AG]																
OLS *(-)*	...	*-16.40*	...	...	...	...	...	...	...	...	*-44.39*	...	...	...	...	...
,	...	**0.74**	...	...	...	...	...	...	...	...	**1.09**	...	...	...	...	...
(+)	...	*17.88*	...	...	...	...	...	...	...	...	*46.57*	...	...	...	...	...
C-O *(-)*	...	*-17.41*	...	...	...	*3.74*	...	...	...	...	*-49.57*	...	...	*-17.42*	...	...
,	...	**0.70**	...	...	...	**14.94**	...	...	...	...	**1.08**	...	...	**1.17**	...	...
(+)	...	*18.82*	...	...	...	*26.14*	...	...	...	...	*51.74*	...	...	*19.75*	...	...
BROADGAUGE ON METRE GAUGE [BG/MG]																
OLS *(-)*	*6946.50*	...	...	...	...	...	...	*-161.39*	...	...	...	...	...	...	*-23.30*	...
,	**6965.47**	...	...	...	...	...	...	**-170.08**	...	...	...	...	...	...	**-32.01**	...
(+)	*6984.44*	...	...	...	...	...	...	*-178.78*	...	...	...	...	...	...	*-40.72*	...
C-O *(-)*	*7222.16*	...	...	...	...	...	...	*-155.86*	...	...	...	...	...	*11.80*	...	...
,	**7245.58**	...	...	...	...	...	...	**-165.98**	...	...	...	...	...	**23.03**	...	...
(+)	*7269.01*	...	...	...	...	...	...	*-176.11*	...	...	...	...	...	*34.26*	...	...
METREGAUGE ON ALLGAUGE [MG/AG]																
OLS *(-)*	...	...	...	...	...	...	*-7.84*	...	*-8.96*	...	...	...	...	...	...	*-13.10*
,	...	...	...	...	...	...	**2.10**	...	**1.12**	...	...	...	...	...	..	**0.68**
(+)	...	...	...	...	...	...	*12.04*	...	*11.20*	...	...	...	...	...	...	*14.45*
C-O *(-)*	...	...	*-5.61*	...	...	*-1.66*	*-9.69*	...	*-10.99*	...	...	...	...	...	...	*-15.62*
,	...	...	**2.73**	...	...	**-12.73**	**2.51**	...	**1.16**	...	...	...	...	...	...	**0.66**
(+)	...	...	*11.08*	...	...	*-23.80*	*14.70*	...	*13.31*	...	...	...	...	...	...	*16.95*
METREGAUGE ON BROADGAUGE [MG/BG]																
OLS *(-)*	...	...	...	...	...	*-24.85*	...	...	...	...	...	...	...	...	...	*-11.76*
,	...	...	...	...	...	**-34.54**	...	...	...	...	...	...	...	...	...	**1.20**
(+)	...	...	...	...	...	*-44.24*	...	...	...	...	...	...	...	...	...	*14.17*
C-O *(-)*	...	...	...	...	...	*-32.57*	*-4.08*	...	*-1.26*	...	...	...	...	...	...	*-14.58*
,	...	...	...	...	...	**-44.11**	**4.36**	...	**7.27**	...	...	...	...	...	...	**1.26**
(+)	...	...	...	...	...	*-55.65*	*12.81*	...	*15.80*	...	...	...	...	...	...	*17.11*

Note: Positive (+) and negative (-) probability limits are defined for freight coefficients at 99% confidence by $\{\hat{b}_i \pm s.e.(\hat{b}_i)t_{0.005}\}$

freight trend is provided by the transition of India from a purely agricultural economy to a growingly industrialised nation. It is here that the time-scale of the data begins to seem inappropriate. While for over 100 years, railway freight operations in India served the purpose of maintaining the economic *status quo*, the five planning decades have initiated a major break with the past. With the economy in transition following the establishment of heavy industry in the state sector during the early plans, downstream economic growth has accelerated in the later period. With this transition still far from complete, a more comprehensive evaluation of economic and infrastructural trends must await the future. The task of the present study is more limited, and concerns the evaluation of railway freight trends and their infrastructural role. This is attempted in the following sections through appropriate regression modelling methodologies.

6.3 IR Wagon-Loadings: Regression Analysis

Although the variations in IR freight-flows are seemingly interrelated, imputation of cause-and-effect across observed patterns of commodity freight is a complex task. While in the main, the declining loadings of certain commodities may be attributed to the rise in loadings of others, the intercommodity relation is in itself a combination of direct and oblique crossinfluences where displacement of one commodity by another may arise from direct competition within the same freight segment, as well as from the displacement of forward-linked or backward-linked commodities in other freight segments. Implicit factors also enter observed variances in the dataset. Holding particular importance among these are the technological determinants of freight capacity which also dictate the differences in relative availability of railway freight services to particular sectors and regions. Spatial factors such as the location of points of originating loadings and the magnitude and direction of commodity leads are also implicitly present within the dataset. Thus a proper investigation of commodity-freight trends must take recourse to specific mathematical tools of analysis which fit the dataset.

In the first approach, simple multiple regression analysis is undertaken to shed some light on intercommodity relationships between the wagon loadings of 15 commodities carried by IR for a period of 35 years commencing with 2FYP in 1955-56. Non-availability of similar data on other major freight categories like foodgrains, fertilisers and POL restricts multiple regression modelling to these 15 commodities and may consequently subject the analysis to modelling problems arising from the non-specification of major variables. After investigating the latter possibility, suitable modelling modifications can be resorted to.

Much more robustness can be added by the regression procedure to the simple working insights obtained from the earlier heuristic analysis. This becomes especially apparent when cross-gauge analysis is made of the statistical influence of IR wagon loadings in the BG network on resulting MG freight patterns. Secular transition in IR freight priorities over the planning period following the change in national transport policy, which can only be dimly perceived from visual examination of the dataset, is also captured much more vividly in the intercommodity regression relationships.

6.3.1 Multiple Regression Modelling

The standard model for the multiple regression analysis has been represented in matrix form below. The regression model comprises 16 freight variables with total gauge loadings for AG, BG and MG as regressands and with the gaugewise commodity loadings of wagons as regressors. One such regression for instance may regress total AG loadings by IR on individual wagon loadings of the 15 commodities carried on the BG or MG. The formal model may thus be stated as

$$Y_i = b_0 + b_1 W_{1i} + b_2 W_{2i} + \dots\dots + b_{15} W_{15i} + U_i \qquad i = 1,2,\dots\dots,35 \qquad \dots\dots (6.1)$$

$$\text{or,} \quad \mathbf{Y} = \mathbf{Wb} + \mathbf{U} \qquad \dots\dots (6.2)$$

with matix and vector equivalents as

***Figure* 6.2: Analysis of OLS Residuals**

Fig 6.2a: Error Estimates on BG Wagon-loading Coefficients

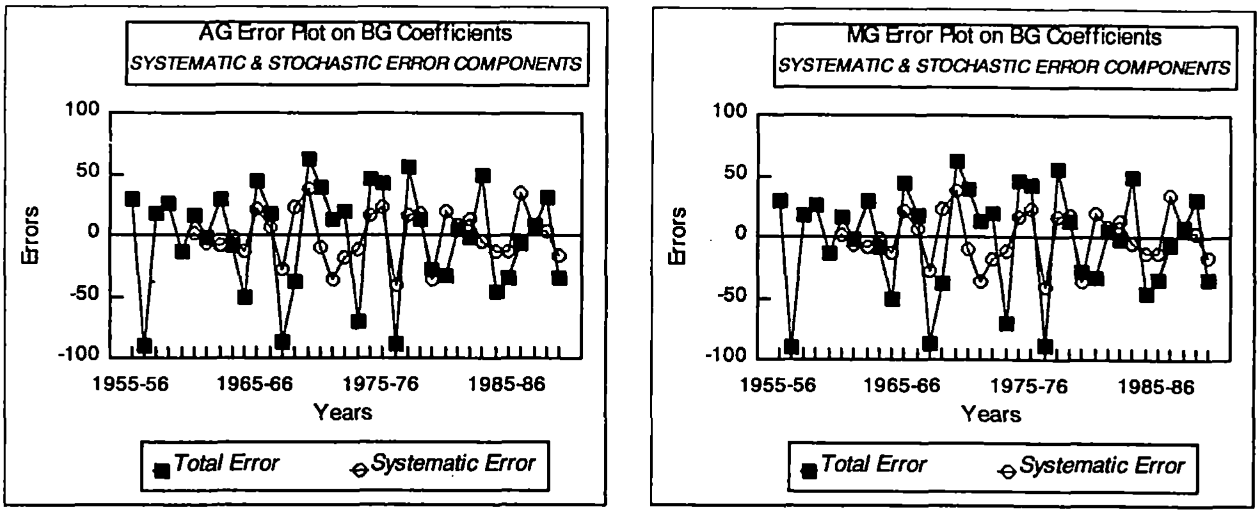


Fig 6.2b: Error Estimates on MG Wagon-loading Coefficients

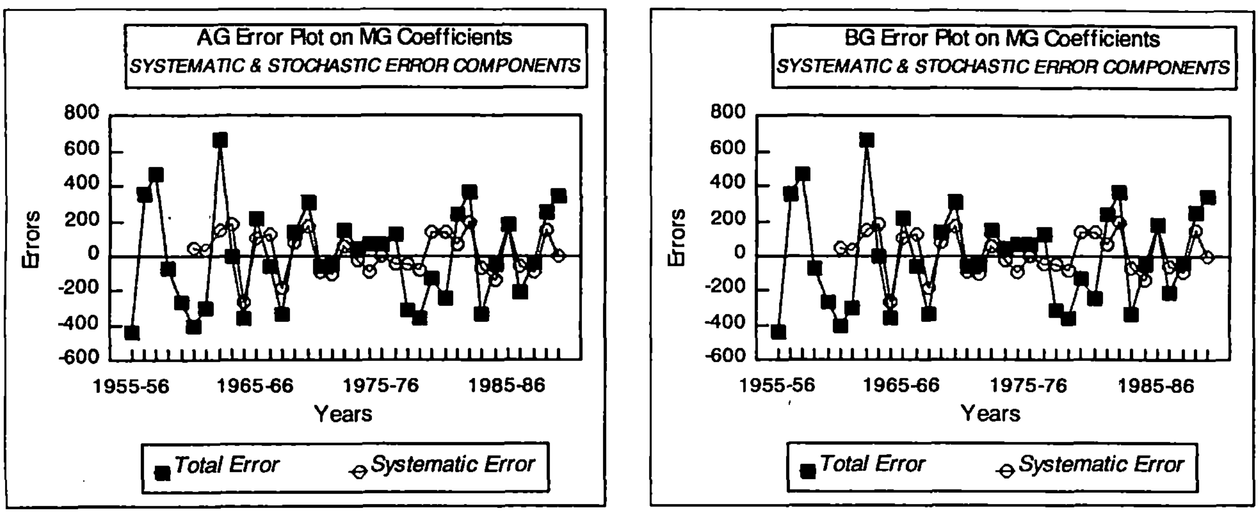
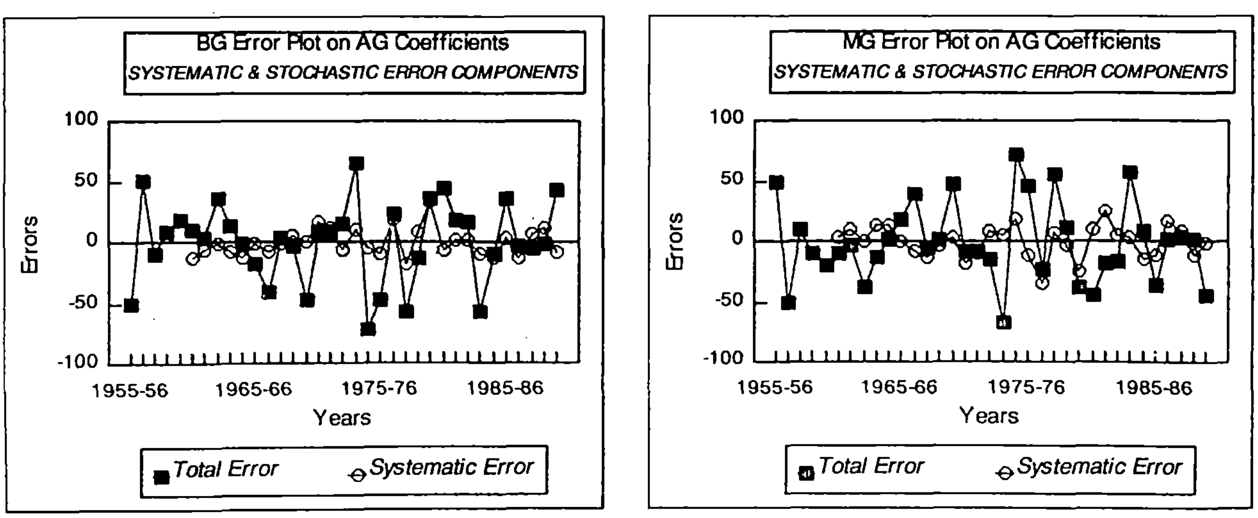


Fig 6.2c: Error Estimates on AG Wagon-loading Coefficients



$$
\begin{vmatrix} Y_1 \\ Y_2 \\ \dots \\ \dots \\ Y_{35} \end{vmatrix}_{[35 \times 1]} = \begin{vmatrix} 1\ w_{11}\, w_{21}\, w_{31} \ \dots\dots\dots\dots \ w_{15,1} \\ 1\ w_{12}\, w_{22}\, w_{32} \ \dots\dots\dots\dots \ w_{15,2} \\ \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \\ \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \\ 1\ w_{1,35}\, w_{2,35}\, w_{3,35} \dots\dots.\ w_{15,35} \end{vmatrix}_{[35 \times 16]} \cdot \begin{vmatrix} b_0 \\ b_1 \\ \dots \\ \dots \\ b_{15} \end{vmatrix}_{[16 \times 1]} + \begin{vmatrix} u_1 \\ u_2 \\ \dots \\ \dots \\ u_{35} \end{vmatrix}_{[35 \times 1]} \quad \dots \quad (6.3)
$$

and where Y_i represent regressand values of aggregate IR wagon loadings for each year of the given 35-year dataframe, w_{ki} represent wagon loadings of the kth commodity in the given year, b_i represent the computed freight coefficients for each commodity and u_i represent the unexplained or stochastic variation within IR freight loadings, attributable to other commodities not within the wagon-loading dataset. The influence of freight historicity on subsequent IR wagon loading patterns are captured in b_0 or the intercept term. The matrix **W** is thus the expanded form of the wagon-loading dataset. A choice of regressor sets is provided by the gaugewise MG and BG commodity loadings of Tables 6.1 and 6.2 and AG commodity loadings over all gauges in Table 7.5 in the next chapter, each choice lending itself to different interpretations. The materialisation of freight demand and subsequent wagon allocation are assumed to be instantaneous processes, so that no explicit lags are introduced into the analysis.

Table 6.3*d*: Regression Analysis of Commodity-wise Wagon Loadings in IR Freight Operations
Tests of the Goodness of Fit of R^2 and $\bar{R}^2$ and Significance of the Regression

Regression Procedure	R^2	Adjusted $\bar{R}^2$	s.e.($\hat{y}$)	*df*	Theoretical $t_{0.05}$	$t_{0.01}$
ALLGAUGE ON BROADGAUGE [AG/BG]						
OLS	**0.999**	**0.999**	56.445	19	*2.0930*	*2.8609*
C-O	**1.000**	**0.999**	52,894	18	*2.1009*	*2.8784*
ALLGAUGE ON METREGAUGE [AG/MG]						
OLS	**0.976**	**0.957**	374.427	19	*2.0930*	*2.8609*
C-O	**0.982**	**0.967**	314.371	18	*2.1009*	*2.8784*
BROADGAUGE ON ALLGAUGE [BG/AG]						
OLS	**1.000**	**0.999**	44.690	19	*2.0930*	*2.8609*
C-O	**1.000**	**1.000**	40.078	18	*2.1009*	*2.8784*
BROAD GAUGE ON METREGAUGE [BG/MG]						
OLS	**0.980**	**0.964**	374.427	19	*2.0930*	*2.8609*
C-O	**0.985**	**0.973**	314.428	18	*2.1009*	*2.8784*
METREGAUGE ON ALLGAUGE [MG/AG]						
OLS	**0.980**	**0.965**	44.690	19	*2.0930*	*2.8609*
C-O	**0.991**	**0.983**	41.224	18	*2.1009*	*2.8784*
METREGAUGE ON BROADGAUGE [MG/BG]						
OLS	**0.969**	**0.944**	56.445	19	*2.0930*	*2.8609*
C-O	**0.983**	**0.969**	52.894	18	*2.1009*	*2.8784*

6.3.2 Cross-Commodity & Cross-Gauge Interrelationships in IR Freight

Regression results for OLS are presented jointly with results from the subsequent Cochrane-Orcutt adjustment in Tables 6.3*a* to 6.3d.An anticipatory word may be said about the development significance of the regression procedures. Specific cross-gauge regression of commodity freight loadings provides an estimate of regional interdependence in IR freight operations, bearing in mind that the MG network had traditionally served to consolidate freight flow from the hinterland to the mainline BG network. Since this regional specialisation of gauge still exists by default, the impact of IR's technological specialisation on hinterland freight flows to the railway network can thus be assessed from the regression. On the other hand, regressions of aggregate or crossgauge IR freight loadings on respective BG and MG loadings of commodity freight capture the relative influence that gaugewise commodity loadings exert on overall freight operations by IR. As such, commodities which have simultaneously either maintained or lost freight presence on both feeder and mainline IR networks exercise a deeper influence on AG wagon loadings than commodities which are freighted primarily over a single railway gauge. Converse regressions of aggregate BG and MG freight loadings on the loadings of commodity freight over all IR gauges capture the evolutionary influence on mainline and feeder railway freight operations exerted by freight policy in general and by its commodity and gauge specialisations.

The regression estimates of the commodity-freight coefficients are also important since they offer a direct measure of the continuing or declining importance of the respective commodity freight flows to aggregate mainline and hinterland freight operations by IR. While negative magnitudes for the commodity coefficient indicate inverse relationships between wagon loadings of the commodity and aggregate railway wagon loadings, the actual direction of influence may vary depending on whether the wagon-loading series have shown increasing or decreasing longterm trends over the 35-year time period. Thus interpretation of the commodity-freight coefficients in Table 6.3*a* has to be accompanied by visual examination of the associated wagon-loading dataset so that a correct interpretation can emerge.

The values for R^2 and $\bar{R}^2$ obtained for OLS regressions of aggregate gaugewise wagon lopadings on the specific loadings of different commodities are indicated in Table 6.3*d* above, which also indicates the theoretical values of the *t*-statistic at 95% and 99% confidence levels for testing the significance of the estimates of the respective commodity-freight coefficients. Table 6.3*b* indicates the intercommodity relationships found significant at 95% confidence levels for the OLS regressions of gaugewise freight loadings on the gaugewise loadings of individual commodities from the 15-commodity dataset. The upper and lower confidence limits for each commodity-freight coefficient form the (+/-) probability bands around each $\hat{b}_i$ coefficient estimate. As the table shows, overall BG freight loadings are significantly influenced by the BG loadings of most commodities, and also by the MG loadings of core industrials like iron ore, iron & steel and cement. These commodities have also been able to hold their own in MG freight operations. Among the other non-core commodities loaded on MG, only manufactured jute products continue to influence AG loading patterns. However, with the commodity-freight coefficient for jute manufactures being negative, around a relatively static MG loading trend, the overall impact of these on the AG/MG regression indicates that the MG commodity-freight in manufactured jute has displaced MG freight in several other commodities. Indication that a more specialised commodity-freight mix has evolved principally on IR's BG freight network is visible in the BG/AG and BG/MG regressions. These show that while aggregate BG freight loadings are influenced by fewer BG commodities, MG loadings of core industrials and jute manufactures continue to influence BG loading trends to almost the same degree as before. This also indicates that the principal MG commodity-freight flows on IR comprise feeder freight which either flows from or to the BG network. This is borne out again by the MG/AG and MG/BG regressions, which show principally that the cutback in IR's MG freight capacity has been absorbed by the longterm decline in BG loadings of cotton manufactures, which has allowed the partial preservation of MG freight volumes in grams & pulses, oilseeds, raw jute and manufactured sugar - all commodities with a feeder relation to the agricultural sector. The remainder of the slack has been taken up increased BG and MG loadings of cement. BG loadings of other core industrials now have scarecely any impact on IR's MG freight operations.

By contrast, the intercommodity freight relationships that remain significant at 99% confidence levels are generally sparse, with IR freight performance being influenced by the freight handling trends of only a few commodities. Overall AG freight loadings are mostly influenced by freight trends on the BG network. AG wagon loadings rise fairly strongly when BG handling of cement, iron & steel and grams & pulses increases and more moderately with expanded BG handling of coal & coke and iron ore. Overall BG freight handling trends on the other hand are less influenced by network-wide commodity loadings on IR, with the exception of coal & coke and grams & pulses. This apparently paradoxical result illustrates the effectiveness of the regression procedure in discriminating between interregional flows of commodities that are jointly handled by both BG and MG networks and involve transhipment, and freight flows involving commodities that are primarily handled within a single gauge. The strong influence of BG freight flows of cotton manufactures on overall IR freight handling deserves special attention, since obviously the freight downtrend in this historically important general-freight commodity frees substantial haulage capacity for other commodity flows. The juxtaposition of trends and coefficients would in fact suggest the displacement of cotton manufactures as a result of IR freight specialisation.

Although historic MG commodity handling patterns have fairly high influence on BG and overall freight handling by IR as revealed by the respective $\hat{b}_0$ coefficients, the converse is not true. This is in itself an interesting result since it indicates slackening of the MG network's feeder role, accompanying the strong departure that evolving BG freight patterns over the 35-year study period have made from the past historic modes of railway freight handling in India. It also appears likely that the major part of this historical influence of MG freight handling reflects MG-to-BG transhipment of bulk commodities rather than the opposite.

The simple correlation matrices obtained for the BG, MG and AG commodity-loading datasets are reproduced in Tables 6.1*b*, 6.2*b* and Table 7.5 in the next chapter. Since each simple correlation matrix is composed of zero-ordered correlation coefficients, where by definition, the degree of correlation between wagon-loadings for any pair of commodities is computed independently of any crossrelation that these wagon loadings show to any other commodity within the dataset. On first examination, the gaugewise simple correlation coefficients computed on the 15-commodity IR wagon loading series apparently show IR commodity freight trends to be highly correlated. It appears likely however that the data matrix is affected by a high degree of multicollinearity because of commodity-freight interdependence, although in the multiple regression analysis, the thumb-rule test of multicollinearity, *i.e.*, high R^2 and insignificant *t*-values for the b_i coefficients might suggest otherwise. It therefore becomes necessary to examine the residuals for the OLS regressions more closely.

6.4 Analysis of OLS Residuals

Assessment of the crossrelation in error residuals from the OLS regressions may begin from consideration of the time-sequence plots in Fig 6.2 of the OLS residuals associated with BG, MG and AG wagon loading coefficients for the 15-commodity dataset. No variation emerges between OLS residuals when BG loadings of commodities are alternately used as regressors for aggregate and MG wagon loadings [*Fig 6.2a*], and again when MG commodity loadings are used alternately as regressors for aggregate and BG wagon loadings [*Fig 6.2b*], indicating overall consistency in the respective OLS regression pairs. This arises from AG wagon loadings being tautologically defined in this case by the sum of commodity-wise wagon loadings on both IR gauges. The extent to which commodity-wise wagon loading trends on either gauge determine aggregate IR wagon loadings as well as loadings on the other IR gauge segment is internally consistent, since trends in the dataset show that while BG wagon loadings have increased substantially over the 35-year study period, MG wagon loadings on the other hand have declined. Differences become apparent however in the character of overall IR wagon-loading response to BG and MG commodity loading trends. Because strong increases in the BG wagon loadings of selected bulk commodities have tended to supplant the wider spectrum of other IR non-bulk freight, OLS regressions made on BG commodity coefficients [*see Fig 6.2a*]underestimate the potential trend of AG and MG freight loadings and overestimate the shortfall or error component e_i. Error-variances being similarly overestimated, the downward BG wagon loading trends in non-bulk commodities are then presumed to have carried over much more strongly than they actually do into the aggregate AG loadings - the displacement of non-bulk freight categories on the MG network being less severe than anticipated. The truth of the matter, verifiable from the wagon-loading dataset, is that while increased BG bulk-loadings by IR over the study period have displaced other commodities from the BG network and some from the IR railway system altogether - this traffic being gained by the other transportation modes - the shift to bulk freight is evident also on the MG network, where higher proportionate loadings of cement, coal & coke, and grams & pulses in the late period mitigate the loss of other IR traffic to a greater extent than would have been anticipated. Another point of observation is that the largest error ranges, i.e. the widest swings in OLS estimates of AG and MG wagon loadings congregate in the middle period of the study, earlier identified as representing an operational 'plateau'. Errors decline relatively in the late period when after the shift to bulk, OLS estimates of firm traffic become more reliable.

Because strong increases in the BG wagon loadings of selected bulk commodities have tended to supplant the wider spectrum of other IR non-bulk freight, OLS regressions made on BG commodity coefficients underestimate the potential trend of AG and MG freight loadings and overestimate the shortfall or error component e_i. Error-variances being similarly overestimated, the downward BG wagon loading trends in non-bulk commodities are then presumed to have carried over much more strongly than they actually do into the aggregate AG loadings - the displacement of non-bulk freight categories on the MG network being less severe than anticipated. The truth of the matter, verifiable from the wagon-loading dataset, is that while increased BG bulk-loadings by IR over the study period have displaced other commodities from the BG network and some from the IR railway system altogether - this traffic being gained by the other transportation

modes - the shift to bulk freight is evident also on the MG network, where higher proportionate loadings of cement, coal & coke, and grams & pulses in the late period mitigate the loss of other IR traffic to a greater extent than would have been anticipated. Another point of observation is that the largest error ranges, i.e. the widest swings in OLS estimates of AG and MG wagon loadings congregate in the middle period of the study, earlier identified as representing an operational 'plateau'. Errors decline relatively in the late period when after the shift to bulk, OLS estimates of firm traffic become more reliable.

The observation however changes when the OLS residual plot based on MG commodity coefficients is considered [*see Fig 6.2b*], because the middle period in this case is characterised by the lowest error-variances. The implication here would be that fluctuations in IR wagon loadings and commodity traffic in the oil crisis-affected period were more a characteristic of the BG networks and of the specific freight-mix carried on them, than of the entire IR system. MG traffic in that period was relatively stable because of the preponderance of agricultural and light industrial commodities in the traffic-mix, which imparted a core of stability to IR freight loadings during the severe recession in medium and heavy industries that hit the Indian economy over the 1970s, consequent upon the twin oil crises.[31] The error residuals estimated when AG and BG wagon loadings are regressed on MG commodity coefficients are therefore consequently small for the given period. The shift to bulk operations on both railway gauges over the 1980s, accompanied by downgrading of MG operations however greatly altered the commodity character of IR freight flows and expanded the associated OLS error-variances in the late period. Another point of observation with respect to the residuals on MG commodity coefficients is that over the 35-year study period, they tend in general to be positively autocorrelated because of their inherently rising trend. The late period of the study has actually been marked by sharp contraction in MG freight capacity because of nonreplacement of traction and rolling stock as a part of official IR policy. As a natural consequence the materialisations of freight traffic estimated on the basis of MG commodity coefficients are higher than the MG freight capacity retained by IR. The excess of this traffic obviously shifts to the roadways especially since it is composed of the very commodities that IR has been trying to exclude from its freight-mix.

While residuals for the paired OLS estimates of overall IR freight loadings on BG and MG commodity coefficients display the symmetry alluded to above, the residuals for aggregate BG and MG freight loadings from their regression on the AG commodity coefficients [*Fig 6.2c*]are markedly different, and in fact show antisymmetry, as evident in the residual plot. This antisymmetry would establish strong opposition between estimated BG and MG freight loading trends, so that MG loading estimates rise in the years when the estimated BG loading shows a shortfall, and vice versa. As a first approximation, residual behaviour of this nature would indicate that the BG and MG commodity freight flows on the IR network - both of which are subsumed in the AG commodity coefficients - are by and large consonant/dissonant in the sense that severe freight losses on one gauge are not entirely carried over to the other gauge, primarily because of the differences in MG and BG freight-loading patterns.

Another point of interest here is that the wagon-loading dataset includes both originating and transhipment loadings of freight, so that the locational pattern of freight operations enters as a determinant. It may be inferred in general from the residual plot that not all originating loadings of commodity freight tranship from one gauge-network to the other, for a high degree of transhipment would usually imply symmetry in BG and MG loadings of the commodity. Instead, what is seen in the wagon-loading dataset and is sufficiently captured in the associated error residuals is the nature of attenuation in IR freight operations in consequence of the rising bulk trend. Thus while wagon loadings of bulk commodities tend to be originating loads and moreover tend to be transported in most cases over a single railway gauge, giving rise to the increases in average freight lead noticed earlier, the same does not necessarily apply to other commodities for which originating loadings are not matched by equivalent transhipment. In a high rated commodity like cotton manufactures, for example, where the principal freight loading originates in the BG-dominated western region, increases in BG bulk freight have induced a shift of originating loads to the roadways. Transhipment loadings on IR do not accordingly materialise. On the other hand, for commodities governed by concessional tariffs, e.g. grams & pulses, originating loadings on one gauge carry over into transhipments on the other gauge. Since the commodity set being considered is a mixed bag of both low rated and high rated commodities, both tendencies exist in the data. But growing preeminence of BG and bulk operations on the IR freight system on the whole ensure the retention of originating loadings in most commodities without concomitant transhipment loadings, implying the delinking of BG and MG freight operations as also of IR and roadways transportation. Since the trend has only multiplied over the passage of time, transportation policy in India is far removed from the cogent utilisation of intermodal freight facilities, despite interventions such as the National Transport Policy formulated by the NTPC.

It is also noticed that the errors in the residual plot have generally tended to widen after the 1970s except for one brief interlude near the commencement of the 7FYP. As expected, the highest residual ranges occur in the mid-1970s, after which IR's shift towards bulk freight never let the subsequent wagon loading trends quieten down. This assessment of the OLS error residuals also allows an overall statement to be made in respect of IR freight policy and especially of its bulk-freight emphasis after the 1970s. In the foregoing analysis, erratic freight-flows in other commodity categories are generally seen to have been the consequence of the bulk-freight policy, with the retention of certain essential commodities of agricultural origin in the IR freight-mix being rendered possible by favourable tariffs. The other category of high-rated low-bulk traffic has generally switched to alternative transport modes despite the retention of some of it on the MG network. However, the downgrading of MG railway operations and nonreplacement of wornout MG railway inventories has jeopardised such retention, and the lack of freight integration between the two railway gauges eventually contributes to the ultimately losing character of the metre gauge.

6.4.1 Tests for Heteroscedasticity in the OLS Residuals

The wagon loading data on which the multiple regression analysis is being made span the rather long time-interval of 35 years, during which several structural changes in railway freight policy and IR wagon fleets had earlier been noted, consonant with the changes in plan emphases over the various FYPs. While aggregate freight tonnages and traffic have accordingly risen, shifts in commodity loadings towards bulk freight have lessened uncertainties regarding the firm availability of freight, which had characterised IR freight operations in the early planning period when a more assorted mix of commodity-freight had been carried. It would be interesting to examine whether such shifts in policy have indeed imparted greater stability over time to the wagon loading performance of IR.

The conjecture to be examined, namely whether variability of freight has been reduced in more recent times, is approximated by positing the existence of heteroscedasticity in the wagon loading data, with the assumption of decreasing error variances over time. An appropriate test for the relevant hypotheses may therefore be applied to the OLS multiple regressions just computed.

In a k-variable linear regression model of the form

$$Y_i = \beta_1 + \beta_2 X_{2i} + \ldots\ldots + \beta_k X_{ki} + u_i \qquad \ldots\ (6.4)$$

the existence of heteroscedasticity can be postulated by linearly relating the error variance σ^2_i to non-stochastic variables Z_{mi}, which may include some or all of the OLS regressors X_{ni} ($n = 2, \ldots, k$). The relationship to be tested in order to validate the presence or absence of heteroscedasticity is therefore accordingly

$$\sigma^2_i = \alpha_1 + \alpha_2 Z_{2i} + \ldots\ldots + \alpha_m Z_{mi} \qquad \ldots\ (6.5)$$

for which homoscedasticity or the *constant-variance* property is established for $\alpha_2 = \alpha_3 = \ldots\ldots = \alpha_m = 0$, so that $\sigma^2_i = \alpha_1$, which is then a constant. Conversely, when $\alpha_2 \neq \alpha_3 \neq \ldots\ldots \neq \alpha_m \neq 0$, the error variance σ^2_i becomes unstable and varies either directly or inversely with values of Z_{mi}. Breusch and Pagan therefore propose an advanced test for homoscedasticity[32] based on whether the B-P test statistic defined by bifurcating the *explained sum of squares* [ESS] into two equal parts approximates the χ^2 distribution, when computed from the regression of p_i on the constructed variables Z_{mi},

$$i.e. \quad p_i = \alpha_1 + \alpha_2 Z_{2i} + \ldots\ldots + \alpha_m Z_{mi} + v_i \qquad \ldots\ (6.6)$$

where p_i relates the squared residual variances not captured within the OLS regression to the Maximum

Likelihood estimate of error variance σ^2 via the relationship $p_i = e_i^2 / \tilde{\sigma}^2$ (where $\tilde{\sigma}^2 = \Sigma e_i^2 / N$).

Table 6.4 : *Analysis of OLS Residuals:* Breusch-Pagan Test for Heteroscedasticity in the OLS Dataset

Form of OLS Regression	Error Sum of Squares [ESS]	Maximum Likelihood [ML] Estimate of Variance	Value of B-P Statistic [Estimated χ^2]	*Nature of Residual Variances*
AG Freight on AG Wagon Loadings	0.00	0.00	7.08×10^{21}	**
AG Freight on BG Wagon Loadings	60534.99	1729.57	0.00	*homoscedastic*
AG Freight on MG Wagon Loadings	2663721.11	76106.32	0.00	*homoscedastic*
BG Freight on AG Wagon Loadings	37946.10	1084.17	0.00	*homoscedastic*
BG Freight on BG Wagon Loadings	0.00	0.00	1.78×10^{22}	**
BG Freight on MG Wagon Loadings	2663721.11	76106.32	0.00	*homoscedastic*
MG Freight on AG Wagon Loadings	37946.10	1084.17	0.00	*homoscedastic*
MG Freight on BG Wagon Loadings	60534.99	1729.57	0.00	*homoscedastic*
MG Freight on MG Wagon Loadings	0.00	0.00	1.75×10^{24}	**

Applying the test to the OLS regression of gaugewise wagon loadings on the individual wagon-loadings by commodity, the values of the B-P statistic computed on OLS residuals are tabulated in Table 6.4 above. Except in the trivial AG/AG, BG/BG and MG/MG regressions where computed χ^2values are apparently significant, heteroscedasticity is not established in the other OLS regressions, indicating that freight policy changes and restructured IR wagonfleets have in fact neither imparted greater stability nor greater variability to IR wagon loading performance over the planning period. Although this inference is partially qualified because gauge-conversion from MG to BG has progressively reduced the levels of transhipment loadings on IR over the time horizon of the study, the changes in IR freight policy thus appear to have been geared towards stabilising the tonnages freighted by IR rather than the freight traffic carried. However, because of the shifting composition of the IR freight-mix towards bulk-freight, these rising tonnage volumes have not been adequately reflected in higher wagon loadings because of intervention from two interrelated factors, as a result of which identical freight tonnages are now transported on fewer wagons because of the growing proportion of bulk commodities, while increased specialisation in the IR wagonfleet and augmentation in the average carrying capacity of IR wagons serves to further reinforce this trend.

6.4.2 Serial Correlation in the OLS Residuals

While the analysis just concluded has shown that the OLS regressions are relatively free of heteroscedastic residuals, so that the stability of the OLS commodity-loading coefficients is not threatened by nonstochastic error, serial correlation between the time-series residuals can still vitiate the OLS regressions. Canonical OLS assumptions demand independence between error terms, in order to maintain the efficiency of coefficient estimates via the ***minimum variance*** property. However the phenomenon of nonindependent errors, which can often occur in the analysis of longitudinal datasets because of inertial tendencies, misspecification of regressed forms, or the existence of serial lags in relationships, can have serious consequences on the accuracy and significance properties of coefficients and consequently on overall surmises about the strength of the regressed relationship. Since the operational indicators for IR explored in the previous chapter had shown conformance to a distributed-lag structure induced by the planning process, strong apprehensions exist that OLS regressions of the wagon-loading timeseries would be affected by serial correlation because of non-lagged specifications, etc. The economic underpinning for the structural patterns of intercommodity and interperiod dependence observed in IR freight loadings lies in the evolutionary path which transportation planning and policy have followed in India over the planning era. Thus the various factors to which the existence of serial correlation in error residuals might be attributed, if established, would also add dramatic insights into the overall consequences of transport and railway policy. Testing of the OLS results for serial correlation is therefore undertaken next.

An exploration also has necessarily to be made of the autoregressive properties of residuals in the OLS regressions. In serially-dependent datasets - a case not uncommon to timeseries, OLS regression coefficients remain consistent and unbiased, but shed their *minimum-variance* property and are no longer considered efficient.[33] Recourse to model adjustments has therefore to be made in order to restore reliability to the coefficient estimates. The serially-dependent nature of the IR wagon loading dataset and the presence of serial correlation in the OLS residuals for the AG and MG regressions on BG commodity-loadings and the BG and MG regressions on AG commodity-loadings is established through the standard econometric test procedure of the D-W *d* test, and alternatively through the nonparametric or *distribution-free* Geary 'Runs' test.[34] The precise impact of serial correlation on the residuals, and consequent distortion in the numerical OLS estimates of different commodity coefficients had already become apparent during the earlier examination of OLS residuals for normality properties, which had allowed the segregation of systematic and stochastic error components in the associated residual plots.

In the context of the present dataset, serial correlation or autocorrelation would occur if current wagon loadings of any commodity were determined by the wagon loadings of the same and/or other commodities in past periods, in which case the classical OLS assumption of *error-independence* would be violated,

$$i.e. \quad E(u_i\, u_j) \neq 0 \qquad i \neq j \qquad \text{....} \quad (6.7)$$

which, for longitudinal data, would translate to

$$E(u_t\, u_{t-1}) \neq 0 \qquad \text{....} \quad (6.8)$$

where t and $t-1$ are time-subscripts, with *auto*correlation translating into *serial* correlation or *lag* correlation.[35]

As mentioned earlier, the point of interest in the tautological regressions concerns the possible presence of serial correlation in the longitudinal dataseries under consideration. Analyses of serial or autocorrelation can thus be utilised to explore the intersectoral relationships of IR wagon loadings for the particular reason that while railway commodity-freight loadings respond partially to production patterns in different sectors of the economy, they are circumscribed severely by the overall freight-capacity constraint imposed by wagonfleet and line-capacity utilisation and freight specialisation. It can therefore be logically expected that variation in the wagon loadings of the commodity inputs or outputs for any economic sector would affect the wagon loadings pertaining to other economic sectors either positively or negatively. Again, because of crossgauge flows of IR freight over spatially-delimited BG and MG networks, changes in any particular gaugewise series of commodity loadings would also carry over into the transhipment loadings of the same category of freight on the other gauge.

For all these reasons, presence of serial dependence in the BG and MG wagon loading datasets cannot and need not be wished away, since the serial correlation characteristics offer a measure of insight into intersectoral dependence in IR freight operations. Other potential sources also exist, to which serial correlation in IR wagon loading series may be attributed. Among these is the likelihood of presence of a large number of collinear series among the excluded commodity-loading categories, for which adequate and separate data was not available. The fact that important railway commodity-freight groups, *e.g.* POL, fertilisers and foodgrains occur among such excluded variables would mean that the included wagon-loading series are affected by freight interdependencies with the excluded series. Serial autocorrelation of the *specification-bias* variant[36] is also very likely to have been induced by the exclusion of major commodity-freight variables.

Inertial or *momentum-generated* autocorrelation,[37] which is also important within lagged and autoregressive model structures, could only be ruled out if IR was deemed to operate in an open market for commodity-freight services, with railfreight services being auctioned to the highest bidders. In such a case, neither inertia nor momentum would exist in the railway commodity-loading series since demand for freight services by each economic sector would depend purely on its production parameters. Such is not the case, if thought is also given to the fact that wagon specialisation over the 35-year period has imposed a freight policy stance on IR which through appropriate rate-setting is predisposed towards particular categories of commodity freight. Since such policy factors also operate via inter-PSU tieups between state enterprises and IR, this line of reasoning - which in effect posits *contestability* as being a characteristic of the Indian railfreight market - would succumb, lending support instead to the existence of some serial dependence in IR wagon loading series attributable to inertia or momentum in crossrelated commodity series. Canonical *autocorrelation,* or serial correlation resulting purely from neglect of lagged relationships within single series is intuitively less appealing, as no plausible reason would come to mind other than the workings of the railway freight manager's mind and his penchant to be guided by past experiences, if such characteristics can at all be attributed to his actions.

The results of the test computations for serial dependence in the OLS residuals are shown in Table 6.5 below. Detection procedures for serial autocorrelation in the OLS estimates for IR commodity freight loading using the Durbin-Watson [D-W] *d*-statistic are also crossverified through the nonparametric Geary 'runs' test.

Table 6.5: *Analysis of OLS Residuals:*
Tests for Serial Correlation in the OLS Dataset

Regression	AG/AG	AG/BG	AG/MG	BG/AG	BG/BG	BG/MG	MG/AG	MG/BG	MG/MG
Durbin-Watson Test									
Computed value of the d-statistic (n=35;k=15)	0.517	2.455	1.838	2.013	0.420	1.838	2.013	2.455	1.641
Geary "Runs" Test									
Positive residuals	*16*	*20*	*16*	*19*	*14*	*16*	*16*	*20*	*20*
Negative residuals	*19*	*15*	*19*	*16*	*20*	*19*	*19*	*15*	*15*
Total	35	35	35	35	34	35	35	35	35
Number of Runs	8	20	16	16	7	16	16	20	14
(Run)-mean	*18.371*	*18.143*	*18.371*	*18.371*	*17.471*	*18.371*	*18.371*	*18.143*	*18.143*
(Run)-var	*0.963*	*0.950*	*0.963*	*0.963*	*0.938*	*0.963*	*0.963*	*0.950*	*0.950*
(Run)-std	*0.981*	*0.974*	*0.981*	*0.981*	*0.968*	*0.981*	*0.981*	*0.974*	*0.974*
95%-lower confidence limit									
E(n)-1.96(std)	16.448	16.233	16.448	16.448	15.573	16.448	16.448	16.233	16.233
95%-upper confidence limit									
E(n)+1.96(std)	20.295	20.053	20.295	20.295	19.368	20.295	20.295	20.053	20.053

The tabular value of the *d*-statistic at 95% level of significance lies within lower and upper confidence limits set by $d_L = 0.546$ and $d_U = 2.716$. The *d*-statistic detects the presence of positive first-order serial correlation in the OLS residuals for the AG/AG and BG/BG regressions. Values of the computed *d*-statistic for all other OLS regressions in Table 6.5 lie in an inconclusive interval between the tabular values of d_L and d_U. Thus in no case is the presence of serial correlation ruled out, since the value of d_U always exceeds the magnitude of the computed *d*-statistic for all OLS regressions. The results of the D-W test are sharpened by additional results obtained from the 'runs' test. These show that the cumulative number of positive and negative runs in the AG/AG, BG/BG and MG/MG regressions, and also in the AG/MG, BG/AG and MG/AG regressions, lie outside the interval-range set by the respective lower and upper 95% confidence limits, leading to a similar inference that the corresponding OLS regression residuals are not autoregression-free. However, for the AG/BG, BG/MG and MG/BG regressions, the cumulative number or runs lie just within the appropriate 95% confidence limits, indicating that the corresponding pattern of runs in OLS residuals appears to be random in nature.

6.4.3 Autoregressive Serial Dependence Schemes

While graphical evidence for the presence of serial correlation can be gleaned from examination of time-sequence plots for the OLS residuals, such as those presented earlier in Fig 6.2, more precise analysis of the intercorrelation of residuals in timeseries data requires that approximation be made of the structure of serial dependence through the choice of an appropriate *autoregressive* scheme of the general polynomial form

$$u_t = \rho_1 u_{t-1} + \rho_2 u_{t-2} + \rho_3 u_{t-3} + \ldots\ldots + \varepsilon_t \qquad -1 < \rho_i < 1 \qquad \ldots\ldots \qquad (6.9)$$

where ρ is known as the *coefficient of autocovariance.*[38] According to whether the general autoregressive structure of the scheme above can be subsumed within a first-differenced (ρ_2, ρ_3 = 0) / second-differenced (ρ_3 = 0) / etc. lag-function, the scheme is described as having an AR(1), AR(2), etc. type Markovian autoregressive structure. Thus the ρ_i coefficients would be described as *first-order* (ρ_1) / *second-order* (ρ_2) / *third-order* (ρ_3) *coefficients of autocovariance,* according to the structure of the autoregressive scheme that fully captures the serial dependence. In the polynomial form, the $\rho_i u_{t-i}$ terms refer to the component of present residuals systematically explained by error residuals of the past, while the ε_t term represents the stochastic component of present errors. Hence serial independence of errors would be assured only if all ρ_i = 0.

Since analysis is to be made in this instance of the residuals from the OLS regressions of IR wagon loadings, it would be appropriate to postulate an AR(5) scheme for estimating ρ_i coefficients, in view of the five-year structure of the Indian planning process - a factor which was also seen to have bearing in determining the polynomial order of the distributed lag scheme estimated in the previous chapter. Values of ρ_i coefficients estimated on the residuals of the OLS regressions of wagon loadings for autoregressive schemes of different orders are presented in **Table 6.6.** These coefficient values show no tendency to decay over the AR(5) scheme, thus indicating that current IR wagon loadings are influenced by the prior loading trends over a fairly long space of time. The AG/AG, BG/BG and MG/MG regressions being of trivial nature, the Markovian structures estimated for them do not hold much importance. For the other OLS regressions, coefficient magnitudes are generally smaller, as would be expected, but exercise a systematic and sustained influence on the nonstochastic component of error residuals. It is also interesting to note that ρ_i coefficients for AG/BG and MG/BG regressions, and again for AG/MG and BG/MG regressions are nearly or exactly equal, indicating similar proportions of nonstochastic *i.e.* autocorrelated error. With the proportion of BG wagon loadings in AG wagon loadings having grown substantially over the 35-year period of the study, the BG-based coefficients of the AG/BG for the former group of regressions are notably stronger.

6.4.4 Autocorrelation Analysis of OLS Residuals

Evidence of serial correlation in the wagon loading dataset from prior analysis of residuals points to a breakdown of canonical assumptions about randomness in OLS error. Since the density function $F(u_i)$ of OLS residuals loses normality characteristics as a result, it ceases to be an efficient estiimator of the random component of error described mathematically by the probability density function $F(e_i)$. In practical exercises, normality in OLS residuals may disappear either because of skewing in the error density function *i.e.* non-normality in the error mean $E(u_i)$, or loss of minimum variance/covariance characteristics in the error dispersions $E(u_i^2)$ and $E(u_i u_j)$, with the precise source of non-normality being defined by the conditions of the analysis. The first aberration is more tied up with problems of heteroscedasticity in datasets and has in fact been shown to present no serious obstacle to the application of OLS to the present analysis. If non-normality of $F(u_i)$ is rooted however in occurrences of autoregressive error, the second aberration springs to life by destroying the credibility of model specifications and coefficient estimates. While prior analysis has signified the presence of serial correlation in the application of OLS to the IR commodity-loading trends, the AR(5) scheme adopted for estimation of autoregressive error was suggested by the five-year timeframe followed by the Indian plans and the cyclical boosts and slumps they have consequently been able to impart to economic activity through their autonomous regulation of investment flows, although it must also be stated that the pure periodicity of such economic impulses has been commuted by intrusion of plan-holidays in several periods. The oscillation noticed in the earlier residual plots is thus not entirely inconsistent with randomness. Nevertheless the ebbs and flows of plan investments in the Indian economy and in IR impart a periodic pulse to railway freight operations which is effectively captured in the ρ_i coefficients of autocovariance presented below.

Estimation of ρ_i coefficients reveals that because of serial correlation properties, the OLS residuals are a combination of *systematic* and *stochastic* error, with the former being responsible for covariance degeneracy in the canonical error assumption $E(u_i u_j) = 0$ following from serial dependence in IR commodity loadings, because of the existence of an overall constraint on freight capacity. As such, it is established that IR freight trends are not independently determined by levels of production and freight demands in the country, but are also defined relative to each other by these constraints. Since meaningful interpretation can be made of these interdependent freight trends, it becomes instructive to study the non-normality of residuals in the IR dataset by apportioning OLS error between its systematic and stochastic components. The task is accomplished by evaluating the systematic component (u_t - e_t) in the error distributions on estimates of ρ_i derived from the AR(5) scheme, thus allowing isolation of e_t or the pure or stochastic element of error. A geometrical exposition is made here with reference to gaugewise plots of systematic errors for OLS applied on AG commodity loadings; however OLS regressions on the BG and MG loadings are excluded from the analysis because their error-means show non-normal characteristics [E(u_i) ≠ 0] and imply a skewing in their error density functions.

Table 6.6: Analysis of OLS Residuals:
Coefficients of Serial Correlation under alternative Autoregressive Schemes

Regression	AG/AG	AG/BG	AG/MG	BG/AG	BG/BG	BG/MG	MG/AG	MG/BG	MG/MG
Autocorrelation Coefficients									
1st-order: AR(1)	0.693	-0.248	0.023	-0.066	0.761	0.024	-0.327	-0.248	0.170
2nd-order: AR(2)	0.513	-0.400	-0.493	-0.195	0.546	-0.493	-0.195	-0.400	0.096
3rd-order: AR(3)	0.573	0.160	0.044	0.090	0.495	0.044	0.090	0.160	0.126
4th-order: AR(4)	0.637	-0.044	-0.121	-0.266	0.499	-0.121	-0.266	-0.044	-0.214
5th-order: AR(5)	0.579	0.112	-0.092	-0.096	0.469	-0.092	-0.096	0.112	-0.206
Estimates	AG/AG	AG/BG	AG/MG	BG/AG	BG/BG	BG/MG	MG/AG	MG/BG	MG/MG
D-W 1st-order p.	0.741	-0.228	0.081	-0.007	0.790	0.081	-0.007	-0.228	0.179

With the AR(5) scheme yielding coherent estimates of the extent to which extraneous correlation - *i.e.* that part of error-variance neither attributable to purely random phenomena or to direct physical interdependencies of commodity and gauge in IR freight flows - is present in the residuals, the influence of factors not directly incorporated into the regressor set, such as railway policy, plan allocations, etc. is caught in the systematic component of OLS errors. As such, the *systematic* error component becomes an important infrastructural variable which captures the indirect forward and backward linkages of railway operations which either govern or else are governed by factors such as downstream production and freighting demands, and the *partial adjustment* process[39] by which investments in railway infrastructure and the creation of freight capacity make deferred responses to these changes. It is worth mentioning that, theoretically, the adjustment of freight capacity by railways to changes in traffic demand is made in two parts, namely, *partial* or short-term adjustment of forward-linked freight operations (*e.g.* wagon-allocations), and *full or* medium-to-long-term adjustment of backward-linked freight infrastructure (*e.g.* wagon-acquisitions, traction and track modifications, route expansion). The association of such adjustments with the systematic error of the plots relates to the *investment-lag,*[40] which is the source of the serial dependence noticed earlier in IR wagon loadings. Thus while in the short-term, the response of IR to increases or decreases in plan investments and downstream production in the economy is a partial reallocation of its freight capacity to cope with the materialisation of new demands, full adjustment to the changes must await the sanction of required funds under the subsequent FYP. If the level of plan investment turns out to be inadequate, the adjustment of long-term freight capacity is further deferred and spills over into a succession of plans, leading to the phenomenon of serial dependence in railway operations. It might also be added that the adjustment of transport infrastructure to restructured fuel economics following the OPEC petroleum price-hike is a classic textbook example of partial adjustment[41] where the period of full adjustment is staggered over several years because of lumpiness of investments and durability of equipment inventories, as a consequence of which the associated lag coefficients may not in fact be subject to quick decays.

The actual estimation procedure for systematic error involves transformation of each direct OLS residual over ρ_i coefficients via the generic autoregressive form $(u_t - e_t) = \Sigma\rho_i\, u_{t-i}$; (i = 1, ...,4). The transformed residuals can then be arrayed into twin timeseries of (u_t - e_t) and e_t for the 35-year wagon loading dataset and yield a distinct density function for the systematic error for the period 1960-61 to 1989-90, with 5 degrees of freedom having been surrendered during the process of estimation. Systematic errors are high in the uniformly unstable $-363.7 \leq (u_t - e_t) \leq 375.8$ range when either BG gauge-totals or overall IR wagon loadings are estimated from the MG commodity-loading trends. The fact that regressions on BG commodity loadings on the other hand yield insignificant systematic error for estimates of overall IR freight trends and a fairly low systematic error range of $-32.1 \leq (u_t - e_t) \leq 30.8$ for estimated MG freight trends thus confirms the greater predictability of BG versus MG freight trends on IR because of the order of causality earlier established between freight operations on the two IR gauges. Higher systematic error ranges are however invariably found for overall MG and BG freight loading estimates when these are estimated gaugewise on the AG commodity regressors. While the systematic error range for the MG/AG regression is still the larger of the two at $-45.9 \le (u_t - e_t) \le 53.2$, it narrows down credibly for the BG/AG regression to $-30.2 \le (u_t - e_t) \le 39.2$, serving to illustrate that the nature of crossgauge displacement in IR freight operations is largely determined by their bulk-oriented BG freight trend.

The time-sequence plots of systematic error $(u_t - e_t)$ on the direct OLS residuals for MG/AG and BG/AG regressions presented in Fig 6.2*c* prove useful in making an assessment of the relative proportion of autoregressed error in the two regressions. As implied above, the error distributions for $(u_t - e_t)$ are small in either case, since the AG regressors which include wagon loadings on both IR gauges subsume internal displacements of commodity freight on the IR system within the OLS estimate. However the fact that they exist at all and are moreover periodic in nature is evidence of the external pulse affecting IR freight operations, which enters the transportation scenario mainly through the mechanism of fund-flows during the FYPs.

The first comment that the timeplots elicit concerns the relative proximity of systematic error to OLS residuals apparent in the BG/AG error plot for most years till the early 1970s, a few truly random dips and peaks indicated by the series outliers notwithstanding. This would associate the generally low error-variances during the years of the early plans with the mixed character of IR commodity-freight loadings for the corresponding period within the dataset. Although BG freight trends appear to have been more stable compared to MG over the early period, as evident also in the lower range in both error-categories, this position is radically altered after the first oil shock. Resulting traffic instability appears to have affected BG wagon loadings more than MG wagon loadings over the rest of the 1970s as seen in the widening of differentials between OLS residuals and systematic error for the former. However the consequences of freight policy shifts thereafter is evident in higher fluctuations of both OLS residuals as well as systematic errors apparent in general ever since then, except for a brief duration during the starting years of the 6FYP, when the MG segment of IR freight operations was stabilised by the shift to bulk and gradual phase-out of MG railways.

An important point to note in respect of MG operations is the fact that the systematic errors here are laterally out of phase with the residuals ever since the 3FYP indicating the operation of a lag, and moreover are in a higher range than systematic errors for BG loading estimates. Since MG loadings rise when BG loadings have been low, the evidence of the lateral lag suggests that the partial adjustment hypothesis is borne out in case of MG loadings which so closely mimic the apparent ranges of the OLS residuals so as to reduce the influence of purely stochastic elements. The adjustment in such cases is first-differenced and has thus generally taken place during the year immediately subsequent to major rises and falls in BG loadings. Since till the new emphasis on bulk traffic appeared, the MG commodity-mix was more representative of downstream economic activity in the economy, inference can also be drawn about the infrastructural influence of BG freight activity on the economy, with periods of low activity in the core sector which contribute the greater part of IR bulk-freight leading downstream to listlessness of forward-linked economic sectors in the subsequent year.

The second and more incisive inference drawn from the two error plots pertains to the evolutionary role that Indian plan investments are seen to have played in shaping the error distributions as well as the order of infrastructural support available to freight flows within the Indian economy at different points of the 35-year dataspan. This inference is drawn from coincidence of pulse patterns in the timeplots with the phases and turning-points of Indian planning. The boosting effect of the buildup in freight capacity ahead of demand over the 2FYP period which is captured in the associated timeplots is seen to have been felt through improvement in the BG freight offtake over the period immediately after, accounting also for the gradual fall in residual errors over the 3FYP. Reluctance to add sufficiently to freight capacity after the 3FYP which forced an industrial slowdown after the mid-1960s appears as freight shortfalls and the rise of residual errors following the mid-1960s. The crises in IR freight operations during the 1970s then break into the regularity of systematic error distributions after 1973-74 and any semblance of order in the evolution of commodity freight flows has been lost over the period since because of policy factors already enumerated elsewhere, such as wagon and freight specialisation, loss of high rated traffic and inroads made by roadways. It is then noticed that over a very short period at the commencement of the 7FYP - by which time IR planning priorities were strongly in favour of technology upgradation and the discouragement of traffic smalls - the IR freight-flows appear to stabilise around steadier bulk BG trends. But since stable bulk freight loadings flow first and foremost to and from the core industrial sector which is linked to the first periodic phase of IR freight operations , the duration of the lag over which increased movement of bulk intermediates and raw materials translates into wider development of downstream industrials can only have become longer. It has already been seen elsewhere in the present study that the promising freight trends in the 7FYP were associated partly with tariff revision and block-rake loadings that further displaced non-bulk freight. These have eventually lost momentum over the 1990s due to the overpricing freight services to levels higher than what the IR bulk-traffic would.bear.

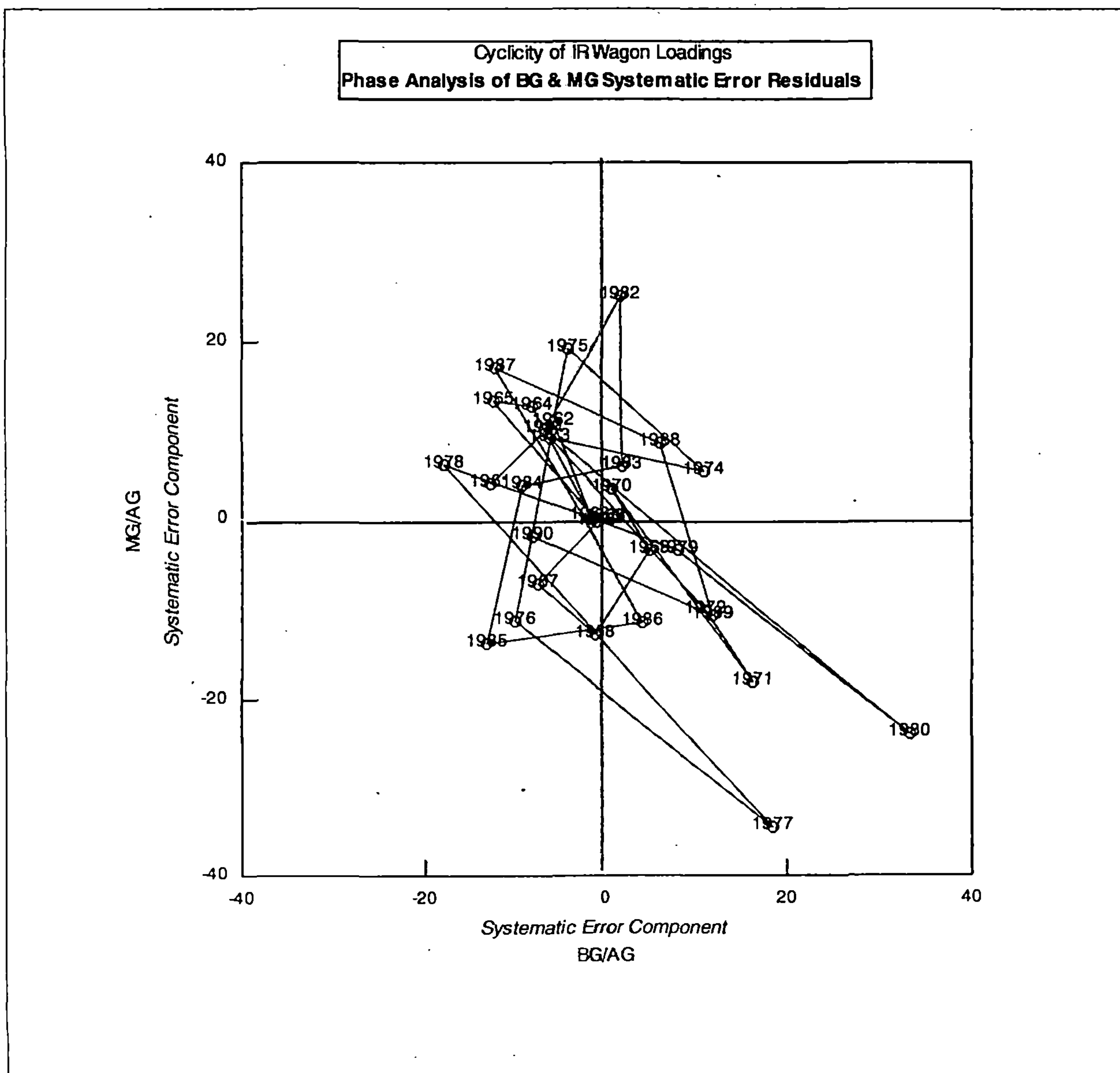
It would seem therefore that the structural character of the relationship between railway freight infrastructure and economic changes was altered substantially in the upheavals brought about by the twin oil crises because of total reorganisation of costs in both the economy and in the transportation sector, in line with similar upheavals witnessed in all major railway systems across the world. A response of this kind is in keeping with the upheavals witnessed by all major railway systems across the world, although the mode of subsequent readjustment is markedly different in the Indian case, as compared especially to the railways in Japan or France, for instance. JNR [later JR] first underwent frenzied tariff revisions in an effort to maintain profit bottomlines over the 1970s and early 1980s before succumbing to privatisation, and has since become increasingly passenger-oriented in its operations. SNCF countered the traffic and industrial relocations induced by rising oil prices through a bold policy of carrying the competition to the roadways, competing on the inherent cost-efficiency of railways in the changed world energy scenario. Two elements essential to the maintenance of cost-efficiency were maintenance of efficient traffic leads and the gradual switch to full trainload traffic, using freight consolidation where necessary in order to trim the network. One freedom that SNCF was bestowed with was the move towards managerial independence in rate-setting which enabled railway competition to take enter even those traffic segments which the roadlines had monopolised. The principal difference in the manner in which IR has adapted to the changed transportation economics of the situation lies in the increasing centralisation of its traffic decisions, in contrast to trends towards decentralisation elsewhere. Thus although features of the JNR strategy are evident in the repeated revisions of freight tariffs in recent years, and somewhat unwittingly in the overwhelming passenger orientation that IR operations have now acquired, the lack of independence and of any overt move towards denationalisation makes sufficient departure. IR's emphasis in the 1980s on technology upgradation, bulk freight specialisation and full trainload operations is in keeping with the direction, if not the scale, of the adaptations made by SNCF. However no effort has been made in the other vital direction of loosening ministerial control to permit the evolution of separate zonal railway strategies that more closely address the regional character of freight flows in India. Emphasis on bulk, when translated into action by railways all over the country, results in neglect of available traffic in quest of commodity flows not found in every region, in the rising leads and absence of return traffic, and in overuse of track and traction without adequate provision for their timely replenishment.

6.4.5 Phase Analysis of Residuals

A characteristic that has been noticeably present in all residual and error plots examined earlier is the phenomenon of freight cyclicity, which from the analysis of systematic errors just concluded, appears to originate structurally in flow-patterns of plan investments on the railways and on industrial sectors that are forward and backward-linked to railway freight operations under the FYPs - rather than merely in short-term endogenous adjustment of IR commodity loadings to the commodity-freight demands emerging from the industrial economy of the country. This position emanates from the overall role assigned to the plans as instruments for channeling investment into desired economic sectors for the achievement of development and industrialisation goals. Since much of the investment over the course of the planning period has been public in character and has enabled India's PSUs to occupy the 'commanding heights' of the economy, economic performance within the country is strongly influenced by the periodicity of the simultaneous capital injections that enter the economy through the process of public investment. No real reason exists why the operational performance of the state-sector IR - which has core mining and industrial PSUs as its principal clients - can remain immune to periodic ebbs and flows, especially with the increasing specialisation of its freight operations around a few bulk commodities. It is also clear that with IR wagon loadings as indicators of operational railway performance, the part of total variance in the wagon loading dataseries that is neither stochastic in character nor fully explained by internal adjustments between commodity- and gaugewise loadings, captures this exogenous pulse in the cyclic character of systematic errors seen in the preceding error plots.

To further dissect the phenomenon of cyclic freight performance and periodic freight capacity adjustments on the two principal IR gauges, phase-analysis of the gaugewise traffic movements implied within the autoregressed or systematic component of the OLS error residuals is now undertaken. This is accomplished by means of the phaseplot above, which pits BG systematic errors against those on MG. Distribution of these error components by positive and negative magnitude creates the 4-orthant space over which systematic errors have been arrayed. Before phasewise interpretation of the error distributions can be undertaken, it is useful to develop an understanding of the nature of each orthant. In the phaseplot, the NE and SE orthants reflect phases when systematic error in the BG wagon loadings estimated against AG commodity coefficients is *positive*, *i.e.*a period when actual BG wagon loadings have exceeded regressed values. Conversely, the NW and SW orthants reflect periods when systematic errors in BG loadings are *negative* and have fallen below levels expected from the regression. When the orthants are viewed from the perspective of MG loadings, the NE and NW orthants both reflect higher MG loadings than regressed values, while the SE and SW orthants indicate the converse. Sufficient insight into the appearance of gaugewise slacks in wagon loadings and into the subsequent modes of adjustment in IR freight handling can thus be gleaned by studying the timepath of the systematic error-traverses made by BG and MG wagon loadings across the orthants, with the years under consideration being identified by their respective end-points.

***Figure* 6.3: Freight Cycles in IR Freight Operations: 3FYP to 7FYP**



Tracing the time-trajectory which commences just above the SW orthant, it is seen that BG freight loadings stood well below par levels at the commencement of the 3FYP in 1961-62. The traffic slack was gradually taken up, first by augmentation of MG loadings and then by increased BG loadings so that in 1962-63, wagon loadings on both IR gauges had risen to near-par levels. The fall in IR freight handling that recurred immediately thereafter resulted from sharp subsequent shortfalls in BG loadings, although the slack was partially relieved by increased MG freight loadings. Freight recovery in 1965-66, the terminal year of the plan, brought IR freight levels close to par again. Thus although the freight handling setbacks encountered by IR over the 3FYP were principally on account of anomalies in BG freight operations, MG freight handling remained relatively high, so that IR freight cycles remained ensconced in the NW orthant where MG loadings proved partially complementary to BG loadings, confining overall IR freight fluctuation within low amplitudes. Nevertheless, since the magnitude of fluctuations in BG freight loadings over the 3FYP was relatively high, the principal impact occurred within the bulk-commodity segment of the railway freight market. Considerable traffic slack consequently prevailed over the 3FYP period.

The subsequent period of Annual Plans was marked by the growth of BG freight loadings at the cost of MG freight handling. However, as noted earlier, the period coincided with mass foodgrains imports to forestall famine-like conditions induced by consecutive failures of the monsoon. While a slippage consequently took place in the BG handling of bulk industrials, MG feeder-freight operations suffered continuously over the period. Only in 1968-69, the year just preceding the 4FYP, did IR freight handling recover substantially, bringing both BG and MG loadings close to par.

The 4FYP commenced with sharp increases in BG freight handling which however induced a shortfall in MG freight realisation by IR. This was quickly followed by a BG freight setback during the mid-years of the 4FYP, as a partial consequence of which MG freight handling was gradually raised in order to take up the traffic slack. While recovery in the bulk-freight segment carried IR's BG and MG freight operations to above-par levels in 1973-74, the terminal year of the 4FYP, this improved railway performance was not unrelated to the dislocations in road freight operations induced by the Oil Shock. Shortfalls in freight loading began to set in with the commencement of the 5FYP, with the fall in MG freight operations proving sharper than that in BG freight. The notable recovery made by BG bulk-freight handing in 1976-77, the mid-year of the 5FYP, drove MG freight loadings to unprecedentedly low levels. However, BG freight realisation shrunk sharply in the very next year and had to be partially compensated by an expansion in MG freight handling. Between 1978-80, the terminal year of the 5FYP and the subsequent rolling-plan year, recovery in the BG freight segments took IR freight handling marginally above par-levels

As the 6FYP commenced, BG freight handling took a sharp downturn, before recovering through the two subsequent plan-years. MG freight loadings remained at above-par levels over this period, but declined from 1982-83 onwards till the end of the 5FYP. This decline was also accompanied by falling BG freight handling in the last two years of the plan to below-par levels, so that IR freight loadings were at their lowest ebb in 1984-85. Over the first two years of the 7FYP, BG freight handling initially declined but the resulting traffic slack was partially offset by increased MG freight handling. Buoyancy was restored to IR freight loadings by recovery in the BG bulk-freight segment in 1987-88 and 1988-89, which however gradually drove MG freight handling to below-par levels. By the terminal year of the 7FYP, decline had set in also within the BG freight segment, with marginal recovery of MG freight loadings.

Several important features of IR freight loading patterns emerge from the phase analysis of autoregressive error residuals. While IR freight loading performance has traditionally been driven by BG loadings of bulk-freight, the existence of adequate MG freighting capacity provided a degree of insulation to overall IR freight performance prior to the 4FYP. The cyclic structure of IR freight operations is clearly evident in the phaseplot. Thus while shortfalls in BG freight loadings occur with distressing frequency on IR, these have been offset on many occasions in the past by compensating increases in MG freight loadings which have served to even out freight fluctuations. Consequently, the amplitude of freight fluctuations during the 1960s was relatively limited, and was characterised usually either by above-par MG freight handling during the 3FYP, or by above-par BG handling during the subsequent Annual Plans. The amplitude of freight fluctuations began to increase during the 4FYP period and reached a maximum over the 5FYP, when wild swings in the time-trajectory are noticed between the different orthants of the phaseplot. The magnitude of these fluctuations also indicates the extent to which IR freight handling was affected by the succession of Oil Shocks during the 1970s, through much of which bulk-freight handling remained at unanticipatedly low levels. The converse case, where high BG loadings have compensated for shortfalls in MG freight loadings, has been less frequent, and occasions when very high freight loading has been achieved on both BG and MG gauge networks are extremely rare.

The resetting of IR freight priorities during the 6FYP and 7FYP also involved a restructuring of the IR freight-base, along with substantial modification in wagonfleet composition, directed towards improving bulk-freight handling capacity. Nevertheless, while the amplitude of freight fluctuation has remained relatively high over the 1980s, the counterbalancing role of MG freight loadings has begun to decline, partially because of the de-emphasis on MG freight operations. Since the dataset had shown earlier that the commodity composition of IR freight differs radically between the BG and MG networks, with general freight being more important to the MG freight segment, this would indicate that the increasing emphasis on bulk-freight over the period under review has narrowed the IR freight-base to a greater degree than had been anticipated by the plans, and has fuelled the exodus of general freight to other modes of transportation. The principal cause of this appears to have been IR's neglect of the MG freight network, and the shrinkage of its freight emphasis to the high-density BG corridors.

6.5 Model Adjustment for Serial Correlation

Although the initial OLS regressions on IR freight loadings were vitiated by the extensive presence of serial dependence within the wagon loading dataset, analysis of the error residuals has allowed substantial insight to be gleaned about the nature of commodity and gauge interdependence on IR freight operations, which showed up through the phenomenon of freight cyclicity. Estimation of the autocovariance coefficients ρ_i on the postulate of an AR(5) autoregressive model has thus captured the adaptive structure of India's 5-year planning horizon, relating IR freight-capacity planning decisions to the cyclicity of crossgauge commodity-freight trends. Resolution is still required, however, of the difficulties imposed by the loss of efficiency in OLS regression coefficients because of the presence of serial dependence - a feature also evident within the simple r_{ij} coefficients for gaugewise commodity loadings arrayed in the correlation matrices. Corrected coefficients estimated on the more elementary postulate of an AR(1) autoregressive structure for the serially-correlated residuals, would allow truer understanding of the magnitude of the aggregate IR freight response to the rising or falling loading trends of given commodities. This is attempted by adjusting the regression coefficients for the presence of serial dependence.

6.5.1 The Cochrane-Orcutt Modelling Procedure

The popular Cochrane-Orcutt [C-O] method,[42] which will now be employed to smoothen coefficient estimates in the presence of serial correlation, is an iterative procedure designed to estimate ρ - the coefficient of autocovariance - in the absence of *a priori* information about its structural nature. The two-step modification of the procedure however restricts the iteration to the simpler first-order *i.e.* AR(1) autoregressive scheme where the estimate of ρ is obtained from the first-order lagged regression of observed OLS residuals, and in analysis, it is found that the original OLS coefficients can then be adjusted for the loss of minimum-variance properties that occurs when running OLS on serially-correlated datasets, thus sharpening the conclusions regarding the original sources of serial dependence, namely the interdependence autonomously induced into commodity-loadings on IR by shortages of freight capacity during the plans.

The C-O two-step procedure is briefly outlined below to explain the modelling adjustment. Under the governing assumption of the procedure, the residual term u_t in the k-variable linear regression model

$$Y_t = \beta_1 + \beta_2 X_{2t} + \ldots + \beta_k X_{kt} + u_t, \qquad \ldots \quad (6.10)$$

is assumed to have been generated by the AR(1) scheme $u_t = \rho u_{t-1} + \varepsilon_t$. Estimation of the regression coefficients of k-variable model is first made by OLS in order to obtain observed residual estimates of u_t, denoted as e_t. For each period, these are then regressed on the observed residual of the immediately prior period to obtain a coefficient estimate of autocovariance or $\hat{\rho}$ from the first-differenced expression

$$e_t = \hat{\rho}\, e_{t-1} + v_t . \qquad \ldots\ (6.11)$$

where v_t is an estimate of the uncorrelated component of error. The computed $\hat{\rho}$ which is a consistent although still biased[43] estimator of ρ may then be used to transform the variables in the dataset to form the *generalised* difference equation of GLS [Generalised Least Squares]

$$(Y_t - \hat{\rho}\, Y_{t-1}) = \beta_1(1 - \hat{\rho}) + \beta_2(X_{2t} - \hat{\rho}\, X_{2t-1}) + \ldots + \beta_k(X_{kt} - \hat{\rho}\, X_{kt-1}) + e(u_t - \hat{\rho}\, u_{t-1}) \quad \ldots\ (6.12)$$

or equivalently

$$Y_t^* = \beta_1^* + \beta_2^* X_{2t}^* + \ldots + \beta_k^* X_{kt}^* + e_t^* \qquad \ldots\ (6.13)$$

with new β_i^* coefficients that are now autocorrelation-adjusted. Since the C-O procedure employs the estimated $\hat{\rho}$ instead of the true ρ estimated from a generalised AR scheme, the estimation of regression coefficients is equivalent to employing GLS methods for coefficient estimation. The estimate $\hat{\rho}$ which is readily obtained from the OLS residuals already computed during the autocorrelation check can then be utilised to obtain the C-O adjusted β_i^* coefficient estimates for the wagon loading dataset.

6.5.2 Analysis of Adjusted Commodity Coefficients

The wagon-loading dataset that is presently being subjected to regression analysis combines commodities which have magnified their freight presence considerably over the 35-year review period, as well as commodities which have lost freight presence as a result. Comparative estimates of OLS and C-O adjusted commodity-coefficients for the gauge-to-gauge regressions of the IR wagon-loading dataset had been presented earlier in Tables 6.3*a*, 6.3*b* and 6.3*c*. After application of the C-O adjustment procedure, notable improvements are noticed in the respective computed *t*-coefficients, indicating therefore that the significance levels of the commodity coefficients improve considerably after the autocorrelation adjustment. The associated R^2 and adjusted $\bar{R}^2$ multiple regression coefficients after the C-O adjustment in Table 6.3*d* also indicate that much closer fit is obtained in the regression after application of the C-O procedure, accompanied by substantial reduction in the standard errors of commodity-coefficient estimates Prior to further analysis of the modified β_i^* coefficient estimates obtained from the C-O adjustment, it is important to note that recourse to the simpler AR(1) scheme for estimation of the autocovariance coefficient ρ under the two-step C-O adjustment for serial correlation is justified because the estimated $\hat{\rho}$ converges to true ρ in large samples on account of consistency between $\hat{\rho}$ and ρ.

Comparing the estimates of commodity-coefficients, their standard error and t-statistics under the C-O adjustment with the respective results obtained before the autocorrelation adjustments, the coefficient estimates for commodities like coal & coke, grams pulses, sugar, cement, iron & steel and tea (for the AG/BG regression) are found to improve sharply. With consequent reduction in standard errors, the t-statistics for these coefficients accordingly improve, widening the confidence limits for the coefficient estimates. The values of R^2 and $\bar{R}^2$ increase for all regressions, sharpening the utility of the related inferences.

The commodity-coefficients estimated by the C-O procedure provide indication of the freight elasticities of increased or decreased wagon loadings of the concerned commodity, namely the degree to which changes in the handling of freight in these commodities affect aggregate IR wagon loadings over all gauges. Considering the intercommodity freight relationships found to be significant at 95% confidence level [*see Table 6.b*], it is seen that a fairly large group of commodities with both increasing and decreasing wagon-loading trends show significant freight elasticity withiin IR's BG freight operations. Most commodities handled on IR's MG network show relative freight inelasticity, with the exception of jute manufactures, iron ore, iron & steel and cement. It is also noted that declining wagon loadings of cotton manufactures, which were a prominent constituent of general freight over most of IR's operational history, have been the most important casualty of changes in the IR freight-base over the period under review, displaying the highest freight elasticities.

Consequent to the IR emphasis on increased bulk-freight handling, the displacement of cotton manufactures has been most severe on the MG freight segment. Freight elasticity is also relatively high for raw jute, which has similarly lost considerable ground within the IR freight-mix. Nevertheless, although wagon loadings of bulk mining materials like coal & coke and iron ore have shown strongly increasing trends in terms of their aggregate freight-handling on both IR gauges, their estimated commodity-coefficients under the C-O adjustment indicate relatively low freight elasticity. Commodity-coefficients for bulk industrials like iron & steel and cement are notably stronger, indicating higher freight elasticity for wagon loadings in this segment. BG freight-handling trends in other mineral ores and sugar, which had displayed insignificant freight elasticity under OLS, are also found to have become significant under the C-O procedure. Only grams & pulses with strongly increasing freight-loading trends and oilseeds and sugarcane with declining freight-loading trends show relatively high freight elasticity within the agricultural output segment of the freight market. Increased wagon loadings of grams & pulses appear to have led to strong displacement of the other two commodities, indicating the mutuality of IR freight gains and losses in this commodity segment. The principal reason for such mutuality would appear to be the common requirement of these commodities for covered wagons, the proportion of which has substantially declined within the IR wagonfleet.

Considering the crossgauge relationships within the IR wagon-loading dataset, the dependence of overall BG freight loadings on MG freight handling is seen to be much lower than the dependence of MG freight loadings on BG freight handling. Little difference is consequently noticed in the BG/MG freight elasticities computed under OLS and C-O procedures for jute manufactures, iron ore, iron & steel and cement. In the MG/BG regression, freight elasticities increase under C-O estimation for commodities like raw cotton, jute and cotton manufactures and to a lesser degree for cement, while the freight elasticities of oilseeds and grams & pulses decline marginally. Since jute manufactures and grams & pulses have retained some presence in both BG and MG segments, this would signify that retention of these commodities by IR has a strong displacing effect on the wagon loadings of other agricultural commodities and light industrials. In the case of cement, which is carried with the longest traffic leads over the entire IR network, the freight elasticity of MG loadings is much stronger than the freight elasticity of BG loadings of this commodity, implying that growing demands for cement in isolated regions of the country which are only served by IR's MG network are an important cause of the escalation in freight dlows of this commodity on the BG trunk network. Rather surprisingly, coal & coke which is the main freight commodity moved by IR shows relatively low freight elasticity for AG and BG loadings and is freight-inelastic in the MG segment. The principal reasons for this would be the specialised wagon and handling needs of this commodity which have been a major source for wagonfleet specialisation on the IR network, as well as the location of most originating points of coal & coke freight within a specific region to the east of the country, thus accounting for the relative paucity of reversed-lead freight and of consequent increases in the wagon loadings of other commodity-freight.

At 99% confidence limits, the number of commodities with significant freight elasticities becomes relative sparse [*see Table 3.2c*] Nevertheless, several commodity-coefficients which are found insignificant under the OLS estimation become significant after the C-O adjustment. Notable among these are sugarcane and oilseeds in the AG/BG regression, cotton manufactures and iron ore in the BG/AG regression, cotton manufactures and oilseeds in the MG/AG regression, and jute manufactures and sugarcane in the MG/BG regression. Conversely, while the freight elasticity of iron & steel in the BG/MG regression declines into insignificance under the C-O adjustment, the freight elasticity of iron ore becomes significant and high. The respective coefficient values of course remain unaltered between the two tables. Thus at 99% confidence, increased BG bulk-freight loadings of cement, iron & steel, grams & pulses, coal & coke and cement continue to have a strong displacing impact on the handling of other freight like cotton manufactures, sugarcane, oilseeds and raw jute on the IR network. A large proportion of this displacement occurs in general freight and light industrial commodities traditionally handled by both MG and BG freight networks, including long-lead freight in cotton and jute manufactures, as well as freight in raw jute and sugarcane with shorter traffic leads. Since the MG and BG networks cover different spatial regions within India, this has a profound impact on the quality of infrastructural services provided by IR to different economic sectors and regions in the country.

Another notable result of the C-O adjustment is noticed in the change in coefficient magnitudes, leading to sign reversals in several cases [*see Table 6.3a*]. Since the C-O procedure theoretically recombines the partial correlations between the wagon-loadings of different commodity-pairs denoted in the correlation matrices reproduced below each gaugewise wagon-loading table, the C-O adjusted commodity coefficients represent corrected freight elasticity estimates that subsume the direct and indirect impact of intercommodity freight relationships within the changing IR freight-mix. While a detailed examination of the magnitude of coefficient changes would exceed the purpose of the present investigation, a few general remarks may be made. It is noticed from Table 6.3*a* that the magnitude of shifts in freight elasticity are notably higher for commodity loadings on IR's MG network. The secular decline in MG freight operations can thus largely be attributed to the downstream displacement of commodity freight as a consequence of IR's bulk-freight specialisation and the narrowing of the freight-focus within the BG network. Thus the apparent withering away of IR's MG freight operations ties in very closely to the dominant railway planning decisions taken over the FYPs. Considering freight trends in cotton manufactures, where IR has lost the greatest amount of ground, the associated commodity-freight coefficients for cotton manufactures in the AG/MG and BG/MG regressions show very strong sign-reversal under the C-O adjustment. Thus while a decline in the wagon loadings of cotton manufactures has been manifest on both BG and MG networks, the change of coefficient sign from a negative to a positive magnitude indicates that the displacement of this commodity from IR freight operations has been magnified manifold by related displacements of several other commodities. Once more attention is drawn to the shortage of covered wagons in the IR wagonfleet which once carried a variety of other general freight on reversed leads after initially delivering consignments of cotton manufactures to different corners of the country. Even this single instance adequately draws attention to the unforeseen consequences of bulk-freight and wagonfleet specialisation, which have seriously undermined the ability of IR to retain a credible share of the highly-rated low-bulk market segment in general freight. At the other end of the freight spectrum, reversals of coefficient signs are also noticed in the AG/MG and BG/MG freight elasticities for coal & coke. Although the coefficient magnitudes are low, freight dominance of this commodity in the IR freight-base ensure that each successive increase in coal & coke loadings has a strong displacing impact on other general categories of freight. The mechanism for such displacement works through wagon specialisation, under which coal wagons are unsuitable for the carriage of other freight and must run empty on reversed leads. Thus increased handling of coal & coke by IR increases the need for traction and associated transhipment loadings, in the long run strengthening the displacement of high-valued general freight to the roadways.

6.6 Longterm Freight Implications for IR

IR is often described in the literature as being the second largest railway system under a single management. Yet at the time of the commencement of the 8FYP, only around 23 percent of the IR route network consisted of dual or multiple tracks and nearly 44 percent of the IR network was served by MG and NG routes. Thus the BG network carried almost 91 percent of total freight and 83 percent of passenger volumes in traffic terms. The MG network which spanned 38 percent of the route network carried only 9.43 percent of total IR freight traffic.[44] The conceptual spread of IR freight services is thus far more limited than the size of the IR route network might suggest. Although the BG wagonfleet at the end of the 8FYP comprised around 88 percent of the IR wagonfleet in FWU terms, the aggregate freighting capacity of the BG wagonfleet at around 9.89MT amounted to more than 92 percent of total IR freighting capacity, reflecting the higher average carrying capacities of BG wagons. [*see ch4, Table 4.2*] The MG wagonfleet, by contrast, had declined by then to only 33 thousand FWUs with an average wagon capacity of 25.8T and an aggregate freighting capacity of 0.85MT. Because of the higher average train running speeds on the BG network, the traffic potential of BG freight operations in net tonne-km terms was even higher. But with most of this traffic flows now being concentrated on the HDCs, IR appeared to have withdrawn from most of its MG and BG single-line network.

Nevertheless, existence of the dual gauge system resulted in relatively high freight transhipment needs, with most transhipments occurring over 14 major transhipment points on IR route network. At the close of the 6FYP in 1984-85, around 3.15 percent of BG originating freight and over 32 percent of MG originating freight was estimated to have required transhipment, with approximately 6.45 percent of total originating tonnages on the IR network actually comprising transhipment loadings. Because of increased gauge conversion and the streamlining of BG freight operations during the 7FYP, transhipment loadings were estimated to have declined proportionately by 1991-92 to 5.6 percent of total originating revenue-earning tonnages of 337.9MT. However, since 6.6MT was transhipped from BG to MG and NG that year, against transhipments of 12.5MT from MG and 0.1MT from NG to other gauges, the feeder character that MG freight operations still retain within the IR system becomes readily apparent.[45] The major commodities requiring transhipment included major IR bulk-freight constituents like coal & coke, iron & steel, cement, foodgrains and POL, as well as limestone and gypsum.

While restructuring of the IR freight-mix through increasing bulk-freight emphasis and wagonfleet specialisation has improved the throughput of BG freight operations by reducing handling and transhipment costs and wagon TAT, its implication on the profitability of IR's freight operations has not been as definitive. As part of this new freight stance, IR now insists on point-to-point movement of bulk-freight in full rakeloads and has accordingly restricted the booking of parcel and break-bulk traffic. Consequently, the seven major freight commodities which include coal & coke, POL, iron & steel, foodgrains, chemical fertilisers and iron ore contributed 87.2 percent of IR freight revenues and 85.2 percent of IR freight traffic in net tonne-km terms in 1991-92 on the threshold of the 8FYP. In pointed contrast, the next seven commodities including limestone & dolomite, salt, sugar, oilcake fodder, other quarried stones, wrought timber and gypsum contributed only 6.1 percent of IR's freight revenues and only 8 percent of revenue earning freight traffic.[46] The principal causes of slow growth in railway freight operations in India may thus be jointly identified as the shrinkage of the IR freight-base to only a few bulk commodities regardless of the traffic offer from the economy, and consequent underutilisation of the IR route infrastructure and assets elsewhere. While no slack appears visible in IR freighting capacity because of the slow pace of wagon replacement and acquisition, the real slacks of the IR system exist in the form of low intensity of operations outside the golden quadrilateral and repressed transportation demands in the economy.

The analysis in the present chapter has served to bring out the longterm implications of such slacks. IR asset renewal under the FYPs has involved substantial inductions of upgraded railway technology into track, traction as well as rolling stock. These have in turn reduced IR's freight focus to a few commodities and a few high-density routes, for which specialised wagonfleet upgradations have had to be made. Because of the production lags which operate between producer goods and consumption goods sectors in the economy, the freight streams from these do not coincide over time. The increasing inability of IR to meet the transportation demands of low-bulk freight segment which raises transportation costs and lowers transportation efficiency throughout the economy ultimately causes periodic interruptions in the bulk-freight flows. The phenomenon of freight cyclicity experienced by IR is thus observed to tie in very closely with the shrinkage of IR feeder freight operations on the MG network and to the consequent surrender of the general freight segment to the roadways. The wagon-loading dataset used in the regression analysis in the present chapter has certain limitations. Multicollinearity in the dataset is the inevitable consequence of the peculiarities of the railway freight scenario to which the regression analysis has been applied, in which the loadings of commodity freight by IR are constrained by available freighting capacity on the IR wagonfleet, and also by the degree of technological specialisation within the wagonfleet. Thus achievement of higher freight loadings in chosen commodity-freight categories tends to crowd out other freight, reducing the loading of low-bulk general freight and also of short- and medium-lead traffic which is accorded lower priority in IR freight policy. However since freight flows on the IR network are unevenly balanced between the BG and MG segments, these changes in freight priorities have specific spatial impact on the regional freight patterns in the country, and also on the backward and forward linkages between railway infrastructure and other sectors of the economy. Detailed examination of such features is made in the next chapter.

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Chapter 7

SPATIAL & SECTORAL IMPACT OF RAILWAY FREIGHT SPECIALISATION

7.1 IR Technology & Freight Specialisation

The preceding examination of the evolution of IR freight operations had distinguished a sequence of three important historical phases covering the periods of railway construction and operational consolidation before 1947, and the period of technological rejuvenation and freight development thereafter.[*see ch3*] It had been noted also that the course of freight development set into motion by the priorities of national planning in India during the post-Independence period also determined railway wagonfleet composition and the resulting IR commodity-freight mix. More stress was thus laid by IR during the planning era on the technological upgradation of its freighting and passenger-carrying capabilities than on spatial and operational expansion of the IR network. The subsequent period consequently witnessed gradual waning of the infrastructural thrust unleashed under the early FYPs, and growing complacency regarding railway freight development because of autonomous growth of roadways. As noted in several earlier reviews of railway transportation planning,[1] the backdrop for this was formed by the quick proliferation of projects and shifting plan focii which led eventually to a severe funding crunch, dissipating the earlier infrastructural thrust under the FYPs.

Although most of the IR's existing route-network was already in place in 1951 when planning began, large sections of its permanent way were badly in need of renewal and line upgradation in order that the new freighting demands of the FYPs could be met. Considerably more running-track was added or relaid by IR after Independence relative to the additions of new route-km to the network, in order to allow the intensification of railway freight operations. Coupled with improvements in the permanent way and railway signaling systems, new railway investments were made on line electrification and the improvement of coaching and traction, as well as on induction of specialised wagon-types into the IR wagonfleet. New allocations of railway capital towards these formed part of the technological package for the modernisation of the railways in India, as well as for the phasing out of railway technology of an older vintage and obsolete railway stock. Consequently the new sunk costs of this package were anticipated to be huge, and were therefore to be phased out over successive FYPs.

It was here that the crux of the problem was encountered. During the period of initial railway construction, the undoubtedly huge costs sunk into railway capital had been met largely through the private borrowings of the construction companies against the assurance of guaranteed returns from Government. The paying out of interest guarantees over a long period thereafter ensured that the sunk costs were eventually transferred to the public exchequer in a deferred manner. However, the capital needs of railway renewal after Independence which again involved huge amounts of sunk cost were left jointly to the public capital mobilisation efforts by Government under the FYPs and to internal resource generation by IR. Besides staggering the process of IR capital renewal, this reduced the magnitude of the operational economies of scale that accrued to IR from the process of technological rejuvenation, while also saddling the IR system with new and old railway technologies of incompatible vintage. Simultaneously, the willingness to channel new public investment to the railways changed considerably over successive FYPs, leaving IR to manage its capital needs as best it could through a combination of fund-outsourcing, leasing and internal resource mobilisation, all financed through successive upward revisions of railway tariffs and rates. Meanwhile, as the spatial and sectoral spread of IR freight services progressively narrowed down to the movement of captive bulk-freight on the upgraded high-density railway corridors in order to maintain freight adequacy and running efficiency, the need for parallel public investment in an alternative highway network for the country gradually became more amplified.

In more recent debates around such issues, several opposing viewpoints on the contemporary role of railway infrastructure as a public good have emerged. While it is being argued on the one hand that restructuring of IR needs to be undertaken in order to 'unbundle' its integrated monopolies and hive several of its non-core services off into separate public corporations,[2] or to completely separate ownership and enterprise functions by eventually corporatising the entire IR organisation into a proposed Indian Railway Corporation [IRC], substituting the Railway Board by a new Indian Rail Regulatory Authority [IRRA],[3] it is also being argued on the other hand that the capital costs of railway development incurred on projects for line electrification and track augmentation projects and on other social obligations borne by IR should be entirely funded by Government through dividend-free budgetary assistance.[4] The phenomenon of 'adverse selection' has thus been visibly present in railway planning in India. While critical needs of the IR freight system including 'de-bottlenecking' of the network and the enhancement of general freighting capacity have gone abegging because of the resource crunch, as much as half of IR's Capital Fund has been sunk into gauge conversions and 20-30 percent of its market borrowings have gone into the construction of new lines without tangible operational benefits. While all these issues are germane to the future of railway infrastructure in India, they also reflect the critical situation arising from capital shortages that has restricted the pace of railway development over the FYPs, gradually eroding the role of IR in the country's transportation infrastructure.

Since such factors have impacted directly on IR freight operations and also indirectly on the freight operations of other alternative transportation modes in India, an attempt will be made during the present discussion to evaluate the extent to which the shifting patterns of IR commodity-freight have altered the spatial and sectoral balances of the economy, also possibly vitiating the intended directions of economic growth sought to be achieved through the FYPs. In doing so, the analysis will build on the preceding findings relating to IR freight cyclicity, by studying the spatial and sectoral character of periodic railway freight bottlenecks through their disaggregated impact on zonal railway operations and on the commodity-freight flows between different economic sectors and regions.

The regression exercises in the previous chapter had encountered both longitudinal and lateral interdependence within the wagon-loading dataset while examining the crossgauge and cross-sectoral interrelationships of IR commodity-freight. These pointed to the presence of serially-dependent errors as well as multicollinearity in the wagon-loading series. Application of the C-O adjustment procedure to correct variance distortions induced by serial dependence in the series aided the drawing of analytical inferences about the changing significance of different commodities in the IR freight-base, and consequently the interdependence of their wagon-loading trends. Since the growing freight specialisation visible on IR has at least partially been the consequence of freighting-capacity limitations associated with changes in the composition of the railway wagonfleet, the presence of multicollinearity in the dataset was not unexpected. Nevertheless, its presence tended to create fuzziness around the degree of influence that individual commodity-loading trends exercised on the overall patterns of IR freight. In order to sharpen earlier inferences about the selective shifts of certain categories of commodity-freight to other modes of transportation as a result of freight cyclicity and capacity bottlenecks on IR, the Factor Analysis approach is introduced as a methodology for examining the possible spatial and sectoral impacts of IR freighting constraints on the economy. Factor Analysis of the wagon-loading series also substantiates that the primacy of core-sector commodity-freight flows emanating from the PSUs over all other commodity traffic has been the principal cause for the surrender of the highly-rated low-bulk freight segment to the roadways in India.

7.2 Spatial Nature of IR Freight Flows

A study of development across national space implies the evaluation of *horizontal* rather than *hierarchical* aspects in development. While the latter are an indispensable attribute of sectoral development, they largely bypass the locational considerations that are important to the former. The origin of freight flows, and indeed of transportation economics, lies in the spatial variation in production costs which under the principle of optimal location determine the nodes of originating freight as those regions where the respective production costs are lowest.[5] Free exchange of both productive resources and products follows as a natural corollary of the existence of means for transportation.

As such, the basket of economic costs defined for each commodity output is composed of direct and indirect *factor* costs (costs of labour, capital, etc., as against raw material costs, etc.) to which the necessity of freightage adds regional *transfer* costs. Optimal location of producing facilities vis-a-vis consuming centres takes care of cost minimisation in both cost aspects. Nevertheless, while factor costs may be similar between regions, regional transfer costs *i.e.* the costs of transportation are conditioned by the relative size of national space. Optimal use of regional resources to minimise transfer costs thus dictates the ultimate dispersal of productive facilities over a period of time.[6] Thus the core determinant of spatial freight flows within a nation is the transportation infrastructure, of which the railways are an important constituent in most cases. The presence of railways in transportation networks however adds a peculiar feature to the optimisation of transfer costs since, much more than in any other transportation mode, it permits the economical transfer of bulk resources and outputs over far greater distance leads and can thus, in effect, counteract the need for industrial dispersal. It is therefore quite obvious that the rising importance of roadways witnessed in most countries of the world preordains the shift in domestic locational patterns across the geography of space.

7.2.1 Freight Flow & Regional Economic Development

Evidence from several countries would support the proposition that regional dominance within them was acquired by specific industrial belts that were traditionally well-endowed with efficient railway transportation links and consequently well-placed to decide the direction and volumes of interregional commodity freight flows. In Britain, this importance was held by London and the Southwestern region[7] which linked the major port of Southampton to London and to the industrial triangle formed by Birmingham, Manchester and Liverpool. A similar position was occupied by the New York-Pittsburgh-Chicago triangle in the American Northeast in the USA[8] and by the Nord-Lorraine axis in Northeast France.[9] In Japan, the region that acquired industrial dominance over the national economy linked the port-cities of Osaka, Yokohama and Tokyo along the east coast of the main Japanese island of Honshu.[10] In India, the region of major concentration of industry through most of the colonial period was located on the eastern mining-industrial axis between Calcutta and the Asansol-Raniganj collieries.[11] However, over the five post-Independence decades during which port activity at Calcutta has also declined in comparative importance, the hub of industrial activity has shifted to the west coast along transport radii emanating from the major port at Bombay, which again is well served by nearly every means of surface transportation.

Regional development in India has been studied in the light of the regional geographic impact of commodity flows by several scholars drawing original inspiration from Gidaḍhubli.[12] Interregional - as opposed to intersectoral - studies however tend to emphasise the spatial dimensions in development since the magnitudes of commodity flows and their backward and forward linkages are determined by the regional and locational specialisations that are causative to exchange. Analogous situations are also found in the case of intercountry commodity-trade flows where specialised production surpluses are freighted to countries which suffer relative resource disadvantages in producing these commodities, under the economics of comparative advantage. In intercountry trade, exchange rate flexibility acts as a balancing mechanism that prevents the concentration of unidirectional single-commodity flows which could lead to transportation inefficiency. The absence of a similar balancing device in interregional trade can however perpetuate the skewed commodity flows that reflect regional disparities and developmental imbalances, with the lack of bidirectional freight flows being both a symptom as well as a cause of transportation inefficiency.

Another important factor determining the direction and volume of spatial freight flows is the location of connective nodes in interregional and international trade. It had earlier been remarked in respect of railway development in India during the colonial period that the commodity-freight flows of the time were directed centripetally to the ports, since they were largely intended for export. Following the advent of the era of planning and development, IR freight flows became more centrifugally directed, with reversal of originating and terminating points in the case of port-oriented traffic as the need for domestic development made the Indian economy progressively more insular.

7.2.2 Regional Importance of Railways

Multivariate methods such as those implied in Factor Analysis[13] are often applied in econometric analyses of interdependent datasets because of their ability to cut through multicollinearity problems which could vitiate OLS estimation. As such, a number of instances exist where they have been employed in the study of spatial and sectoral development, including transportation studies. Setsuko [1968] for example employs Factor Analysis methods in a comprehensive study of freight flows in 32 major commodities over the prefectures of modern Japan to reveal the composition of national, regional and local units. A study in the railway context in India is found in Aggarwal [1982][14] which employs Factor Analysis methods to estimate the composition and influence of commodity-freight trends uptil the early 1970s on the spatial development of regions. Existing regional disparity is measured through an inequality analysis of Lorenz curves and Gini coefficients on a dataset comprising spatially distributed originating and terminating freight tonnages on IR via a regional commodity-flow matrix. Since the referred study resembles in spirit if not in substance, the purposes of the present chapter over a different timeframe, it is useful to draw attention to salient features which would aid the present analysis.

References made earlier to the evolution of railways in India have identified the importance of the old Presidency port-cities of Calcutta, Madras and Bombay (Mumbai) to the design of the Indian network. As such, the IR trunk routes form a golden quadrilateral between these three principal nodes and the national capital region [NCR] at Delhi. Railway trunk-flow patterns in India hence do not follow the more common format of radial flows from a central transportation hub, but instead radiate laterally between the port nodes and the NCR. Traffic development on the feeder network of each principal railway node remained relatively weak during the colonial period because of the lack of industrial diffusion. An outward expansion of economic activity and trade has however been witnessed after Independence, mainly as a result of the parallel development of feeder roads. Where such dispersion has been high, the disparities between nodal and feeder regions have become less stark.

Under the colonial design adopted for the railway network, India was more favoured than countries having a single transportation hub, in its having multiple transportation nodes located in its northern, southern, western and eastern regions from which economic activity could disseminate outwards. In the post-Independence period however, the western region has stolen a march over other regions in industrial development, while the eastern region has lost its old preeminence following the decline of industry around Calcutta, and has lagged consistently since then. In studying spatial development patterns in India, hypotheses would naturally arise[15] on whether increasing economic activity during the planning era represents decentralised development and increased regional independence, or whether development has become increasingly centralised generating increasing regional interdependence. Vindication for either hypothesis would be found in the patterns of growth of IR freight traffic and in the changes in its commodity-composition. In the main, increases in freighting tonnages accompanied by increasing freight leads would indicate progressive concentration of development at a regional hub and the expansion of its hinterland, while increasing freight accompanied by decreasing freight leads would indicate the geographic compaction of development with the evolution of multiple technologically-linked production complexes.

Regional distribution of total IR freight is found to have been highly skewed over the period studied, and the presence of disparity in spatial freight-flows between regions is established by the inequality analysis.[16] High magnitudes obtained for the regional Gini-coefficients indicate the dominance of a few commodities in regional freight shipments and receipts. While the correlation matrices indicate weak orders of relationship between indices of railway freight, industrial production and mining production, the pronounced sensitivity of railway freight traffic to agricultural production and national income is revealed. The Factor Analysis substantiates that the skewing of freight movements has resulted in imbalances between regional clusters of production and consumption activity. Spatial diversification of economic activities is also identified from the freight loadings for areas that specialise in industrial and agricultural production, and the production of specific bulk commodities like coal and POL.

A base is thus established for extended study of IR freight patterns using Factor Analysis as the principal analytical tool. Nevertheless, rather than shifting away from the railways to regional development, the present study retains its focus on freight capacity and IR freight infrastructure. Consequently, the spatial aspects of IR freight operations are studied within the framework railway zones rather than geographic regions, while Factor Analysis is applied subsequently here to identify sectoral changes in IR commodity-freight operations and the resulting intermodal shifts of freight.

7.3 Spatial Distribution of IR Infrastructure

At the commencement of the 1990s, the Indian Railways were composed of 9 zonal railways, comprising Northern Railway [NR] and Central Railway [CR] serving the Gangetic and central plateau region to the country's north and northwest with the largest combined zonal component of 28.8 percent of the IR route network, North-East Railway [NER] and North-East Frontier Railway [NEFR] serving Bihar and the country's northern borders extending upto Assam and Nagaland with 14.8 percent of the IR network, Eastern Railway [ER] and South-Eastern Railway [SER] serving the mining belt around Calcutta and the country's east coast with over 18 percent of the IR network, Southern [SR] and South-Central Railways [SCR] serving the south-coastal and peninsular areas with over 22 percent of the IR network, and the Western Railway [WR] serving the western industrial belt and west coastal areas with around 15.8 percent of the IR route network. Route details of the IR zonal railways and their spatial coverage are provided in Table 7.1 and Map 2.

Table 7.1: Route Networks of IR Zonal Railways 1998-99

[route length in km]

Route Network Details	Northern	Central	North-Eastern	North-East Frontier	Eastern	South-Eastern	Southern	South-Central	Western	Indian Railways
	NR	**CR**	**NER**	**NEFR**	**ER**	**SER**	**SR**	**SCR**	**WR**	**Total IR**
Route Network	11040	7265	5143	3624	4270	7420	7040	7217	10295	63314
%IR	*17.44*	*11.47*	*8.12*	*5.72*	*6.74*	*11.72*	*11.12*	*11.4*	*16.26*	*100*
BG Routes	8920	6240	2300	1175	4135	6135	4630	5955	4600	44090
%IR	*20.23*	*14.15*	*5.22*	*2.67*	*9.38*	*13.91*	*10.5*	*13.51*	*10.43*	*100*
MG Routes	2020	1025	2820	2230	135	1280	2125	1215	4455	17305
%IR	*11.67*	*5.92*	*16.3*	*12.89*	*0.78*	*7.4*	*12.28*	*7.02*	*25.74*	*100*
NG Routes	100	-	23	80	-	4	130	47	890	1274
%IR	*7.85*	-	*1.81*	*6.28*	-	*0.31*	*10.2*	*3.69*	*69.86*	*100*
Mixed Routes										
BG/MG	-	-	-	131	-		155	-	150	436
MG/NG	-	-	-	8	-	-	-	-	-	8
Zonal BG:MG Ratio	***4.4***	***6.1***	***0.8***	***0.5***	***30.6***	***4.8***	***2.2***	***4.9***	***1.0***	***2.5***

Source: Compiled from data on IR Zonal Railways, Indian Railways Fan Club Association, Internet source: http:/www.irfca.org/

The uneven dispersion of railway infrastructure in India becomes readily apparent from the data. While nearly half of IR's route infrastructure interlinks the northern, central and western regions of the country, and its southern regions are also relatively well served, the eastern, east-coastal and northeastern regions are relatively weaker in terms of railway infrastructure. The proportion of BG routes in the zonal networks ranges from 81 percent to 97 percent on NR, SER, SCR, CR and ER against a corresponding proportion of 69.4 percent for the IR route network as a whole. Conversely, the proportion of MG routes on the WR, NER and NEFR route networks ranges from 43 percent to 62 percent. WR, SR and NEFR also hold most of IR's light [NG] railways and many more of their routes still require transhipment from BG to MG and vice-versa. With this unevenness in the spread of railway infrastructure, the extent to which IR is able or unable to serve regional transportation needs varies considerably between the different IR zones. Nevertheless, because of technical factors which have led to the reconstitution of IR's freight-base and have also led to the decline of feeder-freight operations on the MG network, the present freight-focus of IR is largely confined to those IR zones which have high BG:MG intensity.

Table 7.2 in three parts reveals the extent of growth in network infrastructure and operations for the IR zonal railways between 1966-67 and 1990-91, *i.e.* between the end of the 3FYP and the end of the 7FYP. The historical patterns of railway zonalisation in India had already been briefly recounted elsewhere in the present study.[*see ch2*] Spatial variations in the sizes of zonal route networks are largely an inheritance from the 42 erstwhile company and state railways which were consolidated into the new railway zones. While route augmentation on IR after Independence has generally been slow, much larger augmentations in running track have occurred because of the multitracking of busy railway routes on the HDCs. Closures of several uneconomic single-line routes such as those served by the erstwhile light railways have also increased the overall ratio between IR running-track and route lengths. In view of the evidence on route specialisation and phasing out of feeder freight operations deduced in the course of the present study, it also appears unlikely that all routes included in the zonal networks are physically functional as of today. This would partially account for the observed spatial variations in traffic intensity and track utilisation between different IR zones.

7.3.1 Route & Track Characteristics of IR Zonal Networks

Differences between zonal running-track lengths and route-lengths occur mainly because of line-doubling or double-tracking on congested route-sections. The double-tracking ratio between the two thus provides some indication of traffic intensity on the zonal axes. This ratio is highest at 1.57 for ER which links the mining belt to the northern, central and southern sections of the IR network and therefore carries the heaviest traffic. Since the value of the ratio for a fully double-tracked network would be 2, the ratio value for ER indicates that by 1990-91 over half of the route network was already double-tracked. The SER and CR networks which interface with ER also have fairly creditable double-tracking ratios above 1.4. Besides these principal networks, the other zonal railways have much lower ratios in general with lowest double-tracking intensity being observed on NEFR which till today has largely remained a low-intensity MG/NG network with an almost negligible number of double-tracked routes.

It is also seen that network expansions and upgradations between closing years of the 3FYP and 7FYP have not been uniformly distributed over the zonal railways, with the largest network augmentations in terms of route-km occurring principally on SCR, CR, and SER, and of running-track km on CR, SCR and SER, in slightly altered order. NR follows in fourth position in terms of addition to routes, and stands fifth in running track additions. Interestingly NER which has added little route kilometerage to its network over the period of comparison, has shown much higher augmentation of running track because of the double-tracking of its arterial lines. In contrast, the NEFR network has remained virtually stagnant and shows the lowest additions on both counts. Route networks on WR and SR on the other hand show marginal contraction, primarily on account of the abandonment of several low-intensity routes.

It transpires therefore that over the period of four FYPs and their interregnums, railway double-tracking has improved the interzonal connectivity of IR sub-networks on certain major transportation corridors, while leaving the other transportation axes largely unaffected. Considering the track augmentation trends by region, these have improved the flow-capacity of mining outputs and other heavy industrial freight from the mining belt which is covered largely by ER, to the northern, western and southern extremities of the country. While freight flows on NER and NEFR remain at a far more rudimentary stage, railway networks through the country's central region have held the crucial key to freight crossflows to the south and the west, since this region had remained more or less untraversed during the pre-Independence period because of formidable difficulties associated with rockcut railway construction through the Deccan plateau. Most of the route construction in the period after Independence has consequently been on CR and SCR, and has been primarily directed towards improving railway connectivity of the country's northern regions to the west and the south.

The eastern extremities of the country remain isolated in comparison because of the vicious circle of low freight demand and low freighting capacity on NEFR. While the flow of petroleum crude from the Assam oilfields to the Barauni refinery could have stimulated the development of railway traffic intensity in the region if it had been transported by IR, this became a nonstarter because of the construction of the Assam oil pipeline. The principal reason for constructing the pipeline was the predominantly MG/NG-based character of the combined NEFR and NER network. Because of this, the low-intensity zonal networks of NEFR and NER were unable to handle the freighting needs of a refinery located well away from the oilfield region, and the reluctance of IR to build network and freighting capacity ahead of demand precluded subsequent upgradation of the regional railway network. The consequent isolation of the Northeastern region from the principal railway corridors has therefore contributed to slow economic development and slow railway development in the region, also disbalancing the pattern of regional development in the country.

7.3.2 IR Zonal Traffic Intensity

While the zonal distributions of railway route-km and running track provide comparative indication of the line-capacity of the IR sub-networks, the observations made above need to be rounded off with an exploration of the relative freight-intensity of zonal railway operations in the country. Traffic development on IR over the planning era has been marked by increasing intensification of its passenger operations, as result of which nearly 60 percent of IR operational output goes towards meeting the needs of passenger traffic which collectively contribute only 28 percent to IR revenue earnings.[17] Because of the inadequacy of traction and rolling stock and resulting line-congestion, the increasing passenger intensity of IR operations has had to be tackled by circumscribing the increase in freight intensity. Thus in the face of railway capacity constraints, a tradeoff exists in effect between freight and passenger operations. In the present spatial context, it would be pertinent to examine whether this tradeoff has been of the same order across all IR sub-networks, or whether specific regional biases exist between passenger and freight operations on the different zonal railways.

The table under reference reveals that the largest relative contribution to IR freight traffic in net tonne-km terms is made by SER, followed by freight flows over the CR and NR networks which are of similar order. However, the only freight flows that have risen in proportion between 1966-67 and 1990-91 in incremental terms are carried by SCR and SER. While marginal proportionate increase is also noticed in the freight flows on NR, the relative importance of freight contributions from the other IR zonal networks has declined. The sharpest declines in freight intensity have occurred on ER and SR and the conflicting patterns observed over the entire IR system provide strong evidence of the zonal polarisation of freight flows over the railway network. Nevertheless, the zonal tradeoffs between passenger and freight operations do not appear to have been uniform. While higher freight shares on SER and NR have been compensated by lowered passenger intensity of operations, freight compensation in a converse direction is observed on CR and WR where the passenger intensity of operations has increased. No visible evidence of the tradeoff is found however on the other IR zonal railways, and particularly on SCR the proportionate increase in freight share has been matched by almost parallel expansion in passenger traffic, A similar relationship also applies between the declining freight and passenger traffic shares of ER and SR.

7.3.3 Traffic Intensity & Zonal Freight Density

However, the zonal traffic levels achieved on each IR zone in terms of passenger-km and net tonne-km are not wholly adequate indicators of operational intensity in these IR zones, because of wide differences in size between IR's zonal railways. Better indication of relative variations in operational intensity is offered by the zonal freight intensity ratios in the table, computed by dividing the freight traffic component for each IR zone by the associated passenger traffic component. Another useful set of relative indicators in the table compares the freight-density and passenger-density of route and running track utilisation between IR zones, and similarly irons away the absolute variations imposed by network-size.

Examining the first set of these traffic ratios, freight intensity is seen to have remained by far the highest on SER, and has also shown marginal increase between 1966-67 and 1990-91. All other zonal railway networks with the exception of NEFR show fairly marked declines in freight intensity over the same period, which can be alternately attributed to either absolute increases in passenger intensity or relative falls in freight intensity. Although the order of increase in freight intensity on NEFR has been relatively small, it is interesting to observe that it has been achieved through more than proportionate expansion in freight traffic relative to passenger traffic, providing some indication that freight traffic development has been taking place in this region despite its railway capacity constraints. The figure for overall freight intensity on IR on the other hand provides evidence that railway operations in India have on the whole become more passenger-intensive because of traffic congestion and the marginalisation of freight on several zonal railways, of which CR and ER are foremost examples. The fall in overall freight intensity on ER is also indicative of the changing directional flow of freight from the mining belt. While the major part of this used to be routed towards Calcutta in the past, the combined effect of industrial decline in the eastern region coupled with policy factors such as freight equalisation have radically altered the zonal distribution of freight traffic through, for instance, the reorientation of iron ore shipments for export through Paradip Port which is served by SER, and cutbacks in coal shipments to the Calcutta industrial region.

The second set of traffic ratios pertaining to the relative freight-density of utilisation of zonal routes and running tracks provide indication of the density of freight operations per kilometre on the IR zonal networks, besides also offering relative indication of route congestion within each railway zone. Highest freight densities per kilometre of the route-network are observed for SER and ER, which in case of SER are achieved through a tradeoff with passenger density. The higher passenger densities on CR and NER on the other hand reflect a converse tradeoff with freight density. On ER, however, a combination of high passenger density and high freight density is simultaneously observed, pointing to route adequacy and very high levels of route utilisation within the network. However, only on SER can the route operations said to be highly freight intensive, and on almost every other IR zonal railway the growing surfeit of passenger traffic impedes the flow of adequate freight along the network.

It would be interesting to examine whether the doubling of lines has followed the patterns of traffic congestion noted above. Comparing the zonal densities of freight and passenger operations per running track kilometre against corresponding densities per route kilometre, it is noted that while the relative patterns more or less echo each other for most IR zonal railways, variations appear principally in the case of WR and ER. While passenger densities are higher than freight densities on both these railway networks, the apparent traffic congestion is less severe per kilometre of running track because of the availability of alternative lines. This is true particularly for WR. One major similarity between WR and ER is the high incidence of suburban commuter flows to and from the metropolises of Mumbai and Calcutta, which along with the commuter

Table 7.2: Operational Characteristics & Growth of IR Zonal Railways 1966-67 to 1990-91

IR Zonal Railway	Label Ccode	Route -km	Running Track-km	Passenger Traffic in PKm	Freight Traffic in NTKm	NTKm / Route-km	NTKm / Track-km	PKm / Route-km	PKm / Running Track-km	***Double Track Ratio***	***Freight Intensity of Operations***
Year: 1966-67											
South-Eastern	***SER***	6245	8083	7113	20777	3.33	2.57	1.14	0.88	***1.29***	***2.92***
		10.68	*11.74*	*7.08*	*17.82*						
Central	***CR***	5841	7913	16452	20948	3.59	2.65	2.82	2.08	***1.35***	***1.27***
		9.99	*11.49*	*16.39*	*17.97*						
Northern	***NR***	10439	12205	16142	17789	1.70	1.46	1.55	1.32	***1.17***	***1.10***
		17.86	*17.72*	*16.08*	*15.26*						
Western	***WR***	9967	11128	18469	16472	1.65	1.48	1.85	1.66	***1.12***	***0.89***
		17.05	*16.16*	*18.40*	*14.13*						
Eastern	***ER***	4092	6269	13624	18675	4.56	2.98	3.33	2.17	***1.53***	***1.37***
		7.00	*9.10*	*13.57*	*16.02*						
South-Central	***SCR***	6088	6725	3609	4402	0.72	0.65	0.59	0.54	***1.10***	***1.22***
		10.41	*9.77*	*3.59*	*3.78*						
Southern	***SR***	7216	7762	13158	10087	1.40	1.30	1.82	1.70	***1.08***	***0.77***
		12.34	*11.27*	*13.11*	*8.65*						
North-East	***NER***	4952	5132	8741	4026	0.81	0.78	1.77	1.70	***1.04***	***0.46***
		8.47	*7.45*	*8.71*	*3.45*						
N-E Frontier	***NEFR***	3625	3647	3088	3417	0.94	0.94	0.85	0.85	***1.01***	***1.11***
		6.20	*5.30*	*3.08*	*2.93*						
Total	***IR***	**58465**	**68864**	**100396**	**116593**	**1.99**	**1.69**	**1.72**	**1.46**	**1.18**	**1.16**
		100	*100*	*100*	*100*						
Year: 1990-91											
South-Eastern	***SER***	7135	9967	16796	49397	6.92	4.96	2.35	1.69	***1.40***	***2.94***
		11.44	*5.58*	*5.68*	*20.35*						
Central	***CR***	6917	10332	62417	40819	5.90	3.95	9.02	6.04	***1.49***	***0.65***
		11.09	*61.77*	*21.11*	*16.82*						
Northern	***NR***	11023	13144	48645	40504	3.67	3.08	4.41	3.70	***1.19***	***0.83***
		17.67	*7.36*	*16.45*	*16.69*						
Western	***WR***	9845	11619	57758	33955	3.45	2.92	5.87	4.97	***1.18***	***0.59***
		15.79	*6.51*	*19.54*	*13.99*						
Eastern	***ER***	4294	6741	32428	26373	6.14	3.91	7.55	4.81	***1.57***	***0.81***
		6.89	*3.77*	*10.97*	*10.87*						
South-Central	***SCR***	7206	8688	25662	24812	3.44	2.86	3.56	2.95	***1.21***	***0.97***
		11.55	*4.86*	*8.68*	*10.22*						
Southern	***SR***	6924	8059	25044	13467	1.94	1.67	3.62	3.11	***1.16***	***0.54***
		11.10	*4.51*	*8.47*	*5.55*						
North-East	***NER***	5165	6193	21298	6949	1.35	1.12	4.12	3.44	***1.20***	***0.33***
		8.28	*3.47*	*7.20*	*2.86*						
N-E Frontier	***NEFR***	3858	3864	5597	6422	1.66	1.66	1.45	1:45	***1.00***	***1.15***
		6.19	*2.16*	*1.89*	*2.65*						
Total	***IR***	**62367**	**78607**	**295645**	**242698**	**3.89**	**3.09**	**4.74**	**3.76**	**1.26**	**0.82**
		100	*100*	*100*	*100*						
Additions between 1966-67 and 1990-91											
South-Eastern	***SER***	890	1884	9683	28620	32.16	15.19	10.88	5.14	*2.12*	*2.96*
Central	***CR***	1076	2419	45965	19871	18.47	8.21	42.72	19.00	*2.25*	*0.43*
Northern	***NR***	584	939	32503	22715	38.90	24.19	55.66	34.61	*1.61*	*0.70*
Western	***WR***	-122	491	39289	17483	-143.30	35.61	-322.04	80.02	*-4.02*	*0.44*
Eastern	***ER***	202	472	18804	7698	38.11	16.31	93.09	39.84	*2.34*	*0.41*
South-Central	***SCR***	1118	1963	22053	20410	18.26	10.40	19.73	11.23	*1.76*	*0.93*
Southern	***SR***	-292	297	11886	3380	-11.58	11.38	-40.71	40.02	*-1.02*	*0.28*
North-East	***NER***	213	1061	12557	2923	13.72	2.75	58.95	11.84	*4.98*	*0.23*
N-E Frontier	***NEFR***	233	217	2509	3005	12.90	13.85	10.77	11.56	*0.93*	*1.20*
Total	***IR***	**3902**	**9743**	**195249**	**126105**	**32.32**	**12.94**	**50.04**	**20.04**	**2.50**	**0.65**

Source: Computed on RFFC[1993]:*Railway Fare and Freight Committee Report,* 1(30):801, Annexure 30A;
figures in italics indicate percentages

flows to Chennai on SR contribute a very large proportion of total passenger-km traffic volumes carried by IR. Between 1950-51 and 1994-95, IR's suburban rail services have multiplied almost ten-fold with passenger traffic flows increasing from 6.55 billion passenger-km to 67.98 billion passenger-km.[18] From the trends in zonal passenger traffic in the table and longterm trends in IR passenger journey-leads, the growth of suburban passenger flows thus appear to be the principal reason for variation between the route-density and track-density patterns on WR and ER.

Comparing the zonal additions of track capacity with the increments in zonal traffic density, it appears that although the rate of running track augmentation between 1966-67 and 1990-91 has been high on SER, SCR, and CR, with nearly 2500km of track having been added to the latter zonal network, only in the case of SER can this be said to have reflected a positive response to traffic increase and to nearly doubled freight density. As implied by the freight density figures, much greater track congestion exists on WR and NR, where running track additions have been far lower. The CR network on which track augmentation has been highest presently shows the second-lowest zonal freight density, while the lowest freight density of 1.12 net tonne-km per running track-km presently exists on NER, where the freight response to increased track capacity has also been minimal. A strong tradeoff relationship between changing freight density and passenger density in response to track augmentations appears to exist only for SER, and at weakened level for NEFR. The other IR zonal railways show more or less parallel density shifts, with WR showing the highest simultaneous increases in both passenger and freight density. Track augmentation on CR is seen to have led to greater passenger density of operations than to an increase in freight. Among the other zonal railways on which substantial track upgradation has occurred, this is seen to be true also for NR. On all other IR sub-networks, rising traffic density represents a more or less passive increase in traffic, without there having been track augmentation to match.

7.3.4 Spatial Factors in Freight Distribution

The preceding review of IR zonal railway operations highlights two major factors which have altered the regional distribution of IR freight operations. The first among these is the emerging spatial polarisation of IR traffic, with freight operations becoming highly concentrated along the southeast axis where passenger density is also the lowest. Along other major railway routes, the growth of passenger density has led to track congestion of varying extent. Secondly, the growing passenger-intensity of railway operations on most IR zonal networks has in fact impeded the parallel growth of freight intensity, and is thus partially responsible for transportation bottlenecks. Inadequacies in IR rolling stock and traction and low train running speeds compound the track limitations of the zonal railway networks by limiting the overall freighting capacity of IR, while encouraging further freight specialisation in a limited commodity-group. The distortions in the IR freight-mix thus have sizeable impact on spatial equity and on the regional patterns of growth in the economy.

Table 7.3: Net Profits & Losses from Zonal Railway Operations on the Indian Railways 1982-83 to 1991-92

Year	*SER*	*CR*	*WR*	*SCR*	*NR*	*ER*	*NER*	*NEFR*	*SR*	Total Profits of Profit--making Railways	Total Losses of Loss--making Railways	*Net IR Profit or Loss*
1982-83	120.86	153.58	97.84	27.94	53.51	*-99.91*	*-88.90*	*-78.02*	*-107.09*	453.73	*-373.92*	79.81
1983-84	113.55	153.79	113.66	2.65	28.52	*-127.82*	*-128.51*	*-103.14*	*-123.44*	412.17	*-482.91*	*-70.74*
1984-85	30.77	*120.71*	85.60	25.58	13.98	*-165.69*	*-156.13*	*-131.24*	*-136.45*	276.64	*-589.51*	*-312.87*
1985-86	208.23	194.73	135.37	56.02	101.63	*-102.35*	*-153.03*	*-140.46*	*-155.66*	695.98	*-551.50*	144.48
1986-87	216.55	218.42	144.05	4.27	154.21	*-114.18*	*-185.67*	*-163.10*	*-196.47*	737.50	*-659.42*	78.08
1987-88	272.65	212.51	177.33	*-11.09*	212.91	*-180.66*	*-209.77*	*-190.96*	*-225.55*	875.40	*-818.03*	57.37
1988-89	253.17	253.35	201.30	*-0.99*	107.36	*-158.11*	*-239.74*	*-209.62*	*-205.73*	815.18	*-814.19*	0.99
1989-90	344.59	263.16	277.99	10.92	149.63	*-170.93*	*-269.93*	*-204.23*	*-248.35*	1046.29	*-893.44*	152.85
1990-91	368.82	344.13	313.55	*-2.43*	74.09	*-159.81*	*-303.97*	*-238.67*	*-240.22*	1100.59	*-945.10*	155.49
1991-92	515.96	462.91	462.91	87.12	58.40	*-195.82*	*-321.13*	*-275.46*	*-260.22*	1587.30	*-1052.63*	534.67

Source: RFFC[1993]: *Railway Fare & Freight Committee Report*, 1(3):38, Table 3.3

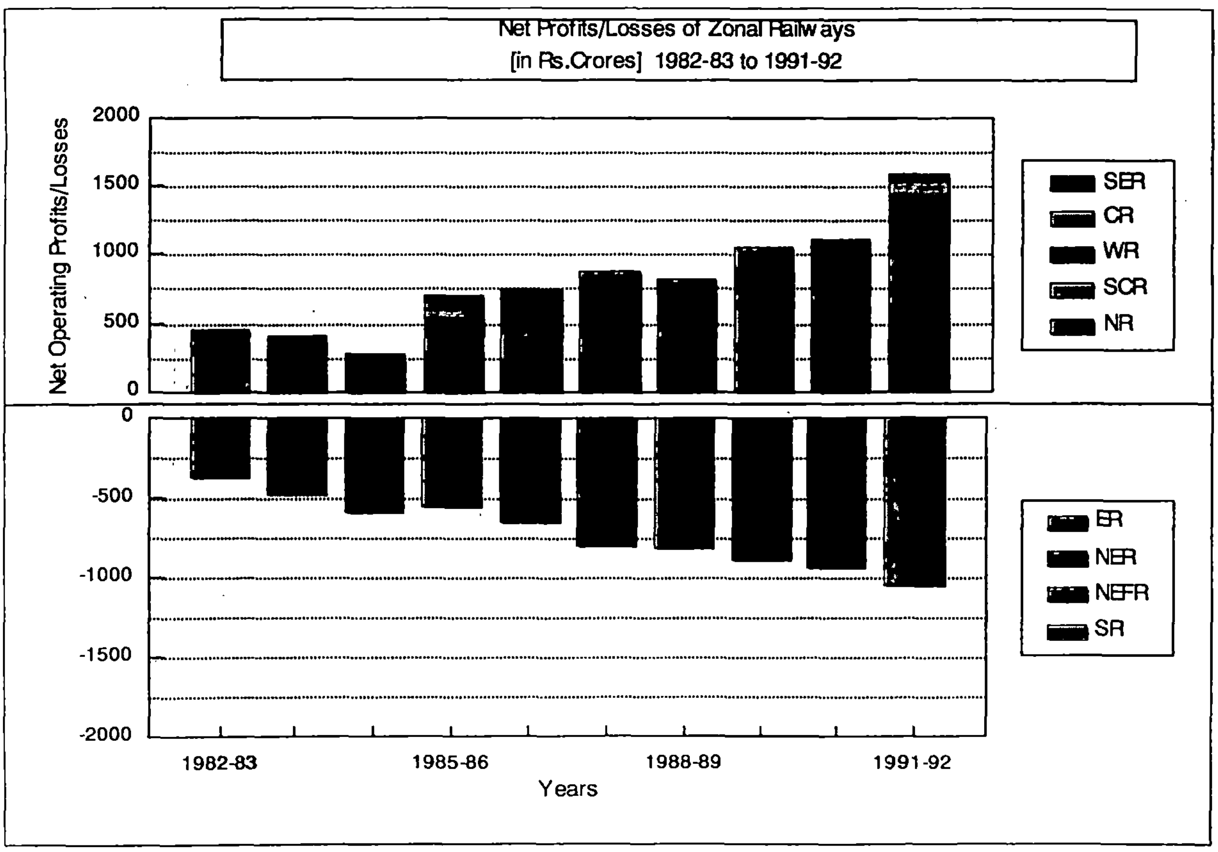
7.4 Profitability of Zonal Railway Operations

Given the wide operational differentials between the zonal railways that constitute IR, differences would also be liable to show up in the relative profitability of zonal railway operations. Although aggregate profit

& loss figures tend to obscure differences between the relative profitability of freight versus passenger operations, it would stand to reason, in view of IR's practice of cross-subsidising social losses on passenger operations by profits derived from freight operations, that the zonal networks showing the highest operational profitability would also be those with high freight density and intensity. Conversely, IR zonal networks where passenger intensity is relatively higher than freight intensity would be more prone to incur operational losses. Variations would occur of course in this thumbrule, depending on the principal categories of commodity-freight carried by each zonal network and the average distance-leads of zonal passenger traffic. Thus zonal railway networks which still continue to attract large margins of highly-rated commodity-freight traffic, or otherwise transport higher proportions of low-lead passenger traffic, would stand to relative advantage over the other IR zones. It needs to be remembered however in context of IR's rising average freight leads, that the larger part of IR commodity-freight flows are interzonal rather than intrazonal.

The profits & losses of IR's 9 zonal railways over the 10-year period between 1982-83 to 1991-92. are shown in Table 7.3, which is accompanied by a timeseries block-plot of the zonal losses & gains in Fig.7.1. With the exception of two loss-making years between 1983-85, IR operations over the period have generally yielded cumulative profits that are well above breakeven levels. Considering the zonal breakup of profits & losses, it is seen however that only 4 IR zones, namely SER, WR, CR and NR have consistently yielded positive profits to IR, although the operational profits of NR have tended to dwindle with time. The financial performance of SCR, which operates very close to breakeven levels, is much more inconsistent with marginal profits or losses in most years. Four other railway zones comprising ER, NEFR, SR and NER show consistent losses. From the preceding analysis, barring the case of NEFR, this would appear to be attributable to the high passenger-intensity of operations on these IR zones. Losses are highest overall on NER, where additional freight offtake has been low despite substantial augmentation of running track because of sharp increase in the passenger-intensity of operations. The highly freight-intensive operations of SER thus been the most consistent revenue-spinner for IR. In 1984-85, the single year when SER profits dipped sharply to Rs.30.77 crore, IR mounted aggregate losses of Rs.312.87 crore. The sharp uptrend in aggregate IR profits in 1991-92, the final year under reference, can again be attributed to the uptrend in zonal profits on SER, WR and

***Figure* 7.1: Regional Analysis of Profits & Losses on IR Zonal Networks**
1982-83 to 1991-92



SCR at levels high enough to retire all operational losses sustained on the other IR zones.

The freight setback that hit IR towards the close of the 6FYP, which had been considered elsewhere, [*see ch3*] appears to have affected some IR zonal networks more than the others. The differential impact on zonal revenues during this period suggests that the setback was the consequence of shortages in particular categories of freight, rather than traffic shortages across the board. Since aggregate IR freight trends during the 6FYP indicate a tonnage spurt between 1983-85 also accompanied by rising freight leads, the setback to IR profits at the time could reasonably be attributed to the loss of profitable categories of freight because of the swing in operational focus towards bulk-freight. SER was most affected by the setback and consequently shows the sharpest dip in profits. Among the other profit-making IR zones, WR, CR and NR were less affected and SCR remained relatively immune. Among the loss-making zonal railways, the traffic setback is seen to have spilled over mainly to ER and NER, leaving NER and SR unaffected. Since the traffic setback resulted from shortage of freight demands for a traffic-category transported largely by SER and ER and transferred to a limited extent to CR, WR, NR and ER, this would point the finger towards shortfall in mining freight and industrial raw materials originating specifically from the mining belt and distributed to industrial locations over the country, and also towards general recessionary conditions within the Indian economy.

7.4.1 Operational Efficiency on IR Zonal Railways

In profit & loss analysis, several factors simultaneously come into play which reflect the relative operating position of each IR zone. While the analysis might also lend itself to narrow efficiency interpretations where relatively favourable positioning for certain zonal railways was attributed to better management of their operations, this would discount the importance of spatial factors such as the availability of physical resources and the relative levels of industrial development in the regions served by each railway zone and consequently the regional composition of commodity-freight, as well as the size, capacity and level of development of the zonal transportation network including that of competing transport modes. Pure efficiency factors such as levels of zonal railway staffing and labour productivity, as well as *operating ratios* i.e. the proportion of zonal working expenses to revenues would also have a role to play. In practice therefore, it would be difficult to isolate the individual impact of each of these factors because of interdependence between them, since a zonal railway network serving a region with low levels of economic and railway development and low traffic-intensity would also show a high ratio of working expenses to revenue, not because working expenses were particularly high but because of insufficient traffic density and consequently low revenue yields. Economic issues such as these need to be kept in mind while interpreting financial figures for the zonal railways.

The first inference drawn here pertains to the overall financial position of IR and to its dependence on the profitability of its regional sub-networks. Although overall IR profit trends improved considerably over the 10-year period of the profit & loss study with the sole exception of 1984-85, the profit magnitudes remained highly unstable. The overall instability of IR profits stemmed from the operational instabilities of a few IR zones, while the other zones displayed steady profit-making or loss-making trends. Profit instability was mainly seen on NR, SCR and ER. Although SCR oscillated between alternating profits & losses through most of the period, the size and scale of SCR operations are too limited for it to have been the sole contributor to instability in IR profits. This role was most definitely played by NR as the largest IR zonal network both in terms of route-length and running track. Thus, while it is seen that NR consistently maintained a profit-making position over the period under study, the magnitude of its profits were far from consistent, swinging from a low of Rs.13.98 crore in 1984-85 to a high of Rs.212.91 crore in 1987-88, with a falling tendency thereafter that defied the strong profit uptrends displayed by SER, WR and CR.

It would thus be illumining to identify the zonal railways separately by their contribution to aggregate IR profits & losses. Reviewing positive profit contributions alone and excluding ER, NER, NEFR and SR from initial consideration along with SCR during its loss-making years, the combined profit contributions made by profit-making zonal railways to IR more than tripled from Rs.453.73 crore to Rs.1587.30 crore over the period between 1982-83 to 1991-92. While profit increases of this order partially reflected the growth of traffic demand, they were also the happy consequence of the IR freight-shift towards more paying categories of bulk-freight accompanied by tariff rationalisations that expanded the revenue yield from these special traffic categories. Barring the revenue setback of 1984-85 which affected the overall profitability of IR operations, railway revenues over the subsequent period have generally remained buoyant after tariff revision.

The position of dominant profit-earner is now firmly occupied by SER which in the initial period had made smaller profit contributions than CR but improved its position dramatically after 1985-86 with the new buoyancy imparted to railway freight operations by the 7FYP, and more than quadrupled its profits over the 10-year period under review. The financial performance of WR was of almost similar order with sharp escalation in its profit contributions, and CR also showed considerable increase in operational profits over the period. Since railway operations on WR and CR had been seen earlier to be more passenger-intensive than freight-intensive, the healthy profit performance on these IR zones would imply that the freight flows handled by these IR zones included significant movements of highly-rated freight commodities to and from the highly-industrialised western region, including import, export and container shipments to and from major ports on the western seaboard. To an extent, this would also reflect the new role of certain west-coastal major ports in redetermining the new directional flows of IR freight.

Similar analysis might be extended to the loss-making zonal railways, which consistently included ER, NER, NEFR and SR, as well as SCR in its loss-making years. In aggregate terms, combined IR operational losses nearly tripled over the decade from their 1982-83 level of Rs.373.92 crore to Rs.1052.63 crore in 1991-92. While the ER and NER losses did show some reflection of the general IR freight setback towards the end of the 6FYP, losses continued to mount steadily thereafter without drawing any remission from tariff revisions. The operational losses of these IR zones would thus appear to bear strong relation to the composition of freight traffic in these zones. Although passenger and freight densities varied widely between the loss-making IR zones, the operational losses incurred by these zonal networks did not necessarily reflect such differences. The highest proportion of IR losses originated from NER, whose operational losses mounted considerably over the period. Substantial investment during the 7FYP on upgradation of the NER track network appears to have led to the escalation of zonal working expenses without matching increase in revenues, mainly because of the limited range of commodity-freight transported on the NER zonal network. Losses on NEFR and SR also mounted over the period, not so much because of absolute shortages of traffic, but because of the lack of freighting capacity on the IR system, as well as the shift of paying categories of freight to other transportation modes. In contrast, the escalation of losses on ER was more moderate because of adequate traffic densities, even though the lack of paying categories of traffic still imposed operational losses.

Considering the spatial and efficiency variations between IR zones observed during the profit & loss analysis, pure efficiency factors are unlikely to play as important a part in determining the extent of profit or loss earned by each zonal railway, as other explicitly spatial factors which determine the composition and density of traffic, the commodity-composition of freight flows and the physical transportation capacity on each zonal network as defined by the availability of track, traction and rolling stock. The profit and loss trends are also seen to be affected to a great extent by locational relationships between each zonal network and the major freight flow axes across the country, which are thus important determinants of the zonal distribution of IR operations and eventually of the levels of regional economic development. The absence of major interzonal swings in the period under review, with the possible exception of NR, predicates that current transportation policies in the country and particularly the IR policy that has favoured specialisation in bulk-freight have only consolidated the regional concentration of industrial development instead of ensuring its equitable dispersal over the country. That this predicament is not solely the result of the railway efficiency calculus is established by the external regulatory components of IR freight policy such as freight equalisation, which while vitiating the locational economics of industrial production, also choked the overall freighting capacity of the IR network by overloading considerable sections of it with unnecessarily long traffic leads and high railway rolling stock and traction commitments, thus forcing vital flows in other commodity-freight onto the more expensive transportation alternative offered by the roadways.

7.4.2 Railway Productivity on IR Zonal Railways

Final word might be said on the zonal efficiency factors by reviewing the operating performance of IR's zonal networks in terms of relative traffic-productivity, partial representation of which is provided by zonal *operating ratios*. Analysis of this kind would also provide some insight into the role of pure efficiency factors in determining railway operational performance. Although the apparatus for costing-analysis of different components of IR operations is not as well developed as on other major railway systems,[19] and therefore precludes specific analysis of railway productivity separately for passenger and freight operations, the percentage ratio of total zonal working expenses to total zonal profits sufficiently reflects general productivity performance of zonal railways, although with the qualification that while a high operating ratio implies low revenue productivity, the reasons behind this may combine physical inefficiency indicators such as overinvestment and overstaffing with economic determinants like low traffic realisation or insufficient realisation of paying traffic-categories, rather than excess railway capacity alone. Secondly, although overt capital costs of the network are excluded from the explicit computation of the railway operating ratios, the phenomenon of *joint* working costs would still exercise an influence, since the ratio would be determined by unit revenue realisations as also by levels of traffic density and freight intensity on the network so that the distribution of zonal railway operations between passenger and freight services would play a significant role in realising revenue differentials even if equivalent costs are incurred on each. A surmise about traffic productivity would therefore to extend beyond concepts of revenue productivity, and hence spatial differentials would continue to play upon the analysis.

Table 7.4: Zonal Operating Ratios on the Indian Railways

	ZONAL OPERATING RATIOS [% Working Expenses to Revenues]									
	SER	*CR*	*WR*	*SCR*	*NR*	*ER*	*NER*	*NEFR*	*SR*	*TOTAL IR*
1982-83	73.50	71.99	88.34	82.36	83.01	109.98	148.77	161.84	118.62	***88.34***
1983-84	77.04	76.27	93.52	89.99	89.14	114.78	174.39	184.39	123.15	***93.52***
1984-85	76.79	79.63	96.25	85.91	92.98	119.02	87.44	209.09	124.36	***96.25***
1985-86	72.92	76.10	90.58	82.11	86.64	101.90	166.96	195.80	119.59	***90.58***
1986-87	75.00	76.83	92.20	89.52	83.63	105.90	171.75	189.23	130.08	***92.20***
1987-88	73.97	78.46	92.47	91.34	82.99	110.30	167.45	196.07	129.51	***92.47***
1988-89	77.10	77.71	93.05	91.12	87.47	106.08	169.81	195.08	122.04	***93.05***
1989-90	75.16	78.89	91.52	90.07	83.47	107.64	169.37	177.60	124.03	***91.52***
1990-91	75.55	77.64	91.97	92.25	90.07	104.93	70.60	177.27	118.63	***91.97***
1991-92	72.93	75.24	89.48	85.52	87.90	105.47	164.78	181.89	117.81	***89.48***

Source: RFFC[1993]: *Railway Fare & Freight Committee Report,* 1(3):64, Annexure 3K

Analysis of zonal railway productivity must thus be made keeping such factors in mind. In Table 7.4, which provides a computation of operating ratios for IR's zonal railway constituents over the period between 1982-83 and 1991-92, it is seen that aggregate IR working expenses have held a very high proportionate equivalent to total revenues, so that the total IR working profits encountered during the preceding analysis have usually represented less than a tenth of revenue earnings. In their zonal composition however, the operating ratios show wide variation across the IR zones, with the zonal railway networks which had earlier been identified as profit-makers generally displaying lower operating ratios than the rest. Similarly, the loss-making networks show working-cost-to-revenue ratios well over 100 percent. SER, the major profit-earner among zonal railways, has among the lowest ratios, while NER, the highest loss-maker, has ratios that are extremely high. However, the correspondence ends there. Although WR and CR had shown similar order of profits in the preceding analysis, CR is seen to possess significant cost advantage over WR, so that WR's ability to achieve high levels of profit seems attributable to traffic availability factors rather than to traffic productivity alone. Similar differences would distinguish WR from NR, both of which have similar working cost structures but show substantial differences in their overall profit trends. The seesawing profit & loss trends of SCR in the previous analysis are not reflected by major variations in its operating ratios. Of the loss-making zonal railways, ER had consistently displayed the lowest losses in the previous analysis and correspondingly has the lowest operating ratios for zonal railways in this category. However although the highest magnitudes of revenue losses had occurred on NER, its operating ratios are seen to have consistently been lower than those of NEFR, while SR and NEFR with similar order of losses in the previous analysis are seen to have widely diverging operating ratios. The connection between operating profits & losses and the relative levels of working expenses is therefore seen to have not been so consistent after all.

A rather important distinction exists therefore between traffic productivity and revenue productivity in IR railway operations, which is brought out by differences in the relative profit & loss positions of zonal railways and the levels of working expenses they incur. Traffic productivity is determined, more than anything else, by the relative traffic density of operations with tradeoffs between passenger and freight traffic also playing their appointed parts. Secondly, even though freight traffic in tonnage or in net tonne-km terms may appear to be appreciably high, revenue earnings and profits are determined by the distribution of this traffic between low-rated high-bulk long-lead commodity flows and those with converse composition. Hence the spatial and locational aspect is seen to be the primary determinant of traffic productivity on IR, rather than pure operational efficiency. By discounting such factors in the railway-efficiency calculus, the infrastructural role of railways in economic development has been made subservient to narrower 'profitability' considerations which have also reversed the initial priorities of India's transportation planning process.

7.5 Sectoral Impact of IR Commodity-Freight Trends

While the spatial dimension of IR freight operations, which had been examined through analysis of their distribution over the zonal railway networks, had also considered IR zonal railway revenues along with operational profits & losses, it has also opened the road to conjecture that the patterns underlying zonal railway freight operations result from the composite of regional production profiles and freight offers acting in juxtaposition to the overall freighting constraints imposed on IR by a policy that has progressively favoured bulk-haulage and long-leads for traffic that can originate in full trainloads. Further support to this conjecture is lent by gaugewise differences in the composition commodity-freight analysed in the previous chapter, which similarly reflect regional differentials in freight demand and in the regional allocation of IR freighting capacity. The issue remains complex since it is seen that in addition to prevailing rates of wagon acquisition and replacements, IR freighting capacity is also determined by the composition of wagonfleets, with the changing level of wagon specialisation reflecting the precommitment of freighting capacity to select commodities in keeping with overall IR freight policy. In the event of non-materialisation of preferred traffic, IR nevertheless has to make short-run adjustments to its wagon-allocation decisions to favour the residual freight-categories, in order to maintain its tonnage targets and revenue bottomlines. While the longterm gaugewise aspects of this adjustment had already been outlined by phase-analysis in the previous chapter, the present section will explore the IR freight adjustment process in disaggregated form by considering the adjustments of individual commodity-loadings that are enjoined within the overall freight decision. In doing so, it will also investigate the sectoral character of IR wagon-loading preferences in order to arrive at credible surmises about the infrastructural impact that these periodic freight adjustments may have on sectoral balance within the economy. This analysis shall however now proceed through explicit use of multivariate methods because of the complex disaggregated nature of the problem to be considered.

7.5.1 Sectoral Characteristics in IR Freight Loading

Wagon loadings of different commodities on the two IR gauge-networks presented separately under Tables 6.1*a* & 6.2*a* in the previous chapter can be combined into cumulative IR wagon loadings of each commodity over all gauges [AG] in Table 7.5*a*. The interdependence of these loadings in the three freight-related datasets which present themselves for joint analysis - namely W_{BG}, W_{MG} and W_{AG} - then indicates the extent to which operational integration exists among the different strata in IR freight operations and may now be used to measure the degree of freight coordination over all railway gauges. Over the period being reviewed, this brings indirect focus to bear also on traffic foregone as a consequence of IR freight policy, and by identifying industrial and economic sectors served and under-served by freight operations, enables the determination of infrastructural impacts.

Transport policy addresses, as its ultimate goal, the twin objectives of developing overall transportation capacity in the aggregate while also coordinating intermodal traffic in a manner that ensures the efficient utilisation of existing capacity. The concept of *efficiency* invoked here widens beyond the engineering sense of the term, since transportation infrastructure produces services that indirectly bear on gross output by influencing factor and product mobility, rather than *direct* outputs like energy or power that are produced by the other infrastructural sectors. The infrastructural role of transport policy stems from its redefinition of the structure of preferences regarding which outputs are to be produced and which resources are to move through the spatial and sectoral economy. But it also needs to be noted here that the roadways and railways in India now compete openly for certain freight-flows because of the manner in which they have evolved in recent times, rather than serving purely complementary freight-needs as would have been desirable for achieving the level of transport coordination that several Government-appointed transport committees (*e.g.* the CTPC, NTPC, etc.) have periodically striven for in their policy statements. Although the areas of freight competition would ideally have been identified by comparing statistics on railway and road operations, study on those

Table 7.5a : Composite Wagon Loadings in Selected Commodities over the Indian Railways System

Aggregates of Originating & Transhipment Loadings over All Gauges (AG) comprising Broad-Gauge (BG) & Metre-Gauge (MG) Sections

[Thousand wagons: 4-wheeler equivalents]

Year	GPulses	OSeeds	Tea	RCott	CottMf	RJute	JuteMf	SCane	Sugar	CCoke	MnOre	OMOre	IOre	ISteel	Cement	Total AG Loadings
1955-56	627.4	144.0	33.4	70.1	41.5	95.2	17.4	268.4	118.1	1163.9	83.8	16.9	206.3	202.3	262.7	3351.4
1956-57	665.0	151.1	37.6	67.3	34.9	134.1	15.2	317.1	135.8	1243.0	101.2	24.5	231.4	231.7	267.2	3657.1
1957-58	811.9	148.0	35.0	67.9	31.2	144.8	16.2	299.3	148.6	1319.5	108.5	34.4	259.5	284.2	314.6	4023.6
1958-59	849.8	143.7	33.8	58.6	20.7	146.4	15.4	226.3	129.6	1466.9	65.5	27.6	293.6	300.4	306.1	4084.4
1959-60	874.8	136.6	35.6	53.2	19.7	148.0	16.0	278.0	128.8	1472.6	76.6	32.2	430.7	327.7	371.9	4402.4
1960-61	836.7	131.8	32.8	52.2	15.8	115.9	14.4	292.8	128.2	1591.1	78.5	34.7	521.5	373.8	401.1	4621.3
1961-62	803.3	114.9	34.1	39.5	14.0	128.5	12.2	292.7	129.8	1705.3	75.5	40.2	578.4	417.0	399.1	4784.5
1962-63	792.4	125.0	32.3	43.3	13.8	150.7	14.0	250.6	143.3	1923.3	74.7	54.9	694.1	487.4	384.9	5184.7
1963-64	913.2	136.0	29.0	41.0	12.7	143.5	12.3	173.2	124.7	2079.9	64.9	49.0	750.2	550.1	413.3	5493.0
1964-65	860.6	108.8	25.8	36.2	7.0	110.6	14.8	225.0	113.4	2005.3	81.1	44.9	767.8	563.1	454.7	5419.1
1965-66	884.1	115.4	29.8	50.1	7.0	140.5	15.7	243.9	124.5	2309.2	77.6	50.1	871.7	541.3	497.7	5958.6
1966-67	975.4	102.8	33.6	48.4	6.2	129.5	13.5	173.6	130.7	2309.9	67.1	52.4	876.1	490.3	492.4	5901.9
1967-68	885.1	97.0	31.9	48.0	6.0	167.0	15.7	102.7	87.1	2382.5	63.4	53.5	901.2	457.2	529.0	5827.3
1968-69	939.7	121.2	37.1	50.4	6.7	115.2	17.4	143.2	66.2	2513.1	64.9	66.6	989.0	483.1	550.2	6164.0
1969-70	901.8	108.5	32.1	49.9	6.7	126.6	17.2	190.9	82.7	2665.0	68.3	74.2	1006.6	484.5	638.8	6453.8
1970-71	863.6	93.7	29.9	49.6	5.8	125.5	21.4	214.6	101.1	2443.7	67.4	72.2	1020.7	456.7	682.7	6248.6
1971-72	862.6	86.4	44.1	49.6	6.5	129.3	24.7	127.9	98.3	2508.0	63.8	67.7	1020.6	473.5	672.8	6235.8
1972-73	828.6	99.8	27.6	43.0	6.1	99.0	26.0	104.7	89.9	2559.7	62.7	63.2	1033.3	507.8	628.1	6179.5
1973-74	769.9	76.8	29.2	43.7	5.1	85.7	23.9	123.3	94.8	2345.1	48.8	49.6	971.9	460.8	585.3	5713.9
1974-75	708.2	73.4	25.6	31.6	3.9	66.8	21.0	116.9	103.1	2720.8	60.7	55.6	1047.2	470.5	526.6	6031.9
1975-76	812.4	82.0	13.7	33.5	3.8	88.9	32.3	99.7	127.6	3068.8	59.9	62.7	1221.7	496.2	661.7	6864.9
1976-77	997.8	85.8	13.8	24.7	1.9	78.0	23.4	94.9	109.9	3174.9	57.1	69.0	1244.2	577.0	781.7	7334.1
1977-78	943.3	62.0	11.2	22.1	2.3	71.6	18.5	97.1	94.3	3271.9	50.5	60.0	1229.9	527.5	752.9	7215.1
1978-79	812.9	60.7	10.1	28.4	2.5	62.1	17.5	123.2	91.6	3017.7	52.3	61.8	1217.2	505.1	684.7	6747.8
1979-80	860.3	64.9	8.7	31.3	0.9	60.3	22.5	75.5	68.1	2892.6	51.6	65.2	1146.1	478.5	513.2	6339.7
1980-81	843.1	54.2	10.1	30.9	0.9	44.6	26.7	68.7	83.8	2928.1	50.0	62.6	1209.1	480.1	500.0	6392.9
1981-82	1012.2	49.6	6.3	16.9	0.9	32.7	24.3	75.7	74.5	3423.6	46.7	66.2	1265.5	538.5	542.3	7175.9
1982-83	1178.3	45.1	4.0	19.8	0.8	34.7	24.3	94.2	86.8	3757.3	43.5	68.6	1244.5	516.6	610.2	7728.7
1983-84	1191.9	38.3	2.6	14.3	0.7	19.9	18.9	89.1	100.5	4061.2	40.5	72.2	1141.8	442.9	753.2	7988.0
1984-85	1033.0	40.5	1.3	11.9	0.5	10.7	17.7	44.4	92.2	4135.6	49.3	75.1	1240.5	457.6	782.6	7992.9
1985-86	1161.5	41.6	1.4	17.4	0.7	13.8	17.9	60.1	142.6	4531.2	50.5	79.8	1331.6	486.5	832.7	8769.3
1986-87	1386.2	38.1	3.6	22.5	0.9	12.9	15.4	60.6	119.8	4789.1	44.9	84.9	1431.1	508.5	921.2	9439.7
1987-88	1403.9	25.8	3.7	14.3	0.2	9.4	8.7	75.0	118.7	5122.5	46.1	84.7	1416.4	514.2	1050.2	9893.8
1988-89	1192.4	18.6	1.9	11.2	0.4	9.2	11.1	70.1	92.1	5510.0	50.7	88.5	1494.9	511.3	1244.9	10307.3
1989-90	1121.1	23.2	5.3	10.0	0.6	4.8	8.5	68.5	100.1	5668.0	54.7	83.2	1634.4	504.2	1324.2	10610.8

Source: Compiled from *Basic Statistics Relating to the Indian Economy,* various years, Central Statistical Organisation, Ministry of Planning, Government of India

Commodity Code:

GPulses = gram & pulses
OSeeds = raw jute
Tea = manufactured tea
RCott = raw cotton
CottMf = cotton manufactures
RJute = raw jute
JuteMf = jute manufactures
SCane = sugarcane
Sugar = manufactured sugar
CCoke = coal & coke
MnOre = manganese ore
OMOre = other metallurgical ores
IOre = iron ore
ISteel = iron & steel
Cement = cement

Table 7.5b: Inter-Commodity Correlation Matrix

AG WAGON LOADINGS

	GPulses	OSeeds	Tea	RCott	CottMf	RJute	JuteMf	SCane	Sugar	CCoke	MnOre	OMOre	IOre	ISteel	Cement
GPulses	*1*														
OSeeds	*-0.718*	*1*													
Tea	*-0.704*	*0.886*	*1*												
RCott	*-0.725*	*0.923*	*0.910*	*1*											
CottMf	*-0.591*	*0.808*	*0.649*	*0.814*	*1*										
RJute	*-0.680*	*0.905*	*0.921*	*0.864*	*0.581*	*1*									
JuteMf	*-0.273*	*-0.108*	*-0.081*	*-0.017*	*-0.224*	*-0.064*	*1*								
SCane	*-0.601*	*0.877*	*0.776*	*0.816*	*0.824*	*0.764*	*-0.314*	*1*							
Sugar	*-0.109*	*0.456*	*0.299*	*0.356*	*0.536*	*0.344*	*-0.366*	*0.589*	*1*						
CCoke	*0.840*	*-0.930*	*-0.856*	*-0.893*	*-0.729*	*-0.874*	*-0.106*	*-0.814*	*-0.319*	*1*					
MnOre	*-0.631*	*0.855*	*0.760*	*0.828*	*0.838*	*0.740*	*-0.254*	*0.895*	*0.561*	*-0.756*	*1*				
OMOre	*0.747*	*-0.850*	*-0.699*	*-0.797*	*-0.852*	*-0.695*	*0.082*	*-0.818*	*-0.462*	*0.890*	*-0.750*	*1*			
IOre	*0.680*	*-0.923*	*-0.788*	*-0.880*	*-0.909*	*-0.774*	*0.174*	*-0.902*	*-0.522*	*0.904*	*-0.841*	*0.940*	*1*		
ISteel	*0.464*	*-0.574*	*-0.465*	*-0.672*	*-0.875*	*-0.354*	*0.147*	*-0.640*	*-0.400*	*0.552*	*-0.623*	*0.722*	*0.779*	*1*	
Cement	*0.743*	*-0.837*	*-0.696*	*-0.780*	*-0.676*	*-0.739*	*-0.161*	*-0.714*	*-0.295*	*0.940*	*-0.643*	*0.863*	*0.862*	*0.532*	*1*

lines would face the daunting task of culling data out of the labyrinthine Indian roadways sector, which comprises private operators, big and small - a few with established companies and fleets of lorries while most are single fly-by-night carriers. For present purposes, this difficulty is obviated by considering commodity-loading data for IR only and tracking the path of commodity-losses from one gauge to the other and eventually from the IR system altogether.

Scope for the sectoral analysis is afforded by composition of series in W_{BG}, W_{MG} and W_{AG}, which together constitute an interesting combination of industrial, agricultural and mining products, some of which are related moreover by vertical input-output linkages linking producer-good to producer-good, or producer-good to consumer-good. In terms of overall freight handling, IR operations over the planning period mark sharply growing absolute and proportional trends in the loadings of cement, coal & coke, iron ore and iron & steel, more subdued or nearly stagnant trends in the loadings of grams & pulses and various other ores, and sharp absolute as well as proportional declines in the traffic in cotton, jute, sugar and tea.

7.5.2 Excess Capacity & Freighting Adjustment

The general freight trends noted above are a joint outcome of the underlying processes behind industrial development in India and commodity-freight specialisation on IR. While railway freight operations have developed a marked preference over the course of the FYPs, for certain chosen bulk commodities which assure guaranteed tonnages, stable operating economies and secure revenues to IR, realisation of this desired traffic depends on the one hand on tariffs offered and the availability of adequate and appropriate freighting capacity, and on the other on production trends at different points of time within the economy. It had been observed during the phase-analysis in the previous chapter that the freighting needs of bulk-commodities in India have tended to oscillate with the scale of plan investment on the core sector and basic infrastructure, leading to periodic recession and underutilisation of IR's freight installations. However, although the declining share of IR in total freight flows reflects the parallel growth of the Indian roadways to the point where they now carry 60 percent of the total freight flow against just 11 percent in 1950-51,[20] *globalised* traffic slack and excess transportation capacity as such has not occurred on IR except possibly over a short period during the 3FYP. Thus the freight shortages that occasionally manifested themselves are better viewed as *localised* excesses of freighting capacity, in both spatial and sectoral senses.

While in gauge-terms, excess freight capacity can arise from growing specialisation within a wagonfleet that contains miscellaneous specialised wagon-types for freighting general goods, coal and other bulk-freight consignments as well as containers and other special-category traffic, the freight shortages defined relative to these depend on the economic nature of the regions to which freight despatches are made, and also on whether adequate traffic for the wagon-types despatched in the railway rakes is available for the turnaround journey. If the originating rake consists of specialised POL tanker-wagons or OHS ore-carriers, for instance, the possibility of turnaround traffic is unlikely. Obviously therefore, specialisation in IR freight operations and wagonfleets binds freight capacity increasingly to certain major railway clients, such as the mining PSUs, power plants and the steel industry, without however maintaining freight adequacy for the two-way journey because of the inappropriateness of the wagons supplied to these clients to carry other categories of freight as may be available. IR is consequently forced to run an increasing number of empty wagon-kilometres, identifying one aspect of localised excess capacity in IR freight-handling that essentially occurs in the short-run.

Two adjustments by IR to changing freight offers, which are captured in the commodity-loading data, have either short-term or long-term implications which deserve mention. In absence of other short-term modes of freight adjustment to changes in freight demand, IR is left the option of drawing wagons away from freight segments and sectors where excess railway-capacity currently prevails, and offering them - *post facto*, as it were - to other potential clients. Difficulties can therefore arise in this capacity being fully taken up in the short-run, because of the need for producers to plan delivery schedules in advance along with production plans, if they are to secure their markets. Therefore, short term adjustments in IR wagon loadings and in the mix of commodities freighted by railway represent a partial response to current market situations, with absolute limits to the adjustment being set by the availability of the required wagon-type, the availability of traction, the possibility of turnaround traffic, and the lead of the journey. Spread over longer durations of time, persistent localised capacity-shortage would however lead to equalising acquisitions of new wagon-capacity, had capacity addition on IR been entirely market-driven. The problem that surfaces with regard to this stems from the external regimentation of IR wagon acquisitions induced by the FYPs on the one hand, and by the lengthy budgetary processes that IR follows regarding the placement of wagon orders. Together, the two rule out efficient correction of capacity anomalies in the short-run, while the conservatism they induce among railway managers in acquiring additional freighting capacity that has not been pretargeted by the FYPs can often vitiate the prospect of market-driven corrections altogether, in the absence of substantial resource-commitments towards the high costs of wagon-acquisition.

7.5.3 Freight Market Contests

Additional market-driven short term transport capacity is added to the Indian freight system however through the growth of roadways, and is evident in the phenomenal expansion of roads and highways in the country, paralleled by growth in the light, medium and heavy commercial vehicle [CV] market and in CV operations. Conjectures about excess capacity would therefore also relate to how the growing roadways sector has intermeshed with the railway sector, and in fact to whether it has intermeshed at all. Three infrastructural hypotheses on the role that has been played by the Indian roadways vis-a-vis IR would accordingly confront the sectoral analysis - namely, that

[A]: the growth in roadfreight flow represents increased and new production from different goods-producing sectors of the economy, and thus supplements the freight-flow traditionally carried by railways;

[B]: the growth in roadfreight flow represents traffic bid away from the railways by competition from roadways, not necessarily because of any cost-advantages offered by the latter but also because of convenience, security, etc.;

[C]: the growth in roadfreight flow represents a combination of both.

Each hypothesis holds a different prognosis for sectoral economic development in the country. If the first is true, then the limits to economic growth as far as transportation aspects are concerned, are set by the rate of growth in the road transport infrastructure. If the second is true, these limits are set by the growth of railway freighting capacity, keeping in mind that railway freight is capacity-constrained by the commodity and wagon specialisations already alluded to elsewhere. In the event of both being true, the infrastructural bottleneck represents an overall shortage of freight-handling capacity in the economy, further distorted by the inefficiencies of intermodal noncomplementarity.

A priori, the third infrastructural hypothesis would appear most approachable. A certain lumpiness characterises all transport variables. The transportation grid as seen from any road & rail map of the country, except for partial duplication along major trunk-routes, is a spatial grid with non-contiguous alignments in most parts. Considerable regions which are either not served or else inadequately served by IR depend on road transport for distributional freight-flows. But the Indian roadways - unlike IR - are no monolithic entity, comprising as they do, the atomistic operation of innumerable unincorporated individual licensees. Prevalence of cartelisation and lobbying among them, and the lack of exactly-substitutable freight services enables them however to operate in a zealously protected market, with obvious consequences on rates and charges. While rate-setting by the railways has a public-utility character, this obviously does not constrain road tariffs. Competition as such is therefore generally limited, and is localised to certain market sectors, such as high-valued short-haul freight-flows. In the face of this, it is not likely that private investment in the road sector and in road-sector growth will rise to the extent that it can take care of all future incremental transport needs in the economy. The same thing could probably be said also of the railway sector, since the pattern of outlays on IR over consecutive FYPs does not indicate a particularly hopeful trend either, as noted earlier.

A second dimension of unequal freight competition between the Indian roadways sector and IR stems again from the public-utility character of railway tariffs. Freight-flows which could in a large part also be carried by road transport, such as those in essential commodities like foodgrains or grams & pulses, had hitherto been granted preferential rates by IR in pursuit of the Government policy on the public distribution system [PDS], so that the transportation-cost component in the final purchase price paid by consumers was necessarily low. Again, commodity-freight flows that involved long leads traversing the entire country have traditionally been directed into the railway sector, through the tapering distance-slab positioning of the IR freight-tariffs, since such commodities also generally have high weight-to-mass ratios, making their transport by roadways neither economical nor locationally desirable. A prime example would be the transportation of shipments of high-grade coking coal imports with low-ash-content from their ports of call to selected power plants and steel plants located deep in the interior of the country. As such, certain categories of traffic exist where the roadways cannot be natural competitors, and there are therefore certain regions in the country which, being underserved by IR, are denied the possibility of core industrial development.

For reasons such as those above, distinctive differences therefore distinguish freight services offered by the roadways from those of IR. Even conceptually - while speaking of the possibilities of intermodal competition within the transportation sector - freight operations on IR and the Indian roadways cannot be seen as close substitutes, except in the very specific segments of short-haul and piece-good traffic. Thus although a gamut of general freight-categories is today being carried by the roadways in India, the infrastructural focus remains on IR with regard to whether the growth it has achieved in its freight services has been commensurate with the potential backward and forward linkages of industrialisation in the country, or whether in fact IR freight-specialisation has constricted these linkages and therefore also the pace of economic development.

7.5.4 Modelling the IR Freight-Adjustment Process

The wagon-loading timeseries in W_{BG}, W_{MG} and W_{AG} can now be used to study adjustments in the IR *freight-mix* and *freight-capacity* made to accommodate shifts in railway freight emphasis over the era of planning. The series as such include both originating and transhipment loadings, and the influence over time of underlying imponderables such as gauge conversion and increased wagonfleet specialisation which have led to qualitative change in intermodal allocations of transport is not directly apparent. Because it is difficult for instance, to sort out the effects of declining transhipments attributable to the decline in MG route-kilometres from increases in transhipments because of increasing commodity leads over the country, and thus the complex interrelationships between commodity-series, the need for explicitly multivariate analysis arises.

It had been seen during regression modelling of the wagon loading series that a considerable amount of autoregressive error existed, which in fact vitiated the coefficient estimates until the Cochrane-Orcutt transformation was applied. Besides the presence of serial correlation in wagon loadings - which was expected, another expected aberration in the dataset would be the presence of multicollinearity in the explanatory series. While this distortion can be anticipated because of the process whereby IR allocation of freighting capacity to bulk commodities reduces capacity available to other commodities, the first impact of multicollinearity in the wagon-loading series would be on the correlation matrices drawn from W_{BG}, W_{MG} and W_{AG} , since the simple bivariate correlation coefficients represented in these would overestimate the degree of direct association between commodity-loadings. Examination of the anti-image of each correlation matrix confirmed that the partial correlation coefficients, *i.e.* the dot-coefficients such as $r^2_{ij.1,2,\ldots i\text{-}1,j\text{-}1,k\text{-}1,k}$ which are adjusted to eliminate indirect associations, are in fact quite low - indicating a high proportion of cross-commodity substitutions across the dataset. The appropriate analytical methodology for handling datasets of this character, namely Factor Analysis, also proved to be ideally suited for theoretical modelling of IR freight capacity adjustments.

The question central to multivariate modelling of variations in IR commodity freight might be posed as follows: Given the constraints on IR freight-handling capacity imposed by the composition of wagonfleets, by zonal and sectoral freight demands, and the prioritisation of certain categories of traffic through differential tariff structure, cross-subsidies and freight equalisation - how does IR allocate available freighting capacity to serve the mix of freight demands that confront it at any given point of time? With the collinear nature of the wagon loadings in different commodities already apparent, a solution to this question would require conceptual modelling of IR freight policy as a set of alternative *freight-mixes* that serve different freight offer situations, and to extract these through application of Factor Analysis. In a methodological sense, this amounts to reallocating the total variances in W_{BG}, W_{MG} and W_{AG} so as to absorb the maximum freight variation in certain ordered and well-defined wagon loading combinations *i.e.* commodity freight-mixes, which represent IR freight-policy responses to transportation demands articulated by the economy in different periods.

Preadjustment of the data is however necessitated since the wagon loading series included in data matrices W_{BG}, W_{MG} and W_{AG} defined on IR freight-handlings of 15 commodities over the 35-year span between 1955-

56 and 1989-90, suffer from extreme inequality in their scalar measurement-range, for the obvious reason that while loadings of the bulk commodities have increased almost exponentially over the study-period, those of commodities like cotton - which had once been the foundation of railway freight operations in India - have now dwindled into insignificance. The required adjustments involve *normalisation* of the above data matrices, or transformation of the data values $w_{ij} \in W_{I..J}$ by *centering* them around series-means $\bar{w}$ and *standardising* the series variance, so that

$$\bar{w}_{ij} \in \bar{W}_{I..J} = [w_{ij} - \bar{w}] / \sigma_w \qquad \text{.... (7.1)}$$

The procedure defines the *standardised* data matrices through the transformations $\underset{k \times t}{\bar{W}_{BG}}$, $\underset{k \times t}{\bar{W}_{MG}}$ and $\underset{k \times t}{\bar{W}_{AG}}$, where

$$\underset{k \times t}{\bar{W}_{I..J}} = \begin{vmatrix} \bar{w}_{11} \ldots\ldots\ldots\ldots \bar{w}_{k1} \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ \bar{w}_{1t} \ldots\ldots\ldots\ldots \bar{w}_{kt} \end{vmatrix} \quad \begin{array}{l} \text{where } [k = 1,\ldots\ldots,15] \\ \qquad [t = 1,\ldots\ldots,35] \\ \text{for } \underset{k \times t}{\bar{W}_{BG}}, \underset{k \times t}{\bar{W}_{MG}} \text{ and } \underset{k \times t}{\bar{W}_{AG}} \end{array} \qquad \text{.... (7.2)}$$

The *normalising* transformation effectively removes the influence of the measurement scale from the data, while unitising the scale of variance, so that variations over time in each commodity series are treated on a proportionate scale, rather than as absolute magnitudes. While factor estimations from standardised data matrices differ from those on the untransformed dataset, no choice virtually exists in practice because of the vanishing magnitudes of certain commodities, as well as the limitations of the computer procedure. Since the *correlation* and *dispersion* matrices are identical for standardised data matrices,[21] factor extraction is in fact equivalent to the evaluation of the eigenvectors of the standardised correlation matrices for $\underset{k \times t}{\bar{W}_{BG}}$, $\underset{k \times t}{\bar{W}_{MG}}$ and $\underset{k \times t}{\bar{W}_{AG}}$..

With the $\bar{W}_{I..J}$ matrices capturing the unitised variance of IR wagon loadings over the study period, the factors are extracted as linear combinations of wagon loadings in the 15 commodities considered, and define unique freight-mix solutions that have been adopted by IR in tackling the variety of freight-demand situations that have confronted it between the 2FYP and the 7FYP. While mathematical rigour would identify a large number of alternative freight-mixes to account for all the variance in the datasets, it is found that the first few freight-mix solutions adequately explain most of the interdependent variation seen between IR commodity handling series.

Computation of the freight-mix vectors, denoted as $\mathbf{f}_{kI..J}$, proceeds under the governing condition that each apportions series variance among the loaded commodities in decreasing order, depending on which freight-demand situation confronts IR. In infrastructural terms, this captures changes in commodity-loadings by IR made in response to the degree of shortage in freight that persist at given periods, measured as a departure from the targeted levels of freight-loading. As explained earlier, while minor variations may not be addressed at all, overall freight shortage is redressed in the short term by reallocation of existing freight capacity along the lines just mentioned, and in the long term, ultimately by revision of capacity. Freight-mix vectors $\mathbf{f}_{kI..J}$ which are extracted as adjusted loading responses by the Factor Analysis are also amenable to dual interpretation, since while short-term adjustment of freight loadings may leave idle freight capacity on certain classes of special wagons, the long-term adjustment to persisting freight anomalies is achieved by tuning the wagonfleet composition to the freight most accessible in assured tonnage quantities. The adjustments made can be represented commodity-wise in vector-form as the IR *freight-adjustment vector* $\alpha_{kI..J}$ which spans the k commodities within the dataset. Since the *normalisation* and *factor-independence* conditions of Factor Analysis also ensure that freight-mix vectors will be linearly independent pairwise, each vector postulates a unique freighting response to uncorrelated freight-demand situations, allowing sufficient separation to be maintained between the character of IR responses and between the extreme situations which eventually provoke them. The k freight-mix vectors over which freight variance in the dataset is to be distributed are defined then by the following vector expression

.... (7.4)

$$\mathbf{f}_{k[..]} = \bar{W}_{[..]}\,\alpha_{k[..]} \qquad \text{for } [k = 1,......,15] \qquad \text{and } \alpha_{k[..]} = [\alpha_{k1[..]} \;\; \alpha_{k2[..]} \;\cdots\cdots\; \alpha_{kl[..]}]\;\; \begin{smallmatrix}[k = 1,\, ...,\, 15]\\ [l = 1,\, ...,\, 35]\end{smallmatrix}$$

subject to fulfillment of the inner-product conditions of unit-variance and zero-covariance, which imply *normality* of each $\alpha_{k[..]}$ and *orthogonality* between the consecutive adjustment vector-pairs $\alpha'_{k[..]}\,\alpha_{l[..]}$,

$$i.e. \quad \alpha'_{k[..]}\,\alpha_{l[..]} = \begin{cases} 1 & k = l \;\; - \text{unit-variance} \\ 0 & k \neq l \;\; - \text{zero-covariance} \end{cases} \qquad .... \quad (7.5)$$

Fulfillment of inner-product conditions for consecutive vectors is ensured by setting up the unit-variance and zero-covariance conditions as Lagrangean constraints and maximising the *constrained* Lagrangean objective function Φ, which for the $\mathbf{f}_k$ and $\mathbf{f}_l$ freight-mix vector-pairs with $k \neq l$ is defined alternately by

$$\Phi_k = \alpha_k'\,\bar{W}'_{[..]}\,\bar{W}_{[..]}\,\alpha_k - \lambda_k(\alpha'_{l[..]}\,\alpha_{k[..]} - 1) \qquad \text{for } \mathbf{f}_k$$

$$\Phi_l = \alpha_l'\,\bar{W}'_{[..]}\,\bar{W}_{[..]}\,\alpha_l - \lambda_l(\alpha'_{l[..]}\,\alpha_{l[..]} - 1) - \mu_k(\alpha'_{k[..]}\,\alpha_{l[..]}) \qquad \text{for } \mathbf{f}_l \neq \mathbf{f}_k \qquad .... \quad (7.6)$$

with λ and μ as respective Lagrange multipliers. After k vector-solutions for $\mathbf{f}_k$ have been extracted along with the α_k adjustment-vector relevant to each, the general freight-adjustment solution for IR may then be expressed in matrix-form, after squaring the k freight-mix vectors, by

$$\mathbf{F}_{[..]} = \bar{W}_{[..]}\,\mathbf{A}_{[..]} \qquad \text{where} \qquad \begin{bmatrix} \mathbf{F} = [\,\mathbf{f}_1'\mathbf{f}_1 \;\; \mathbf{f}_2'\mathbf{f}_2 \cdots \mathbf{f}_k'\mathbf{f}_k\,] \\ \mathbf{A} = [\alpha_1\;\alpha_2 \cdots \alpha_k\,] \end{bmatrix} \qquad .... \quad (7.7)$$

$\mathbf{A}_{[..]}$ which is defined by the adjustment vectors α_k is an *orthogonal* matrix, while $\mathbf{F}_{[..]}$ is a *diagonal* matrix defined by the matrix-product $\mathbf{F}_{[..]} = \bar{W}_{[..]}\,\mathbf{A}_{[..]}$ with the vector-squares $\mathbf{f}_k'\mathbf{f}_k \in \mathbf{F}$ as its diagonal elements and zeroes as its off-diagonal elements. This establishes that the new freight-mix vectors $\mathbf{f}_k$ are pair-wise uncorrelated so that each is capable of uniquely addressing existing IR freight-capacity to a given freight-demand situation that cannot be addressed by other freight-mixes, with adjustments in the loadings of different commodities that are necessitated by the process being defined by α_k. Thus the elements $\mathbf{f}_k'\mathbf{f}_k \in \mathbf{F}$ and $\alpha_k \in \mathbf{A}$ are pair-wise associated for *[k = 1,......,15]*, with the latter denoting the individual adjustment necessitated in IR commodity loadings, while $\mathbf{f}_k = \bar{W}_{[..]}\,\alpha_k$ is the *factor* or eigenvector (or latent vector) that represents the full scale of freight-capacity adjustment made by IR to a persistent freight demand situation by reallocating wagons over its commodity loadings. The score of each factor *i.e.* eigenvalue (or latent root) corresponding to each $\mathbf{f}_k$ is found as the vector-square associated with that factor along the main diagonal of $\mathbf{F}_{[..]}$ and evaluates the amount of series variance apportionable to the particular freight combination defined by the loading adjustments in α_k. It can therefore be used to assess the degree of compaction achieved by application of Factor Analysis, and therefore the degree of complementarity in certain commodity-loadings found in IR freight operations, as well as the magnitude of their displacing effect on other freight categories.

7.6 Factor Analysis of IR Freight Adjustment

The high order of series interdependence in the correlation matrices drawn on W_{BG}, W_{MG} and W_{AG} above offers indication that multicollinearity exists between pairs of predictor variables, which in timeseries problems also indicate possible overparameterisation, rendering normal regression procedures ineffective. This combination of circumstances implies that overall variations in IR freight loadings may be adequately explained by fewer than k commodity-loading trends, justifying the recourse made to Factor Analysis in order to decompose the variational components attributable to each commodity-trend, and to rank the commodities with respect to the influence they have on total IR wagon-loadings. The zero-determinants of the singular correlation matrices also suggest likewise, because of linear dependence between their columns and rows.

A particular test of the appropriateness of Factor Analysis to IR freight-mix modelling based on these principles is provided by the Kaiser-Meyer-Olkin [K-M-O] Measure of Sampling Adequacy routinely provided in

SPSS output, which compares the magnitudes of the simple correlation coefficients r^2_{ij} between paired wagon loading series to the partial correlation coefficients [PCCs] $r^2_{ij.1,2,...i-1,j-1,k-1,k}$. If the sum of squared PCCs between all commodity-pairs is small compared to the sum of squared simple correlation coefficients, the **K-M-O** index is close to 1, indicating that most of the series-variance is sourced from the lateral collinearity of wagon loadings in the dataset. Small values of the statistic on the other hand would indicate that Factor Analysis is inappropriate, since the interdependence between any commodity-pair would not be attributable to the indirect influence of IR freight adjustments made in respect of other commodities. The K-M-O index thus yields high values if removal of other collinear control variables from the dataset considerably reduces the absolute values of the *direct* or simple correlation coefficients of the correlation matrix. K-M-O tests run individually on W_{BG}, W_{MG} and W_{AG} matrix loadings for IR show values of 0.86, 0.81 and 0.88 respectively, establishing that most of the interdependence apparent within wagon-loading data matrices occurs because of the dominant loading trends in a few bulk commodities and the collinear trends of other commodity loadings.

Table 7.6: Interrelatedness of Gauge-wise IR Commodity-Freight Loadings 1955-56 to 1989-90
FACTOR ANALYSIS

Factors	Factor Scores *(Eigenvalues)*														
Freight-Mixes	f_1	f_2	f_3	f_4	f_5	f_6	f_7	f_8	f_9	f_{10}	f_{11}	f_{12}	f_{13}	f_{14}	f_{15}
BG Loadings	10.996	1.457	0.947	0.499	0.395	0.268	0.138	0.085	0.074	0.050	0.034	0.028	0.016	0.010	0.004
MG Loadings	8.833	2.538	1.452	0.577	0.428	0.305	0.197	0.190	0.135	0.118	0.069	0.062	0.051	0.032	0.014
AG Loadings	10.524	1.756	0.934	0.575	0.387	0.291	0.176	0.102	0.069	0.057	0.05	0.038	0.024	0.010	0.006
BG % Variance	*73.3*	*9.7*	*6.3*	*3.3*	*2.6*	*1.8*	*0.9*	*0.6*	*0.5*	*0.3*	*0.2*	*0.2*	*0.1*	*0.1*	*0.0*
MG % Variance	*58.9*	*16.9*	*9.7*	*3.8*	*2.9*	*2.0*	*1.3*	*1.3*	*0.9*	*0.8*	*0.5*	*0.4*	*0.3*	*0.2*	*0.1*
AG % Variance	*70.2*	*11.7*	*6.2*	*3.8*	*2.6*	*1.9*	*1.2*	*0.7*	*0.5*	*0.4*	*0.3*	*0.3*	*0.2*	*0.1*	*0.0*
BG % CumVar	*73.3*	*83.0*	*89.3*	*92.7*	*95.3*	*97.1*	*98.0*	*98.6*	*99.1*	*99.4*	*99.6*	*99.8*	*99.9*	*100.0*	*100.0*
MG % CumVar	*58.9*	*75.8*	*85.5*	*89.3*	*92.2*	*94.2*	*95.5*	*96.8*	*97.7*	*98.5*	*98.9*	*99.4*	*99.7*	*99.9*	*100.0*
AG % CumVar	*70.2*	*81.9*	*88.1*	*91.9*	*94.5*	*96.4*	*97.6*	*98.3*	*98.8*	*99.1*	*99.5*	*99.7*	*99.9*	*100.0*	*100.0*

7.6.1 IR Freight-Adjustment Mixes

Examination may be made now of the ordered vector solutions $\mathbf{f}_k$ for IR commodity-freight loadings derived from application of the procedures outlined above. While advancing beyond previous applications of Factor Analysis found in the literature, [22] the interpretative model allows insight to be gained into the intergauge and intermode freight-adjustments implied in the extracted factors. The Factor Analysis of IR wagon loadings in terms of the freight-adjustment model defines 15 adjustment vectors (eigenvectors) α_k, each uniquely specifying a feasible freight-mix solution $\mathbf{f}_k$ specifying loading proportions for the 15 commodities on the associated IR gauge.[*see Table 7.6*] While these solutions adjust IR freight capacity to the availability of freight in order to minimise the slack in transport, they also amount statistically to the reallocation of the variances in the dataset among the 15 loaded commodities under consideration. The degree to which overall series-variance is offset by the freight-adjustment is indicated by the diagonal elements $\mathbf{f}_k'\mathbf{f}_k \in \mathbf{F}_{l..l}$ which define the factor scores or eigenvalues for each eigenvector solution. Since the standardising transformation of the data prior to Factor Analysis has unitised the variances of dataseries so that the sum of variances over all series is now 15, reassignment of variance by adjustments of commodity loadings by IR expressed in the freight-mix can be expressed in ratio or percentage to this. Comparison of the factor scores then allows assessment of the degree of compaction in commodity-freight loadings that can be attributed to each IR freight-mix, with these being stated accordingly as variances and cumulative variances in the table below.

Consideration may first be made of the factor scores derived on the AG wagon-loading dataset. By nature, these arise from the joint apportionment of BG as well as MG freight capacity by IR among different commodities as part of the overall freight-mix adjustment, and thus subsume the spatial aspect. A considerable degree of compaction is immediately noticeable here, with as much as 91.9 percent of overall series variance being attributable to just the first four freight solutions. Factors beyond $\mathbf{f}_7$ in fact contribute very insignificantly to overall variation in IR wagon loadings, indicating that the dimensionality of the IR wagon-loading data can be considerably reduced without sustaining information-loss, by narrowing the freight focus to a subset of the important commodities that are carried by railway. Well over two-thirds of variability in the AG freight-series is attributable to the single freight-mix $\mathbf{f}_1$ and to the freight-adjustments α_1 that are made within its ambit. While offsetting a fairly credible proportion of the overall series variance, the freight-mix $\mathbf{f}_2$, following from the *orthogonality* property, is adopted in a freight situation unrelated to the one to which $\mathbf{f}_1$ bears reference, and $\mathbf{f}_3$ - again unrelated to $\mathbf{f}_2$ - is able to address a fair proportion of the residual variance.

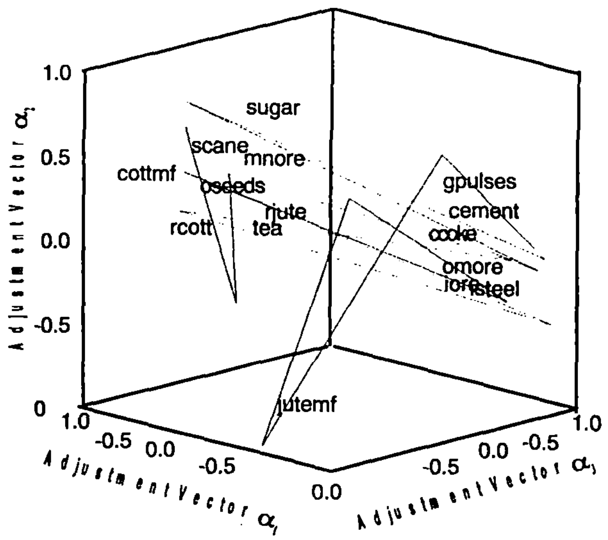
Table 7.7: Vector Coefficients for First Three IR Freight-Mixes
(sorted on the absolute AG coefficient scale)

	BG			MG			AG		
	Factor1	Factor2	Factor3	Factor1	Factor2	Factor3	Factor1	Factor2	Factor3
	$\alpha_{1[BG]}$	$\alpha_{2[BG]}$	$\alpha_{3[BG]}$	$\alpha_{1[MG]}$	$\alpha_{2[MG]}$	$\alpha_{3[MG]}$	$\alpha_{1[AG]}$	$\alpha_{2[AG]}$	$\alpha_{3[AG]}$
IORE	0.974	-0.103	0.102	0.647	0.648	-0.082	-0.973	-0.097	0.113
OSEEDS	-0.954	-0.084	0.078	0.955	-0.213	0.034	0.964	-0.044	0.161
CCOKE	0.944	0.269	0.095	0.504	0.762	0.129	-0.945	0.281	-0.044
RCOTT	-0.950	0.020	-0.107	0.901	0.010	0.246	0.940	-0.108	0.059
OMORE	0.927	-0.082	0.167	0.690	-0.026	-0.464	-0.921	0.003	0.209
SCANE	-0.930	0.255	-0.110	0.883	-0.237	-0.183	0.917	0.235	0.100
MNORE	-0.824	0.326	0.134	0.795	-0.267	0.296	0.890	0.209	0.088
COTTMF	-0.908	0.314	-0.174	0.548	-0.724	0.180	0.885	0.258	-0.304
TEA	-0.863	-0.069	0.338	0.931	0.106	0.181	0.873	-0.152	0.338
CEMENT	0.849	0.352	0.222	-0.513	0.705	-0.045	-0.862	0.293	0.100
RJUTE	-0.859	-0.242	0.314	0.961	0.135	0.009	0.858	-0.178	0.428
GPULSES	0.901	0.267	0.017	0.545	0.106	-0.746	-0.771	0.456	0.086
ISTEEL	0.836	-0.263	0.294	0.852	0.374	-0.104	-0.713	-0.256	0.564
JUTEMF	0.487	-0.478	-0.648	0.601	0.329	0.596	-0.109	-0.838	-0.320
SUGAR	0.405	0.731	-0.232	0.900	-0.236	-0.200	0.498	0.610	0.012
Explained Freight Variation									
Variance	10.996	1.457	0.947	8.833	2.538	1.452	10.524	1.756	0.934
% Variance	*73.30*	*9.71*	*6.32*	*58.89*	*16.92*	*9.68*	*70.16*	*11.71*	*6.23*
% CumVar	*73.30*	*83.02*	*89.33*	*58.89*	*75.81*	*85.49*	*70.16*	*81.86*	*88.09*

However, the AG freight-mixes as such represent the cumulative commodity loading-position of IR, and depend on the base figures for wagons loaded on the two IR gauges. Comparison of AG, BG and MG factor scores from this perspective is therefore both warranted as well as instructive. The table shows that BG wagon loadings, which comprise by far the bulk of AG freight loadings, display a sharper response to the freight adjustment, with the $\mathbf{f}_{1[BG]}$, $\mathbf{f}_{2[BG]}$ and $\mathbf{f}_{3[BG]}$ vectors subsuming 89.3 percent of series-variance, compared to 88.1 percent for AG loadings. Nevertheless the main component of this, *i.e.* 73.3 percent, is accounted for by the freight-mix $\mathbf{f}_{1[BG]}$ and is higher than that for $\mathbf{f}_{1[AG]}$, reflecting the strongly polarised pattern of IR's BG freight operations arising from the focus on bulk-freight. The next two freight adjustments however absorb lower proportions of series-variance than they did for AG, indicating that most of the freight-adjustment made in situations when bulk traffic does not materialise in the desired proportion takes place in the MG segment of IR's freight operations. Accordingly, although the compaction of series-variance is also quite credible for MG commodity loadings, with 85.5 percent being absorbed by the first three freight-mix solutions, the distribution of series-variance over $\mathbf{f}_{1[MG]}$, $\mathbf{f}_{2[MG]}$ and $\mathbf{f}_{3[MG]}$ freight-mix vectors is radically different, and while the first solution which corresponds to high bulk loadings on the BG segment offsets only 58.9 percent of the freight variation, the second and third freight adjustments individually offset as much as 16.9 percent and 9.7 percent, respectively.

The individual adjustment vectors α_1, α_2 and α_3 defined by the three principal AG freight-mixes in Table 7.7 are plotted in simulated 3-space in *Fig.*7.2 below to illustrate the interdependencies of IR loadings of commodity-freight within the freight adjustment adjustment process. Closer understanding of the gaugewise nature of IR freight adjustments is obtained from separate 3-space simulations of the three principal IR freight-loading mixes represented by the $\mathbf{f}_{1[..]}$, $\mathbf{f}_{2[..]}$ and $\mathbf{f}_{3[..]}$ vectors for AG, BG and MG operations, which are plotted subsequently as topological surfaces in *Figs.*7.3, 7.4 and 7.5. For better clarity, the freight-adjustment vectors in these plots for each IR gauge are viewed as topologies from forward as well as reversed viewpoints, so that the sequence of commodity-freight adjustments in the three freight-adjustment vectors can be visually ordered relative to each other.

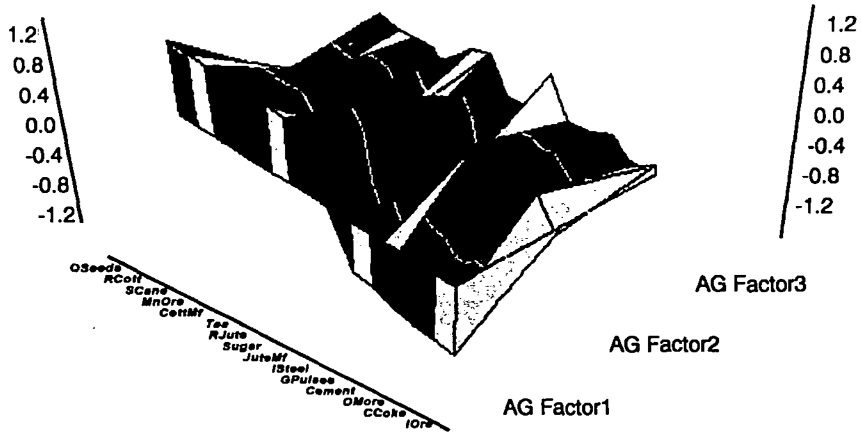
Figure **7.2 : IR Freight-Mix Simulation**
3-axis Vector Plot for AG Freight Adjustments



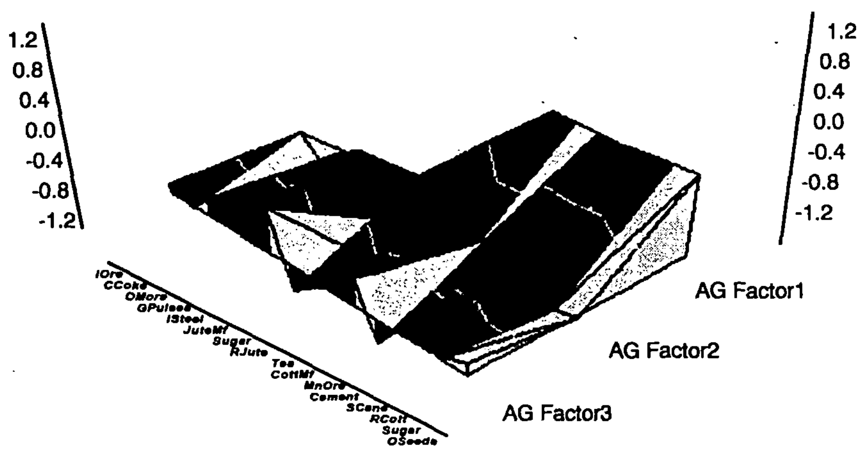
The 3-space simulations clearly show the commodity clusterings in the three commodity-freight adjustments that IR most commonly has to make in its loading operations over all railway gauges in the face of its freighting constraints and the traffic offer availability of freight traffic. In the most common freight situation which explains over 70 percent of the variance in the AG dataset, freight shortfalls in major bulk commodities like coal & coke, cement, iron ore and iron & steel, as well as grams & pulses and jute manufactures have to be compensated by increased loading of oilseeds, raw cotton, raw jute, sugarcane, cotton manufactures, sugar, tea and manganese ores. Since the shortfalls of bulk-freight create operational slack on the BG network, MG feeder-freight flows have to be accepted in a return to the classic mode of feeder-and-trunk freight operations on the Indian railway network. Less commonly and accounting for around 11 percent of loading variations, IR is able to substantially increase its bulk-freight loadings of coal & coke, cement and grams & pulses. Because of gauge-wise interconnections and changes in directional leads, the resulting pattern of slacks on the freight network also permits increased MG loading of sugar and sugarcane, and cotton manufactures, but the loading of iron ore & iron & steel as well as oilseeds, raw cotton, raw jute, tea and jute manufactures remains short. The least common freight situation which accounts for just over 6 percent of series variance, occurs when IR loadings of iron & steel are the highest with adequate loading of other major bulk commodities. In this freight situation, which IR would aspire to most, the freight loadings of all other commodities are also adequate with the exception of cotton and jute manufactures, leaving little freight slack on the IR system. The exercise undertaken above also brings out the implied characteristics of freighting adjustments which have been determined by changes in the composition of IR wagonfleets. In *Fig.*7.2, therefore, the adjustment planes of IR freight-capacity reallocation under the three principal freight situations encountered by IR are thus seen to effectively triangularise the freight adjustments between triads of commodities that can normally be freighted on an identical wagon-type.

The analytical findings from Table 7.7 may thus be summarised as follows. The freight situation that IR generally aspires to serve accords overwhelming priority to railway bulk-freight operations because of plan objectives as well as the structural composition of the IR wagonfleet that has evolved over time. When these traffic expectations are met, the MG freight operations extend in part to the transhipments necessitated by upstream traffic flows on the BG network, and accordingly exhibit less variation. However when a shortfall in BG loadings occurs, freight-mix adjustments are proportionately higher on the MG network, which as earlier noted accounts for the major part of commodity loadings in agricultural products and agriculturally-sourced raw materials. Because of the regional distribution of originating freight, the freight-adjustment probably also involves changes in the spatial direction of traffic flows as well, since while short loadings of iron ore or coal cannot actually be compensated by increased loadings of other freight from the same originating points, the specialisation in the IR wagonfleet prevents the traffic slack from being fully covered. In such circumstances, scope remains for further freight adjustment down the line, which is adequately captured by the additional freight-mix solutions - the main adjustments invariably being made on the MG freight network.

Figure 7.3 : IR Freight-Mix Simulation
AG Wagon Loadings

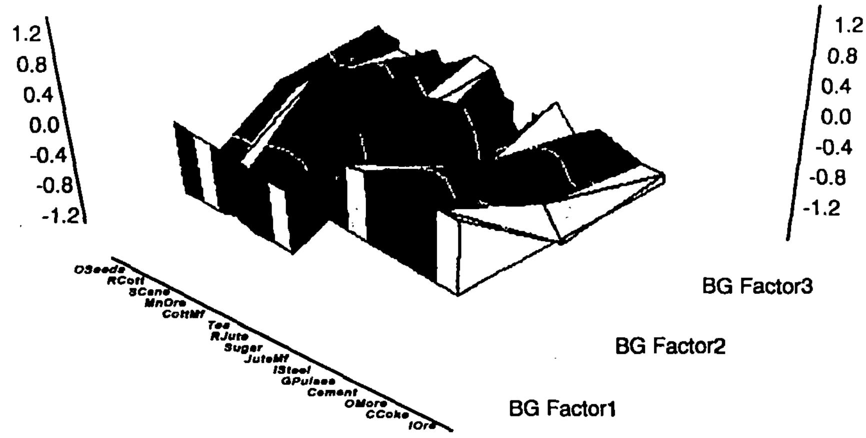


IR Freight-Mix Simulation
AG Wagon Loadings
Reversed Factors

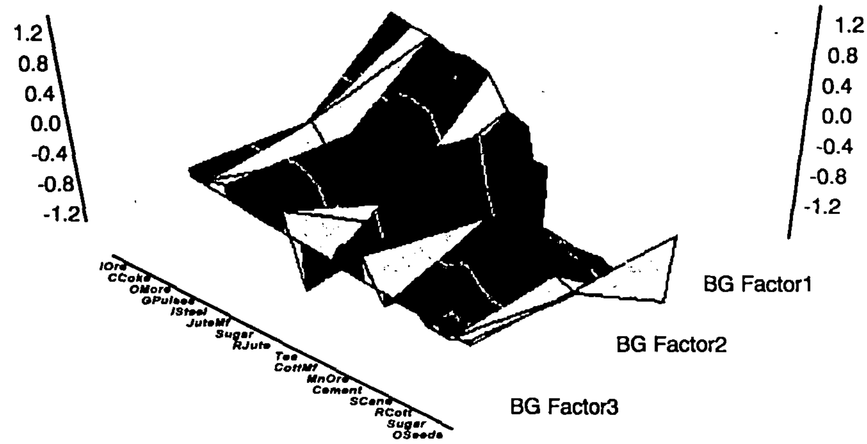


Turning attention now to the adjustments in individual commodity loadings identified by the vectors $\alpha_{k/..j}$ in the table, it is seen that the freight-mix solutions discussed earlier imply nonidentical commodity-loading adjustments for gaugewise IR freight operations, with the respective BG and MG loadings also being partially interdependent depending on which freight offer is actually confronted by IR. The first point for consideration while assessing the freight-mixes f_k defined by these adjustments relates to the mathematical sign sported by individual commodity-loading coefficients, which in the table are aligned in descending absolute order of the coefficients in $\alpha_{k/AGj}$. As such, while two clustered or vertically contiguous coefficients in the table having different mathematical signs may represent similar proportionate adjustments in freight loadings of associated commodities, the direction of the adjustments are opposite, with loadings of one commodity expanding at the expense of the other. For the freight-mix $f_{1/..j}$ over all railway gauges, the impact of IR freight focus on a core group of bulk commodities comprising iron ore and other metallurgical ores as well as iron & steel, along with coal and cement is principally felt on BG freight operations. However, because of either extreme regionalisation of production or surplus, three commodities from other sectors of the economy, namely grams & pulses, sugar and jute manufactures, maintain their presence in IR freight. Of these, the presence of the last two might be classified as more of a toehold, but the status of grams & pulses in BG freight is far more important. Over time and with network expansion, there has in fact been a gravitation of the traditional traffic in sugar and grams & pulses from the MG to the BG network for distributional reasons affecting the entire country. However, while freight loadings in grams & pulses and jute manufactures have been able to graft themselves almost entirely to IR's BG operations, as also noted in the previous chapter, a considerable part of the long-lead traffic in sugar has in fact left the IR network and is now distributed by road, as evinced by modal-share figures for the roadways of over 65 percent of the net tonne-km traffic,

Figure 7.4 : IR Freight-Mix Simulation
BG Wagon Loadings



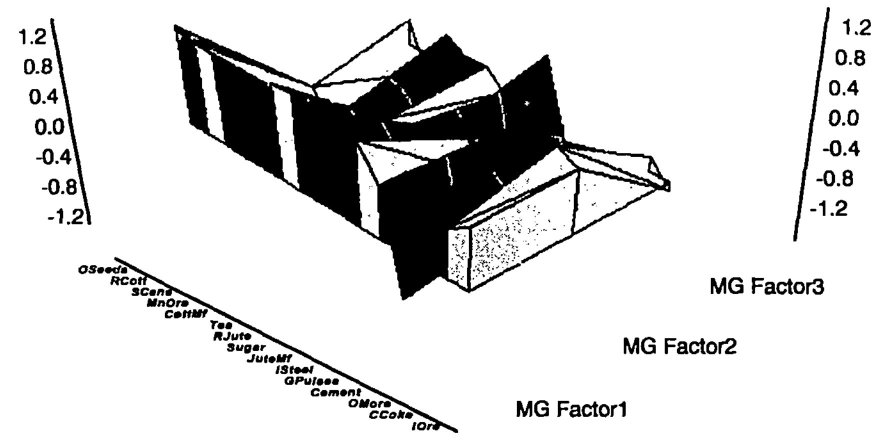
IR Freight-Mix Simulation
BG Wagon Loadings
Reversed Factors



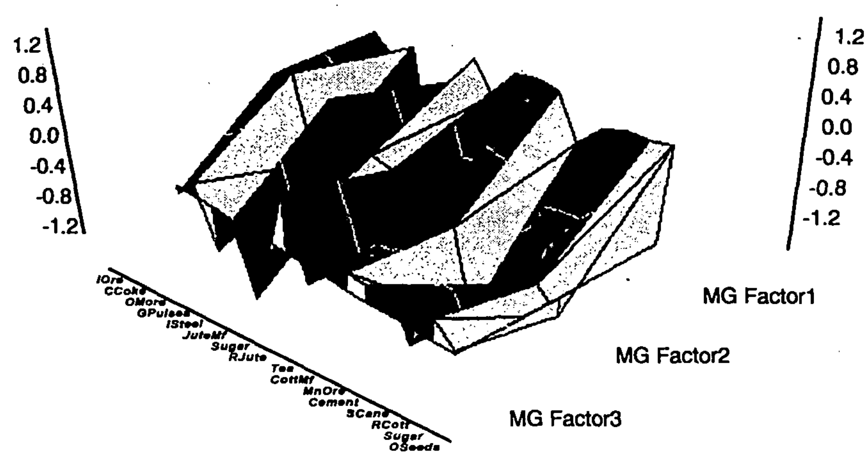
even while nearly 61 percent of the originating tonnage still remains with IR.[23]

In obvious contrast however is the impact of IR's bulk-freight focus on traffic emanating from agriculture and other allied economic sectors. In this case, the order of traffic decline is also invariably very high illustrating the freight tradeoff between bulk and non-bulk commodities in IR freight operations. Interpreting the adjustments jointly with their gauge-wise implications, when adequate traffic in preferred commodities materialises on IR's BG network, the freight-mix adjustment demands that a substantial proportion of freight capacity be drawn away from other categories of commodity freight. This has its strongest impact on the traditional traffic in agriculturally-sourced commodities, which is felt particularly on the MG network because of the low degree of specialisation in its wagonfleet. The only commodity therefore that retains importance in MG railway freight is cement, mainly because of the localisation of surplus production and the country-wide needs, but also - importantly - because the normal mode of carriage for cement is the covered wagon designed for general carriage, which is a major workhorse of the MG wagonfleet. The high allocation of MG freight capacity to cement however causes sharp displacements of other MG traffic, particularly in originating loadings of a number of agricultural raw materials and products which once fed the IR freight network when the MG lines were evolved as regional feeders. Obviously, such categories of traffic are displaced to the roadways at much higher freight-costs. It is also a characteristic of the MG freight adjustment that capacity continues to be heavily assigned to other bulk commodities like ores or coal, even though their loadings have declined marginally over time. Again, the main factor contributing to this is the less-specialised MG wagonfleet which, while it is able to cater to increasing loadings of cement with its covered wagons, must draw these away from the general freight categories, and is unable to adequately address the needs of other bulk-freight both because of the lack of technical adaptation and the absolute shortage in the MG wagonfleet.

***Figure 7.5:* IR Freight-Mix Simulation**
MG Wagon Loadings



IR Freight-Mix Simulation
MG Wagon Loadings
Reversed Factors



In the cumulative AG freight operations therefore, the BG bulk trends predominate, and very little difference exists in the sorting order of BG and AG commodity coefficients. The magnitudes of these coefficients are however altered by the cumulative effect of MG freight operations. It is seen in fact that the basic carryover traffic from BG to MG in the normal freight situation comprises cement and coal & coke, since the adjustment coefficients for these commodities in the overall IR freight-mix are higher than those for the BG freight-mix. However in every other freight-category, the adjustment coefficients decline from BG to AG, indicating the less polarised nature of IR freight operations in these freight-commodities across the country. Of the other commodities, only loadings of grams & pulses, manufactured jute, sugar, and to a very limited extent tea, prove consistent with the rising trends in core bulk traffic, again because the regional production flows and distribution leads of these commodities can utilise the MG turnaround capacity on the covered wagons that have been used for the outward transportation of cement. Since other commodity traffic is not as similarly adapted either in its point of origin or effective lead, IR MG freight capacity cannot adjust to its requirements.

A new freight-mix adjustment emerges however when freight demands do not materialise in the expected form. In the bulk group, such a situation particularly reflects short loadings of commodities required or produced by the metallurgical group of industries, since the freight adjustment lowers the freighting capacity assigned by IR to traffic in iron ore and other metal ores, as well as to finished iron & steel in such cases. With traffic in iron & steel being a notable moneyspinner in IR freight operations, short loadings of this commodity inevitably require that aggressive increases take place in loadings of other commodities, both in order to remove slack from the system and to make up for revenue losses. Accordingly, the freight adjustment made in AG loadings strives to focus on light industrial categories with long traffic leads, such as sugar and cotton manufactures, as well as on sugarcane traffic which feeds the sugar industry. Besides a parallel increase in coal loadings, the other major loading-adjustment is made in cement, which offers the advantage of perennial and countrywide demand along with relatively high tariff rates. Short loadings of metallurgical commodities have a much stronger impact on BG freight, because of specialisation in the BG wagonfleet. A technical slack of this kind cannot wholly be offset, and while the BG adjustment occurs mainly in the spatially-complementary loading segments of cement and sugar which can both be freighted in covered wagons, the second BG freight-mix defined by $\mathbf{f}_{2[.BG]}$ is unable to absorb more than a modicum of the residual variation in the series. In contrast, freight loadings on the MG network show considerable adaptation of the loadings in agricultural commodities and account for the difference between AG and BG freight loading patterns, thus making up a part of the slack being experienced by IR.

The third freight situation in the table reflects the gauge-wise freight-mixes subsumed within $\mathbf{f}_{3[..]}$. The material difference in this freight situation is that where the materialisation of traffic from the metallurgical industries has been relatively adequate, there are short loadings of important bulk commodities like cement and coal as well as of important agriculture-dependent freight, which mimics in part the freight offer that might exist during and after a year that has been adverse for agriculture. The burden of adjustment to this again falls in larger measure on agricultural and other bulk and non-bulk commodity loadings by the MG network, while the slack on the BG traffic segment of IR operations is made more severe by the specific slack in the utilisation of coal wagons, and by the lack of cement traffic which causes a shortage of turnaround wagons for the movement of sugar, jute manufactures and grams & pulses. While in revenue terms, this freight situation may not be as adverse as the second because of the good loadings of metallurgical commodities that still obtain, the highest fall would take place in tonnages because of short loadings of coal which is by far the most important single commodity to IR freight operations.

In sum, therefore, freight-adjustment by IR takes place over three major commodity mixes, which though not wholly coincident in time because of the different orders of variance subsumed within each, reflect the freight offer situations obtaining from three principal states within the Indian economy. In the first situation, which is the most usual, the economy displays fair levels of core and basic industrial production. IR freight capacity is accordingly adjusted towards the carriage of bulk-freight with long traffic leads, and in fact accommodates only those other commodities which can provide reverse traffic with similar leads. The second economic state and the resulting freight offer emerges when there is a major setback in the metallurgical segment of industries, even when other economic sectors are still performing creditably. Because the strong infrastructural linkages of railways across most of the world with the evolution of mining and metallurgical industry, a considerable freight slack consequently emerges, which remains unattended if the wagonfleet does not have an adequate complement of general-purpose wagons. Thus while the railways underperform, a considerable part of the freight demand in the country goes abegging, mainly because of specialised underutilisation of the railway wagonfleet. The third and relatively more infrequent state of the economy extends in a period when the production and offtake of metallurgical industries is high, but there is slack in other core industrial sectors arising from shortage of basic production inputs like coal or cement. Since such shortages also affect downstream activity in other manufacturing sectors of the economy and create recessionary conditions, the railways have to fall back on primary movement of agricultural and agro-based freight to overcome the traffic slack.

The commodity-freight patterns of the IR wagon-loading dataset may also be examined in relation to the economic sectors from which they originate or are destined to, or in other words as the input and output flows between coordinated pairs of economic activities. Using the sectoral classifications adopted in the preceding chapter, the wagon-loading series may thus be regarded as representing originating freight-flows of primary and secondary outputs from the mining & heavy industrials sector and the light industrials sector, and also of essential commodities, raw materials and agro products from the agricultural sector. Viewing the commodity-freight trends in this light, the factors underlying structural change in the IR freight-base appear to relate to the transport policy stress on bulk railway movements of the basic inputs originating from the Indian mining sector to core heavy industries, and also on downstream bulk movement of the industrial outputs originating from heavy industry. Consequently, IR freight loadings of these commodity-groups have shown tremendous increase over the 35-year timeframe spanned by the wagon-loading dataset. The principal freight tradeoff on this account has been with light industrials, and the agro-based commodity-group comprising unprocessed or processed outputs of agricultural origin.

In spite of the increasing emphasis on bulk movement of mining and heavy industrials, the social obligation carried by the railways on account of being in the public-sector commits IR to the freightage of several essential commodities mostly originating from agriculture for distribution across the entire country, this historic pattern harking back to the advent of railways in India as an instrument for famine alleviation and price control.[*see ch2*].Such freight-flows involve social burdens from subsidised and cross-subsidised freight-rates, causing the related freight operation to run a loss. An instance of this is the railway freightage of sugarcane to the sugar mills, estimated to involve a subsidisation loss amounting to nearly 11 percent of the gross social burden borne by IR, which is then recovered in part through cross-subsidisation from other commodity-freight.[24] Since all freight of non-bulk or destructible nature must usually be hauled on general-purpose covered wagons whose presence in the IR wagonfleet is limited, the obligation of maintaining such essential freight-flows under social imperatives causes further freight displacement of light industrials, raw materials and agroindustrial outputs to the roadways. Thus whatever agricultural commodity-freight is carried by IR competes for the scarce freighting capacity that might otherwise be utilised by light industry, with the balance of competition eventually being decided by prevailing social imperatives and freight rates. Finally, since greater importance is attached by IR to strategic raw material flows than to the freight-flows of light industrial products, all industry other than key PSUs and heavy industrial units is put through a freighting squeeze that escalates transportation costs and eventually tells on the overall cost-economics of industrial production. Thus in sum, the freight services offered by IR no longer span the gamut of inputs and products required by the economy.

7.6.2 Interdependence in IR Commodity-Loadings

Although the freight-adjustment model developed for IR wagon-loadings adequately captures the process by which IR freight-mixes are adapted to changing freight offers in different economic situations, the adjustment process is neither smooth nor seamless, because of lumpiness in IR capacity variables as well as in the commodity-flows. An area for further investigation thus relates to the longterm adaptations that are made by individual commodity-freight flows in response to IR's periodic inability to provide the required freight service, which has been seen to depend principally on aggregate IR freighting capacity as well as on IR wagonfleet composition. Several additional constraints can indirectly limit the ability of IR to supply wagons of the required type in the requisite numbers that match the freight demands of the consigners. These include the current line capacities and sectional trainspeeds of the IR route-network, as well as the originating and destination points of prior freight consignments which decide the directional flows and make wagon rakes available for the loading of new freight on subsequent turnaround journeys. In the face of such additional constraints, the railway freight system continually operates against an unpredictable traffic slack, and must maintain excess system and freighting capacity in order to adapt smoothly to changes in freight offers. But because of critical capacity shortages that have been precipitated by underfunding of IR's capital needs under the FYPs, the IR freight system has to adapt to the changing freight offer without the insulation that would have been provided by wagonfleet adequacy. Further, because of progressively increasing freight-specialisation within the IR wagonfleet, the general freight services now provided by IR can only adapt within a narrow range to changes in the critical flows of bulk-freight commodities. Consequently, the commodity-loadings by IR have become highly interdependent, and the loading trends of bulk commodities have appreciable influence on the wagon-loadings of other commodity-freight across the entire IR route-network.

The impact of such constraints is captured in the collinearity of commodity-loading series in the IR wagon-loading dataset. The collinearity indicates in substance that IR wagon-loadings for most commodities are not determined instantaneously by the freight offer from the producing sectors, and also depend strongly or weakly as the case may be, on the interrelated wagon-loading trends of other commodities on the IR route-network. This is borne out statistically by the high degree of intercommodity correlation observed in the off-diagonal elements of the correlation matrices for BG, MG and AG wagon-loadings in Tables 6.2*b*., 6.3*b*.and 7.5*b*. The K-M-O statistic, which provides a test for the adequacy of the freight-adjustment model based on this, also conceptually shows that most of the interdependence apparent in the simple correlation coefficients between any pair of IR commodity-loadings in the correlation matrices is explained by the interdependence of these with other IR commodity loadings. K-M-O values of 0.86, 0.81 and 0.88 for BG, MG and AG respectively, accordingly lend themselves to further interpretation based on the fact that the order of values of the statistic suggest that interdependence of IR commodity-loadings is greater in BG freight operations than in MG freight operations, and is thus highest for cumulative AG offerings where the gauge-wise commodity-loading patterns have to interact with each other. The alternating coefficient signs in the freght-adjustment vectors α_k that define each freight-mix solution f_k also indicate the sequence of interdependent commodity-freight adjustments that must be made by IR in order to respond to the freight offer that prevails in the given economic situation. Consequently, the loading patterns of the different freight commodities become interdependent and create collinearity within the gaugewise and crossgauge wagon-loading datasets.

The pattern of interdependence between the commodity-loading trends, which captures the group behaviour of these series, is of considerable interest since it identifies which interdependent commodity groups have either gained or lost importance in the course of the evolution of IR freight operations over the period under review. This behaviour may be interpreted from the *communality* attached to each commodity-loading series in standard SPSS output, which statistically reports the proportion of variance in each individual commodity-loading series that can be explained by its covariances with other collinear commodity-loading series. The scaling of communalities by order of magnitude of explained variances also identifies the dominant commodity whose freight-loadings exercise the greatest influence on the loading of other commodities by IR

Table 7.8 presents the comparative results on commodity-interdependence in the BG, MG and AG wagon-loading datasets obtained after applying the IR freight-adjustment model to the data. Because of the orthogonality of successive freight-adjustment vectors, a communality can be assigned to a specific commodity in each freight-mix on the basis of its commodity-dominance within the concerned freight-adjustment vector, keeping in mind that the model is being applied to standardised wagon-loading data after centering and dispersion adjustments have been made. Standardisation of the wagon-loading datasets brings the pure variational trends of individual commodity-loadings to light and draws as much attention to decreasing wagon-loading trends as it does to increasing trends, since the absolute magnitude of wagon-loadings for each commodity are discounted.

The commodity-loading series which accounts for the highest communality in each freight-adjustment vector α_k has been identified in the table by the relative magnitude of interdependent commodity variances it explains for each of the successive freight-mixes f_k. An important observation from the table is that no change occurs in the order of commodity-dominance in the communalities for the BG, MG and AG wagon-loading datasets, indicating that commodity-freight interrelatedness remains identical between the two IR gauges, even though the relative proportions of variance explained by each dominant commodity change somewhat. This indicates that although the dominant commodity-loadings on IR's BG freight operations leave a strong stamp on MG freight operations, some measure of gauge-autonomy still exists on the MG system, and ties in closely with the earlier observation from the K-M-O statistic which had revealed that BG and AG freight operations by IR show greater commodity-interdependence than MG freight operations. In any case, two dominant bulk-commodities, namely cement and coal & coke account for the greatest proportion of longterm variations in IR wagon-loading trends, although the proportion of explained variance is cumulatively less in the case of MG freight operations.

Table 7.8: Analysis of Commodity-Interdependence In IR Freight Adjustments
BG, MG & AG Wagon-Loadings

IR Freight-mix	Commodity with Greatest Commmunality	*Percentage of Variance Explained* MG	BG	AG
Freight-mix f_1	Cement	*58.9*	*73.3*	*70.2*
Freight-mix f_2	Coal & Coke	*16.9*	*9.7*	*11.7*
Freight-mix f_3	Cotton Manufactures	*9.7*	*6.3*	*6.2*
Freight-mix f_4	Raw Cotton	*3.8*	*3.3*	*3.8*
Freight-mix f_5	Grams & Pulses	*2.9*	*2.6*	*2.6*
Freight-mix f_6	Iron Ore	*2.0*	*1.8*	*1.9*
Freight-mix f_7	Iron & Steel	*1.3*	*0.9*	*1.2*
Freight-mix f_8	Jute Manufacures	*1.3*	*0.6*	*0.7*
Freight-mix f_9	Raw Jute	*0.9*	*0.5*	*0.5*
Freight-mix f_{10}	Manganese Ore	*0.8*	*0.3*	*0.4*
Freight-mix f_{11}	Oilseeds	*0.5*	*0.2*	*0.3*
Freight-mix f_{12}	Other Metal Ores	*0.4*	*0.2*	*0.3*
Freight-mix f_{13}	Sugar	*0.3*	*0.1*	*0.2*
Freight-mix f_{14}	Sugarcane	*0.2*	*0.1*	*0.1*
Freight-mix f_{15}	Tea	*0.0*	*0.0*	*0.0*

While both cement and coal & coke have gained critical importance in IR freight operations and have displaced other freight from the IR freight-mix, the next group of commodities that account for the greatest proportion of commodity-interdependence in the freight-mixes $\mathbf{f}_3$ and $\mathbf{f}_4$ are cotton manufactures & raw cotton, both of which are low-bulk commodities that have lost considerable ground in IR freight operations and are also vertically related to each other by direct input-output linkage. In fact, such vertical production linkages are found elsewhere in the table of ordered communalities over all IR gauges, although sometimes with their input-output order reversed, for iron ore and iron & steel, jute manufactures and raw jute, and sugar & sugarcane. The intuitively appealing reason for the presence of such closely associated input-output linkages in the order of commodity-freight communalities appears to be the assurance of turnaround traffic to the railways, Nevertheless, from visual examination of series-behaviour in the IR wagon-loading datasets, it is seen that the wagon-loadings in the cotton group have moved antisymmetrically to increased cement and coal & coke loadings, and again that wagon-loadings in jute group have declined while iron ore and iron & steel loadings have been increasing. Interdependent commodity-freight behaviour of this type gives notable insight into the sectoral displacements of commodity-freight in IR freight operations, as a result of the increasing IR focus on bulk-freight.

From the numeric variances in Table 7.6 which have reapportioned the total standardised variances of the BG, MG and AG wagon-loading datasets over 15 alternative freight-mixes $\mathbf{f}_k$, it is seen that the degree of data compaction achieved by the freight-adjustment model is quite good, with over 70 percent of total variance in the AG dataset being explained by $\mathbf{f}_{1[AG]}$ alone. Even higher compaction with over 73 percent of total variance being explained in the BG dataset is achieved by $\mathbf{f}_{1[BG]}$ alone. Although commodity-loading patterns on IR's MG network are less interdependent, over 58 percent percent of total variance in the MG dataset is explained by $\mathbf{f}_{1[MG]}$ alone. In all three cases, IR commodity-freight loading patterns of cement play the decisive role in determining the freight loadings of other commodities. The first four freight-mixes $\mathbf{f}_1$ to $\mathbf{f}_4$ listed in the table explain cumulative variances [*CumVar in Table 7.6*] of around or over 92 percent for BG and AG , and over 89 percent for MG.

Viewing this jointly with the communalities for the first four freight-mixes in Table 7.8 above, it is noted that although the proportional dominance of cement and coal & coke in determining the freight-loading patterns of other commodities differs significantly between IR's BG and MG freight operations, and increasing MG loading trends of coal & coke cause more disruption in other MG commodity-freight flows than they do on BG, the freight-flow that has been displaced by increased cement and coal & coke loading on both IR gauges has mainly comprised commodities in the cotton group. The latter commodities were important traditional constituents of IR low-bulk freight which were carried over reversed lead distances and very long journey leads through combined feeder and trunk operations over both IR gauge networks, and accordingly show similar orders of displacement in both BG and MG freight operations. Consequently, the proportion of freight variances cumulatively explained by the first four freight-mixes $\mathbf{f}_1$ to $\mathbf{f}_4$, which collectively account for the displacement of long-lead IR freight in the cotton group by increased bulk-loading of cement and coal & coke, becomes more or less identical after $\mathbf{f}_4$ for both BG and MG freight operations, indicating that freight adjustments in MG commodity-loadings have been made to accommodate the new patterns of dominance in BG bulk-freight. Since such freight displacement has occurred in the highly-rated low-bulk segment , the utility of this exercise for understanding the broad patterns by which the changing freight-focus of IR has radically altered the railway presence in the Indian freight market becomes self-evident

7.6.3 Commodity Dominance & IR Freighting Capacity

Broader understanding of commodity dominance and displacement patterns in IR freight operations can thus be obtained through joint analysis of the commodity communaliities listed for each freight-mix $\mathbf{f}_k$ in Table 7.8. Since under the freighting constraints of the IR system, the underlying variances in the standardised wagon-loading datasets are as much the reflection of commodity-freight substutution as they are of increasing IR bulk-freight volumes, the communalities in the table help to identify the commodities which have gained freight dominance as well as the commodities they have displaced.

Cement, which has the highest interdependence with the loadings of other IR commodity-freight, is a strategic bulk-commodity with widely-distributed demand. It is therefore carried over a relatively long average lead of 723km[25] by combined freight operations on both IR gauges, and is distributed from the nearest cement plants to locations all over the country. Since India is not entirely spanned by BG rail-links, a significant amount of cement traffic is still carried over MG, and the wagon-loadings for cement in the datasets would account for a large number of MG-BG and BG-MG transhipments in addition to loadings of originating freight. Since cement requires safe carriage in general-purpose covered railway wagons whose proportion in the IR wagonfleet is short, increasing freight-flows of cement over the IR network restrict the availability of such wagons for other general freight except on reversed leads, and displace several other commodities from the IR freight-mix. Consequently, the interdependence of other IR commodity-loadings with the loadings of cement is very high, and is captured in the associated communality for cement. From the proportionate difference in the magnitudes of BG and MG communalities for cement, it becomes clear that the commodity-displacement resulting from increased cement loading is much greater in IR's BG freight operations than it is on MG. Two reasons would underlie this. With the BG freight-mix being polarised around a limited number of bulk-commodities, the loading and directional leads of cement simultaneously affect the assignment of freighting capacity by IR to other competing freight-flows to a greater extent, particularly in the general-freight segments. On MG freight operations where the freight-mix is more diversified, the degree of freight competition between cement and other general freight-flows is lower and accounts for less commodity displacement. Until the unlikely event occurs of conversion of the entire IR route-network to BG through pipe-dream projects like UNIGAUGE, the increasing freight-flows of cement will require the acquisition of adequate covered wagon capacity by IR to preempt the displacement of other general freight, and will also require the maintenance of wagonfleet adequacy on the MG network.

Ranking second by the proportion of interdependent commodity-freight variations it explains is coal & coke, IR's most important bulk-freight commodity both in terms of tonnage volumes and earnings,, which is also carried over a relatively long average freight lead of 626km.[26] With IR wagon-loadings of coal & coke showing tremendous increase during the period under review, IR wagonfleet capacity has adapted accordingly by acquiring a growing complement of specialised BOXN wagons designed exclusively for the carriage and mechanised handling of coal. Partly as a result of this increasing wagon specialisation, IR freight operations have become less diversified over time, and the loadings of coal & coke which initially accounted for around a third of all IR wagon-loadings have now risen proportionately to around one half. While in gross terms, this has led to the decreasing importance and displacement of several other commodity-freight flows, the manner of commodity-displacement differs from that in the case of cement since it has also involved the displacement of general freighting capacity in the IR wagonfleet by specialised BOXN freighting capacity dedicated to the carriage of coal, which is not suited to the carriage of commodity-freight in other forms. Consequently, the nature of IR freight-adjustment in the wagon-loadings of other commodities also differs when there are variations in coal & coke loadings. In BG freight-operations, other commodity-freight flows are displaced by line saturation when there is heavy traffic in coal & coke, both on the leading journey as well as on the turnaround when the returning BOXN rakes often have return empty. Consequently, IR's BG bulk-freight operations in coal & coke have increasingly taken a closed-circuit form, since they are specialised towards the efficient running of full trainloads of this commodity and no other commodity-freight enters the circuits. Both in times when there is high and hurried handling as well as in times when there is short-loading of coal, the resultant slack caused by the displacement of other freight traffic shows up in physical terms on the BG system in the form of empty wagon-kilometres run.[27]

Coal & coke is still carried in bulk over IR's MG network, and with the bulk tariff-rates charged by IR still being more favourable than the charges for alternative road haulage, slackening in MG loadings of coal & coke has not been as sharp as witnessed in many other commodities. However, since the MG wagonfleet is not specialised for the handling of coal unlike the BG BOXN wagonfleet, the persistence of coal traffic in IR's MG freight operations has probably done more to divert other general commodity-freight flows to the roadways, accounting for the relatively higher proportion of intercommodity variances explained by the communality for coal & coke in MG freight operations compared to the proportion of variance explained by this communality in BG freight. The high proportionate variance for the commodity in AG loadings also establishes that these commodity-crosslinkages of coal & coke pervade both the BG and MG freight systems.

The close interdependence of coal & coke loadings with IR's wagon-loading trends in other heavy mining materials is related to the input-linkages of the metallurgical and heavy industrial sector. However, unlike the wagon-loadings of coal & coke, iron ore and other metal ores which have closely interdependent trends, the wagon-loadings of manganese ore have followed a different trend because of the presence of export shipments in addition to domestic use by the steel industry. Over the long period for which the wagon-loading dataseries have been studied, the increase in the number of integrated steel plants [ISPs] in the country from two to six has led to the location of more steelmaking capacity near the mining pitheads, consequently reducing the average freighting leads of iron ore and manganese to 362km and 411km respectively.[28] This shortening has however been compensated by growing iron ore shipment for export because of a mismatch between the outputs of the mining and metallurgical sectors, and also by the long average lead-distances of 1162km[29] involved in the freighting of finished iron & steel from the ISPs to dispersed downstream users such as the automotive industry located at great distances from the mining & steel belt.

Taken together, the cotton group accounts for a significantly high proportion of interdependent commodity variances in IR's BG and MG freight operations, although cotton manufacturing has higher communality than raw cotton. This is partly explained by locational factors. While the textile industry remains concentrated in the extreme west of the country, cotton cultivation has diversified from the Deccan to the deltaic regions in the south. On the other hand, the distributive flows of cotton manufactures are not confined to specific geographical regions, but are freighted across the entire country. Consequently, a vast difference exists between average IR commodity-leads for raw cotton at 2238km and for cotton manufactures and piecegoods at 1261km.[30] With the leads for raw cotton being too long and the rates unremunerative to interest roadways transporters, freight-movements in raw cotton have tended to stay with the railways, while the commercial freight in cotton manufactures has shifted because of greater delivery efficiency to the roadways. The critical importance of transit speeds in determining the state of competition between railways and roadways in the commercial segment of the general freight market is thus underlined by the longterm behaviour of IR wagon-loadings in these high-valued freight commodities. For the freight-consigner, the relative cost of the freighting service includes the cost of loading and transit delays, which in the case of IR freight operations, is escalated by trunk-line congestion and notional handling delays caused by the unavailability of adequate wagons. Thus, despite approximately equal IR tonne-km tariff-rates for the two cotton commodities, the additional cost of delays in moving commercial freight by railway renders this segment of the market contestable, enabling the roadways to outcompete IR even with higher average freight-charges.

Nevertheless, although the longterm IR wagon-loading trends of the two commodities have shown a decline because of successful roadways competition, the bottomline for this freight competition has not been set by the rate-contest but by critical shortages of IR freighting capacity, which reduce IR's ability to flexibly adjust wagon allotments to the current freight-market offer. This becomes evident while studying the commodity-interdependence between the cotton commodities and other commodity-freight. In situations when the freight offer from the bulk-freight segment has been short and has freed BG line-capacity, IR loadings of the cotton commodities and other independent commodity-freight tend to increase in order to compensate for the loss of revenue-earning traffic in other freight-market segments. But the inadequate unavailability of watertight covered wagons which minimise the risk of spoilage to high-valued commodity shipments impedes the reentry of IR into this market segment. Once again, increasing specialisation within the IR wagonfleet is seen to have divided the aggregate freighting capacity of the IR wagonfleet into discrete, non-substitutable compartments. While the current wagonfleet may seem adequate in terms of wagon numbers and aggregate freighting capacity, its capacity to meet the freight offer from the highly-rated low-bulk sector has shrunk overall, because of freight compartmentalisation. Hence the older manner of freight-adjustment by IR, when low-bulk freight flows could be flexibly adjusted to compensate for traffic losses elsewhere has all but disappeared.

Although the communalities for other commodity-freight flows in Table 7.8 appear to be individually unimportant, they collectively explain over 7 percent of the intercommodity variance in IR's BG freight operations and over 10 percent in MG freight operations. The difference in MG and BG proportions reflects the more diversified character of the MG freighting-mix compared to BG. Within these proportions, the combined freight-loadings of iron ore and iron & steel account for approximately 3 percent of the intercommodity freight variation on both IR gauges, although the commodity-displacement attributable them is higher on MG than on BG because of bulk-freight specialisation on the latter gauge. Wagon-loadings of grams & pulses which are freighted almost entirely by IR on preferential terms because of their essential nature, account almost equally for just under 3 percent of the intercommodity variation, while the loadings of the jute group explain 2 percent of the intercommodity variation in MG freight and 1 percent in BG freight.

The crossgauge implications of the relative levels of BG and MG commodity-freight loadings on composite IR freight operations are captured in the differences in the proportion of intercommodity freight variation explained in each freight-mix f_k by the dominant commodity, *i.e.* by the lateral differences between BG communalities and the composite AG communalities for each commodity in Table 7.8. Where the proportion of such differences is low, the composite AG freight-loading by IR are more polarised around the BG freight-loading trends of the given commodity. Except for cement, iron ore and raw cotton which generate relatively steady freight streams for IR, freight cyclicity appears to affect all other commodities and is particularly high in the bulk commodities in which IR specialises. This has led to alternating coverage of the freight offers from other commodities and eventually to their exodus from the IR freight operations, to the ultimate profit of the roadways.

7.6.4 Sectoral Character of IR Commodity-Freight Flows

A brief sectoral assessment may also be made of the implications that these patterns of commodity-dominance and displacement have had on IR's composite freight operations and freight-market share. The intercommodity relationships for composite AG wagon-loadings show complementary increase in iron ore loadings with the loadings of other metallurgical ores, and with coal & coke and iron & steel. The point is interesting to note, since freight-flows in all these commodities have close linkages with the steel industry in India. The metallurgical products of other metal industries are important to the production of various ferro-alloys, and coal & coke is an important common input in all metallurgical industry. The symmetry between iron ore loadings and freight-flows in iron & finished steel is in character with the downstream linkage that would have been expected. Production of iron ore in the country is either in large mechanized mines in the public-sector or in several small manual or semi-manual mines in the private-sector.[31] Major freight-flows in iron ore are intended mainly for the public-sector ISPs, for export and for the newer private-sector MSPs that utilise less energy-intensive electric-arc technology for steelmaking. The steady increase in wagon-loadings in iron ore over time to an extent not emulated by the production stream of finished iron & steel indicates that the aggregate steelmaking capacity of the country has been outstripped by its mining capacity, leading to the channeling of increasing exports of iron ore by the Mines & MineralsTrading Corporation [MMTC] through specialised ports like Paradip. It is also pertinent to note that the while the export demand for iron ore has outstripped the demand from domestic steelmakers, a piquant situation exists now where the downstream demands of engineering industry for special rolled steels are partially being met from imports rather than from the ISPs.[32]

The upshot is that average IR freighting leads for iron ore have been shortened as iron ore shipments are redirected from mine headings to the nearest specialised ports, while the average freighting leads of finished iron & steel to the rolling plants and foundries have become considerably longer because of greater dispersal of light engineering industry, which then supplies value-added finished products and castings all over the country largely through the roadways. Freight traffic in finished iron & steel from the ISPs has remained with IR largely because of the freight-equalisation scheme under which all freight consigners were charged equivalent freight-rates, irrespective of the freighting distance. Besides being a means for ensuring regional dispersal of the foundry and metalworking industry, the scheme was also visualised as a measure for securing captive long-lead bulk traffic from the ISPs to steel stockyards for IR.[33] Although freight-equalisation was partially rolled back during the 8FYP because of the deregulation of the Indian steel industry under the new economic policy, the cumulative impact of its withdrawal on IR's captive freight-flows from the ISPs has yet to be seen. But although there has been a rising transportation demand for the movement of finished engineering products like automobiles, and other iron & steel piece-goods from their fabrication points to locations all over India, hardly any of this new freight stream is being moved by IR, because of technological specialisation and bulk-freight focus in IR freight operations.

From the analysis, it is seen that the growth of IR freight movements coal & coke, iron ore and iron & steel which are strategically connected with the power plants and the steel industry has generally had a displacing effect on IR freight-handling of sugarcane and sugar, raw jute, and oilseeds. The retention of grams & pulses in IR's composite wagon-loading operations reflects the social compulsions of moving essential commodities at preferential tariffs over vast freighting distances from a few specific surplus-producing locations to delivery points located all over the country. Although India has achieved self-sufficiency in foodgrains production, the principal centres of surplus production are in the northern states and freight movements of essential commodities continue to be made by railway, since the combination of long distances and low tariffs makes it unattractive for essential commodities to be carried by the roadways. Only IR is able to make these balancing movements equitably and efficiently, and fulfils an important social purpose by doing so. However, since IR has to reserve freighting capacity over both gauges in order to make these movements. The balance of other agricultural inputs and products show a sharp decline in IR freight handling polarised around the decline of MG freight operations, principally because of freight specialisation on IR's BG trunk network and the failure to maintain an adequate wagonfleet for composite freight operations.

7.7 Freight Specialisation & IR Freight Share

Modelling of freight-adjustment by IR through multivariate Factor Analysis methods thus offers considerable insight into the interrelationship of IR freight operations with the levels of sectoral and regional economic activity that determine the freight offer of the economy. Explanation is also obtained of how certain downstream intersectoral freight-flows may shift to alternate transportation modes when the existence of critical freighting-capacity shortages on the railway system do not allow IR to respond flexibly to the current freight offer. Since a notable role is played in such intermodal traffic shifts by the production lag between upstream and downstream economic activity, more insight is now gained into the phenomenon of railway freight cyclicity noticed during the phase analysis in the previous chapter.[*see Fig.6.3*] It had been observed that system capacity on IR during the early FYPs had more closely balanced the freight offer from the economy because of the rudimentary state of roadways competition and the willingness of IR to add freighting capacity well ahead of anticipated demand. The amplitude of freight cycles were consequently smaller because MG feeder-freight operations providing balancing freight-flows to the IR network when slowdowns in the core sectors created slack on the BG system. In this sense, the existence of freight adequacy on the MG network added flexibility to railway freight operations, allowing IR to meet the freight offers from the economy more closely.

The freight market crisis which utlimately increased the amplitude of IR freight cycles occurred because of wagonfleet inadequacies following the compartmentalisation of freighting capacity through wagon specialisation and the slow replacement of overaged wagons after the 3FYP, when traffic slack had been observed. Because of the disappearance of freighting-capacity margins, the IR freighting system was unable to handle the unanticipated traffic swings that occurred through the 4FYP and 5FYP periods when the saturation of freighting capacity and freight bottlenecks were first observed. Because of the new priority assigned to coal movement, this triggered further wagonfleet specialisation and rendered the complement of general-purpose covered wagons in the IR wagonfleet inadequate for meeting the traffic needs of general freight because of growing wagon obsolescence. Ultimately, this also led inevitably to the prescription that that IR should henceforth focus exclusively on the handling of bulk-freight where it held technological advantage, leaving the other segments of the freight market to roadways. While this made engineering sense by improving the operational efficiency of IR's bulk-freight handling, it also ensured IR's diminishing presence in the general freight segment, where the newly deregulated roadways mounted a strong contest, spiriting away a major part of IR's high-rated traffic share and destroying the elasticity of IR freight revenues.

Thus the critical role played by adequate and timely investments on railway infrastructure in maintaining the competitiveness of railway freight services is made abundantly clear by the Factor Analysis. In the case of IR freight operations, the critical investment variable has been the railway wagonfleet, particularly the general-purpose covered wagon. Wagonfleet adequacy in the general freight segment would have protected IR's freight share and kept transportation costs in the Indian economy at reasonable levels, while increasing the capacity of IR to mobilise internal resources for investment on its own expansion plans without needing periodic succour from the public exchequer. The fact that technological concepts of efficiency have prevailed over capital and investment efficiency has progressively driven the IR system into further wagon and bulk-freight specialisation to the ultimate detriment of its financial health.

Considering the findings from the Factor Analysis in a futuristic sense, two strands in the analysis can be traced which have bearings on IR's future. Firstly, the pattern of intercommodity relationships observed in IR freight operations carries over into the country's potential for industrial and economic growth. The position of IR in India's transportation sector is still as important as it once used to be, in the sense that the key inputs to the economy comprising mining products and heavy industrials all move on rails. Why this should be so is the result of preferential tariffs, national prerogatives and also the need for one PSU to support the others, since by virtue of ownership, the railways, mining and heavy industry are still the preserve of government or at least of regulated industry. However, the shift of IR freight-focus over the 35-year period of study from a broad spectrum of general freighting services to a narrow specialisation in the carriage of longhaul bulk-freight has told heavily on the financial health and freight efficiency of India's railways. Consequently, the roadways have been able to aggressively contest IR's freight-share and make substantial inroads into other segments in the freight market, and have had considerable success in bidding away the lucrative break-bulk, slow-bulk and piecegoods segments. Since the tariff markup is high on goods freighted by the roadways, the surrender of freight in this segment by IR has pushed up industrial and marketing costs, eventually imposing its own infrastructural restrictions on the achieveable rates of economic growth.

Within IR, freight specialisation has carried its own escalating costs since hi-tech investment in long-lead bulk-freight operations, comprising wagon upgradation, track & traction augmentations, and switching & signals improvement, etc., adds up to sophisticated maintenance needs and greatly-enhanced capital requirements, which IR has been unable to mobilise from internal resources. In some sense, freight specialisation limits all future specialisation because of the capital-crunch. Since the commodities moved in this theatre of freight operations are largely basic inputs, raw materials and capital goods, a slowdown has occurred in the core sector of the economy, evidence of which is already being noticed today in India's steel sector.

The interweaving of these analytical strands reveals that IR freight specialisation and the resulting freight contests between IR and the roadways combine to raise transportation costs across the entire economy and eventually curb the real rates of economic growth. While some effort has recently been expended by IR to at least financially recover lost ground through rate rationalisations and tariff revisions, the loss of freighting elasticity because of wagonfleet inadequacies has limited the elasticity of IR's revenue earnings from rate-revision. Meanwhile, because of the critical production linkages of the basic and intermediate economic sectors that IR freight services largely cater to, this sparks off cost-cascades with far-reaching effects on the economy.

Against this, road-freight operations in the country have grown in scale, but not in resource-efficiency. This follows from the fact that freighting costs and the tractive effort expended per tonne-kilometre are lowest for railways and highest for roadways. Even so, while IR has been denied the capital infusions which would have restored freight-equilibrium and operating efficiency to their operations, the roadways have been artificially kept afloat by the cross-subsidisation of fuel costs, which destroys the natural optimum in the freight market which would have resulted had IR and the roadways been put on an identical footing regarding their fuel economics. Moreover, while IR's efforts to induct private capital into the railway-freight sector through leasing schemes like OYW for privately-owned rolling stock have mostly gone abegging, the Indian leasing market has grown phenomenally through liberal credit schemes for automobile and trucking finance. The upshot of this reallocation of financial capital from one competing mode of transportation to the other is seen in the freight market. While the number of CVs on the country's roads has multiplied by leaps and bounds, the freighting capacity of IR is further constrained by the inability to invest in the acquisition of more wagons - the critical units of efficient railway transportation. This is the real manifestation of the infrastructural bottleneck in Indian transportation today.

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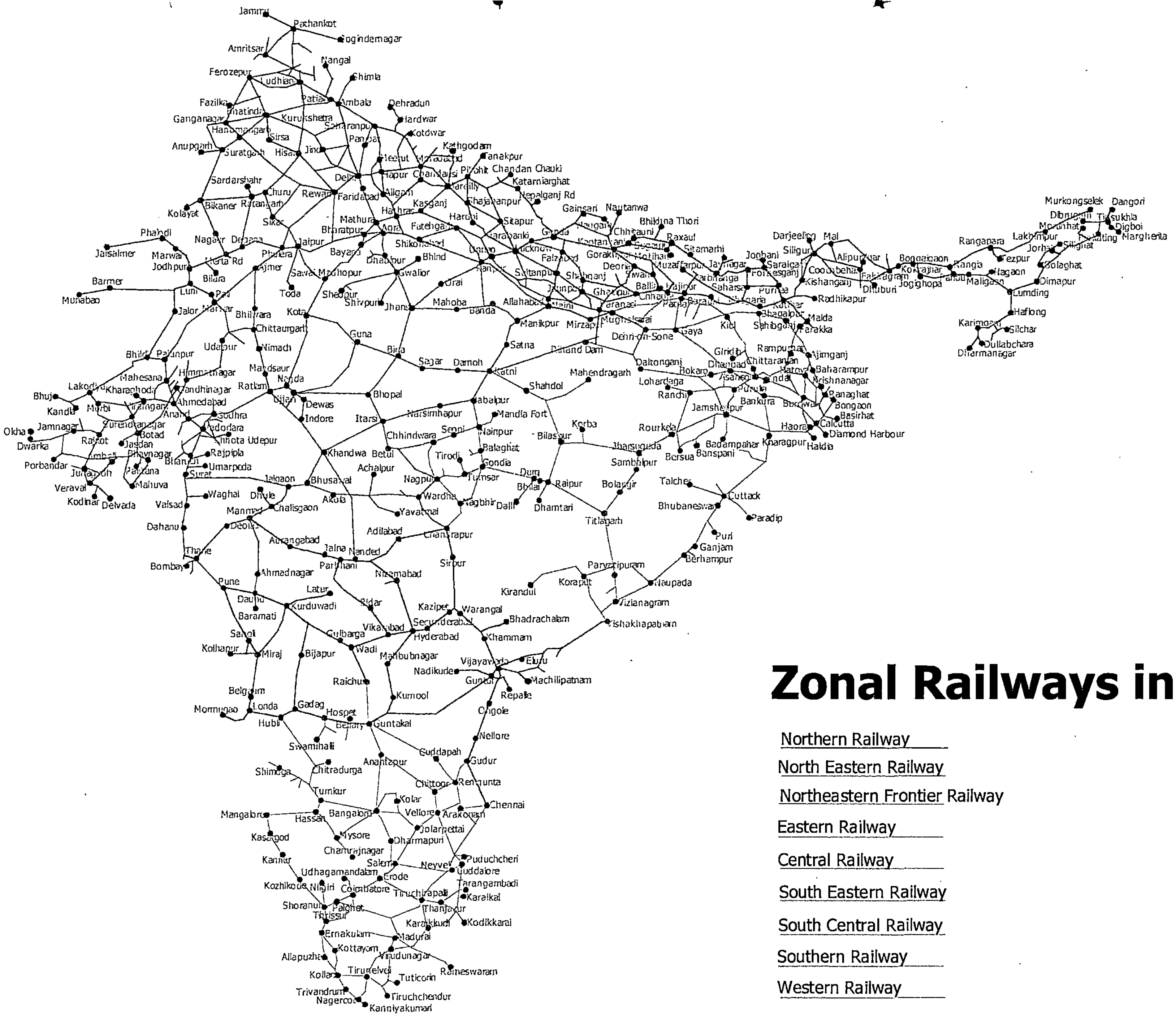

Zonal Railways in India

Northern Railway

North Eastern Railway

Northeastern Frontier Railway

Eastern Railway

Central Railway

South Eastern Railway

South Central Railway

Southern Railway

Western Railway

Chapter 8

FUTURE FREIGHT POLICY FOR THE INDIAN RAILWAYS

8.1 Critical Findings from the Study

8.1.1 The Railways as Infrastructure

Infrastructure has engaged the attention of both academic and policy economics because of the intrinsic stimulus it provides to economic development. Instead of being defined as a specific product or activity, infrastructure is better identified in terms of the characteristics which render it distinct from other production processes. Usually representing a *social* output rather than a measurable output quantity, the principal identifying characteristic of infrastructure is the creation of *external* economies through its existence, as a result of which the net benefits yielded by it are far greater than its quantifiable product. Inevitably, the scale of the processes that yield such external economies is large to the extent that the financing of these involves public policy questions. For a long time the role of government in the provision of infrastructure has remained implicit and theoretically unquestioned, even though several instances exist in practice where infrastructure has been created on private initiative, albeit with active government encouragement.

The capital financing needs of infrastructure are large. The investments made require a long gestation before they begin to yield a long and sustained stream of benefits. In theory, the creation and maintenance of infrastructure becomes the responsibility of the government *by default*, i.e. in the absence or inadequacy of private capital commitment, and infrastructure is classed as a *public good*. The largescale presence of governments in infrastructure through most of the present century has therefore been justified on the 'merit good' argument, even when the infrastructural service in question does not possess the canonical virtues of *non-rivalry* among users and *non-excludability* from consumption. It is only in the present decade that this viewpoint has been challenged by the inability of governments to mobilise the scale of infrastructural financing required, making new inroads possible for private capital.

The railways which have been the principal point of focus for the present study are an important constituent of transport infrastructure. Although by no means universal in their presence, the railways have been intimately associated with the process of world industrialisation witnessed over the last 150 years, heralded by what has come to be known as the 'Transport Revolution'. Provision of railway services on a large spatial scale was mainly a product of the second half of the 19th century; the stream of backward and forward external economies this yielded was however sustained through most of the 20th century even though accompanied by a second revolution through the advent of road transportation. India, interestingly, was an early witness to the railway revolution, but without being leveraged into the same commanding economic positions that the railways engendered elsewhere. Against this historical backdrop, the present study has closely examined the process of transport-led economic development in the period after Indian Independence and the institution of economic planning. Comparisons have inevitably been made with the position of railways in a world perspective, as a potential reminder that the problems that currently beset railway transportation in India are to an extent policy-determined, rather than being mere symptoms of management failure. But instead of confining itself merely to transportation economics and the technical efficiencies of railway operations, the study has approached the problem from the infrastructural and policy perspectives, namely through examination of the determinants of capital finance and technological capacity. Such an approach has necessitated a look beyond the confines of five decades, and has indeed reviewed salient features of the entire railway experience of India. A brief summary of findings and conclusions drawn therefrom can now be attempted.

8.1.2 Infrastructural Policy Issues

Transportation provides an impetus to the flow of economic goods and services. In this, not all forms of transportation are equal, just as not all economic goods are equivalent. As a infrastructural service, the main predecessor of the railways were the waterways including man-made canal networks, as is brought out by international comparison. It is important to note in this context that both systems competed in providing transportation to bulk traffic at economical rates, allowing cheap movement of minerals and metallurgical outputs to industrial locations, which had previously been impossible. Nevertheless, the ascendancy of the railways was *technologically* determined, *i.e.* by the smaller extent of capital that needed to be sunk into providing railway track overland than in the massive earthworks required to dig canals. The principal reason for the unimpeded success of the railways during the first phase of world industrialisation was possibly the absence of a rival transportation mode which could compete on equal footing without necessitating new sunk investment.

Nevertheless, the scale of railway investment during the 19th century called for a scale of capital mobilisation even beyond the latent ability of sovereign governments, let alone a colonial government such as that which existed in India. *Large* government is a creation of the 20th century Keynesianism; in the 19th century the limited task of government was to direct the flow of private capital into the desired direction. Support of the government to railway enterprise was achieved indirectly through the important means of land grants and interest guarantees, yet the 'Golden Age' of the railways did not last beyond the phase of railway construction. Possibly, the asymmetricity of information which allowed railway construction companies to mobilise huge capital balances from the London Money Market on the promise of high and guaranteed returns faded with the launching of railway operations. By the 1870s, slack had set in the pace of railway construction through most of the world, during which governments in India and elsewhere reviewed debt outgos against commercial returns and decided in favour of government entry into railway operations. Thus the transition from the Old Guarantee system to State construction in India is echoed in parallel developments on many other railway systems. Without the support of private capital, however, railway development dwindled to a position from which it has never really recovered. An important insight offered from the foregoing discussion relates to current problems of infrastructure development in India. The same sequence of events - from state-supported capital formation, to low returns and a capital squeeze - is being rewitnessed.

Partly as a fallout of the earlier experience, the attitudes of governments towards railway operations changed towards a philosophy of regulated enterprise. This is true even in the case of railroads in the US, where government has never directly entered railway operations. A period originating in the penultimate years of the 19th century during which railway construction was renewed over most of the world coincides with the New Guarantee period on Indian railways. Capital mobilisation was now made by the state from private sources on less liberal terms, but with the state offering the protection of the natural monopolies that railway operations enjoyed. A fundamental contrast between this and the previous phase of private capitalisation of railway infrastructure relates to the perspective from which railway investment was viewed by the private investor. Where railway investment during the railway boom had been fuelled by information asymmetricity and had attracted substantial inflows of *risk* capital, in the second phase of private capitalisation of railways, public perceptions were no longer swayed by the promise of astronomical returns, since the reality of operating profits and losses on the railways was already in view. Instead, railway investment lost its speculative dimension and became a *safe* investment guaranteed by governments, subject to maintenance of the railway monopolies. Primarily because of this vital difference, the scale of capital inflows was much reduced, and in India has led to nonrealisation of the route targets set by the Mackay Committee even after eight decades.

Particularly in India, the state did not immediately become a railway entrepreneur. Railway operations were entrusted instead to professional managements acting on behalf of the state, with the commercial operations becoming more dividend-centred. The state involvement with the commercial viability of railway operations led to a phase of restructuring and/or amalgamation of several small railway companies into larger and commercially-viable units. The process received an impetus from an appreciation of the strategic importance of railway communication which had been created by WWI. Both in railways in Britain (the mother country) and the Indian railways, concerns were also expressed about the lackadaisical way in which railway maintenance expenditure was being funded till then. Consolidation of larger railway companies brought about the realisation that the financial arrangements within which railways operated had to be ordered to the scale of railway capital-at-charge, which included the vast amounts invested in railway *sunk* capital in the form of track and railway estate. The railway reform committees set up in Britain and India voiced common issues including the need for separating railway finances from the general exchequer and for making provisions for depreciation charges before extracting railway operating surpluses.

It is a pity that the recommendations of the Indian Railway Committee (Acworth Committee), which sought to make a total break with the past, were so quickly beset by the recessionary wave that spread across the world at the end of the 1920s. As is normally the case, the recessionary impact was greatest on capital goods and on capital-intensive infrastructural investment. Thus the more far-reaching recommendations, such as those on comprehensive periodic maintenance of track and bridgeworks under depreciation provisions, and on zonalisation of the Indian railway network to improve competitive efficiency were effectively shelved. Since the philosophy underlying railway infrastructure in the Committee recommendations foresaw government eventually assuming full responsibility for this vital sector because of its importance as a merit good, implementation of the full range of recommendations would have instituted a proper public policy in relation to railway finance. As matters transpired however, reformulation of public policy remained in abeyance till Independence and railway nationalisation two decades later. The interregnum in fact saw magnification of the capital squeeze being induced by world recession, and no significant additions to railway capacity occurred as a result.

Fundamental changes were wrought to railway operating equations all over the world by the advent of road transportation. While the maximal impact of freight competition was probably felt in the USA, the common response of the state-protected railway systems was to preserve their monopolies by regulating the access of the new entrant to existing routes. Regulation of this nature drew an academic footnote with the establishment of transport economics as a separate subdiscipline, and a gradual focus on transport pricing in the associated literature. That this development appears at its strongest in the US context may be attributed to the absence of state-operated railroads in that country as well as to the vastness of its physical space, which added more contestability to the existing freight market. In India at the other end, competition from roadways was restricted by the more drastic stratagem of not constructing roads in order to preserve railway monopolies. It was only during the 1960s and 1970s, following improvements in road transport technology and a change in the commodity-character of national freight markets that the roadways appeared as formidable competitors both elsewhere and in India.

At the policy level therefore, both in India and elsewhere, a transition was marked by the shift from the initial period of railway *construction* to that of railway *operation.* Where the first phase had required voluminous injections of sunk capital which was beyond the government's capacity to provide and hence had seen substantial partnership with foreign private capital, the phase of operations changed the policy focus to efficiency questions. While no immediate pressures seem to have arisen for railways to operate on commercial lines, the tendency for railway monopolies to be abused by fixation of railway rates at unreasonable levels quickly drew government attention. Recognising the stimuli that the railways could provide to economic growth and development, the overriding imperative before government was to keep rates low. The means for doing so involved direct arbitrage (*e.g.* through the ICC), monitoring checks on railway company accounting through the use of traffic indicators (*e.g.* introduction of physical traffic ratios such as net tonne kilometres), and through takeover and nationalisation in the extreme event. The two countries where the latter means seem to have made the earliest advent were Japan and France. Gradual involvement of government in railway rate maintenance soon brought about realisation of the conceptual difficulties of railway pricing and the creation of a new pricing literature around that time - as exemplified in the famous Pigou-Taussig controversy - which was not entirely divorced from more far-reaching debates around the feasibility of pricing without the intervention of markets. Rooted in this discourse also were prominent railway and infrastructural pricing mechanisms such as 'what the traffic will bear', differential rate-setting and long-run marginal cost pricing. With the railways as the largest public or government-regulated enterprise the world over, the period saw the formulation of railway economics *per se.*

Inspite of the richness of infrastructural pricing literature, the major issues raised within it remain open-ended till the present day. This is partly because the issue of whether government should at all be in the business of infrastructural provision is not yet finally resolved. The phases of development in the pricing literature therefore reflect the phases of government involvement in railway pricing. The issues here are multidimensional. Although the reason for keeping railways as a natural monopoly relate to the cost-efficiency of having a single provider of bulk transportation, and those for keeping them under the watchful eye of the government relate both to the regulation of monopoly power and the maximisation of their infrastructural potential, the presence of *joint costs* or *sunk costs* ensures that railway efficiency varies directly with a rise in traffic. However with traffic itself being subject to the seesaws of economic expectations, a holding principle appears necessary for the guidance of railway pricing. Very logically, two orders of aggregation are involved here. Where railways have to recover fully-distributed operational costs, the first order of computation has to be based on cross-sectional aggregation of costs and revenues across all traffic categories and all segments of the railway network at a given *point* of time. However, a second and more complex computation has to be based on the aggregation of costs and revenues over a fairly extended *period* of time in order to capture the infrastructural impact of the railways. Thus while the period of railway construction was not reasonably expected to lead to revenue realisation of an order that matched railway costs, the period of railway operations was anticipated to yield a large outflow of revenues without significant outlays of cost. This feature - possibly the most pervasive principle within railway finance and operation - intrinsically defines profitability for the railways as a longterm variable, thus imparting to the railways the character of infrastructure. Explicit recognition of this pricing principle is made in the literature on social time preference, where present costs are juxtaposed to the stream of future social benefits in assessing the viability of infrastructural investment.

For nearly a century after their advent and comprehensive ascendancy over the waterways, the monopoly of the railways over overland transportation remained unchallenged, the invention of the internal combustion engine notwithstanding. The fact that trucking first arose in the US indicated the initial complementarity of the railways and roadways, with the latter mainly stepping in into the contestable freight-market segments of break-bulk and intercity traffic. Trucking technology limitations were partly responsible for this low-key entry, and in a country as vast as the US, expansion of roadways did not immediately imply direct confrontation with the railroads. Very often, the roadways served to complement railroad freight flows by assembling and feeding traffic smalls into consolidated trainloads. Even so, the major proportion of US railroad freight comprised the traditional bulk-freight commodities of coal, minerals and metallurgicals, to which petroleum tanker traffic was gradually added. Thus in the US as well as in other countries, the railways operated with the cushion of captive traffic, recognised in principles such as differential rate-setting. Perhaps the most serious longterm challenge to the railway monopoly was mounted by the nature of investments called for by roadways. Except for the roadbeds - where a similar order of sunk investment was involved as in railway track-laying, capital investments on road stock and rolling stock differed significantly in nature. Railway rolling stock required consolidated investment, posing an entry barrier to private competition. The roadways on the other hand opened the doors to freight competition because of the small and discrete capital outlays required per road vehicle which in any case was little more than a self-propelled cart. This divisible character of road stock vis-a-vis the indivisibility of railway investments soon made the roadways emerge as formidable competitors in countries of more restricted size, where the road and rail networks inevitably involved a substantial amount of duplication. To protect the state monopoly, recourse was often taken in such cases to the establishment of legislative barriers against the entry of road competition. Such examples were seen both in Britain, and in India until fairly recently.

The advent of road competition also brought to light the phenomenon of rate competition, especially during the period of cheap petroleum. The alternative means of contending with this that could have been adopted by railways were either to seek protection of the state (*non-competition*), or to lower railway operating costs through technological upgradation, such as through introduction of diesel and electric traction. While the latter means in effect made the transport monopoly more cost-efficient, they also led to the same conceptual difficulties of sunk costs and social time preference regarding their eventual benefits. Thus, since roadways operators were largely free of these conceptual constraints, they were not necessarily deterred by this, and resorted to counterveiling technological upgradation of their own, again without having to incur sunk costs. Legislative barriers to road competition were therefore often seen as necessary evils by governments keen on stabilising the railways.

Perhaps the principal impediment to the natural evolution of multimodal transport lay in the competition between public policy and private enterprise, embodied in road-rail competition. A single freight authority, with jurisdiction over all modes of transport, would have hastened a compromise through multimodal sharing of the freight market. The existence of such an authority was however hard to conceive in the non-socialist world, and the same goals had to be achieved through negotiation and persuasion - a far more difficult process that still has not been accomplished in entirety.

Another important factor in assessing road-rail freight competition has been the technological indivisibility of railway technology versus the relative divisibility of technology on the roadways. Through much of their history, railway operations had maintained country-wise specialisation, with citable evidence from the multiplicity of railway gauges and rolling-stock and coaching designs. India, as an example, offers the unique instance of three different railway gauges being operated within a single country-network. Noncompatibilities of this nature also led to specialisation in other equipment and eventually to the need for the railways to establish maintenance and manufacturing facilities of their own, adding to cost overheads. Against this, advances in roadways technology in one country soon found their way to roadways in other countries through vehicle and equipment exports; moreover, production could be centralised with a few major automotive manufacturers to protect scale economies. Technological innovation on the roadways therefore proliferated faster than that on the railways, even though the economies created by innovation may have been larger in the latter case

Indivisibilities of cost and railway technology, as also the other infrastructural issues explored above, have been major determinants of railway operational performance in India. Only two distinct periods may be identified when social time preference held sway in deciding government railway policy. The first was obviously the period of trunk-network construction in the 19th century, when the government soldiered ahead without any firm guarantees of traffic,. The second occurred over the first fifteen years of post-Independence transportation planning, when technological upgradation of the railways was underwritten by expectations of economic development occurring further downstream. A notable difference does exist however between the two periods in terms of the sources of infrastructural finance; where in the former, reliance had been placed on the inflow of private foreign capital, in the second instance the government sought to mobilise the entire capital outlay from budgetary sources. The direction of transportation policy by an 'act and wait' philosophy was strongly reflective of the principles of infrastructural finance and time preference. Although - to a lesser degree - another phase of building railway capacity ahead of demand occurred again in India during the 1980s, and on a more continuing basis in continued subsidisation of loss-making zonal networks, the financial rationale operating behind these stressed capital-borrowing as a *source*, and improvements in profitability as the mode of *repayment*, thus departing from the earlier philosophy. In practice, the departure has been seen to be self-defeating, since it has led to the retreat of the Indian Railways from open freight competition into the shelter of guaranteed captive traffic, opening vast portals for the roadways to enter.

8.1.3 Financing the Railways

The post-Independence phase of railway operations in India commenced with nationalisation of the Indian railway companies. Although several companies had earlier passed into state ownership under buy-out clauses, complete nationalisation of the network opened new vistas for the reorganisation of railway services and railway finance. It is important to note that railway nationalisation, which in India followed precedents set earlier in Japan, France and Britain, also transferred the liability of capitalising the railways to the state, and to plan-finance in the Indian case. Certain advantages were anticipated from the step. For instance, unification of railway management would allow transference of operating surpluses from one segment of the network to others, permitting optimal expansion of freightage capacity in all segments. Unification was also conducive to standardisation of track and traction equipment and permitted greater economy in the modernisation of railway capital. Economies in haulage could also be anticipated from the promotion of through traffic encouraged by unified railway operations. But certain other objectives also stand out in the Indian context and need to be noted.

Following Indian Independence, nationalisation of the railways was deemed important to the task of nation-building through infrastructural development. As such, with railway development on the nationalised IR being geared to the needs of a growing economy, social objectives often loomed ahead of purely commercial considerations, allowing short-run losses on certain traffic segments to be carried on the strength of differential tariffs and anticipated longterm gains. Such gains were not expected to be internal only to IR but were expected to be converted into external economies which would benefit the industrialisation process. Considering, however, that the period since the 1920s had seen considerable capital depreciation and hardly any railway expansion, the implication of state control was that a massive amount of capital resources had to be raised by the state and sunk into post-Independence railway modernisation and expansion. Instead of leaving the capitalisation decision entirely to IR managers, the planning apparatus of the state was inducted into decision-making, with a view to maintaining parity between the needs of the economy and IR's capacity to provide. The crucial assumption behind this was of continuous traffic growth and buoyancy in IR revenues - something that the planners also sought to ensure by raising the public sector to the commanding heights of the economy. While in the first instance, the investments in railway capacity were large enough to keep pace with the rise in public and private sector demand for transportation, a shortfall in the former during the 3FYP reversed expectations and consequently changed perceptions of IR profitability.

Economic pessimism regarding the financial viability of the IR infrastructure deepened with the onset of recession in the mid-1960s. With hindsight, it would also appear that the timidity of the state in financing railway expansion during this crucial period caused the infrastructural character of IR to change. Thus from the objective of providing general transportation services to all economic sectors, IR began to cater only to special traffic categories because of shortages in capacity. These special categories comprised captive traffic which remained tied to the railways for two distinctive reasons:

(i) either the traffic on offer was so heavy that it could not be carried by alternative haulage modes; or

(ii) the traffic was composed of essential commodities to be carried, as a matter of public policy, at subsidised freight rates unmatched by alternative modes.

In either case, carriage by IR made sound technological sense. Both traffic categories generally comprised bulk commodities and came in full rakes allowing economies in handling and haulage, and in most situations had to be freighted over long leads. However, subsidisation of the latter had to be compensated by the rates set for the former for cross-subsidisation to work, particularly since general freight gradually disappeared from the railways. It is important to note that captive high-tonnage freight in the first category was largely composed of producer goods, and that the passing on of high freight charges to ultimate users led to cascading escalations of costs in the economy. At the same time, the mixed economy instituted by planning in India ensured the operation of state monopolies in both capital goods production and haulage. Thus despite declarations that the state sector was intended to pin down costs in the economy, in practice both monopolies operated at lowered production levels and higher costs - a reversion to the case of classic monopoly. While operation on these lines was sustainable so long as downstream users and producers were willing to absorb additional costs, the situation was aggravated by the later budgetary practice of frequently increasing IR freight rates, which came into vogue after the decline in support to IR from the state exchequer.

Thus escalation in costs in the Indian economy might be closely linked to the dwindling of government finance for railway infrastructure. It was no longer the gamut of IR services which was being viewed as a public good; conversely, only selected traffic and network segments were deemed eligible for continued subsidisation by the state.

Strangely, the reordering of infrastructural priorities which led to pressure on IR to raise capital support from internal sources did not reduce dividend and other associated obligations. For one thing, renewed expansion in IR capital-at-charge without overaged assets being written off raised interest liabilities. With dividends from net revenues to the state being accorded the status of *first* charge, commitments to dividend were made ahead of reserve fund appropriations leading to substantial deferments of replacement expenditure at times when railway revenue performance was poor. The practice of carrying dividend liabilities in perpetuity, it had earlier been noted, was instituted by the IRC in 1924 and was designed to compensate the state for the loss of direct revenues which followed the separation of railway finances from the general exchequer. To this day, dividend payments still remain a major assured contribution to the revenues of the Government of India. Thus despite considerable debate over the issue and recommendations of several Railway Committees for either lessening or abolishing dividend charges, the government has been reluctant to accede. The net impact on the capital position of IR has been damaging in at least three ways. Firstly, the dividends paid out are not necessarily matched by equivalent current injections of railway capital by the state. Secondly, since in bad years dividend charges have had to be paid ahead of contributions to the depreciation reserve, IR replacement and maintenance suffer and lead to a backlog of dead stock - this has been highlighted, in the course of the present study, particularly in the context of the IR wagonfleet where substantial backlogs in replacement have been created. Thirdly, the annual outflow of railway revenues against dividends weakens the operating surplus earned by IR and has in recent years forced greater dependence on borrowing and lease-finance for capital mobilisation.

An appeal that has been made on several occasions by IR which was also echoed in the most recent White Paper relates to the social burden carried by the railways on uneconomic services and sectors. This burden, which exists on most major railway systems across the world because of the public-good character of railway services, was estimated by IR to amount to Rs.3282 crore in the year 2000-1001.[1] The practice of fully subsidising national railways for such losses, as followed in most countries, does not exist in India. Thus IR in essence carries *dual* social obligations: firstly, it has to absorb operating losses on uneconomic sectors within the operating surpluses earned from others and yet show positive surpluses overall; secondly, it has to support the general budgetary resources of the government by contributing dividends and additional amounts when its financial performance is positive. The joint operation of these obligations deeply affect the viability of internal resource mobilisation for railway development. IR is placed at a relative disadvantage in this respect when compared to other major state-owned railway systems like SNCF. Moreover, the fact that subsidisation of a segment of railway operations in India is in effect made by IR rather than by the Government of India speaks rather poorly of government attitudes towards maintaining the 'public-good character' of railway services. In practice, it is neither government nor IR which subsidise unremunerative services. It is instead the captive users of IR's bulk-freight services who carry this liability in the form of the cross-subsidisation. In a sense, IR is again forced to misuse its monopoly position to pass on social burdens in the form of inflated freight charges adding to the eventual costs of producer goods. The reality is even more disturbing, with a shrinking number of bulk transporters having to carry not only the burden of subsidising low rated freight traffic such as in foodgrains, but also of subsidising passenger services, unremunerative lines, as well as IR contributions to the finances of the Government of India!

IR has therefore appealed (so far without result) for either the writing-off of dividend obligations on past investment after a fixed period or for full offsetting of the notional subsidy that has to be borne on account of its social burdens. The present financial arrangements under which IR operates have only promoted higher and higher freight tariffs and have led to substantial losses in traffic in the highly-rated categories. For railway services in India to be restored to competitiveness and for their infrastructural potential to be revived, a thorough financial review would be needed.

8.1.4 Railway Operational Trends in India

Closer focus on trends in railway operations in India since Independence reveals both *evolutionary* growth and *physical* (*i.e.* quantitative) growth. The first feature is hidden within the second and has to be unmasked. Review of the broad indicators of railway operational performance such as tonnages carried and traffic transported show phenomenal increases over their pre-Independence levels. On the surface, such trends might be deemed encouraging, short-term slacks notwithstanding. Division of the entire planning-horizon into subperiods shows sharpening growth trends in the first and third phases, with the intervening phase between the mid-1960s and the late-1970s showing a slowdown. However the exploration of underlying causes also points towards substantial readjustments in the railway traffic profile, rooted particularly in rising specialisation of IR freight operations. In quantitative terms, this hidden trend shows up in the proportion of changes in traffic relative to tonnages. This is captured, for instance, in the trends in average traffic leads over the period.

For the true picture of railway traffic development to emerge, cross-comparison has to be made between freight tonnages, freight tonne-km and freight leads. A rise in loading tonnages unaccompanied by similar increases in freight tonne-km might, for instance, indicate stability of the traffic profile. Conversely, joint movement of the two freight indicators in the same direction endorsed by corresponding changes in freight leads would indicate a substantial shift in traffic profiles. Thus a review of aggregate operational trends on IR since the 1950s throws up interesting conjectures. Over most of the period, the growth in tonnages has reflected the growth of bulk-freight operations, rather than growth over all categories of freight. With bulk-freight (particularly coal) having to be carried over increasing distances in consonance with plan priorities, the rise observed in net tonne-km traffic has been characterised more by growth of traffic *leads* than of traffic *loads*. This is verifiable also, for most of the period reviewed, from the trends in average freight leads.

While it would therefore appear that freight trends in this direction were dictated by planning policy rather than by accident, since the economic philosophy underlying Indian planning has traditionally emphasised state-sponsored development of the producer goods sector, the possibility would remain that the order of specialisation observed from IR freight trends was actually more than was bargained for. Particularly in the 1970s when average freight leads rose to phenomenal levels, and in the 1980s when the rate of growth of freight tonnages had also sharpened, the latter possibility appears more probable since IR over the relevant period was in troubled financial straits because of the lowering of fiscal support. Another curious phenomenon in marked evidence over the latter period was the emergence of pronounced cyclicity in IR operational performance, with transitions from traffic growth to traffic slack becoming far more frequent. Analysis has shown that freight specialisation in IR has been achieved at the cost of traffic surrender to the roadways. Thus what has been witnessed in practice over the period is the stratification of the Indian freight market into distinct *bulk*-freight and *general* freight traffic-segments. While IR has retained its monopoly over the former because of the intrinsic cost-efficiency of railways in transporting bulk-freight, its erstwhile presence in the general freight segment has been severely contested by smaller freight players belonging to the roadways. Over time, the attrition of IR market share in this market segment has been so severe as to reduce it virtually into a non-player. Since it is general freight which is the most high-valued market segment, the withdrawal of IR from the segment has had serious revenue implications and has partly been responsible for the erosion of IR's financial viability. Meanwhile, the success achieved by the initial roadways players has sparked off intense competition in the roadways sector leading to uncoordinated growth.

Superficially, this sequence of events reflects similar positions and responses that have occurred on railways in many countries. Except possibly in the erstwhile socialist bloc, of which the experience of China had been briefly surveyed, the roadways emerged as serious freight competitors after the 1960s through technological innovations such as containerisation and improved handling. Upgradation of highway networks and the removal of restrictions on intercountry operations have provided an institutional boost which has also increased the competitiveness of road transport in the developed countries. Once again, the discrete nature of vehicular units and the smaller scale of capital investment required have worked to the longterm advantage of the roadways in freight competition. The continuing ascendancy of the railways in the socialist countries, on the other hand, may possibly be attributed to restrictions on the entry of private transport operators. In sum, the growing contestability of the small freight market in India need not be regarded as an isolated feature, but is also characteristic of the transportation sector in large parts of the world. It had also been noted that industrial transformation and growth of the consumer goods sector since the 1960s has generally been conducive to the growth of roadways, because of the low-bulk and low-lead character of the traffic this generates. In this, the railways were clearly outclassed since their operational efficiency lay in bulk traffic and full rake-loads to be transported over long leads. Resultant segmentation of the freight market, to a some extent, was inevitable.

What is of crucial importance to this review however, is whether the change apparent in IR freight structure over a period of five decades has originated from demand failure or from supply restriction. In the event of the former, much more attention would have been drawn to issues like freight-pricing, etc., since the drifting away of certain categories of traffic to the roadways would be wholly explained by the railway rate-structure. On the other hand, the possibility of supply failure would bring in issues relating to longterm capital financing in addition to rate-structure problems. The point needs to be elaborated.

Given the public character of IR, freight demand-supply gaps would not immediately bid up freight rates, allowing excess freight demands to persist in the short term. In the long run, a bridging of this gap would then be accomplished if capital investment were to be made at an adequate level. However, because of the public objective of low tariff operation, capacity gaps in particular freight segments would not immediately impart buoyancy to operating profits in view of the delinking of railway rates and profits from public policy objectives. As a result, excess demand in a particular freight segment would not be interpreted as a signal for reordering freight capacity and freight investment, and the bridging of the gap would then depend entirely on autonomous investment decisions made in accordance with infrastructural priorities. Similar inferences could also be drawn if excess supply prevailed in other freight segments.

With nationalisation, investment on IR came to be identified very strongly with public policy. Under the new objectives, the decision to invest on the railways was guided by the concerns of economic development further downstream, rather than by the commercial profitability of railway operations. The scope for *market correctives* became correspondingly limited.

What emerged then were classic command-economy disequilibria between traffic demand and capacity, the problem being rendered more intractable by the infrastructural character of investments. With longterm freight growth trends over the period of planning passing from growth to slack to growth again, and short-term freight responses inevitably being lagged compared to growth in freight capacity, obviously the same corrective would not be applicable over all situations. What this implied more subtly was a choice between breaking even (in capacity-utilisation terms) in the short run *versus* breaking even in the long run. By their nature and because of the bulkiness of railway capacity investment, both goals would not be achievable simultaneously, since the removal of traffic slack in the long run would mean that short run slacks would have to be tolerated. This inner economic logic was embodied in the strategy adopted during the early plans of building railway capacity *ahead* of demand, and represented a more public-policy oriented principle of railway operation. By the end of 3FYP however, the inability of IR to raise sufficient revenues brought about a sense of fiscal alarm, rendered more severe by the fact that the railways in India remained a departmental undertaking contributing directly to general public revenues. What followed therefore was a squeeze in fiscal support which had direct bearing on further additions to IR capacity.

Besides the circumstantial impact of two oil crises, where in fact the impact on the railways should have been beneficial, the funding crunch appears to have been the main factor in changing the freight structure of IR. With lower energy costs of operation and the ability to use electricity as an energy substitute, the railways should not have encountered heavy weather over the oil price hikes. Rather, the restructuring of production and freight markets following the energy crisis should have enabled IR to reenter freight segments where roadfreight rates had risen substantially. However for this to be accomplished, slack capacity would have had to be on hand which could be switched to the contestable freight categories. It was here that IR fell short. With railfreight services not being close substitutes for roadfreight, the latter was able to hold on to a considerable part of the small freight segment even at higher rates. A primary reason for this was the unavailability of wagon capacity on the railways to carry general freight, because of the prior investment squeeze on wagon acquisition.

A predicament of this kind is not immediately apparent from the IR freight trend figures, because of their cumulative nature. On the surface therefore, freight tonnages and traffic continued to increase along with substantial additions to BG rolling stock. A more glaring camouflaging factor was the practice of reporting annual performance and setting Railway Budget freight targets in tonnage terms rather than in traffic (net tonne-km) terms, thus masking shifts in the freight structure. As a result of the practice, the growing dominance of coal freight in the IR freight structure masked the losses of low-bulk-freight share without revealing the immediate consequences of the fiscal squeeze on railway freighting capacity. For these hidden features to emerge, special investigation was therefore made into the growth and nature of IR freight capacity, which is determined principally by the IR wagonfleet.

It may be noted, in passing, that the oil crises had also engendered upheavals in the freight market in other countries with advanced railway systems. In these countries, the railway response had been to escalate capital investment in upgradation and modernisation so as to compete with the roadways for freight market share on technological superiority. In the case of SNCF for example, it was seen that the bulk-freight sector - the area of core competency for the railways - grew considerably as a result during the 1970s. However SNCF did try to carry competition into the low-bulk segment on the same technological principles, *i.e.* by consolidating low-bulk-freight into full trainloads, by offering superfast or value-added services, or by increased containerisation in order to lower handling costs. Moreover, with the highway and roadway systems and multimodal transport in these countries also being technologically advanced, what traffic was surrendered by their railways in the process of freight restructuring was absorbed by the roadways. In India, on the other hand, the level of infrastructural and technological competition was low - the Indian roadways having primarily evolved either as auxiliaries to the railways (*e.g.* in feeder networks) or as small individual ventures built around the traffic that IR was unwilling to carry. Further, the relative state of underdevelopment of highways in India reduced the multimodal complementarity of the two transportation systems and slowly increased direct competition in limited parts of the transportation network such as the Golden Quadrilateral.

8.1.5 The Growth of IR Freight Capacity

Over nearly 150 years of railway operations in India, considerable change has been witnessed in the railway technology adopted. Besides improvement in handling and traction technology, the changes having most profound impact on railway freighting capacity have been in wagon technology. It is pertinent to note however that technological progress on the colonial railways was necessarily limited by the low scale of capital investment once the period of railway construction was over. Thus for a long period from the turn of the century till Independence, railway capital stock in India remained essentially of an old design. The situation changed materially after the infrastructural thrust imparted by the FYPs, which sought rapid augmentation of freighting and haulage capacity to keep pace with the anticipated growth of the economy. With the present analysis being limited to freight operations on IR, it is the nature of innovations in wagon design that becomes important.

It was noted earlier that the wagon industry in India had developed downstream of the Indian metallurgical industries, and for this reason was principally located around Calcutta. Although a pre-Independence creation involving reputable rupee companies incorporated in India, the wagon industry occupied a position ancilliary to the Indian railway companies. As such its sophisticated metallurgical inputs were supplied through the direct agency of the railway companies, and methods of construction remained labour intensive because of relative cheapness of the labour market. Even after nationalisation of the railways, this organisational mode was retained. However, where innovation had been lacking in the earlier period, consolidation of IR and the launching of railway development plans called for radical upgradation in wagon design and in wagonfleet composition. Having inherited the past ancilliary structure, IR took on the direct responsibility for providing 'free supply' inputs which were of a more sophisticated nature, while preserving the labour intensive methods of construction. Because of this industrial structure, the pace of wagon innovation was solely dictated by IR both as the single monopsonistic buyer, and also as the wagon designer through its auxiliary units such as RDSO. While the arrangement had obvious merits with respect to design standardisation and also relieved the wagon industry of the burden of R&D costs, it placed impediments to the organisation of the wagon-producing units into full-fledged manufacturing and industrial units. The system of contracted buying further reduced the financial resilience of the WPUs and in most cases they remained merely fabricators. Thus when the capital squeeze was applied and orders became uncertain, several WPUs inevitably succumbed to industrial sickness. A few private-sector units like TEXMACO did prove more resilient because of their diversified product lines, indicating that stability of the wagon industry depended very much on its escape from the clutches of a monopsonistic market. But since the majority of the units were located in the public sector, diversification hardly existed and innovation was slow. The market device adopted as an escape from ruinous competition for wagon orders was cartelisation of the WPUs under Wagon India Limited. Although as a sellers' consortium, WIL represented the exercise of countervailing power on the part of the WPUs, the cartelisation protected producer inefficiency and through a vicious circle pegged wagon prices to unjustifiably high levels. The net result was a cutback in wagon orders, with IR occasionally taking recourse to direct wagon imports from countries like Spain which shared the same BG gauge with the IR, as a means of forcing down wagon prices. The fact was obscured that - with freight cross-subsidisation burdens in India increasingly being borne by the steel producers - IR was also contributing to the rise in prices of Indian-built wagons. At the present point of time, IR is well on its way to scrapping the system of consortium buying by instituting an open tender system for placement of wagon orders.

Inspite of such vicissitudes in wagon acquisition, the complexion of the IR wagonfleet has changed considerably with the upgraded BOXN wagon well on its way to becoming the *de facto* IR *standard wagon*. This change also demarcates the shift in the direction of freight policy since the 1980s. With the standard bogie-type wagon being particularly suited to rapid bulk haulage of commodities like coal and minerals in full trainloads, the rising percentage of such wagons in the IR wagonfleet reflects the withdrawal of IR from a large segment of the Indian freight market comprising both high value low-bulk traffic and unconsolidated traffic smalls. The overwhelming freight capacity shortage is therefore of covered wagons suitable for safe carriage of commodities like foodgrains, cement and general merchandise. Moreover, the technical specifications of the upgraded wagons are designed towards assembling specialised rakes for mechanised lading and high-speed haulage. Since traffic meeting these specifications is available primarily on trunk routes and is unidirectional in nature, there has been a rise in the number of empty wagon-km as well as a shrinkage of IR freight operations to the detriment of the feeder network.

The response of IR to the challenge of high energy prices is therefore seen to have been *technological*, and has more or less mimicked the technological responses of major world railways. The nature of this response has been dictated by declaration of a new national transport policy for multimodal transportation. However, where containerisation has been the principal means by which major world railways have sought to retain general freight, the overall resource constraints on IR have prevented a similar breakthrough. Also, the *organisational* component of the changes in freight management witnessed in countries like Britain and Japan, which have gone in for corporatisation of services and outright privatisation of rail services, has not been witnessed on IR. Instead, the departmental structure of IR remains firmly entrenched with operational decisions remaining under the tight control of the Ministry. It might be remarked in general that organisational adaptation would be the more appropriate response for development contexts. Thus limiting the IR response to the technological adaptation that has been instituted by developed railway systems has robbed the adaptation process of its potential infrastructural impact, even while superficially improving freight-efficiency indicators such as wagon turnaround times and wagon-km per day.

Certain crucial transport policy decisions taken during the early-1980s have marked the watershed between the return of wagon efficiency to IR, and the prior period. Efficiency of freight operations has actually been achieved by technologically upgrading the special wagonfleet and reducing the traffic focus to bulk-freight and full trainloads. The two decisions are actually intertwined. The technology introduced for improving wagon efficiency, which is designed around specially adapted BOXN wagons and mechanised handling, is conducive for the efficient haulage of coal. Over the time since, coal has become the dominant commodity freighted by the railways and is carried mainly to steel plants and to thermal power stations. Thus the technological adaptation has in fact reduced the spread of IR's freight services, a trend borne out by the high rate of increase in freight tonnages and leads over the 1980s. On the other hand, the degree of specialisation that the IR wagonfleet has undergone after the mass introduction of BOXN wagons leaves far too little traction and carriage capacity for general freight. Moreover, since shipments of coal generally move in one direction from the mining pitheads to the plants, return traffic is often unavailable. Consequently, empty wagon-km have risen considerably. In recent times, IR has in desperation been offering special rebates for the shipment of foodgrains and cement (which have reverse leads) in open BOXN wagons. There are few takers however, since both these commodities require safe carriage in covered wagons which IR is unable to supply in adequate number.

The other crucial policy decision taken during the same period has been to phase out MG freight. Recollection of the history of railway expansion in India points out that the MG network actually came into existence on feeder routes. Thus when both MG and BG freight networks were in full-scale operation, the MG routes had a critical role to play in the consolidation of general freight for IR. To this day, the freight-mix on surviving MG services differs radically from the BG freight-mix. Since the alternative plan of converting the MG routes to BG under the UNIGAUGE project has made tardy progress, a part of IR's freight network has actually withered away and the commodities freighted there have switched over to the roadways. It is a matter of pity that the UNIGAUGE conversions had to be undertaken as a result of the resource crunch rather than as part of a consolidated transport plan which included prior traffic appraisal. The consequence is that the conversion projects remain incomplete, heavy sunk costs are added and anticipated traffic volumes do not materialise, all of which further aggravate the resource position of IR.

With hindsight, therefore, the policy decisions seem ill-conceived. In all fairness, it might still be said that the National Transport Policy document had envisaged retention of the railway share of general freight rather than further attrition. For this, fiscal support to IR would have had to remain high, so that the modernisation programme could proceed apace with regular wagonfleet maintenance and renewal. However, fiscal policy changes during the 1980s queered the pitch by making the modernisation programmes heavily dependent on external borrowing by IR. The result seems to have been a truncation of maintenance and renewal expenditure - at the cost of railway safety, as certain recent observers point out. Ironically, the adjustment of IR to the freight situation following the oil crises has resembled the adjustments made by advanced railway systems in another unintended way. Where the advanced systems have deliberately curtailed uneconomic network services and reduced the freight focus, network contraction on IR has been achieved by default because of the downgrading of MG services. The difference is that while the advanced systems made proper provision for consolidating miscellaneous freight-flows at fewer terminal points to increase the throughput of wagon trains, IR has proved unable to do the same because of the basic shortage of appropriate wagons.

The preceding observations draw attention to wagon capacity as a crucial determinant of the scale and nature of railway freight operations. It must be noted also that wagon specialisation segments the overall freightage capacity of a railway system into non-substitutable compartments. Thus the effect of wagon-supply constraints on the railway freight market is to separate it into several independent freight categories, depending on commodity-characteristics, directions of flow and distance-leads. Such segmentation can render several market segments contestable, especially if the railways lack freightage capacity of particular kinds. The context makes it useful to investigate the policies and decisions on wagon acquisition for IR and their freight impact.

Two aspects are important to this analysis. Firstly, the will of the state is often reflected in the strength of allocations made to public capital. Thus a state mindset which is well-attuned to the nature and potential of infrastructure development will make budgetary decisions after careful consideration of their possible consequences on railway operations and performance. Fairly strong will on the part of the state was in evidence, for example, during the first three FYPs. It is therefore pertinent to explore whether prior operational factors have exercised any influence on IR decisions relating to wagon acquisition. The other aspect, which is probably of equal if not greater importance, relates to the projection of anticipated traffic. In summary terms, the matter for investigation therefore is whether the changes noted earlier in wagon acquisition policy were guided by the experience of the past, or by anticipations of the future, or by neither. The realm for investigation is the railway component of the National Transport Policy as declared by the NTPC in 1980, and IR performance and performance-projections in the years preceding and following this declaration.

It has been noted in this context that plan allocations to the transportation sector had already begun to dwindle from the mid-1960s, as a consequence of industrial recession. Thus the exuberance of the early plans regarding the importance of public investment in infrastructure was already fading. A mixture of fortuitous circumstances and macroeconomic disequilibrium precipitated a fiscal crisis which temporarily derailed the planning exercise. Inability of the economy to return immediately to the growth path triggered bureaucratic complacency about capacity levels - evidence of which is also seen in other infrastructural sectors such as power. Thus excess capacity which was at best a momentary consequence of the recession was allowed to lengthen into a capacity crunch. With transportation being the hub of commodity-flows within the economy, the squeeze on transport imparted a squeeze on economic growth. Even so, and without any substantial restoration of plan allocations to infrastructure, the economy had begun to recover in the 1970s. But with low levels of capacity addition, IR was inadvantageously placed to absorb traffic flows affected by the impact of the Oil Shocks. Some restoration of plan grants to transportation and infrastructure is evident from the 1980s, coinciding with the implementation of National Transport Policy. However, this was with the rider that IR undertake a similar exercise in augmenting internal resource generation to fund its capital expansion. Intentionally or unintentionally, this imparted short term focus to the capacity-expansion exercise, since IR began to seek operating surpluses by focusing on its efficient *i.e.* bulk-freight operations, curtailing uneconomic operations whenever permitted to do so. Also, the overall shortage of capital combined with the exigencies of expanding bulk operations changed the direction of application of capital funds to special freight rather than general freight.

8.1.6 Freight Capacity Planning and IR Freight Preferences

Changes were made in the freight policy that governed IR when the proposals in the NTPC and RTEC Reports were implemented during the early 1980s. The primary thrust of the policy change was towards modernisation and upgradation of railway freight services, rather than towards their outward expansion. Still, in view of projected increase in the size of the freight market, it was anticipated that IR would increase freight tonnages and traffic considerably, while maintaining its market-share vis-a-vis the roadways. Thus the technological components of the modernisation were geared more towards maintaining railway efficiency than towards freight specialisation. It should also be remembered that the terms of reference of the NTPC were very broad, encompassing the roadways as well as multimodal transportation. Thus its projections of the freight market included both IR and roadways shares.

Several other exercises at freight projection were also conducted during the mid-1970s and 1980s. Of these, only the NTPC projections were holistic. That so many projections were being made at that time reflects the level of concern that existed in the country over the persisting disequilibrium in freight services induced by the Oil Shock. Departure was thus made from the prior practice of supply management on the basis of assumed freight demand, to the projection of freight demand itself. Although attributable to differences in projection methodology, the wide range of divergence observed between successive projection estimates carries lessons of its own. Projecting infrastructural demand is a difficult art, because of the need for estimating infrastructural multiplier effects including the genesis of new sectoral demands downstream. Thus *ceteris paribus* conditions cannot be maintained. Gravity methods, such as those that were adopted by outside consultants for their projections, are much more sensitive to potential multiplier effects and project high levels of future freight demand provided that present freight growth has followed an optimal path. Trend-related methods, on the other hand, are much more conditioned by the immediately preceding experience and tend to project lower future demand levels. Although the policy-making exercise by the NTPC adopted the latter methodology, the projections by outside consultants now reveal the possible extent of infrastructural opportunities foregone by IR. The fact that even the NTPC's more modest freight targets have not been realised by IR till date offers an avenue for further investigation of the malaise afflicting railway freight operations. Firstly, since tonnage shortfalls between freight targets and freight actuals are not as large as the shortfalls in traffic, there is sufficient reason to believe that the unanticipated loss fell disproportionately on the low-bulk category of traffic. Secondly, since the wagon and handling modernisations suggested by NTPC were directed to more efficient carriage of bulk-freight, it would seem that policy implementation tended to focus much more on advancing IR bulk operations than on retaining general freight. In view of the precipitous decline in the IR wagonfleet since that time, one begins to wonder whether the non-achievement of projected freight targets in the subsequent period reflects the skewing of IR freight capacity *i.e.* the *supply* of freightage, rather than an overall shortage of the freight *offer* or freight demand. In such circumstances, current freight achievements by IR reflect the *restricted demand* for freight services, rather than the total railway freight offer of the economy revealed by the gravity-projections. The shortfall between the restricted and unrestricted freight demands in such a case would not entirely be transferred to the roadways because of routing and cost factors. Thus the transfer of freight share from IR to the roadways masks the more deep-set capacity shortages which have shown up as transportation bottlenecks in the economy.

Analysis must therefore focus on the IR wagonfleet and IR wagon acquisition levels. Provided that these wagon acquisitions were being targeted to projected traffic, a certain regularity should have characterised the placement of wagon orders. In view of the overall resource squeeze applied on IR capital acquisitions, it would be unrealistic to assume that its annual wagon order placements represented single-period adjustments of freight capacity to anticipated demand. Rather, the inability of IR to secure adequate capital funding would have led to lags in acquisition of the wagons required to meet the periodically projected levels of freight demand. Thus undercapacity would be likely to prevail in normal years. While the forward linkages of this would, to an extent, depress future flows of freight, the backward linkages from accumulation of unmoved freight inventories of primary freight commodities would depress future production levels. Since the entire production schedule in India was being coordinated through the FYPs, unanticipated interruption in freight-flows at particular points of time would disrupt production schedules, causing excess supply to prevail in certain core sectors and unsaturated demand in other downstream sectors. Thus, what started out as a minor shortfall in freight capacity would be magnified into a *production cycle* by the infrastructural multiplier. The consequences of miscued wagon acquisition would then turn into instability and oscillation within the economy.

In the empirical exercise, the *polynomial distributed lag* [PDL] model proposed by Shirley Almon to model partial adjustment processes was applied to partial wagon-stock adjustments on IR. To monitor the implications of the NTPC recommendations under this methodology, the PDL model was estimated on the dataset used during the NTPC projections. Further, to include existing disequilibrium levels within the analysis, data on physical disequilibrium indicators such as empty wagon-km, etc., were added to the dataset. A study was then made of the relationship of the IR wagonfleet and the annual wagon output by the WPUs to different macroeconomic and physical variables. With railway fund allocations in the FYPs providing distinguishable capital adjustment nodes in the IR wagon acquisition process, the effect of variable fund flow over the plan horizon was captured by postulating a 5-year adjustment lag, after experimenting with other lag structures. While the use of linear estimating equations captured the nature of the partial adjustment process as determined by the levels of various freight demand indicators, the lin-log estimating equations captured the elasticity of the IR wagonfleet acquisitions in response to the rates of growth in the economy as represented in these indicators.

Despite there being as many as 15 variables in the expanded dataset, both IR wagonfleet and wagon output were found to be strongly related only to freight traffic (*i.e.*railway tonne-km). Remembering that the estimation was done on data for the precursor period i.e.the 17 years from the 3FYP till the time of the NTPC study, which was characterised by industrial slack, it becomes evident that the NTPC recommendations relating to bulk-freight specialisation by IR were made on a severely restricted demand projection. Particularly, since the general freight flows emanated from industrial sectors which had been severely hit by recession, the magnitude to which these might recover in the subsequent period was not correctly anticipated. Thus, as IR went into a modification of its freight capacity structure geared towards bulk-freight specialisation, it shed the vital general freight capacity which had previously been the mainstay of its revenues. Again, because production cycles in the core sector tend to be deeper and have more prolonged consequences, the freight disequilibrium between the two sectors severely disrupted coordination in the FYPs. Ideally, if roadfreight services had been an exact substitute for the shortfall in railway freight capacity, the infrastructural impact might have been minimal. Instead, while the IR freighting capacity shortfall created inroads for roadfreight, the cost economics of the latter directed their entry into the high-valued freight segment only. A mass of important commodity-freight, including produce from the agricultural sector, was thus denied equitable freight services.

Evidence was also found of pessimism on the part of IR regarding the potential growth of traffic, leading to policy concentration on improving efficiency in current freight operations through reduction of wagon turnaround, etc. Addition of freighting capacity was therefore guided by the direction of continuity in past traffic trends and even wagon replacement was lagged as a result. Since the sources of IR finance at the time were primarily budgetary funding under the FYPs, the fact that traffic expectations were being pegged at decidedly low levels kept apparent concordance with the scaling down of plan finances. Although these low-growth anticipations were quite in keeping with the general recessionary mood of the economy, their projection into the future during the NTPC exercise badly affected the subsequent recovery of railway freight operations. Low levels of wagon acquisition by IR during the period also afflicted the wagon industry permanently. Showing evidence that pessimism deepened as the recession ran its course, the study revealed - surprisingly - that the cutbacks in freighting capacity additions and wagon orders made during the early part of the recessionary period were never restored to prior levels thereafter. Since this pessimism affected both replacement and acquisition orders, the wagon industry began to show chronic excess capacity leading to sickness and closure of several WPUs and takeover of others. In the meantime, because of the lowering of traffic targets, IR was able to show that existing freighting capacity was quite adequate for anticipated traffic and hence no move was made through the 1970s to restore freight adequacy in real terms to the IR wagonfleet. To some extent, the inevitable surrender of freight to the roadways formed a part of these expectations and reduced the competitiveness of IR. Since the budgetary deficits incurred by IR were then being underwritten by the exchequer and the growth of passenger traffic volumes had remained largely unaffected during the recession, gradual shifts occurred in the operational intensity of IR services which raised the level of emphasis on passenger services vis-a-vis freight operations. Since the financial health of IR depended on the latter, the shifting emphasis had grave implications for the internal resource position. Again surprisingly, no evidence was found of wagonfleet and wagon acquisition bearing any noticeable relation to industrial and economic growth rates of the economy, which would have extended the recovery of economic activity into optimistic traffic expectations. Eventually therefore, even the pace of economic recovery was constrained by transportation bottlenecks. Evidently, the infrastructural role of IR freight operations was severely circumscribed by the experience of recession and the changing composition of freighting capacity thereafter. So, although IR tonnage loadings still continue to be an important indicator of the state of economic performance of the heavy industrial sector, railway transportation in India appears to have lost its capacity to lead the economic recovery.

8.1.7 Evolution of IR Freight Handling Patterns

Wagonfleet capacity thus materialises as the principal determinant of freight handling by IR. In view of the changing composition of the IR wagonfleet and the commercial policy factors adduced earlier, it becomes relevant to consider the impact that changing wagonfleet composition may have had on the commodity patterns of IR freight movement. A certain degree of disaggregation in the analysis now becomes necessary because of the peculiarities of transportation infrastructure as an economic sector. Firstly, transportation is a *spatial* variable and is therefore subject to regional commodity specialisation. Secondly, transportation is a *development* variable which undergoes evolution in terms of its commodity character as a result of economic growth and the creation of new commodity flows. Thirdly, transportation is an *indicative* variable which at different points of time reflects prevailing levels of economic flux in the producing sectors of the economy and their various constituents. Thus while wagonfleet composition and carrying capacity adequately delineate supply factors and constraints within freight transportation, freight handling by IR is representative of both spatial and developmental demands for transportation as articulated by the economy. Disaggregation of freight handling patterns on a regional and sectoral basis is therefore useful in the identification of partial slacks and excesses in transportation demand. Availability of credible timeseries data from CSO on the IR wagon loadings of different commodities allowed thorough investigation of these issues to be made.

A visual review of the commodity-wise freight trends displayed in the wagon-loading datasets confirmed that the nature of wagon loadings was responsive to evolutionary factors and structural change in the Indian economy. Thus while the growing dominance of coal in IR freight could be viewed in association with the decline in wagon loadings of general freight, the precise points at which these changes appeared tied in very closely with the external reference points identified by the planning and policy literature. Most noticeable in the data trends however was the gradual redistribution of wagon loadings over the BG and MG networks, caused partly by reduced transhipment but also mainly reflecting the change in gauge emphasis and gaugewise freighting capacity following the traffic readjustments of the 1970s. What became amply clear was that the imperative of increasing shipments of coal for power generation in the wake of the changing energy scenarios during that period caused coal shipments to thrust their way into the limited wagon capacity available on IR, thereby displacing the freight commodities which had hitherto occupied a dominant position. It has already been noted in the preceding discussion that the accommodation of this new freight stream was not made so much by incrementing the IR wagonfleet as by substituting its freight-flows for other commodity-freight. Inevitable consequences appear to have followed which have been captured in the mutual relativity of BG and MG wagon loadings after the 1970s. It was not only that wagon loadings of general commodities were displaced by coal, but also that the commodity streams which had traditionally entered the IR network through its feeder MG services began to wither away, lowering the overall commercial viability of MG operations. It was then but a short step to the decision to write off the 100-year old MG network and turn the tide in favour of UNIGAUGE.

The analytical exercise on freight demands therefore considered the evolution of IR commodity freight in terms of wagon loadings on its BG and MG networks over a continuous period from 1955-56 to 1989-90, during which most of the freight policy initiatives and modifications that have been described above had occurred. It was thus known *a priori* that the freight impact of technological change and specialisation in wagonfleets, shifts of freight-policy focus from MG to BG networks and the resulting spatial patterns of development were present in the variances of the wagon-loading series in different commodities. Multivariate regression analysis was then used to identify the patterns of evolution of bulk-freight dominance in IR freight loadings in terms of the impact of increased bulk-freight handling on the variances of other commodity-freight flows. The use of wagon units rather than tonnages or tonne-km as the basis of demand analysis tied in these findings with the changing composition of IR freighting capacity *i.e.* the freight supply variable demarcated earlier.

While regression results indicated that certain bulk and essential freight commodities such as coal, iron & steel, iron and manganese ore, raw jute, sugarcane and sugar, and oilseeds at least partially retained importance in the evolving IR freight-mix, as reflected by the wagon loadings of these commodities, several other commodities appeared to have lost relevance altogether. For commodities of the first group, falling MG loadings were at least partially compensated by increased BG loadings over the relevant period. Only in the particular case of cement were wagon loadings on both gauges seen to remain similarly high, because of the locationally-specific nature of the cement industry relative to widely-dispersed consumption demand which necessitated freight distribution of the commodity across the country. Also, although BG commodity loadings became more dominant with time in the case of most of the listed commodities, MG movements of coal & coke, sugar and sugarcane did not decline by as large a factor as in the others. The patterns observed suggested the working of a complex chain of economic factors within the evolution of IR commodity freight. While a primary constraint existed in the shortage of wagonfleet capacity (particularly in MG operations during the later period), short-lead traffic in industrial raw materials was less affected by this because of proximate location of user industries. Only in the case of coal & coke - where the commodity flows had to be carried over long leads to reach distantly located power stations, and in the case of cement - where the commodity flows again had to be carried over long leads to reach dispersal and distribution points, could the relevant IR commodity loading patterns be described as having remained dominant and relatively stable over time.

Although the estimation of commodity-freight coefficients through simple OLS was vitiated by sizeable presence of serial correlation between the wagon loadings of consecutive years, this situation was not entirely unexpected. Serial correlation is a common characteristic in longitudinal data in most empirical situations. In the situation of constrained wagonfleet capacity at hand, where the nature of commodities loaded by IR was defined partly by its earlier investment decisions concerning the wagon-mix to be maintained, serial correlation appeared as a logical consequence of gradual change in IR freight composition and deserved separate study on its own. Accordingly, an autoregressive scheme was applied to the serially-dependent errors obtained from OLS, in order to estimate an appropriate lag structure for the correlated component of the residuals. Quite obviously, such residuals captured unforeseen freight displacement, freight adjustment and other such factors. The results of this exercise proved extremely interesting. It was seen that the process of commodity-freight adjustment was cyclical with considerable growth of amplitude during the 1970s and 1980s. The impact of railway freight cyclicity in India has also been noted in several studies and reports in the literature, without hard evidence being provided. In the present study too, the earlier exercise of fitting a polynomially distributed lag to IR wagon stocks had also shown evidence of cyclic acquisitions of wagons by IR in response to phased funding sanctions over successive FYP periods.

Interpreting this close coincidence of circumstances in association with the correlated residual patterns, it thus became possible to reconstruct the infrastructural implications of IR wagonfleet specialisation on consequent commodity-freight movements, with particular reference to the 3FYP experience and after, which may be hypothesised as follows. The initial years in every FYP start an upsurge in autonomous public investment, which flows into enhanced production plans at the PSUs and into related capital acquisitions by IR to aid realisation of these production plans and circumvent possible transportation bottlenecks. Since the concerned PSUs operate primarily in the heavy industrial sector, the emerging freight flows are of bulk nature, to which IR freighting capacity has to adapt accordingly. However, since planning in India deals with a mixed economy, downstream derived demands from private-sector units for additional capital goods output from the PSUs are estimated on an indicative basis, conditioned by expected growth of the economy and expected improvement in incomes and consumption demand. Experience has shown that actual economic growth in most FYPs has been substantially slower than that anticipated leading to the mismatch of PSU production plans and derived demand realisation from the private sector, as well as to a slowing in the release of FYP capital grants. In such an event, sizeable accumulation of inventories occurs at the PSUs forcing them to scale down their production and their transportation demands. At such a point, IR - which has steadily been specialising its wagonfleet in keeping with the anticipated needs of the PSUs - encounters a traffic slack and cuts back wagon acquisitions. Finally, towards the closing years of the FYPs, when PSU inventories have declined, release of the remaining plan grants initiates another spurt of autonomous capital investment in both the PSUs and IR causing bulk-commodity loadings to pick up.

The role of BG and MG wagon capacity in the hypothesised scenario is critical. While not dominating IR commodity loadings in any way, MG wagon loadings retain a complementarity arising out of the origins of the Indian MG network as a feeder to BG operations, evident for example in the radically different composition of the MG freight-mix. While traditionally the MG operations provided the means for mobilising scattered traffic from the hinterland and marshalling it into loading units that were appropriate for BG carriage and vice-versa, changes in the IR freight-focus in favour of bulk commodities have obscured this former role. In normal situations where bulk traffic expectations materialise, the role of MG operations is automatically marginalised by the inability of IR to allocate adequate BG wagon capacity to the transhipment of MG feeder flows. This marginalisation has in fact been reinforced by the planning process which has created a substantive degree of autonomous commodity-flow in the economy through the agency of the PSUs, ultimately warranting the writing-off of MG freighting capacity. However in periods of slack when bulk traffic expectations refuse to materialise - again because of the autonomous nature of their freight flows, the remnant freighting capacity of the MG wagonfleet serves as a buffer to IR freight operations by once more attracting disaggregated non-bulk commodity flows to the IR network for transhipment and onward transportation on BG. While shortening of MG wagon capacity reduces this buffer role, the high degree of specialisation in the BG wagonfleet aggravates it further, since - even with abundant freighting capacity overall - there is a shortage of particular wagons capable of handling general freight. At certain times therefore, even routine feeder-flows from the MG network vanish causing a general slack to appear in IR freight operations. These three alternative freight demand situations in fact sum up the common freight scenarios encountered by IR which are further explained in the Factor Analysis, and account also for the triangulation noticed in the patterns of correlated residuals and their cyclic nature.

To correct distortions in the estimated OLS commodity coefficients introduced by the presence of serial correlation, resort was made to the Cochrane-Orcutt adjustment procedure. Use of the C-O procedure reallocated observed variances in the wagon-loading data to the commodity flows most responsible for these, giving rise to corrected estimates with uncorrelated residuals. It was noted that substitution of Cochrane-Orcutt coefficient estimates did not materially affect the inferences for bulk loadings of the major IR freight commodities like coal & coke and cement. The remarkable result of the C-O transformation was the identification of both *displacing* and *displaced* commodity flows which could then be interpreted in terms of the sectoral and spatial characteristics of the commodities involved. In general, it was seen that with increased wagon specialisation and increased loadings of bulk-freight on the BG network, freight flows of general manufactures were displaced on both BG and MG networks, providing indication of freight replacement as well as of shortages of appropriate covered wagon capacity. Nevertheless the MG network, which did not witness technological specialisation before or even during the process of being written off, retained such general freight flows as could be carried over short leads, *i.e.* within its network. In most cases these comprised raw material flows from cultivating or mining destinations to production centres which, by inference, could be transported over reverse leads allowing two-way utilisation of freighting capacity. The produced outputs then either entered the BG network or roadways transport for onward distribution across the country. In other cases, where for instance only distributive flows were involved, commodity traffic tended to leave the IR system altogether, except in the subsidised 'essential goods' segment. In contrast, BG commodity loadings showed evidence of increased traffic polarisation as well as of partial takeover of the erstwhile MG bulk-freight flows. It would stand to reason, on the basis of the earlier structural analysis of IR capital acquisitions and the IR wagonfleet, that these freight trends were induced by the critical freighting capacity constraints that arose from financial stringency. The infrastructural impact which the constraints had on the Indian economy has been both *sectoral* and *spatial.*

Attention was drawn to the critical phenomenon of IR freight cyclicity by the phase-analysis of OLS residuals prior to the C-O adjustment procedure. Because of serial dependence, these residuals comprised an autonomous or stochastic component as well as an autoregressed component that represented unmet or over-realised traffic expectations. Although the latter situation was found to be extremely high, it was noticed that the amplitude of freight cycles had been smaller when IR BG freighting capacity had been complemented by adequate freighting capacity on the MG network, thus enabling feeder freight operations to step in whenever there were critical BG bulk-freight shortfalls. The economic adjustments to Oil Shocks which occurred over 4FYP and 5FYP vastly increased the importance of coal freight operations, dislocating IR's MG freight operations because of the shortage of general freighting capacity on the BG network. Thus the cyclic oscillations of IR freight flows increased phenomenally in terms of wagon handling during the 1970s, even though this remained cloaked in the corresponding tonnage and traffic figures because of increased bulk-freight loading and the expansion of freighting leads. The surrender of general freight occurred in the subsequent period when intermodal competition between the roadways and railways was deregulated by liberalising the national permit system for roadways carriers. Because of their ability to handle low-volume freight flows and to reach the more isolated corners of the country, the roadways were able to compete more effectively with IR's MG freight networks which served similar general freighting needs. Thus while the BG network remained insulated because of its absolute cost-advantages in bulk carriage and its captive freight flows, the MG freight operations were slowly driven to virtual obsolescence because of freight contestability and the lack of capital investment on MG freighting capacity and infrastructure. As a result, although the freight-focus of IR BG operations has gradually narrowed down to a group of seven captive bulk-commodities whose freight flows are seen as being more dependable in traffic terms, this has required substantial capital investment in specialised railway technology and infrastructure, without yielding equivalent revenue increments for IR. Widening of the freight cycle over the 1980s may thus be seen as the result of the production-lag between producer goods and consumer goods in the economy, with periods frequently occurring when IR faces considerable bulk-traffic slack.

After their estimates had been corrected by the C-O adjustment, the commodity-coefficients estimated from the wagon-loading datasets provided a better idea of the freight elasticities of different commodities present in the IR freight-mix, enabling the joint identification of the displaced and displacing freight flows. It was thus seen that IR freight-specialisation towards mining and core-sector freight flows had tended to displace railway movements of agricultural commodities and light manufactured goods, primarily because of rising shortages of general freighting capacity because of line saturation on the BG network and increasing wagonfleet specialisation. Because of the consequent inability of the BG network to provide trunk linkages to the freight flows of IR's MG network, commodity-freight that originated on the latter tended to lose presence in the IR freight-mix. Thus only essential or strategic commodity movements such as those of grams & pulses, coal and cement still continued to have visible presence in IR's joint freight operations.

8.1.8 Freight Operations & the Evolution of Commodity-Freight Patterns

The changing IR freight-mix and the disappearance of certain commodity flows which had traditionally been important to railway freight operations in India were then assessed for their spatial and sectoral implications. This in itself was a complex exercise since it involved the decomposition of IR's aggregate freight operations by commodities and regions. The key link for this was provided by the associations between regional commodity flows and the regional patterns of economic activity. While insights into these had been provided by certain studies in the earlier literature, these had focused on regional development in India rather than on the spatial economics of railway freight transportation. Accordingly, the spatial analysis in the present study was made by assessing the freight performance and other operational parameters on IR's nine zonal railways. A vital component in this assessment was the unequal distribution of BG and MG routes over the zonal networks, as a consequence of which important arterial railways like ER, SER, NR, CR and WR were able to record higher freight turnovers and better profitability, vis-a-vis largely MG-based zonal networks like NER and NEFR which served the country's extremities and recorded consistent operating losses. Attention was thus also drawn by the spatial analysis to the weaknesses of freight operations on the IR system, as a result of the increasing concentration and congestion of bulk-freight flows along the HDCs linking the golden quadrilateral, and the retreat of freight operations elsewhere because of the dislocation of feeder-freight flows from the main IR freight corridors. Once again, a critical role was played by the IR freight policy shift that had favoured bulk-freight, which reallocated more railway investment towards technological change and the upgradation of specialised BG capacity in order to relieve freight congestion on the HDCs. Changes were also found to have occurred in the IR freight booking policy which now favours full wagonload and trainload traffic over parcels and smalls, in order to improve freighting efficiency on the BG network. Since the adverse consequences of this policy fell disproportionately on IR's MG network, it was found to have placed the regions and IR zones served by MG-dominated zonal railways at relative disadvantage. These changes in the regional commodity-freight flows and in gaugewise freight operations were also likely to have influenced the IR freight-mix, with the freight offers of different regions and commodities receiving less attention because of IR's increasing preoccupation with BG bulk-freight.

Consequently, a separate multivariate study examined the longterm cross-commodity and crossgauge evolution of the IR commodity-freight mix, which made explicit use of Factor Analysis. Although previous applications of this technique were found in two instances in the regional planning literature, no previous instance was found where the technique had been applied to the analysis of railway operations. When applied to the IR wagon-loading datasets, Factor Analysis was able to decompose the joint variances of the different commodity-freight loadings and define the freight-adjustments that IR has frequently been called on to make as a consequence of freight cyclicity and the nonavailability of preferred categories of freight. Consequently, a freight-adjustment model was developed around the results of the Factor Analysis. Simulation of IR freighting adjustments through this model revealed that the wagon-loading trends of different commodities on either IR gauge were highly interdependent. In situations described during the phase-analysis, where the freight offer of preferred mining and heavy industrial commodities was small, IR was found to return partially to feeder operations and to allocate more MG and BG wagon capacity to low-bulk general freight. When freight offers from the core sector - comprising the seven major IR bulk-freight commodities - were high, IR's BG line capacities and wagonfleet capacity tended to get saturated, causing traffic congestion on the golden quadrilateral and freight-slack over the rest of the IR network, which adversely affected the feeder-freight operations and the general freight segment.

Over the entire course of IR freight operations during the period reviewed, generalised slack that had affected the entire IR system was only found to have occurred during the 3FYP. The freight traffic anomalies noticed in connection with the Oil Shocks of the 1970s were found to represent wild swings in IR freight operations between general freight and bulk-freight. The subsequent period which coincided with IR's decision to phase out MG operations was found to have reduced freight traffic swings, but was also responsible for IR's loss of traffic share in the remunerative general freight segment. In most common situations encountered over the 35-year period of study, the freight offer from the bulk commodities tended to be smaller than expected, leading to the partial wastage of specialised freighting capacity which had been added at great cost to the IR system.

The freight adjustment model also allowed exploration of the patterns of commodity-dominance and commodity-displacement which have gradually developed within the IR freight-mix. These were captured in the *communalities* of the freight-adjustment vectors defined by the model to illustrate IR's freight response in different market situations. Each freight-adjustment vector gave freight dominance to a particular commodity whose wagon-loadings were high in the given situation. The patterns of commodity-displacement in each vector were found to be determined by the compatibility of freight-flows between the dominant commodity and other commodity-freight over the entire IR network. Consequently, while major bulk commodities like cement and coal & coke which had high communality tended to displace other general freight when their wagon-loadings were high, IR was found to substitute other commodity-freight when traffic in these commodities was slack. This had far-reaching spatial and sectoral implications for the entire economy.

It was also noted that the critical variables in the freight-adjustment process were the freighting capacity of the IR wagonfleet and the units in which the freighting-capacity was defined *i.e.* the IR railway wagons. The introduction of specialised wagon designs and increasing specialisation of the IR wagonfleet which had been resorted to in order to augment the bulk-freighting capability of IR were found to act as a limiting factor in situations of traffic slack, since the freighting-capacity which IR could switchover to the carriage of other commodity-freight, had become progressively limited. Through this step-wise analysis, the present study was able to identify several critical problems which have begun to tell heavily on the operational and financial health of IR.

8.2 Critical Problems of the Indian Railways

After the nationalisation of the company railways and their regrouping into suitable territorial zones, IR began operations as a unified national carrier by expanding its freighting-capacity well ahead of immediately perceived needs. The huge capital investments that went into this tied in closely with the strategy of national planning. Over the early FYPs, IR's freight-focus in its extended BG and MG freight operations was thus to serve the transportation needs of the entire country and provide the vital infrastructure for regional development. While extending its technological capabilities to meet the new requirements of an industrialising economy, IR continued to interlink the freight-flows from diverse points of origin throughout the country through the trunk and feeder operations for which the network had been designed. For this, maintenance of adequate railway infrastructure and freighting capacity on all parts of the network was a prime necessity in order to facilitate the continuous flows of general freight between the country's developing markets. Technological upgradation of IR was visualised as part of the process of asset renewal, during which worn-out railway assets were to be replaced with improved variants that would augment IR's technological capabilities for serving the specialised needs of India's new core sector. Although substantial growth in bulk-freight and strategic traffic was expected as a result of the planning effort, balance was maintained between the commercial freighting needs of the economy and the tactical needs of the core sector by maintaining wagonfleet adequacy. Thus, even during the freight crises of the 3FYP which were sparked off by the non-materialisation of bulk-freight in anticipated volumes,[2] IR's general freight continued to move without much of a hitch.

The subsequent change in IR's freight-focus was a partial consequence of the reconstruction of India's energy priorities following the Oil Shocks. Since the capacity to freight coking coal in huge volumes was critical to the establishment of new thermal power plants, capital investment on railway technology and on IR wagon replacement became increasingly specialised around the freighting needs of this single bulk commodity. The gradual decline of parity between IR's general freighting capacity and the freight offers of the economy because of wagonfleet inadequacies led to growing incidence of freight cyclicity. Because of route-congestion on the arterial network and the nonavailability of suitable wagons elsewhere, the complementarities between feeder and trunk freight operations on the MG and BG networks were lost, causing constriction in other segments of the freight market, partly because of line congestion and partly because of wagonfleet inadequacies. While the critical deficiencies of the IR system that were attributable to the lack of sufficient capital resources to simultaneously meet the needs of technological upgradation and asset renewal were taken note of during the review of the 6FYP,[3] the railway component of the 7FYP continued to focus on technological renewal rather than on improving wagonfleet adequacy.[4] Meanwhile, IR decided to do away with the mounting arrears in wagon replacement through the simple expedient of deciding to phase out MG operations and shifting the investment focus to gauge conversion. By progressively reducing the freighting capacity of the MG feeder network, the shift of short- and medium-distance general freight to the roadways was ensured.

Deregulation of the Indian roadways had begun in 1975 during the 5FYP period through introduction of the National Permit system for roadways operators as part of the 20-Point Programme.[5] Following the recommendations of NTPC [1980] for developing intermodal transportation in the country, the ceiling on issuance of Zonal and National Permits by the Indian state governments to roadways operators was abolished in January 1986, which allowed the Indian roadways to emerge into formidable competitors in the freight market.[6] It was consequently noted during the 9FYP,[7] that private roadways operators had moved in aggressively to contest the freight-market space that was vacated by IR.

During this duration and over the period since, IR has remained starved of new capital support from public funds, and has been forced to finance its capital requirements for the acquisition of adequate rolling stock through market borrowings from the IRFC and a flurry of tariff revisions. While the mobilisation of market funds has saddled IR subsequently with increasing debt-servicing costs and has eroded its slim operating ratios, the tariff increases led to further captures of high-valued general freight by the roadways forcing IR's share in the Indian freight market to fall continuously. Today, 89 percent of IR freight traffic comprises seven captive bulk commodities, namely coal & coke, chemical fertilisers, cement, POL, essential foodgrains, iron ore and finished steel and the flow of raw materials to the ISPs, with 99 percent of freight revenues accruing from BG operations and 65 percent of freight traffic being carried on the high-density HDN network linking the 'Golden Quadrilateral'.[8]

Yet, in spite of being in dire financial straits, the phenomenon of 'adverse selection' of railway development projects has continued to plague IR ever since the 6FYP.[9] While mounting arrears on physical renewal of track, traction and rolling-stock continue to squeeze IR freighting capacity,[10] as much as 70 percent of IR plan outlays are expended on new railway projects that do not directly generate capacity.[11] Similarly, while around half of the IR capital fund has been absorbed in UNIGAUGE, an estimated 20-30 percent of IR's market borrowings are being invested in the construction of new lines where traffic will take a long time to develop.[12] Meanwhile, essential investments on IR freighting capacity which would have restored resilience and competitivity to IR freight operations are either not made (in the case of MG wagons) or are staggered over such a long period of time that their effectiveness in meeting the freight competition is lost.

8.2.1 Insights into the Weaknesses of IR

A review of the research undertaken of Indian Railways freight mobilisation in the country perspectives reveal two important aspects that have been similar to other major railway systems in the world. Firstly, most of the systems had to undergo reforms owing to organisational conflicts and declining capital investments. Secondly, the travails the railways had to bear owing to intermodal competition have led to reordering of commodity mix and modernisation of freight transport in order to survive the fierce competition. Historical exploration of the railway systems indicate the various ways through which the reforms have been effected, with allowance for the adaptation of each method to the typicalities of the economy. What remains to be researched presently is whether such reforms or measures can be made applicable to IR in order to overcome the present degenerative status.

It has been seen that the capitalisation needs of the railways are recurring by nature and thus any disruption in funding such requirements can create serious bottlenecks in the provision of future services. Such investments are not only recurring but need to be accompanied with increments in the capital outlay, a basic imperative to accommodate the expanding economy. These twin considerations governing the capitalisation of IR has been greatly impeded by the declining budgetary provisions. In addition, by virtue of its nature as a natural monopoly and the largest public sector undertaking, it is expected to function both as a commercial enterprise and also as a infrastructure to provide a 'socially optimal level' of transportation infrastructure through cross-subsidisation and maintenance of unremunerative services. This is a distinctive feature of IR and the other railway systems reviewed do not necessarily share the same social infrastructure perspective. Thus it is only natural that the reforms undertaken in other systems may not be as viable in the Indian context where generation of internal resources leaves much to wanting along with lack of incentives to achieve cost reduction.

Most of the major railway systems in the world have taken one aspect very seriously under consideration. Their need to upgrade and go for largescale modernisation sometimes have made it necessary for them to reform their organisational structure. For example, the SNCF had undertaken largescale modernisation including rapid transit systems [TGV] and Freight Forwarder Schemes for efficient delivery of freight. This was very much required to compete with the burgeoning road transport. British railways on the other hand, because of passenger domination could privatise their operations to provide the best of services through healthy competition among companies. Japan with its outright privatisation had both political and economic underpinnings. While some have argued about privatisation efforts in the 1980s as similar to 'sale of family silver' during the Meijis in the 1880s, economic arguments are stronger since privatisation could revive the financial health of the JR and also improved the efficiency of the system. Premium services were offered by Shinkansen to enhance efficiency and improve the financial health of the railways. Chinese Railways, with a very similar position as IR, have resorted to private borrowing but at the same time has been expanding its network to increase its internal resources. Whatever be the mode of reform modernisation have always been a priority along with the enhancement of efficiency levels. IR for example, had introduced the Rajdhani and Shatabdi expresses in the lines of TGV and Shinkansen for passenger transport, while leasing schemes like OYW or BOLT were introduced to reduce the burden on freight division to subsidise the capitalisation needs. But the latter was unable to make much headway since private initiatives were not forthcoming and the required monitoring of the schemes were not attended to. Whatever be the *modus operandi* the railway systems have been trying to overcome or handle the major problem of surplus generation without which the continuous capitalisation needs cannot be met. In IR the problem is all the more acute because of the longstanding dividend payments to the government at first charge even when the railways are suffering from severe fund shortages.

8.2.2 Operational Genesis of the Above Problems

A general phenomenon that has affected the major railway systems is related to the consequences of inducting new technology. Ushering in new technology has often been counterproductive as it escalates the cost of acquisition with the laying off of old capital assets. To generate more resources for capitalisation needs, the brunt is usually borne by the heavier segment i.e., the bulk commodities that are subjected to regular tariff revision with escalation in tariffs, as is evident from the IR experience. Consequently high rated traffic is chased away and there is a fall in the demand for freight services resulting in slowdown of industries and the macro economy at large. This phenomenon is stark in railway systems of developing countries like India where resource crunch has had a serious detrimental effect on the growing economy since the 1970s. Thus to maximise its gains from new technology subjected to capital constraints, effective measures have been adopted and often successfully implemented by the SNCF, the JR, the British railways and the American railroads is to make the system cost effective. Enhancing efficiency levels or reducing the costs of operations are the two aspects on which IR needs to stress upon before venturing into other areas of reform.

Thus it is apparent from the previous analysis that capital flows towards infrastructure is the major determinant of its expansions and operations without endangering the capacity utilisation and efficiency parameters. However, the unsustainable and most often erratic nature of budgetary support in the case of IR has its own implications while the situation is aggravated by the operational inefficiencies created within the framework. In the face of declining Government budgetary support to the IR, generation or mobilisation of internal resources for railway development has become an imperative and in the face of this situation proposals for privatisation or deregulation of IR has come to the forefront as suitable alternatives to the existing state-owned structure. The proposed alternatives point towards the commercialisation of railway operations in India following the already privatised or deregulated operations of other countries. But the inherent inadequacies of IR do not leave any room for emulation but a proper analysis of the constraints and a prescription that is best suited for IR. All possible means of accomplishing revenue generation would need to be explored, including the raising of rail tariffs, and reducing railway costs.

It would be worthwhile to identify the various inefficiencies and their causes while trying to suggest the obvious way out.

8.2.3 Inefficiencies in Management

The first endeavour on the part of the railways to generate more resources and become commercially viable within the existing framework can be understood to be an attempt to reduce the railway costs and to raise the productivity standards with respect to both labour and capital. Certain inefficiencies in both management and operations need to be treated in order to accomplish this. While the aspect of productive efficiency is important in every organisation, special attention needs to be given to those units where efficient handling of operations proves conducive to the growth of the economy and increase in social welfare.

China, comparable both in terms of state ownership and its vast network, shows a much more favourable operating ratio in terms of personnel cost and the total revenue generated [26 percent in China against 45 percent in India; *see ch2*]. Modernisation of railway operations and mechanisation of freight handling in many cases have led to surplus personnel and a consequent decline in labour productivity. Since a significant portion of the revenue generated is earmarked for personnel cost, it has caused IR to be a high-cost organisation since retrenchment possibilities prove difficult in a PSU. With a distinct shift towards a specific freight-mix and the consequent specialisation of wagons, handling of freight operations have become highly specialised and less labour dependent. For instance, specialised wagons for handling coal and other bulk items like the BOX and BOXN are equipped with side discharge arrangements to facilitate unloading of coal at sidings. Bottom discharge wagons like the BOBS/BOBX are specialised to transport ballast and ores which can be unloaded at the plant sidings. Computerisation of certain facilities have also added to the redundancy of railway personnel.

While the immensity of the staffing problem cannot be understated, it is also difficult to arrive at any cogent solution to this issue through privatisation or deregulation. The question remains that can privatisation ensure increased labour productivity with deliberate reduction in manpower? The true yardstick of the success of privatisation is the privatised railway company's ability to pay a stable dividend without recourse to fare increase. In practice, this requires reduction of in the ratio of personnel costs to revenue, so that salary revisions do not introduce a cost cascade. As noted earlier, JNR in its heyday in 1974, had a ratio of 86 percent which in 1986 had declined to 63 percent. Privatisation had however brought an immediate decline to 28 percent in 1988, considerably raising productivity. The eventual target has been to reduce the total number of employees to 68000 through introduction of high technology and computerisation, so that the cost ratio stabilises at 20 percent.

Apprehensions and general misgivings amongst the employees in pre-privatised JR because the government would no longer provide job security had led to initial problems within the privatised JNR. However, JNR could effectively bring down the cost ratio by successfully reallocating surplus personnel to the development of subsidiary business by the railway companies.

8.2.4 Operational Inefficiencies

From the previous analysis it is apparent that labour productivity in the case of IR provides a dismal picture and a reduction in operative cost can be brought about only by curtailing expenditure on salaries or wages or reducing the staff strength. Under the present state-owned structure this avenue being non-applicable, it is necessary to ensure a higher capital productivity to generate higher revenues in the near future. Efficient utilisation of capital assets has thus been the key to resource generation. However, improvement in the efficiency in certain operational indicators *[see ch4]* can arrest the decline in capital productivity in IR as noted earlier. One such indicator is the turnaround time (TAT). An increase in TAT can be attributed to system inefficiency factors like track congestion or slower movement of wagons owing to less tractive effort. Considerable scope exists to achieve a lowering in the costs of railway services through a reduction in TAT. While at the current train-speeds, daily wagon utilisation is of 5-6 hours, optimal utilisation of wagons requires that each wagon be kept on the move for at least 10-12 hours. Reduction of wagon turnaround time from the present TAT-level of 10-11 days would create additional wagon-loading capacity of another 12 to 15 thousand wagons per day, without raising capital costs or interest and depreciation. Freight efficiency could also be improved by induction of latest wagon technology that would raise axle loads to 24-25T consequently raising loading-weight of the wagons to 100T.[13]

Another aspect that demands exploration is the increasing incidence of empty wagons on track, a fallout of specialisation of freight-mix on IR. This also has a bearing on the increase in TAT. If the policy once again is oriented towards a diversified freight-mix with commensurate wagons that are upgraded general categories of wagons, then the inefficiency owing to running of empty wagons may be reverted. Scope for productivity improvement exists with improvement in coaching utilisation from 408km per day to 600 km per day at an average speed of 40kmph and coach availability of 15hrs per day. Wagon turnaround can be reduced from 11.5 days at present, since at least 8.5 days from this presently go into empty movement and maintenance. Allied to this is the concentration of traffic on the trunk routes leading to congestion and a consequent increase in the TAT. Line capacity utilisation presently varies between 40 trains per track km per day on Golden Quadrilateral routes to 21.4 trains per track km per day overall. Technical feasibility would in fact allow 72 trains to be run per day with mean headway of 20 minutes, substantially raising handling capacity.[14]

A likely alternative to the present system of operations may be investments on new tracks and doubling of the existing lines. However the former alternative is not appealing at this juncture because of the immensity of investments and the long gestation period involved before receiving any returns. Investments would also have to be made on electricity provisions to run the trains unless we acquire diesel-electric engines like France to run on those routes that are not electrified.

Cost reductions would also have a financial dimension. Conservation of railway resources would imply the optimisation of capital-use. In practice, this suggestion would require a rolling-back in the manufacturing activities currently being executed by the Indian Railways, and would permit private-sector manufacture of rolling stock not only to meet the requirements of the Indian system, but also with the intent of achieving exports. Another innovative method of relieving wagon-constraints would be to allow the establishment of leasing companies which owned their own wagons and made these available to shippers under contract. Leasing activity has been the primary impetus behind the growth of the roadways sector over the last few decades, in India and throughout the world. Entry of leasing into the railway freight sector [as in France] would therefore replicate the inflows of credit-capital that expanded road freight operations in India, without overloading the Indian Railways with interest charges. The recent schemes of OYW and BOLT are being floated to derive more resources through leasing. The proposition, although may sound effective in overcoming the capacity constraints, lacks in proving itself as a general phenomenon to cover all commodities handled on both commercially viable routes and commercially nonviable routes but socially desirable routes. Leasing activities in all probabilities will be restricted to those sections where the demand for wagons are assured by the captive traffic and thus the basic thrust on infrastructural development as a national objective may be missed.

On the tariff side, although some extent of cross-subsidisation between inter-freight services and between freight and passenger operations would have to be retained in the interest of social objectives, the general direction of tariff reforms should be to reduce both the spread and the extent of freight subsidies on commodity traffic. Similar rationalisations in case of passenger-subsidies would also relieve financial pressure, particularly if passenger operations as a whole were made self-sufficient, with the cost of subsidies in lower classes of travel being entirely borne by passengers in the upper classes.

8.3 Policy Review & Recommendations

The two broad objectives of IR as laid down in the Status Paper and subsequently in the White Paper on Railway Projects are penetrating by nature but overlook the role of infrastructure as a major determinant of economic growth. The first objective entrusts IR with operating on commercial principles to cope with the 'needs of the burgeoning national economy', while the second requires the IR to fulfill the aspirations of the people as represented by the 'local, State and Central Government agencies'. Nothing really prevents IR from running as a commercial undertaking, but for it to run autonomously and efficiently, a separate corporate identity is deemed necessary. The disadvantages of monolithic and monopolistic organisation are to be overcome, even as the efficiencies and economies of scale resulting from the organisational mode are retained. While addressing this issue it should be kept in mind that sufficient scope exists to improve coordination between the Railways and their major users both as institutionalising present operations and planning expansions, and also to integrate railway development in the regional planning exercises. A clash inevitably occurs between social and commercial objectives in railway operations at this juncture when curtailment in capital support over the plan periods (from 75 percent in the 5FYP to 23 percent in 8FYP) are practically making it imperative for IR to operate on commercial principles.

The primary underlying reason for developing an infrastructural utility or service in a country is the extended linkages this has with economic growth and development following the Schumpeterian innovation cycles and Kondratieff long waves. Infrastructure being an auxilliary to *development* process, has the capacity to induce qualitatively superior and diverse forms of economic activity that ensure development of downstream activities. The choice before the government is either to broaden and strengthen the economic base or to focus on downstream positions, both critical in determining the overall productive capacity in the economy. While both are necessary as complementarity can be noticed between the two positions, a certain sequencing of the investment decisions will ensure the continuous flow of services from one to the other. An obvious choice for developing countries like India in the face of capital scarcity is to first broaden the economic base with various infrastructural facilities so that it initiates a development process and takes the economy to the takeoff stage. Investment in transport infrastructure had been an important objective in colonised India and with independence it had also occupied a primary position in the initial Plans. Among the alternative modes of surface transport, railways in India hold a special importance as it is the fastest and most efficient form to improve communication linkages covering long internal distances. While the advantages of a railway system has been amply made clear in the White Paper,[15] a justification of IR as an infrastructure remains to be included. The thrust on IR as an infrastructural variable in the first two Plans was never repeated in the subsequent plans, diminishing the role of IR as an important development determinant. The spill-overs from developing a transport infrastructure like the railways into the Indian economy was strangulated by the lack of initiative to maintain a continuous flow of investment to this sector. Once the gestation period was over the downstream effects would have been more pronounced. What it requires is the acknowledgment on the part of the planners that the development of railway infrastructure can be continued along with investments on other infrastructural facilities. While it is an established fact from country experiences that alternative modes of transport can be most efficiently utilised if they run complementary to each other, a lot remains to be desired from the Indian experience. Controversies arising around the non-viability of railway projects and the viability of roadways are baseless if both the systems are allowed to operate in a noncompetitive manner and the development of one cannot be made at the expense of another.

The problem of funding railway infrastructure in India is a moot question in the Status Paper as well as in the White Paper. The philosophy of infrastructural investment has been that with uninterrupted flow of investments would, after a time lag, ensure a continuous flow of returns - both economic and social. While the public utility aspects, dealt with earlier, relates to the provision of transport infrastructure on noncommercial terms, satisfying 'wants' that merit to be provided for 'through the public budget', lack of budgetary support over continuous periods of time now demands the running of IR on commercial principles. The rationale behind public investment advanced in relation to railway infrastructure is based on the prevalence of investment that is lumpy, give low returns, are technically indivisible and incur high fixed capital costs - characteristics that are otherwise unappealing to private investors. In the presence of such non-profitable situations, apprehensions that privatised provision would lead to suboptimal supply and inadequacy of services cannot be ruled out. Although theoretically public provisions for infrastructure is the best means of fulfilling the social and economic objectives through capacity creation, history shows that government policies towards financing infrastructure have most often been responsible in impeding development in this sector, restricting the benefits of large scale economies in the long run. Fund flows, as is evident from the plan allocations, have been declining giving rise to delays in clearing backlogs and carrying over of present investments into the future. The lack of concern on the part of the Government over the last three FYPs precipitated the situation. As an infrastructure of great social importance IR had to operate under restrictive circumstances where primary social objectives were served through low-cost prioritised haulage at the expense of commercially preferable operations. Internal generation of resources were thus low and added to this was the decline in capital flow from the General Exchequer. This crunch eventually manifested itself in capacity constraints which in turn led to narrowing down of the total freight-mix comprising of socially-preferable traffic and bulk traffic to other PSUs. In a bid to maintain only the assured traffic, IR shifted its focus in modernising transport capacity to handle the specific commoditities and thus the high valued traffic diverted to the fast growing roadways.

The phases of the emergence of the resource crunch thus had a direct effect on the patterns of IR plan investment, especially after the 3FYP, with the 'plateau' phase of IR operations being closely coincident with the investment slowdown between 1965 and 1980. Accumulation of a massive backlog of rolling stock and track replacement created a pressure on IR which eventually attempted to ease situation since the 6FYP with a planning shift towards bulk-freight and the BG network and an associated pickup in investment towards upgradation and modernisation of rolling stock to cater to bulk. As a result a substantial portion of the then existing MG capacity remained underutilised.

Many causes can be ascribed towards the resource crunch, primary among which is the high cost of technology induction on the BG network. Other issues relate to the shifting of plan focii from a largely infrastructural plan in 1FYP allowing the transportation sector to claim the highest percentage share of investments made, to a divergent policy of subscribing to direct participation of the state in economic activities leading to a proliferation of public sector units. Support to infrastructure took a backseat accordingly, partly also because of the inability of IR to raise revenues and internal generation of resources. Reliance on market borrowing in the later plans is a device to find solutions to the resource crunch, and an admission that substantial state funding is not likely to be forthcoming. The option that remains for IR is either to raise internal surpluses or to avail capital credit. While the former option is being thrust upon IR, the primary avenue to mobilise resources through increasing traffic is constricted by a shift to low-valued bulk only and nonavailability of additional capacity to accommodate increased traffic. Under these circumstances, the IR revised its rate schedule in quick succession under pressure to generate internal resources. As is evident the upward revision in rates only aggravated the situation since it failed to woo back any traffic from the roadways by way of lowered costs. Another stronger manifestation of catering to specialised freight has been the focus on only a few busy routes implying that many other lines would soon become unprofitable and the IR will be caught in a vicious circle from which there will be no escape.

The second option of market borrowing is an expensive proposition since loan capital will only generate more pressure on IR in the form of interest payments. Investment in infrastructure being characterised by 'lumpiness' and 'low returns' on capital requires a higher interest rate guarantee to attract capital in this sector, a fact that has been historically proven. Hence to compensate for the dwindling capital funding by the General Exchequer the IR is being caught in a debt trap and a careful evaluation of this option is becoming imperative.

8.4 IR: Scenarios for the Future

Restructuring of the railways is currently an important area in international economic debate. Through most of their history, the world's railways have operated either under direct control or close regulation by government. These operational modes relate as much to the history of railway construction as to the economics of public utilities and limited transport competition. Sinking of large amounts of capital on railway projects with long gestation required the active agency of the state. However, given the present state of affairs on IR, considerable debate has centred around reorganising IR. Before entering the debate centering around privatisation of Indian Railways, certain features are to be kept in mind. A layer of government policy that is neither micro nor macro is the attainment of social objectives that is best described as social policy. The government in such cases cannot remain a passive observer but needs to be an active participant in economic decision-making through interventions such as controls and regulations. Market failure in the case of provision of merit goods such as railway infrastructure compels government intervention and hence if privatisation is to be entertained, it needs to pass the test of fulfilling social objectives.

IR being a natural monopoly, public sector production is indicated. Thus it is difficult to leave it to private production. However, it has been advocated by many that induction of new technology have reduced the area of natural monopoly and that regulatory measures can reduce the scope of extortionist pricing. Recent experiences of privatisation measures in UK have shown that 'it is institutionally easier to regulate a private monopoly than it is manage a public monopoly, to serve the public interest tolerably well'. [16]

What exactly does railway privatisation mean in an Indian context? It can either mean that there would be complete change in ownership over IR, with outright sale of assets to private institutions and individuals or can mean joint management of IR by both public and private owners, with partial deregulation and reduction in government controls. In the case of the former, it should be borne in mind that IR is one of the world's largest monolithic organisations and it would be extremely difficult for a single private institution to purchase its huge assets along with its huge existing liabilities. In a situation like this, private ownership - if at all possible - cannot be socially efficient since all unremunerative railway operations would be shut down to make railway enterprise cost-efficient. In the case of the latter proposition, it is possible to hand over certain operations of IR to be managed by private institutions, as has been done in the UK by handing over British Rail operations to private sector, without impinging on the infrastructural and social objectives of running the railways.

However, with India being a country of subcontinental dimensions, with innumerable cross-country freight movements, it would be extremely hazardous to entrust the responsibilities of coordinating all traffic movements to a private institution. A third definition of railway privatisation would mean the outsourcing of certain railway services and utilities to private-sector organisations while the ownership of the railways continued to vest with the state. This is the only possible case for IR, where tertiary services like catering and the running of railway hotels could be left to private managements.

As the history of the Indian railways has portrayed, privatisation had failed to prove its worth in the early phases of railway development in India. Various forms of private-sector association with railway development in the country are seen during the prenationalisation period from 1849-1924, which may be subdivided further into three separate phases over the subperiods 1849-1869, 1869-1882, 1882-1924. In all such associations, private entrepreneurial capital only evinced interest as long as the returns from railway investment were attractive, and its interest did not extend into the long term. Hence, applying the lessons of the past to the present context, no assurance is gained that private execution and operation of infrastructure projects would in the long run prove more efficient than government involvement. Even if the lessons from history cannot be drawn into the present circumstances where IR is running an operating loss, one cannot deny the positive attributes of having a state-owned utility like railway infrastructure. Considering the public-utility character of railway transportation - although this was not overtly emphasised during colonial rule - the Indian state in its early FYP allocations had aimed at transforming the infrastructural base of the country in keeping with national and development interests. The problems of lumpiness in infrastructural investment and the disincentives of low capital returns thus made it imperative for the renewal of railway infrastructure in India to be funded by the state. However, the insurance against capital losses guaranteed by the steady flow of government equity also has the danger of injecting further complacency within the IR organisation. This can only be ruled out by assuring the efficiency of IR operations. An attempt has been made in the foregoing chapters to identify the operational weaknesses of IR and the capacity constraints that ensued. If alternatives like largescale privatisation and total deregulation need to be implemented, it is necessary to seek remedies or corrective measures within the alternatives in order to pose stronger arguments in their favour.

Traffic shares of the Indian Railways have been falling despite growth of tonnages and tonne-kilometres, because of the inability of the railway infrastructure to handle the existing level of traffic demand. The main reason for this is the inability of the Railways in the face of resource constraints and declining budgetary support, to meet the capital costs of new railway construction, maintenance of railway rolling stock and equipment, and technology upgradation. Privatisation is therefore often the mooted solution, following the recent examples of developed countries over the last two decades. The forms that privatisation has followed in these countries are varied and include divesture, contracting, concessionary/subsidised private operation, joint ventures, and deregulation. Privatisation is believed to improve efficiency, quality of services and the speed with which technological innovations are incorporated into railway systems, without compromising with the primary welfare objective of providing transport infrastructure to the people. However the present levels of Indian Railways infrastructure vis-a-vis available technology, and the degree of lumpy, long-gestation capital investment that will be required to bring its services on par with advanced railway systems, is still the principal disincentive to a privatisation effort.

Although Build, Operate & Transfer [BOT] concepts are already being contemplated for the highways and power sectors, prior experience of privatised railway development between 1849-1869 should alert policymakers to the need for building in a monitoring provision into the concessions granted, which would reward good performance and penalise bad.

In view of the foregoing, and in the interest of supporting overall economic policy in India, core railway services would have to be retained in the public sector, although ancillary and peripheral activities could be partially privatised, which could include terminal, handling and storage operations, container depots, telecommunication uplinks, captive power installations, and the marketing of freight services. Another important area where privatisation might be considered is the production of railway inputs, as also civil maintenance of railway colonies and stations. Privatisation of the Railways' production undertakings would have to proceed progressively, from their present form as departmental undertakings to their constitution as joint-sector commercial undertakings.

Even in the developed countries where railways have been privatised, entry of private enterprise has largely been confined to economically viable projects only, because of the trade-off between private profits and social objectives that takes place whenever a public utility is privatised. The scope for privatisation of railways depends on the operating environment within which they function. Hence the experience of privatisation in other countries can often prove a poor guide to the operational prospects of privatised railways in India. The factors governing railway deregulation and privatisation in the US and the UK were partly conditioned by a general trend towards privatisation of public industry. In India therefore, the objective of improving railway efficiency that underlies the privatisation debate might be achieved as effectively by the lesser step of reconstituting Indian Railways into a public-sector corporation with room for private sector participation in equity. Such a device would provide autonomy of investment and pricing policies, while simultaneously expanding the capital base.

Even in the theoretical literature deregulation is differentiated from privatisation. While, under the argument of the Theory of Property Rights that a privatised structure provides incentives towards optimisation, privatisation implies the actual transfer of ownership, deregulation implies the removal of state restrictions on entry and withdrawal, and in this light is the spirit that guides the present liberalisation ethos in India. Either measure is equally capable of improving productivity and efficiency since there is close association between the 'free market', and the 'contestable market' of deregulated industry where all firms access identical production methods and hence have identical cost functions. For an industry to be truly contestable, the process of entry of a contestant should involve no sunk costs, which would otherwise impede exit on account of irrevocable investments made. In the US, the contestability theory has been the main foundation for deregulation of railroads.

In Britain however, the effort to improve the efficiency and coverage of railway services has proceeded on the basis of transfer of ownership to create incentives for profit maximisation within an optimal industrial structure. Besides improving efficiency and technology, two external objectives which also guided the privatisation exercise were the augmentation of government resources through divesture of railway equity, and the disciplining of militant trade unionism. Even so, the principal motivation behind largescale privatisation of public sector undertakings in the UK was the sale of state assets to mobilise revenue for the exchequer.

Deregulation in the US and privatisation in the UK have succeeded by and large in those industries where the proportion of sunk costs are insignificant and cost contestability prevails. The roots of indifferent PSU performance in most countries lie not in inferior managerial ability but in the additional constraints that shackle managerial innovation and initiative. Applying the context to the railways, the additional constraints that operate pertain to the social welfare objectives of transport operation. Market allocation processes, such as those in the so-called free market, have to apportion both costs and benefits efficiently, bearing in mind that while costs are a supply variable affecting producers, benefits or utilities are a demand variable affecting consumers. The 'Conventional Wisdom' of welfare economics therefore holds public ownership to be most appropriate in those social contexts where although efficient apportionment of costs may ensure efficient supply, the market mechanism works inefficiently when it comes to distributing benefits. Thus across-the-board privatisation in such cases would hurt allocative efficiency, even while promoting productive efficiency, primarily because the viability of public sector investment and particularly of railway investment has to be assessed on social cost-benefit considerations rather than on the pure return to capital.

Granted then that privatisation involves both gains in productive efficiency and losses in allocative efficiency, privatisation might be advisable for PSUs where the former would more than outweigh the latter. In infrastructural contexts however, the object of allocative efficiency acquires long-run developmental significance that is of far greater importance than short-term efficiency in supply. In the given situation, privatisation cannot be the best alternative for the Indian Railways, since its success in maintaining allocative efficiency is not attested to by the experiences of railway privatisation in other countries.

This does not detract however from the importance of improving efficiency of supply of railway services. The situation under which the Indian Railways have operated has assigned disproportionate importance to the social objective of achieving allocative efficiency, because the extent to which the Railways are publicly accountable for productive efficiency as a departmental undertaking is limited to realisation of dividends of 6.5 percent on total capital-at-charge to the General Revenues of the Government of India. The price of this limited accountability is limited autonomy since Railway investment programmes are determined by the Planning Commission and pricing policies by Parliament, leaving the Indian Railways no freedom in prioiritising investment or determine tariffs. Certain other technical factors also limit privatisation possibilities, including technical indivisibility of Railway assets, the scale and lumpiness of Railway-capacity investments that render these beyond the reach of private investors, the 'sunken' character of Railway costs, the vertical integration that distinguishes railway operations, and other features such as scheduling services, etc.

Therefore, to induct commercial principles into railway operations in order to improve productive efficiency, without sacrificing allocative efficiency, the halfway solution would be to reconstitute the Indian Railways as a autonomous public corporation empowered to take its own decisions and pricing an investment.[17] To augment capitalisation of Railways, and therefore to remove the major constraint that presently limits their expansion, the private sector could conceivably be persuaded to participate in the equity of this corporation.[18]

As is evident from the above privatisation of the Indian Railways is not desirable at this juncture, a move is needed to allow it the autonomy to function within broad policy parameters laid down by Government. Accordingly the manufacturing activities that are presently administered departmentally and are a part of the Indian Railways for historical reasons should be separated and constituted into independent PSUs. Ultimate privatisation of these allied activities would release considerable resources for railway development, while permitting the Indian Railways to concentrate on core business. Similar separation of railway construction activities might also be envisaged.

Whatever be the form of organisation, it is imperative that a huge capital investment is the necessity of the hour to give IR a new lease of life. This has been true for the SNCF too. Along with the investment, what is needed is a commercial strategy which can bring in aggressiveness in competition like the SNCF. For this, no reforms in the organisation is actually required. What is needed is the luring back of traffic from the roadways. Once IR can dominate the freighting scenario like the 1960s, the financial health of IR is going to revive automatically. To run IR commercially what is necessary is sufficient autonomy. Subsidisation of tariffs and fares to cater to certain sections of the economy, continuing operations of unprofitable lines, provision of mass transit are some of the social obligations that IR has to meet. Other goals which IR needs to serve is to support regional development and development of industries related directly to transport infrastructure like construction and heavy industries. While these goals need to be supported since they are inherent to any infrastructural development, it has become a burden for IR to generate resources from socially preferable operations. In addition, the dividend payment to the Exchequer is a burden that IR is compelled to bear inspite of other investment priorities. Such multiplicity of goals has created conflicts of priorities which have tended to slow down the decision-making process regarding projects and piecemeal adjustments of investment towards the projects have most often rendered them counterproductive. Thus while the multiplicity of goals retards the policy- and decision-making process, it is necessary to prioritise the goals once-and-for-all and earmark investments for the projects undertaken for future convenience. In this context, it is necessary for IR to have the autonomy to decide on its priorities and undertake its investments.

What the study has proven is that the revival of IR lies in its own hands. As has been rightly pointed out by NCAER [2002] and as seen from the study that the railways are vulnerable to cyclical fluctuations in the core sectors of the economy since the railways have concentrated on freighting bulk-commodities. Except for a few captive commodities like coal and iron & steel, even these commodities are registering a decline with IR revising its tariff more frequently than is desirable. This eventually leads to a cost cascade within the economy and forces a changeover from the railway mode of transportation to the roadways. To win back the freight already lost, IR has to gear up to provide 'reliable services at a competitive rate'. Following the footsteps of the SNCF, IR can improve on its acceptance of the smalls and piecemeal traffic which are very often high-valued freight. Even the feeder networks need to be revived instead of writing them off. Concentration on the HDCs will not help in ensuring a continuous increase in traffic volume since extreme congestion and inadequate freighting capacity will deprive many freight offers. Thus, judicious investment in creating capacity ahead of demand - a golden rule in infrastructural investment - is the need of the hour, no matter who or what the source is. And this is the only way IR can benefit in the future because increasing freighting capacity is essential for the running of a transportation infrastructure. Keeping the implications of the role of infrastructure in mind, it is necessary for the Government to renew its thrust on IR development programmes and make provisions for a steady capital flow to the sector to rejuvenate the railway system. While the primary capital investment to clear the backlogs and add to capacity should be from the General Exchequer, the IR needs to devise its own policies to generate more resources than before. This is the only way by which both the social and commercial objectives of railway infrastructure can be preserved.

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