EFFECTS OF ECONOMIC REFROMS ON X-EFFICIENCY OF INDIA'S PUBLIC SECTOR BANKS: AN ECONOMETRIC FRONTIER APPROACH

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DECLARATION

I declare that the thesis entitled Effects of Economic Reforms on X-efficiency of India's Public Sector Banks: An Econometric Frontier Approach has been prepared by me under the guidance of Dr. Indrajit Ray, Professor of Commerce, University of North Bengal. No part of the thesis has formed the basis of any degree or fellowship previously.

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ABSTRACT

Financial development is the back bone of economic development and hence the efficiency of the financial sector foretells on the economic health of the country. The concept of X-efficiency is a new entrant in the field of efficiency measurement. The X-efficiency deviates from other types of efficiency as X-efficiency is said to arise due to changes in qualitative factors like motivation and competition. The unit of analysis in the X-efficiency theory as per Leibenstein is the individual in the organization rather than the firm. The thesis thus studies the X-efficiency of India's Public Banks, particularly the impact of banking sector reforms on X-efficiency. Majority of the banking literature concentrate on the technical, scale and allocative efficiencies while very sparse literature is available on the study of X-efficiency of Indian Banks. The thesis tries to make a comparison between the effect of the first and second generation reforms initiated in 1991 and 1998 respectively. It also tries to make a comparison between the banks on the basis of ownership by comparing the performances of the Public Sector Banks, Private Domestic Banks and Private Foreign Banks.

The X-efficiency has been measured here using two alternative methods, Generalised Least Square (GLS) estimation and Maximum Likelihood Estimation (MLE). The study makes use of the translog cost function and panel data for the period from 1994 to 2012. The panel comprises of 57 banks, comprising of 25 Public Sector Banks, 17 Private Domestic Banks and 15 Private Foreign Banks. The outputs used in the cost function are loans and advances, and investment while the inputs taken into consideration are price of labour, price of fund and price of capital.

It is found that ownership does not play a very significant role in determining X-efficiency. During the period of analysis it is found that the most efficient banksare the public sector banks at 80.24 per cent X-efficiency score, while the private foreign banks score 79.93 per cent and the private domestic banks 77.3 per cent. Taking into account only the second generation reform this study reveals that the private domestic banks register a growth in X-efficiency at 88 per cent while the public sector banks following very closely at 87 per cent while the private foreign banks are at 83 per cent. These signify that X-efficiency is not affected by the ownership of banks. A comparison between the GLS and MLE estimation also reveals that there is quite similarity in the results obtained from both the methods.But the MLE is more appropriate in X-efficiency study as there is a loss of data in the GLS estimation.

PREFACE

As a student of economics, I grew an affinity towards macroeconomic variables and their interplay in the economy. The love for the subject grew from my schooldays when I was first introduced to the subject and right through my master's level study. What interested me much was the subject of banking and finance, and in it, the topic of behavioural finance. It provoked me to think how individuals who are selectively rational make rational decisions. My interest got cemented when I joined a private foreign bank –the Deutsche Bank –and was posted at Bangalore. It was there I came across the concept of X-efficiency. That point I thought the topic to be theoretical and full of ambiguity, something that was understandable but not doable. For the sake of academic pursuits, however, I finally joined University of North Bengal where I met Dr Indrajit Ray who had been working in this field for a number of years. My understanding of the topic grew with the articles I read, and finally, my choice of topic settled at the present one.

I am indebted to a cross section of individuals. My sincere gratitude goes to my guide Dr Indiajit Ray, Professor and Head, Department of Commerce, University of North Bengal, who continuously inspired me and guided me during my course of study. I would be forever grateful to him for giving me the opportunity to work under his guidance.

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Last but not the least, I express my humble gratitude to my parents and other family members, especially my sister Ms. Sumita Pradhan, for being my strength and backbone during the whole course of my study. Without their constant effort and encouragement nothing would be possible.

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INTRODUCTION

India opted for holistic economic reforms in 1991, and over the last quarter of a century, several reforms followed in her macroeconomic management. The process, indeed, began with the financial sector reforms. A general curiosity is then: Why should the financial sector reforms precede the overall economic reforms? Its answer explains the *raison de etre* of this dissertation. Belonging to a broader genre of efficiency issues in commercial banking, our line of argument is that the financial sector crucially promotes economic development in a country so that, prior to thinking about economic prosperity, the policy-makers should seek for efficiency of financial intermediaries. This is, indeed, the subject matter of Section I in this chapter. Keeping this backdrop in mind, we proceed to examine in Section II whether India's commercial banking system subserved the growth interest of the country prior to the days of reforms. This establishes the rationality of the banking sector reforms in India. Section III narrates in brief the major reforms in this field during 1991-2016 so as to understand the underlying objectives of India's financial sector reforms. In Section IV, we discuss the main motivation of this dissertation, that is, the question of efficiency, in theoretical sense. Various types of efficiency measures that are developed in the literature are discussed here. Finally, Section V presents the major objectives of this dissertation, its underlying research questions, as also the organisation of chapters that follow. Section VI summarises the major observations and suggestions by way of conclusion.

Section I: Finance and Economic Development

Money is primitive to the financial system. A financial economy develops only when money steps into the real sector, *a la* Don Patinkin,[1] as a commodity. Though it is bought and sold in the market like other commodities, it ushers in a breakthrough in the growth trajectory of the real sector. Finally, it gives rise to a monetised economy, as opposed to the real economy, based on the financial sector. But a pertinent question is: how does money perform this development task? To Adam Smith, the division of labour is the kingpin to the rapid economic progress; and, without money, the division of labour cannot take place.[2] Facilitated by the use of money, the division of labour ushers in specialisation among various workers in the society, whereby their productivities are augmented, and the wealth of the nation adds on. Adam Smith establishes this argument theoretically with rigour, and also empirically citing the evidence of ancient economic development in Bengal and China.[3]

But the perception about money, and hence about the financial system, undergoes changes in the writings of neo-classical economics. There we find money acting simply as a veil in the economy - beneath the veil, the real sector operates. Money is, therefore, neutral to the real sector development. The neo-classical macroeconomic system[4] consists of a production function

$$y = F(N) \qquad (1.1)$$

[1] Patinkin, *Money, Interest, and Prices*
[2] Smith, *An Inquiry into the Nature*, pp. 3–20
[3] Ibid
[4] Ackley, *Macroeconomics*, pp. 144-146

where y is the output and N the level of employment; the labour market equilibrium:

$$f'^{-1}\left({}^{W}/_{p}\right) = F\left(\frac{W}{P}\right) \qquad (1.2)$$

where $f'^{-1}\left({}^{W}/_{p}\right) = N$ is the inverse demand function for labour, $F(\frac{W}{P}) = N$ is the supply function of labour; and, finally, the capital market equilibrium:

$$I(r) = S(r) \qquad (1.3)$$

where $S = S(r)$ is the saving function and $I = I(r)$ is the investment function. Given that $f'(N) > 0, F'\left({}^{W}/_{p}\right) > 0,\ S'(r) > 0$ and $I'(r) < 0,$ we obtain the values of $N, y, r$and ${}^{W}/_{p}$.

To derive the money market equilibrium, the Fisher's quantity theory of money is used:

$$M = kPy \qquad (1.4)$$

Given the supply of money M, and also the equilibrium values of y and k, we get the equilibrium price level P. Now, if the supply of money is changed, the price level simply moves concomitantly keeping the real sector unaltered. Even, it cannot generate any impact for the capital market since equilibrium condition for the market does not involve any of these money market variables. However, by using money as a commodity, Patinkin removes this dichotomy between the real and monetary sector on the basis of the Say's Law in the identity sense and the Walras Law.[5]

[5] Patinkin, *Money, Interest, and Prices*

In the Keynesian system,[6] however, the dichotomy is totally absent mainly because of the reformulation of the demand for money. Keynes introduces the demand for money function as

$$M_d = L(Y, r) \qquad (1.5)$$

With the classical assumption that

$$L'_y(Y, r) > 0 \qquad (1.6)$$

he assumes

$$L'_r(Y, r) = 0 \text{ at} r = r_{min}$$

$$= \infty \text{at} r = r_{max}$$

$$< 0 \text{ otherwise}$$

Now if there is any change in the money supply, there would be no change in the transaction demand for money (M_t) as $k, P$and$y$ remain unchanged. Hence, the speculative demand for money changes, which, in turn, lead to a change in the rate of interest. The capital market would then be affected since investment is a function of the rate of interest. Thus, the money market equilibrium in the Keynesian formulation

$$M = L(Y, r)(1.7)$$

integrates the real sector and the monetised sector. Thus, the changes in y in the real sector affects the money market equilibrium through the transaction demand for money; and the changes in r in the money market equilibrium leads to changes in the real sector through the capital market.

[6] Klien, *Keynesian revolution*, pp. 56-90; for Keynesian theory of money and price, see Hansen, *Guide to Keynes*, pp. 183-204

From the classical perception of macroeconomic behaviour, however, the present literature advocates two important lines of argument in support of the relationship between finance and economic development. One line, as provided by Joseph Schumpeter,[7] is that the circular flow of income across various sectors in the economy leads to economic stagnation. Only the innovator can break through the circle by way of introducing new products and/or new processes in the society. Such innovations are difficult to keep afloat without financial assistances from banking institutions. Here lies the role of commercial banks in economic progress. Schumpeter writes, 'The banker therefore is not so much primarily a middleman in the commodity of "purchasing power" as a producer of this commodity'. 'However', he continues, 'since all reserve funds and savings today usually flow to him, and the total demand for free purchasing power, whether existing or to be created, concentrates on him, he has either replaced private capitalist or become their agent; he has himself become the capitalist par excellence.'[8] Thus, to him, a bank 'stands between those who wish to form new combination and the possessors of productive means. He is essentially a phenomenon of development, though only when no central authority directs the social process.'[9] Growth dynamics are thus injected in a stagnated economy through the network of financial intermediaries.

Schumpeter also anticipates the second line of argument that Gurley and Shaw develop. The Schumpeterian analysis is based on the division of the society in two groups, the savers and the investors, or in the language of Schumpeter, 'the possessors of productive means' and 'those who wish to form new

[7]Schumpeter, *Theory of economic Development*
[8]Ibid, p.74
[9] Ibid, p.74

combination'.[10]Taking this as the starting point of their hypothesis, Gurley and Shaw[11] examine the significance of finance in economic progress using Adam Smith's paradigm of the division of labour. They begin with a surmise that there exists a division of labour in the society in respect of individuals' income-expenditure levels. Some are deficit units, and the others are surplus, who subsequently play the respective roles of savers and investors in the economy. If everybody carries out balanced budget, the need for financial intermediaries would no longer be felt. However, the division of labour between savers and the investors 'leads to issue of primary securities by ultimate borrowers' and to 'acquisition of financial assets by ultimate lender.'[12] As the economic growth progresses further, the division of labour becomes more intricate, leading to the evolution of financial institutions. Growing still further, Gurley and Shaw argue, the division of labour leads to financial institutions taking money from the savers by 'paying a deposit rate' and lending it to the investors by charging a lending rate of interest.[13] The spread between those interest rates pays off for the risk of intermediation. This argument reinforces the belief that financial development is a necessary condition for economic development, and also underlines that the financial sector grows in complexity as economic development takes place. They further argue that, in the course of economic development, financial assets grow at a grater pace than the rate of growth in gross national product.

[10] Ibid, p.74
[11]Gurley and Shaw, 'Financial Structure'
[12]Ibid, p.259
[13] Ibid, p.259

Table 1.1: Cross-country Evidences for the Gurley-Shaw hypothesis, 2013

World Bank Classification of Countries[1]	Countries	Financial Development Index[2]	Financial Institutions Index[3]	Financial Market Index[3]	UNDP HDI[4]
Low Income	Chad	0.083	0.154	0.01	184
	Nepal	0.176	0.323	0.026	145
	Sudan	0.086	0.171	0	171
Lower Middle Income	India	0.392	0.344	0.431	135
	Pakistan	0.197	0.261	0.129	146
	Sri Lanka	0.27	0.349	0.185	92
Upper Middle Income	Brazil	0.652	0.79	0.502	79
	China	0.572	0.511	0.63	91
	Thailand	0.645	0.666	0.61	103
High Income Non OECD	Singapore	0.731	0.752	0.695	9
	Saudi Arabia	0.53	0.396	0.653	34
	UAE	0.473	0.449	0.488	40
High Income OECD	Germany	0.747	0.748	0.731	6
	Korea, Rep	0.854	0.789	0.902	15
	United States	0.877	0.833	0.903	5

Sources: 1. World Bank, *Global Financial Development Database*; Retrieved on 15 March 2016 from http://www.worldbank.org.

2 & 3. Svirydzenka, K. *Introducing a broad Based Index for Financial Development*; Retrieved on 15 March 2016 from https://www.imf.org,

4. UNDP, *Human Development Report2014*; Retrieved on 15 March 2016 from http://hdr.undp.org,

In Table 1.1, we seek to gather information in support of the Gurley-Shaw hypothesis. On the basis of the UNDP's cross-section data on the Human Development Index (HDI) in 2013, the table brings out the relationship between financial development and economic development. The financial development is measured by the financial development index, which comprises of the financial institution index and the financial market index. Each of these indices contains various sub-indices relating to financial access, financial depth and the efficiency of the financial institutions and the financial market. The income-wise classification of countries is, however, based on the World Bank's classification. The table suggests that the low-income group countries rank low on the financial development index as well. Thus, the poor countries like Chad, Nepal and Sudan belong to the lower end of the financial development index, at 0.083, 0.176 and 0.086 respectively. Financial markets are seriously lacking in them - either totally absent, or only at a nascent stage of development. The financial market index for Chad, Nepal and Sudan stands at 0.010, 0.026 and 0.000 respectively. Let us emphasise also the case of the Human Development Index (HDI), which represents an alternative measure of economic development. The table underlines that low values of this measure are associated with the countries where the financial development index assumes lower values. The story is opposite for high-income group countries - such as those belonging to both the OECD and the non-OECD blocks – which are characterised with a high financial development index, so also its constituent indices. Columns 4, 5 and 6 of Table 1.1 corroborate this proposition.

McKinnon[14] and Shaw[15] shed further insights into the hypothesis of concurrent movements in financial and economic development. Their argument is that the financial repression adversely affects savings and investment, and thereby economic growth. A financially repressed country is characterised by a high degree of government intervention in the financial market, whereby its competitive environment is lost. The rate of interest is suppressed, and hence, savings shrink and investments are distorted, preventing economy to grow optimally. A body of empirical studies corroborate this hypothesis. Reading this hypothesis in the reverse way, we are inclined to conclude that a free financial market, which promotes financial development, must usher in rapid economic development. Similar logic is reiterated by Goldsmith[16] who views savings as the means of 'financing of capital formation'.[17] He emphasises that it is not only the rate of savings, but also its distribution, which determine economic development. Goldsmith pioneers the study of international comparison in financial development on the basis of various ratios relating to financial development.

However, the question that is blurred in the literature is the line of causation between the economic development and the financial development. Patrick[18] recognises both ways of this relationship classifying them as 'demand following' and 'supply leading' phenomena. The former refers to the case where 'the creation of modern financial institutions, their financial assets and liabilities and related financial services is in response to the demand for these services by investors

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[14] See McKinnon, *Money and capital in economic development*.
[15] See Shaw, *Financial Deepening in Economic development*.
[16]Goldsmith, *Financial Structure and Development*
[17]Ibid, pp. 114-123
[18] Patrick, 'Financial Development '

and savers in the real economy.'[19] In contrast, the ' "supply leading" scenario represents creation of financial institutions and the supply of their financial assets, liabilities, related financial services in advance of demand for them.'[20] The financial sector plays only a passive role in the former case. But, in the latter, it performs twin functions together, (i) transfer of resources from the traditional sector to the modern sector, and (ii) promotion of entrepreneurial skill in the modern sector.[21]

Levine and King[22]contest this line of argument on the basis of empirics for 80 countries over 1960-89. Their objective is to investigate the 'relationship between level of financial development and future rates of long run growth'.[23] They conclude, 'Financial development is a good predictor of long run growth over next 10 to 30 year.'[24] Their further finding is that financial development is 'strongly' and 'significantly' associated with the 'future rates of capital accumulation' and 'efficiency of capital use.'[25]

Levine[26] puts forward five explanations for the impact of the financial development on economic growth. In the wake of growth in financial intermediaries, the economic growth is promoted as: (i) the exchange of goods and services is facilitated; (ii) savings are augmented; (iii) capital accumulation and technological innovations are accelerated; (iv) the resources are properly allocated; and finally (v) the resources are better utilised under the supervision of financial intermediaries. Levine argues that, because of information asymmetry, high transaction costs are

[19] Ibid, pp. 174-176.
[20] Ibid, p.175
[21] Ibid, p.175
[22] King and Levine, 'Finance and Growth'
[23] Ibid, pp. 718 - 719
[24] Ibid, p.719
[25] Ibid, p.719
[26] Levine, 'Financial Development and Economic Growth'

always involved, which financial intermediaries minimise by diversifying the liquidity risk. As a result, savings are promoted, resources are better allocated, and finally, a high rate of long-run economic growth follows. According to him, with the reduction in information cost ‘markets are better at selecting the most promising firm and managers will induce more efficient allocation of capital and faster growth’.[27] Along with providing the financial help to a business firm, the financial intermediaries can also enforce corporate control on the managers by compelling ‘firm managers to manage the firm in the best interest of the owners.’[28] His line of argument is that: ‘More specialisation requires more transaction. Because each transaction is costly, financial arrangements that lower transaction cost will facilitate greater specialisation.’[29] This is surely in tandem with what Adam Smith professes: specialisation is the main source of the wealth of a nation. Levin’s logic is thus clearly in line with Gurley and Shaw.

Section II: The Indian Financial System

The banking system that India inherited from the British rule was underdeveloped, and also highly skewed towards urban areas. According to an RBI source of 1947, there were 200 commercial banks in Madras, 106 in West Bengal, 40 in Bombay.[30] These states contemporaneously exhibited flourishing commercial activities, and that was why, under the spirit of lassiez faire, the banking service was concentrated in those states.

Banks’ private ownership also contributed to a lop-sided development in Indian banking. Only a small group of shareholders had ownership over those banks

[27] Ibid, p.695
[28] Ibid, p.696
[29] Levine, ‘Financial development and economic growth’, pp. 690-701
[30] RBI, *Report on Currency and Finance*, 2006-08, p.85

so that the country's financial power got highly concentrated. The underlying proprietorship also gave rise to the phenomenon of inter-locking directorship between banks and business houses, whereby a same set of people controlled both the institutions. Because of such inter-locking, bank loans were sanctioned without much consideration about their proper utilisation and/or the rate of return there from. The country's financial resources were not, therefore, properly allocated. But, in other respects, those institutions were highly risk-averse. To minimise the business risk, they used to finance trading activities, and that too, only the activities undertaken by large business houses. Bank loans remained, therefore, largely beyond the reaches of small and medium entrepreneurs. The flow of fund that followed thus generated skewed distribution of wealth and income in the economy. Skewed regional development was also an outcome in this process. Insofar as the big business houses and their commercial activities gravitate around urban areas, bank loans were meant for economic development only in those places, leaving the vast rural tract underdeveloped. Even in 1969, we find that the rural areas were served only by 17.6 percent of bank branches, where a meagre 3.1 percent of total deposit was mobilised, and only 1.5 percent of total credit was allocated. In contrast, the metropolis, only a few in number, shared as much as 18.3 percent of bank branches with a 49 percent share in total deposits and a 67.2 percent share in credit.[31]

The force of the logic, as perceived above, suggests that India's commercial banks should have historically little involved in agricultural financing as it suffered from high risks in a developing country like India. Because of its dependence on monsoon, Indian agriculture was always risk-prone, on the one hand, and, on the other, agricultural farms were held by a large number of small and tiny farmers with a

[31]Narayana, 'Banking sector reforms', p. 27.

very low level of credit-worthiness. Commercial banks did never accommodate them. Unable to get any bank accommodation, they became the prey to the village money-lenders, who always charged a very high rate of interest. To validate this line of argument, we note that, in 1951-52, only 0.9 percent of the credit came from commercial banks while 44.8 percent were obtained from village money-lenders.[32] Agriculture's deplorable scenario was also reflected in that, notwithstanding its 55 percent share in GDP in 1950, the sectoral deployment of credit stood only at 2.3 percent for agriculture, compared to 32 percent for commerce and 51.7 percent for industry.[33]

While these factors explain the misallocation of financial resources prior to 1969, the contemporary banking practices handicapped the mobilisation of savings as well. Since the vast tract of rural India was largely out of the banking arena, the rural savings could not be optimally mobilised. Also, in the absence of banking, there was least incentive to save. There were, indeed, high propensities to keep wealth in jewellery, which obstructed the flow of fund to investment. Sources indicate that, in 1968, India's savings stood only at Rs 3122 crores[34], which, as we see shortly, rose rapidly once its rural hinterland was brought under banking network.

To remove these shortcomings, 14 major commercial banks were nationalised in 1969, heralding the age of 'directed' finance in Indian economy. The erstwhile drawbacks were largely addressed in the reforms that followed. One was surely the spread of banking service across the country, including its rural areas. In about five years after the nationalisation of banks, the number of bank branches grew by 129 per cent, and by 1990, there were as many as 59,752 branches of commercial banks in

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[32]RBI, *Report on Currency and Finance*, 2006-08, p.91
[33]Ibid, p.90
[34] Ibid, p.102

India, as against only 8,187 in 1969. It significantly augmented banking services in the country. The population per branch evidently declined from around 65,000 in 1969 to 13,756 in 1990. Rural areas were greatly benefitted thereby. Their share in the banking network increased from 17.6 per cent in 1969 to 58.2 per cent in 1990 representing more than three-fold augmentations. These holistic changes were ushered in under the auspices of the RBI's branch licensing policy. RBI also sought to ensure that the rural deposits were not siphoned off to urban financing. To this end, the banks were required to maintain a credit-deposit ratio of 60 per cent regionally.[35] In the regional spectrum, therefore, balanced economic development followed. Thus, for example, the shares of southern and western regions of the country in the total distribution of banks decreased from 33.7 per cent and 20.9 per cent respectively in 1975 to 26.8 per cent and 15.4 per cent in 1991. In contrast, the share of the erstwhile neglected areas of north-eastern and eastern regions rose from 1.5 per cent and 11.8 per cent respectively to 3 per cent and 18.4 per cent during the same time period. [36]

The branch expansion gave a fillip to household savings since a larger number of people were brought under banking services. The household savings escalated from 8.5 per cent in 1969 to 14.3 per cent in 1980 undergoing an annual growth rate of 6.2 per cent, on the average. The growth continued, and became more discernable in the absolute scale. For 1969-90, the rate of growth in this scale was 19.38 per cent per annum - from Rs.3,122 crore in 1969 to Rs. 15,828 crore in 1990. Likewise, bank deposits grew annually by 9.87 per cent - from 10.5 per cent in 1965 to 21.9 per cent in 1980.[37]

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[35]Ibid, p. 98
[36] Ibid, p. 99
[37]Ibid, p.99

Bolstered by the accumulation of fund at banks, Indian policy-makers sought to make use of it in development planning. To subserve the basic planning objective of more equitable distribution of income and wealth, RBI devised the concept of priority sector lending to financially assist the poorer sections of the society, as also to channelize the available funds to desirable sectors in the economy. A given percentage of banks' lending - about 40 per cent[38] - was earmarked for that purpose. Also, lower interest rates were prescribed for them. For the economic activities belonging to the non-priority sector, selective credit control policy was adopted to restrict the flow of fund there. Thus, a differentiated interest rate structure came to prevail in India's commercial banking.

Along with these positive manifestations, the banking sector reforms in the sixties bred some evils in the banking system, which gave rise to inefficiency. The crux of the problem was certainly the state intervention in the management of financial policies under India's avowed objective of 'socialistic pattern of society'. With the nationalisation 14 banks in 1969 (followed by six more banks in 1980), the public-sector banks dominated the country's flow of fund. Moreover, new entry was totally prohibited during 1969-90 under the contemporary licensing system, which completely restricted competition in the industry. Although smaller private banks were not nationalised, their activities were highly restricted reducing them to insignificance. A further dimension of the problem was the lead bank scheme (LBS), under which each district was allotted to a particular nationalised bank. Those banks were responsible for assessing the credit needs of their respective areas and chalked out plans for branch expansion for different banks. There is no doubt that the branches had expanded thereby, but the banking industry largely resembled to an amalgam of

[38] Ibid, p.100

market-sharing oligopolists. The safety-net provided by the government to the nationalised banks, and the absence of competition, guaranteed by prohibition on new entry, enabled the public-sector banks to grow in size, but with a loss of efficiency. It is indeed an economic truism that a restricted market and its monopoly structure always breed inefficiency.[39]

Another serious drawback of India's contemporary macroeconomic management was the interdependence between the fiscal and monetary policies. For one thing, the promotion of economic welfare of the poorer sections of the society, and also the removal of regional backwardness, are the issues that fiscal policies should solve. But, in India, we find that, through the Reserve Bank of India, commercial banks were instructed to lend financial assistances to them at subsidised rates of interest. Since about 40 per cent of bank loans were earmarked for the so-called priority sector, the financial health of banks was at stake. This was surely not what the principles of commercial banking suggest. Nor was it proper for any central bank to execute. While the theory always preaches for independence between fiscal and monetary policies, this basic principle was subverted in India. It should be noted that, because of the priority-sector lending, the credit worthiness of loan recipients was not properly assessed so that the commercial banks started to growingly encounter the problem of loan repayment and growth of non-performing assets. Also, since the banks were compelled to provide loans at various subsidised rates of interest, market forces could not determine the price of fund in India.[40] Another field of blatant intervention of fiscal questions in monetary policies is the pre-emptive ratios for the banks. We are aware that commercial banks should optimally determine

[39] Samuelson and Nordhaus, *Economics*, p.186
[40] RBI, *Report on Currency and Finance*, 2006-08, p.95

these ratios to trade-off between high costs of fund from the central bank and the cost of unutilised resources. In the case of low pre-emptive ratios, the banks may be compelled to seek accommodation from the central bank if liquidity problems arise in the wake of heavy withdrawal. On the other hand, a high pre-emptive ratio involves non-utilisation of fund that has been mobilised on interest. In modern banking, the central banks are statutorily authorised to fix those rates for the safeguard of public at large, keeping surely the financial interests of banks at the centre. In India, the scenario was different. From the second Five-Year Plan onwards, the Government of India had been increasing its expenditure without proportionately increasing the income so that the fiscal deficits increased. It rose from 3.1 per cent of GDP in 1970 to 10 per cent in 1991.[41] To make good a part of those deficits, the treasury bills were declared as liquid assets, which the commercial banks could hold as Statutory Liquid Assets (SLR). At the same time, RBI steadily increased SLR from the statutory minimum rate of 25 per cent in 1964 to 38.5 per cent, as it was in 1990.[42] In such circumstances, the commercial banks were to keep their funds in this less productive asset, and the government's interest was promoted. Their financial health accordingly deteriorated. The fiscal deficits that could not be accommodated in the above way, however, caused inflationary pressure in the economy. In 1990, for example, India experienced a double-digit inflation rate presumably for the macroeconomic mismanagement.[43] Then again, the government fell back on the Reserve Bank of India to correct inflationary pressures. To check the price rise, the Reserve Bank raised the Cash Reserve Ratio (CRR), and thus further hurt the commercial banks. Let us note in this context that before the 1960s, the CRR and SLR were not revised

[41]Bahttacharya and Sivasubramanian, 'Aspects of Banking Sector Reforms', p. 4151
[42] RBI, *Report on Currency and Finance*, 2006-08, p.105
[43]Little and Joshi, 'Macroeconomic Stabilisation in India', p.2659

appreciably. But an upshot followed since 1969, and in 1990, we find the former at 15 per cent with an incremental CRR of 10 per cent, and the latter at 38.5 per cent[44]. Both were at their respective statutory ceilings. The evil effects of those interventions are easily understood in a hypothetical situation. Recognising the contemporary scenario of pre-emption at 55 per cent (15 per cent as CRR, around 1.5 per cent as incremental CRR, and 38.5 per cent as SLR), we note that only 45 per cent of the mobilised funds were available for lending. Given the priority sector lending at 42 per cent, only a slim amount was left at the disposal of the banks for the corporate sector. Assuming the contemporary deposit rate at around 9 per cent, and the interest on the government treasury bills at around 3 per cent, we may get an idea about the evil effects of contemporary banking policies. For a deposit of Rs1000, a bank was to pay Rs 90 to the depositor at the end of the year. Given the pre-emption at Rs 550 (containing Rs 385 as SLR), the bank could get Rs11.55 at the maximum. Of the remaining amount (i.e. Rs 450), 42 per cent (i.e. Rs189) was directed to the priority sector. If the rate of interest on the priority sector is at 7 per cent, it would earn an interest of Rs13.23. In this hypothetical scenario, the bank was to charge an interest rate of about 25 per cent from the corporate sector to attain the break-even point. With such a high rate of interest India's corporate sector became highly uncompetitive. Also, commercial banks became highly inefficient without any fault of their own.

We should add also that, in the absence of competition and various forms of financial repressions, Indian commercial banks became highly inefficient, adversely affecting the country's development prospect. Available sources indicate that the return on assets of PSBs evidently fell from 0.59 in 1970 to 0.15 in 1990.[45] Again, in

[44] RBI, *Report on Currency and Finance*, 2006-08, p.105.
[45]RBI, *Report on Currency and Finance*, 2006-08, p.107

1992-93, the non-performing assets of PSBs accounted for 24 per cent of total credit. Only 15 PSBs earned profit while others faced negative net worth.[46] With such a financially weak commercial banking, it was difficult to achieve a high economic progress.

Section III: The Financial Sector Reforms.

India’s policy-makers, however, gradually kept abreast of these shortcomings of financial repressions, and set up two committees, one by RBI under the chairmanship of Sukhamoy Chakravarty in 1985, and the other by the Government of India under the chairmanship of M. Narashimam in 1991. The thrust of the former report was to infuse competition in commercial banking. Without altering the basic tenants of India’s socialistic structure, it recommended for relaxations in administered interest rates that had then been in practice. It viewed the low rates of interest as a means of monetisation of government debt, which, in the long run, discouraged proper allocation of credit among borrowers, incentives to save among consumers, and also profitability among banks. As to the questions of various interest rates, the committee recommended that: (a) RBI should take into account the deposit rate of interest in real term, which should be added to the expected inflation rate, to arrive at the nominal rate of interest on deposit; (b) RBI should fix up only the floor rate of interest for lending with a minimum administered spread of 3 per cent, and allow for market competition among banks; and (c) there should be an upward revision of the interest rates on Treasury Bills so that they could compete with other rates in the open market. The issue of competitive environment thus dominated the recommendations of the Chakravarty Committee.

[46]Shirai, ‘Assessment of India’s Banking Sector Reform’, p.101

The issue of market competition was farther carried by the Narasimham Committee.[47] Three-prong strategy was recommended to this end. The foremost one was to increase the number of players in the market by allowing both private Indian banks and foreign banks in India's commercial banking. The government had accepted the recommendation, and acted accordingly. As many as 19 private Indian banks and 43 foreign banks came up by 2013. Foreign Direct Investment (FDI) had also been brought under the automatic route.[48] For private banks, the FDI limit (including the investment by FPIs) is now 74 per cent - automatic up to 49 per cent and from 49 per cent onwards through the government route. At present, foreign bank operates in India through only one of three channels, (i) branches, (ii) wholly owned subsidiary, and (iii) subsidiary with aggregate foreign investment up to a maximum extent of 74 per cent in private bank. [49] The Bank authorisation policy was also liberalised in 2013. The scheduled commercial banks (SCBs) have been allowed to open branches in Tier1 to Tier 6 centres without any approval of RBI. The same rules do not, however, apply for foreign banks. The foreign banks have to bring in a capital of US$25 million upfront at the time of opening new branches in India. The branch expansion of foreign banks is in consonance with India's commitment to WTO.[50]

The second strategy for the promotion of competition was to partially privatise the nationalised banks, enlisting them in stock exchanges, so that the exchange markets could act as the watch-dog to monitor their performances. But, in the contemporary scenario, private investors were averse to banking scripts since their account books were largely window-dressed, concealing the bad loans. To remove those confusions among private investors, the Committee recommended for reforms

[47]M Narasimham was a member of the Chakravarty Committee.
[48]Consolidated FDI policy effective from May 12th 2015, GOI.
[49] Ibid, p.68
[50]RBI, Master Circular on Branch Authorisation, July 1st 2014.

in banking accounting standards, which also the government accepted. In line with the international standards, income recognition and asset classification norms were introduced in the second phase of reforms in 1998. This has been done for proper positioning and transparency in the published accounts. The policy of income recognition is based on the record of recovery. Income on NPA is not recognised on accrual basis but has to be booked only when it is actually received. Provisioning is required for non-performing assets (NPA). An asset is defined as non-performing if it ceases to generate income for the bank for more than 90 days[51]. With effect from 2005, the NPAs are classified as (i) sub standard assets, (ii) doubtful assets and (iii) loss assets. A provisioning of 25 per cent is to be made on outstanding balances of assets classified as substandard assets. With regard to doubtful assets, 25 per cent provisioning is required for a period up to one year, 40 per cent for a period between one to three years and 100 per cent for more than three years.[52] In 2014, RBI recommended to set up Central Repository of Information on Large Credit (CRILC) to collect and store credit data for dissemination among lenders. The banks were required to provide information on all borrowers having exposure of Rs.50 million and above (fund-based and non-fund based).[53] To take corrective actions, a proposal was made for the establishment of the Joint Lenders Forum (JLF). [54]

The changes in the accounting standards, however, exposed a very high level of non-performing assets, so also a very low capital base, for public-sector banks. Their Gross NPA stood at 23.2 per cent in 1993,[55] which was unacceptable to private investors. Under constant vigil of RBI, it was, however, reduced to 2.29 per cent in

[51]RBI circular on Prudential Norms on Income recognition, asset classification and provisioning pertaining to advances, July 1st 2015.
[52]Ibid, p.22
[53]RBI, Early recognition of Financial Distress, January 30th 2014.
[54]Ibid, p.4
[55]RBI, *Report on currency and finance*,2006-08, p.113

2009 but rose again to 4.1 per cent in 2014, and 7.3 per cent in 2015.[56] Since those assets were largely written off, the capital bases of those banks severely weakened. In such a situation, the mobilisation of funds through stock exchanges was surely a route. For the loss-making banks, which private investors disliked, accommodation was given in the union budget. The total contribution of the government to nationalised banks was Rs.20,046 crore by March 1998.[57] Further privatisation was recommended in the second Narasimham Committee report, submitted in 1998. It proposed that the RBI/Government should reduce their minimum stake from 51 per cent to 33 per cent[58], so that private control over bank management would be augmented, and greater efficiency would follow. According to the Indradhanush Plan that the Government of India adopted in 2015, the PSBs would require an extra capital of Rs 1,80,000 crore by 2019 to meet to Basel III norms. Out of this amount, the government would infuse Rs.70,000 crore in four instalments and the rest should come up from the market.[59]

The third leg of the strategy for competition was to deregulate the rate of interest so that the pricing mechanism operated. We have already noted that the pre-reform era was characterised by the cross subsidisation of interests whereby the market was fragmented, and inefficiency crippled proper allocation of fund. A series of corrective measures were adapted to this end. In the first place, the RBI also abolished the minimum lending rate so that the banks could fix their own prime lending rate. The RBI prescribed only the maximum deposit rate of interest for a period less than a year[60]. Also, the Prime Lending Rate (PLR) was deregulated in a

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[56] Economic Times, 29 June 2016
[57]RBI, *Report on currency and finance*,2006-08, p.111
[58] Report of Committee on Banking Sector Reforms, p.53
[59] Ministry of Finance, Indradhanush Plan to revamp Public Sector Banks, 2015, p.8
[60]Rangarajan, Financial Sector, p.5

phased manner. In 1994, it was deregulated for loans above Rs.2 Lakhs and was converted into Benchmark Prime Lending Rate (BPLR) in 2001.[61] From 31 March 2016 the BPLR has been changed to Marginal Cost Lending Rate (MCLR). The MLCR comprises of (a) marginal cost of funds (which includes the marginal cost of borrowing and return on net worth), (b) negative carry on account of CRR (i.e. nil return on CRR held by banks), (c) operating costs and (d) tenor premium (i.e. a higher rate that a bank may charge for longer tenor loans). It should be noted that, unlike the previous BPLR and PLR, the changes in the repo rate are immediately reflected in the MCLR. In fact, the MCLR makes the banks competitive in the commercial paper market. It is a move towards the international standards, reduces the cost of borrowing and ensures that the lending rates are more dynamic.[62] Side by side the lending rate, the deposit rates of interest have also been deregulated. The short-term deposit rates were totally liberated in 1992, save an overall maximum rate for term deposits. The term deposit rate was fully liberalised in 1997. As per the RBI directive on October 25, 2011 the SCBs are free to determine their saving rate provided they meet two conditions, (1) each bank offers a uniform rate of interest on savings bank deposit up to Rs 1 lakh; and (2) a bank may provide differential rates of interest from amount over Rs 1 lakh subject to the condition that there is no discrimination at a given point of time and at a specific branch.[63]

The rates of interest on government securities have also been raised and many money market instruments have been introduced enabling the corporate sector (including banks) to get short-run accommodation there from.

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[61] RBI, Evolution of BPLR,20 October 2009, pp.5-9

[62] RBI, Master Direction-Interest Rates on Advances, March 29th 2016

[63] RBI, Master Circular-Deregulation of Savings Bank Deposits Interest Rate-Guidelines, October 25th 2011

While infusing competition in banking, the RBI has been cautious about the evils of excess competition. It is reflected in the practice of Asset Liability Management (ALM), which has been followed in a number of countries after the financial crisis of East Asia in 1997. The ALM provides a 'comprehensive dynamic framework for measuring, monitoring and managing liquidity, interest rates, foreign exchange and equity and commodity risk of a bank that needs to be closely integrated with banks' business strategy'.[64] The RBI is also empowered with a supervisory role in 1994 by way of amending the Banking Regulation Act 1949. The basic objective of supervision is to assess the solvency, liquidity and operational health of banks. The inspection is based on the CAMELS (Capital Adequacy, Asset Quality, Management, Earnings, Liquidity System and Controls) which are a modified version of the international CAMEL for domestic banks. For the foreign banks, however, performance is judged on CALCS (Capital Adequacy, Asset Quality, Liquidity Compliance and Systems). Also, a new framework of accountability has been introduced to ensure proper internal and external audit.[65] The performance of the PSBs is now measured by Key Performance Indicators (KPI), which is linked to the bonus paid to the MD/CEO of banks.[66]

Along with the infusion of competition in the banking industry, the Narasimham Committee recommended for removal of state interventions that crippled the financial health of commercial banks. An important recommendation in this regard was to minimise the priority sector lending. The committee recommended for the reduction of this lending from 40 per cent to 10 per cent, and also to reduce the number of activities belonging to this sector. The recommendation has not been fully

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[64]RBI, circular on Asset Liability Management, February 10th 1999.
[65]RBI, *Report on currency and finance*,2006-08,pp.116-117
[66]Indradhanush, Ministry of Finance, GOI, 2014, p.6

adhered to.[67] The definition of priority sector has, however, been changed from time to time. As per the RBI circular on 1 July 2015, it includes (i) agriculture, (ii) micro, small and medium enterprises, (iii) export credit, (iv) education, (v) housing, (vi) social infrastructure and (vii) renewable energy and others.[68]

As to the pre-emption ratios, the incremental CRR of 10 per cent was totally removed, and the CRR has been reduced in phases to 4 per cent in 2016.[69] The SLR has also been brought down in phases to 21 per cent.[70] These measures have definitely increased the lending capacity of the banks, and hence, their efficiency. We emphasise that higher return from government securities has reduced banks' burden of provisioning SLR by government securities. Also, the use of the Liquidity Adjustment Facility (LAF) since 2000 as an anti-inflationary measure, rather than the use of CRR, has reduced the state intervention in commercial banking.

Section IV: Various Concepts of Efficiency.

We thus find that, for the sake of gain in efficiency among commercial banks, India adopted banking sector reforms in two phases, once in 1991 and then in 1998. But a pertinent question at this stage is: Did those successive reforms inculcate efficiency in financial intermediations? The present dissertation seeks to answer this question. It deals only with commercial banking since it represents the major segment of financial intermediaries in India. To deliberate on this question, however, we should first clarify the concept of efficiency.[71]

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[67] Note that the Priority sector lending till date is 40%, see RBI Master Circular-Priority Sector Lending-Targets and Classification, July 2015.

[68] RBI, Master Circular-Priority Sector Lending- Targets and Classification, July 2015.

[69] RBI, www.rbi.org.in, Last checked on 13th September 2016

[70] ibid

[71] For the concept of efficiency, especially in the macro sense of the term, see Prabhat Patanik, 'On the concept of efficiency', EPW Vol.32 (43).

The concept of efficiency broadly refers to the minimisation of the wastage of resources, which are scarce in a society.[72] The problem of scarcity is tackled by producing on the production frontier, which represents the maximum output attainable from a given input vector.[73] Since the output levels on the production frontier are obtained by combining various inputs on the basis of the most efficient technology, they represent technically efficient points of production. Technical efficiency is, therefore, synonymous with productive efficiency. Under this definition, technical inefficiency of a production point is measured by its distance from the production frontier

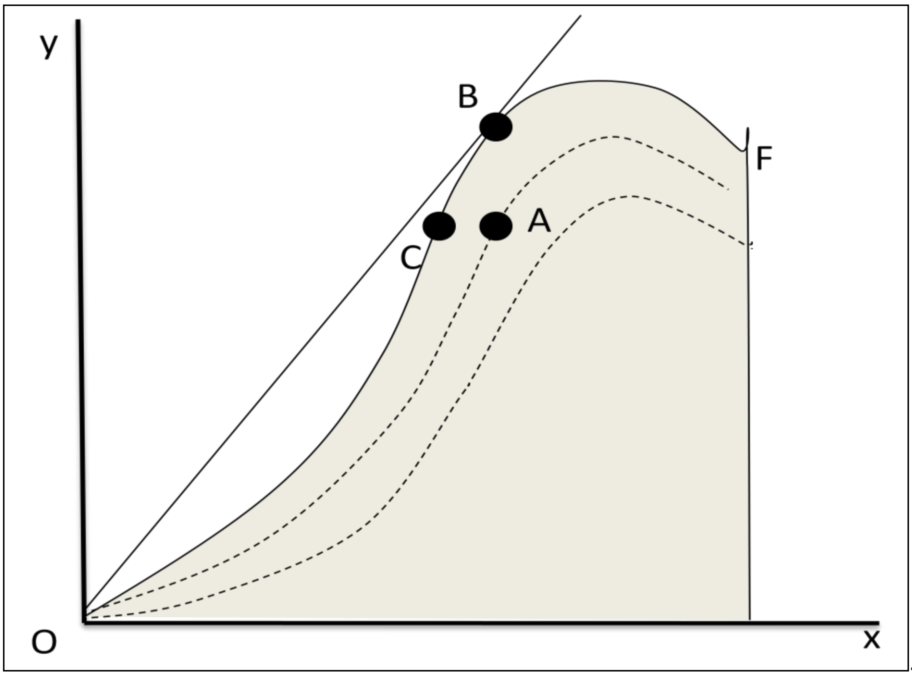

Fig 1.1. Production Frontier and Technical Efficiency

[72]Patnaik describes that 'if with the resource endowments available in an economy in any given situation (in the sense of being offered by their owners), the output obtainable is not in a vectorwise sense larger than what is produced, then the situation is one of "efficient" production.' 'On the concept of efficiency', p. 2807

[73]Coelli et al, *An Introduction to Efficiency and Productivity Analysis*, p. 3

For a firm with a single input (x) and a single output (y), the production frontier is represented by the locus OF in Figure 1.1. The points *B* and *C* which lie on the frontier are technically efficient points of production whereas *A* which is inside the production frontier is technically inefficient. Any point beyond the frontier is not technologically feasible at the given point in time.

Technical efficiency can be calculated without any knowledge of input/output prices. The imposition of a behavioural constraint of profit, cost and revenue transforms the production frontier into analogous concept of profit frontier, cost frontier and revenue frontier. A cost frontier represents the minimum expenditure to produce an output. A producer operating on the cost frontier is considered to be cost efficient. The revenue frontier represents the maximum revenue obtained from a given bundle of inputs, and a producer who operates on the frontier is considered revenue efficient. The profit frontier represents the maximum profit that is gained from a given production activity, and we may define likewise the profit efficiency. [74]

The overall efficiency of a firm (often referred to as the economic efficiency as well) is often denoted by concomitant occurrence of technical and allocative efficiency. The latter type of efficiency is described taking into account some behavioural constraints, such as cost minimisation, revenue maximization, or profit maximization. From the perspective of the economy, however, the allocative efficiency is defined as the allocation of resources that maximises the social surplus. Samuelson defines allocative efficiency as ‘when no possible reorganisation of production can make any one better off without making someone else worse off.’[75] Remaining in the realm of microeconomics, we note that the economic efficiency

[74] Kumbhakar and Lovell, *Stochastic Frontier Analysis*, p.17
[75] Samuelson and Nordhaus, *Economics*, p 158

(EE) is decomposed into its constituent parts of technical efficiency (TE) and input- or output-oriented allocative efficiency (AE).[76]

$$\mathrm{OE} = \mathrm{TE} \times \mathrm{AE} \quad (1.8)$$

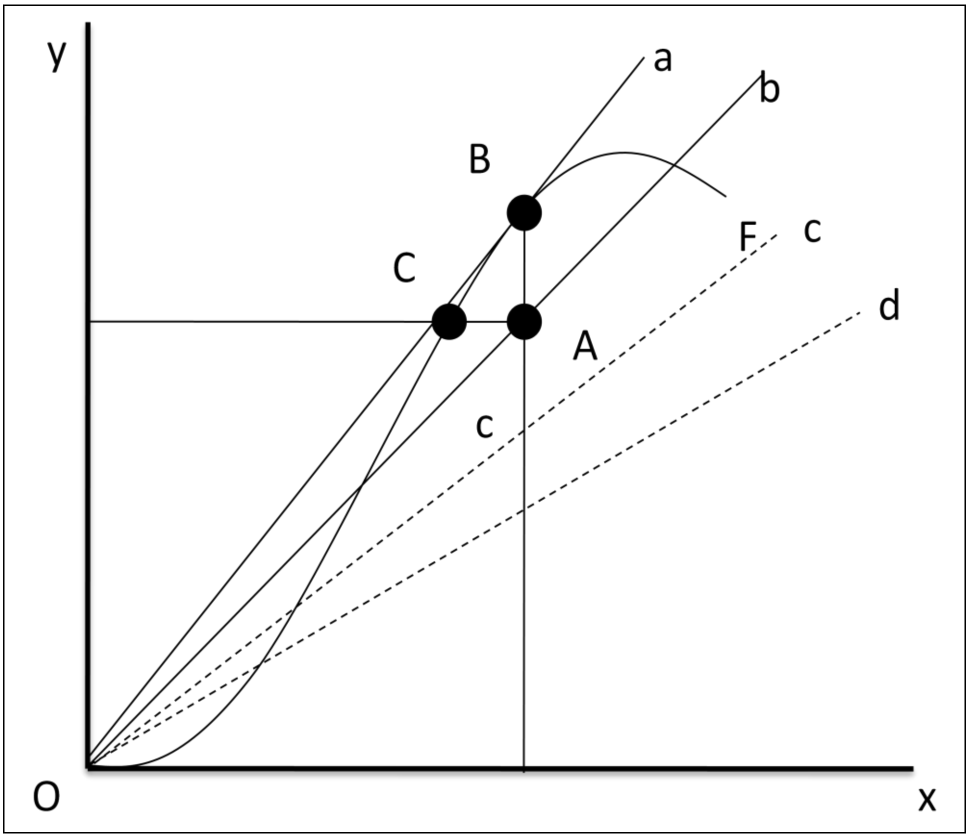

Fig 1.2. Scale efficiency

Figure 1.2 explains the concept of scale efficiency. It underlines that a point may be technically efficient, but not scale efficient. The line OF in this figure is same as that in Figure 1.1 so that all points on it like B and C are technically efficient. Note that, in the long run, each point on OF represents a production level corresponding to a given plant size. We now superimpose in the figure a number of rays such as Oa,

[76]For details of such decomposition, see, for example, Kumbhakar, *Stochastic Frontier Analysis*(2000), Battese and Coellie, 'Frontier Production Functions, Technical Efficiency Panel Data with Application to paddy Farmers in India' and 'A Model of Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data' (1992 and 1995), Kopp and Diewert 'The Decomposition of Frontier Cost Function Deviations into Measures of Technical and Allocative Efficiency' (1982), Greene 'The Econometric Approach to Efficiency Analysis' (1993).

Ob, Oc and Od, representing different output-input ratios (y/x). Now, the ratio y/x is maximised at B (i.e. the highest efficiency is reached in terms of maximum output for a given level of input, or, minimum input for a given level of output). In other words, the firm should choose the plant size corresponding to B, where the ray Oa is tangent with the production frontier OF. It should be noted that though the points C and B are both technically efficient points of production, they are not scale efficient. Only the production at point B is both technically and scale-wise efficient. Thus a firm can increase its productivity and move to a point where it is operating at an optimal scale. The concept of scale efficiency can be alternately represented in the following diagram.

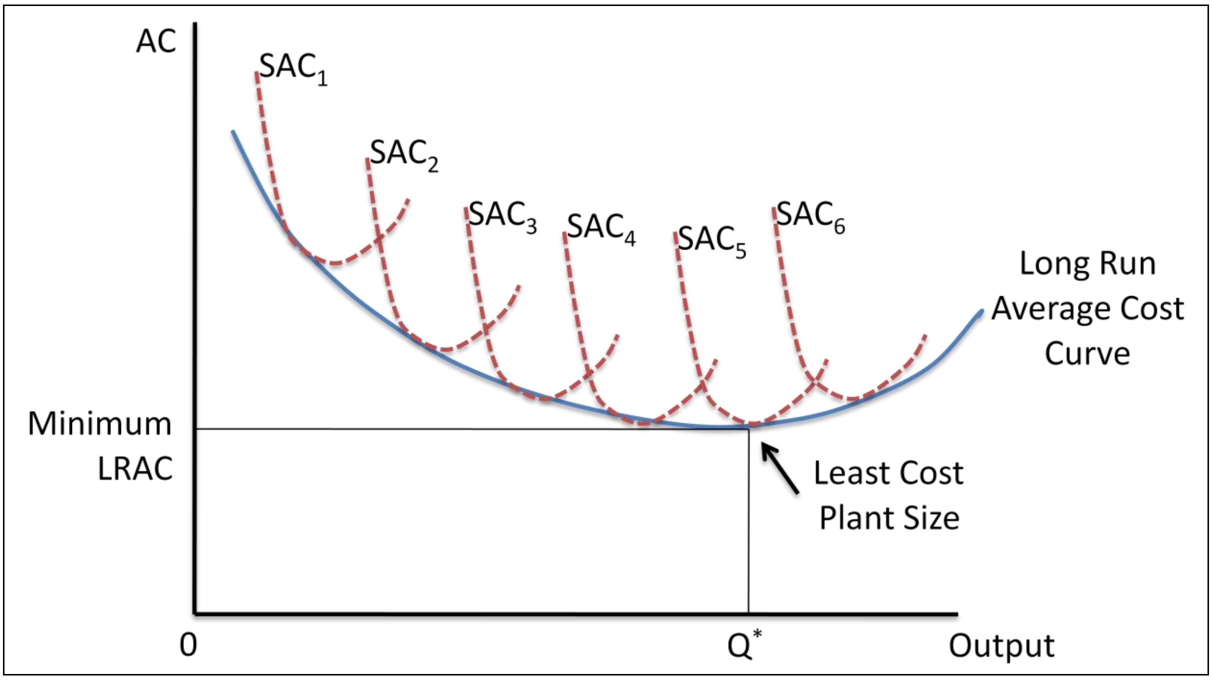

Fig 1.3. Scale efficiency (Least cost optimal plant size) with the help of Long run average cost curve (LRAC)

We know that the long run average cost (LRAC) curve envelopes the short run cost average curves (SAC), each of which represents a given plant size. A shift from one short-run average cost curve to another implies a change in the plant size of production. The lowest point on the LAC curve coincides with the optimal plant size. Expansion beyond this point leads to increase in the average cost as diseconomies of scale sets in. Hence, the movements from SAC_1 to SAC_2, SAC_3 etc through SAC_5 represent gain in scale efficiency.

The idea of scope economies was introduced by Panzar and Willig in 1977,[77] but popularised by Baumal, Penzar and Willig in 1982.[78] Considering that two outputs q_1 and q_2 are produced by a firm, they define the scope economies as

$$S_{co} = \frac{\left[C\left(q_1, q_2^{min}\right) + C\left(q_1^{min}, q_2\right) - C(q_1 q_2)\right]}{C(q_1, q_2)} \qquad (1.8)$$

where q_i^{min} is the smallest value of q_i, approaching to zero. If $S_{co} > 0$, we infer that it is more profitable to produce q_1 and q_2 separately. Otherwise, the firm should go for their joint production.

The three-dimensional Figure 4 is an adaptation of Baumols scope efficiency where a firm is producing two commodities, q_1 and q_2. The curve CTC` is a U shaped cost curve. The lowest cost of production for the firm is to produce at point U on the ray R where the firm is producing both q_1 and q_2 rather than producing single commodities at point A (q_2) and B (q_1).

[77] Panzar and Willig, 'Economies of Scale in Multi-Output Production'.

[78] Baumol et al., *Contestetable Markets and the Theory of Industry Structure*, pp. 73-75. For an analysis of this concept, see Leonard Waverman, 'U.S. International competition.' In R.W.Crandall and K. Flamm, *Changing rules: Technological change, International competition, and Regulation in telecommunication*', pp. 62-82, especially 78-80.

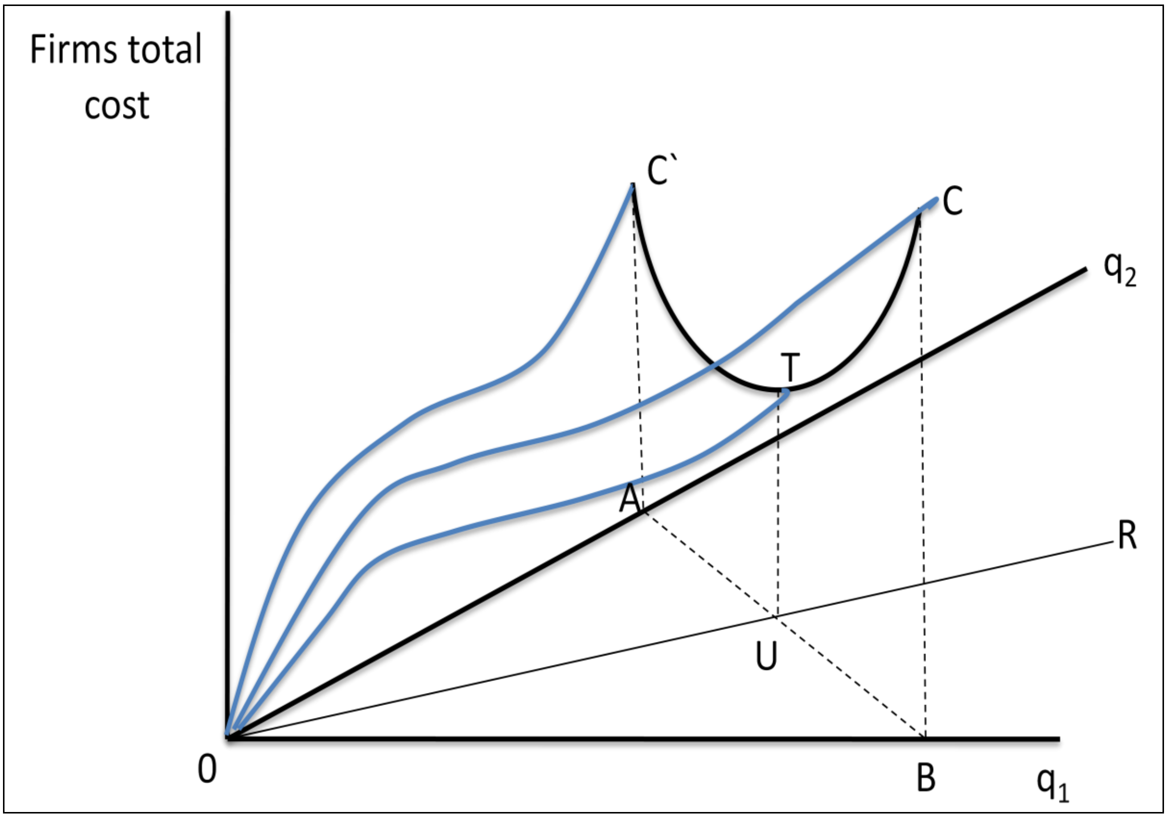

Fig 1.4. Scope efficiency of firms producing two commodities[79]

Though most of the studies on efficiency and productivity concentrate on technical and allocative efficiency, Harvey Leibenstein introduced the concept X-efficiency in 1966. On the basis of various empirical studies, he notes that the distortion in productivity as explained by allocative inefficiency is very negligible. The welfare losses due to allocative inefficiency were less as 1/10th of 1 percent[80]. Leibenstein points out that the traditional theory, based on assumption of profit maximization or cost minimization, holds good so long as there is complete information. But there are many unforeseen distortions in the reality that are not deliberated in the conventional analysis. Leibenstein conceptualises them under a term X-efficiency, which is the culmination of a different line of thought on the

[79]Baumol, 'Contestable Markets', p.10
[80] Leibenstein, 'Allocative Efficiency Vs X-Efficiency' p.397

question of efficiency. The next chapter discusses the concept at length. We only note here that given that the X-efficiency exists, the overall efficiency is decomposed as

$$\mathrm{OE} = \mathrm{TExAExXE} \qquad (9)$$

Section V: Research Objective, Questions and Plan of study

India had thus experienced a serious efficiency crisis in the financial sector during 1969-1991, which had its cascading effects on her overall economic performance. We have also deliberated how, through various financial sector reforms, our policy-makers sought to address the underlying problems. But the question that arises in this context is whether those reformative measures have enhanced the efficiency of the country's commercial banking. The central objective of this dissertation is to find out a plausible answer for this question, especially in the field of the X-efficiency. In particular, there are four objectives in this study. Those are:

(i) To discuss the concept of X-efficiency and its genesis in the literature;

(ii) To calibrate an appropriate methodology for the measurement of X-efficiency among commercial banks in India;

(iii) To study the impacts of the financial sector reforms on the X-efficiency of the banking sector during 1991-2012 as a whole, and during the period of the second-generation reforms, 1998-2012;

(iv) To assess the effect of ownership on the bank performance in terms of X-efficiency.

Thus, the research questions that this dissertation seeks to answer are as follows:

(i) What is the genesis of the concept of X-efficiency?

(ii) What are various methods of measuring X-efficiency and which one is the most appropriate for India's commercial banks?

(iii) How had the financial sector reforms of 1991 affected the X-efficiency of the Indian commercial banks?

(iv) Were the second-generation reforms better than the first-generation reforms from the viewpoint of gain in X-efficiency?

(v) Was banks' ownership an important variable in the question of their X-efficiency?

There are five chapters in this dissertation in addition to the present one. The second chapter deals with the genesis of the concept of X-efficiency. Though it was formally advocated by H. Leibenstein in 1966, it has its origin in Hick's Quite Life of 1935 and in Bain's Structure-Conduct-Performance paradigm of 1959, which are also discussed in this chapter. Those theories bring into fore the subjective factors that influence the efficiency of the firm or an organisation. Leibenstein's X-efficiency theory is, indeed, based on such subjective factors.

The third chapter is on the review of literature. It discusses in a nutshell various studies pertaining to efficiency and its measurement. In addition to the X-efficiency, the central theme of this dissertation, the chapter deals also with the technical efficiency since there are some common methodologies used in these fields. In particular, there are two broad methods of efficiency measurement that are used in such studies. One is the Data Envelopment Analysis and the other is the Stochastic Frontier Analysis. We review them in brief separately for Indian experiences and experiences in other countries.

The methodology and the underlying data set for this dissertation are the subject matters of the fourth chapter. Recollecting the available methodology in the field from the previous chapter, we choose here the most appropriate one for our study, and calibrate it for our use. The chosen methodology guides us about the type of data that are required to compute it. While selecting the period of the data set, we are careful about the basic objectives of our dissertations, especially (a) it should properly account for the effects of India's financial sector reforms; and (b) the effects of the first-generation and second-generation reforms can be segregated. For the former, we consider the data set from 1994 so that the first-generation reforms, started in 1991, began to bear fruits. To tackle the second issue, we take into account two separate data sets, one for 1994-2012 and the other for 2000-2012.

The fifth chapter reports and analyses the empirical findings. Results from two alternative methods, viz. the generalised least square method (GLS) and the maximum likelihood method (MLE), are presented, and, on the basis of its merits, the second set of results are analysed. Keeping in view the objectives of the dissertation, the chapter reports the results for two periods, 1994-2012 and 2000-2012. Those results are analysed categorising the banks in three groups, public sector banks, private domestic banks and private foreign banks.

The sixth chapter, however, summarises by way of conclusion the major findings of all previous chapters.

Section VI: Conclusion

This chapter thus deliberates on three major issues in the literature. One, there is a close link between the financial sector development and economic progress. The relationship is typically of two-way type so that one re-imposes the other. Moreover, since the former is the necessary condition for the latter (and vice versa), the economic progress gets frustrated in the absence of, or the stagnation in the financial sector. Two, Indian commercial banking suffered from acute inefficiencies during the phase of financial repression, 1969-91, on account of various administrative constraints. Acknowledging the prevalence of inefficiencies amongst them, as also their outcomes on the country's economic progress, Indian policy-makers adopted a series of financial sector reforms since 1991. These two findings are, however, the main motivation of this dissertation, namely, to study the gain of efficiency among India's commercial banking in the wake of those economic reforms. But the word 'efficiency' is a wide-ranged concept accommodating various terms such as technical efficiency, allocative efficiency and X-efficiency. This study, however, takes up the concept of X-efficiency for examination. Our review of literature would show that there are many studies on the efficiency of Indian Banks. These works are more concentrated towards the measurement of technical efficiency of the banks. This thesis concentrates only on the X-efficiency of the Indian banks post reform for a period of 1994 to 2012.

Chapter II

THE CONCEPT OF X-EFFICIENCY: ITS GENESIS AND EVOLUTION

In an emerging market economy, efficiency is the kingpin for survival and development. Inefficient productive units cannot survive domestically in the face of competition from multi-national corporations; nor could it grow based on global markets, thanks again to more competitive firms. The question of efficiency is, therefore, taken up very seriously in the context of economic reforms in many countries, including India. But the theme has its genesis at the dawn of European economic thought – in the writings of the so-called Physiocrats. In the Physiocartic era, however, 'efficiency' was interpreted in the macro-economic framework. Quesnay's '*Tableau Economique*' is an example in point.[81] It continues down to the classical tradition, and dominated the writings of Adam Smith and David Ricardo.[82] A paradigm shift is, however, noticed in the neo-classical era, as the focus shifts to the micro economic level – more specifically, at the firm - or at the industry- level. Here we find new concepts emerge, for example, allocative efficiency, scale efficiency, and later on, scope efficiency, which determine the efficiency score of a firm. The contribution of Alfred Marshall,[83] W.S. Jevons, C. Menger[84] andW. Baumol[85] may be cited in this context.

One of the conclusions that the neo-classical writers have established is that monopoly is inefficient from the viewpoint of resource allocation; sub-optimality of production leads to higher average cost of production, and hence, a wastage of

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[81] Robbins, *A history of economic thought,* pp.77-113
[82] Dobb, *Theories of Value*, pp. 38-95
[83] Marshall, *Principles of Economics*, Book IV
[84]For Jevons and Menger, see Robbins, *A history of economic thought,* pp. 258-284
[85] Baumol *et al*. *Contestable Markets*

resources. The earlier Neo-classical economists, especially Marshallians, however, believe that perfect competition is the natural state of a market. Under the weight of Sraffa's concept of 'Laws of returns', which invalidates the continuance of perfect competition[86], they use the concept of 'externalities' in support of their belief about the competitive market, as Marshall himself did. But gradually the monopoly, as conceived by Cournot, is accepted as 'the natural case'. Hicks writes, 'With this assumption, this cardinal difficulty of increasing returns disappeared, since a firm might still be in equilibrium under conditions of diminishing cost.'[87] From this field of study has emerged an interesting branch of literature where monopoly has been discussed from different angles - mainly, the reasons thereof and the consequences thereto. These form the central theme of this Chapter. We take up three important hypotheses in this field, namely, (a) the Quite Life Hypothesis (QLH) that Hicks developed in 1935; (b) the Structure-Conduct-Performance Paradigm (SCPP), as proposed by Bain in 1959; and (c) the X-efficiency theory, where, following the deliberation of Leibenstein in 1969, a number of economists have contributed to. These three hypotheses are discussed in three sections that follow. In section IV, however, we seek to develop a logical thread amongst them.

Section I: Quite Life Hypothesis

In the neo-classical tradition, a competitive firm maximises its profit when the ruling price equals the long-run marginal and average costs. It represents the lowest point of the long-run average cost curve so that the utilisation of resources gets optimised. Thus, in a competitive equilibrium, the profit maximising point coincides with the optimal resource utilisation point. In monopoly, however, the profit maximising (MR = MC) point does not so behave, giving rise to wastage of economic resources. Thus,

[86]Hicks, 'Annual survey of Economics', p. 2
[87]Ibid, p.2

from the societal viewpoint, it is an inefficient point, though efficient from the monopolist. Moreover, as Hicks argues, a monopolist is often found to produce away from the MR = MC point, though in its neighbourhood. The question that now arises is: Is it irrational to belong to a point away from MR=MC? To Hicks, it is not irrational. In the conventional analysis, revenue and cost are measured in financial or monetary terms. More specifically, revenue is defined as the money value of all the products a firm produces, and the cost as the money value of all resources it employs. But, in essence, revenue should represent what he gets, not only in terms of money, but the pain and discomfort as well which he suffers in the process.[88] Hence, the inequality between MR and MC in monetary terms should not be taken to represent the inequality between MR and MC in the true sense of the term. This is especially true since, as a human being, a monopolist is affected by a host of qualitative factors, or the so-called 'subjective factors', *pari pasue* with the monetary factors of production. Thus, guided by his subjective and objective factors, a monopolist equates his 'emotional' MR = 'emotional' MC, where emotional MR is defined as the monetary MR plus the subjective gain; and emotional MC is defined as the monetary cost plus the subjective cost. This idiosyncratic emotional MR = emotional MC may not be equal to the financial MR= financial MC. The monopolist will not make an attempt to move to the theoretical utopia of financial MR=MC as he takes up his subjective costs into consideration. This propensity of the monopolist to maintain his position away from the profit maximising MR= MC is referred to as 'the Quite Life' by Hicks in his article in 1935. It should be noted that Hicks has not analysed the subjective gains and losses in detail; nor how they counterbalance each other. We will see shortly that Leibenstein delves into these questions in a theoretical framework.

[88] These issues were first discussed by Jevons. See his *Theory of political economy*, especially the Chapter on 'Theory of pleasure and pain'.

Hicks argues that the monopolist will not exert himself to reach the point of MR=MC as he enjoys 'the Quite life', the greatest reward of monopoly power. This behaviour of a monopolist goes against the conventional assumption of rationality as underlying the neo-classical tradition. While refuting this conventional sense of the term, Hicks argues that the monopolist will not try to reach the level of MR= MC due to his 'highly rising subjective cost'. We emphasise that this is the maiden effort of considering subjective factors as an explanation of the so-called irrational behaviour of a firm. He believes that if the monopolist has a 'sharply rising subjective cost', he would verily dedicate himself to maintaining his monopoly position rather than moving to the point where MR=MC. Another question that arises in this context is whether such an act of the monopolist, though technically inefficient, should be considered rational from the viewpoint of resource allocation as well. This brings us to the contention that a monopolist, or for that matter any producer, would be rational not to move to the profit maximising position. Fare *et. al.,*[89] so also Bogetoft and Hougaard,[90] explain this behaviour of the monopolist by describing it as 'rational inefficiency'. This concept signifies that it would be perfectly rational to maintain a point of inefficiency if the cost of reducing this inefficiency outweighs the gains arising out of a movement towards efficiency. Rational inefficiencies are said to exist in markets where firms enjoy a certain amount of market power. Fare *et al.* suggest that a monopolist does not maximise his revenues, but optimises a quite life that he enjoys situating himself in a monopoly position.[91] According to Bogetoft, the term 'inefficiency', which he describes as the 'slack', could be a part of the 'fringe benefits' that stakeholders enjoy - it could be in the form of compensation paid to

[89] Fare *et al* , 'Rational Inefficiency: The quite life'
[90] Bogetoft and Hougaard, 'Rational Inefficiencies'
[91] Fare *et al* , 'Rational Inefficiency: The quite life', p. 2

employees so that a loyal group of workers is generated. Thus, inefficiency may not be completely irrational and waste. This kind of slack would be a part of the long run plan of a monopoly producer.[92]

The Hicksian concept of 'the quite life' and its implications, as narrated above, has many offshoots in the literature. This idea is recurrent in the rationales for economic reforms in many countries, including India. In his quest of maintaining a quite life, a monopolist affords to remain inefficient without going for technological up gradation and/or exploring new markets. Organisational inefficiencies are also not infrequent in this type of market. Such an application of 'the quite life' is dominant in the writings of Vins and Koetter[93] , Berger and Hannan[94], Casu and Girardone[95]. In India's economic reform, this idea of quite life has been a guiding light. This is evident in that the thrust of India's economic reforms rests on the promotion of competition by way of repealing the MRTP Act, liberal import policies, and easy entry of private banks, both domestic and foreign origin.

Prima facie, though the above line of thought is apparently in line with Hicksian concept of quiet life, it is not really so in the final analysis. Monopoly and inefficiency are analysed there from the view point of the economy. The existence of the quiet life leads to inefficiency and this is reflected by the welfare loss for the economy. But Hicks discusses the issue from the micro perspective, especially from the viewpoint of a monopolist, and to him, monopoly is not at all inefficient.

[92]Bogetoft and Hougaard, 'Rational Inefficiencies', pp.1-30
[93] Vins, 'The Quite Life in Banking'
[94] Berger and Hannan, 'The efficiency cost of market power', pp 454-465
[95] Casu and Girardone, 'Does competition lead to efficiency?'

Section II: Structure-Conduct-Performance Paradigm

At the time when Hicks' idea of a monopolist enjoying 'the quite life' had been at the centre of discussion, Edward Mason, a contemporary of Hicks, brought forward the idea of the Structure-Conduct-Performance paradigm. The idea that remained fluid with Mason was later crystallised, and that too, with due empirical supports, by J.S Bain in 1959. The underlying tone in the theory, which Bain has elaborated, is how efficiency is guided by the scale of operation, the pricing policies and the competitive forces. His line of argument is that the barriers to entry (including product differentiations) enable individual firms to expand their scale, and thus, raise the concentration of a market (i.e. higher market-share of individual firms). But the question is: Are bigger firms more efficient than smaller ones? We note here that Bain defines such efficiencies – as generated through the expansion of scale – as the technical efficiency in the sense of optimal use of resources. This line of argument he juxtaposes against an alternative hypothesis: that smaller firms are more efficient. The theoretical logic underpinning the proposition is that greater competition compels the firms to make all-out efforts to raise productivity – and, hence, more efficient - as the 'survival of the fittest' is the rule of game in competition. To Bain, it is the allocative efficiency. Two opposite forces thus prevail in the domain of efficiency: a) the allocative efficiency, varying inversely with the degree of concentration in an industry; and b) the technical efficiency, varying directly with the degree of concentration.

Before deliberating on Bains' question of efficiency, we discuss his concepts of 'structure, 'conduct' and 'performance', the three legs on which his hypothesis is built. 'Structure' in the SCPP hypothesis denotes the 'organisational characteristic of a market',[96] which indeed reflects sellers' concentration therein. The concentration determines whether the market is 'atomistic' or oligopolistic. In an atomistic market structure, a single seller can not affect the ruling price to his own advantages (or, for that matter, the quantities he sells). In an oligopoly market, on the other hand, he can do so, after duly anticipating 'the reaction of the rival in the industry'.[97] In such markets, higher the degree of seller concentration, higher is the probability that the sellers enjoy a greater monopoly power in the market, and hence, more profit efficiency; conversely, lower market concentrations lead to less profit efficiency. Equally important component of a market structure is the product differentiation, which generates monopoly power for a firm, giving him flexibility in setting the prices. Bain, however, points out that, because of product differentiation, a large number of small firms exist in such markets producing goods similar to those differentiated products. Bains' oligopoly market is thus constituted by a small number of big firms side by side a large number of small firms. The oligopoly market is also characterised with, according to Bain, the barriers to entry, which explain the degree of competition, in general, and the relationship between the new entrant and the old producers, in particular. Higher barriers to entry are associated with monopolistic pricing policy, while moderate barriers to entry lead to limit pricing. When the barriers are low, the market structure is often found unstable.

Market conduct refers to the profit seeking activities of the firms. It includes how (i) different sellers react against their 'intrinsically rivalrous decision and action'[98] so that they make successful rational decisions; (ii) the pricing policies are

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[96]Bain, *Industrial organization*, p. 7
[97]Ibid, 114
[98] Ibid p. 302

adopted by the sellers and (iii) the ‘predatory tactics’[99]and ‘exclusionary tactics’[100] are used. An oligopolist’s conduct, just as it is in other markets, is guided by its ultimate goal. Bain, however, considers the maximisation of profit as the goal of a firm. In this context, he considers four alternative concepts of profit that an oligopolist might pursue: (a) joint profit maximization, (b) individuals’ profit maximization, (c) hybrid profit maximization[101]; or else, (d) maximizationof fair profit. Of all these concepts of market conduct, only the third one can be tested empirically.

Market Performance encompasses the strategically end results of market conducts. For the sellers it is measured by how well do they adjust their outputs to the changes in effective demand; and for the buyers, by their ability to adjust to the changing supply in the market. Though performance is multi-dimensional with variations across industries, this performance determines the efficiency of a firm. Bain, however, takes into account both technical efficiency and allocative efficiency to measure performance. Technical efficiency is constituted of the efficiency arising out of technical aspects of the organisation and internal efficiency of individual members. The efficiency of the organisation is measured by the scale of operations (scale efficiency), degree of vertical integration (scale efficiency) and the efficient utilisation of plant resources. Internal efficiency is the efficiency of the managers in minimizing cost, which, in turn, depends on their degree of wisdom to this end. Allocative efficiency is concerned with the rate of output in the industry. This is measured by the long run relationship between its selling price and marginal cost.

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[99] Predatory tactics are used by established firms in the industry to weaken or eliminate established competitors.

[100] Exclusionary tactics are aimed to discourage potential new competitors

[101] Hybrid profit maximization entails both joint profit maximization and independent profit maximization. In markets where there are significant seller concentration and seller interdependence, the sellers are motivated topursue individual profit maximization at the expense of the rival. Bain, *Industrial organization* , p. 319

The synthesis of these concepts leads to various questions. The basic one is: How does the size of an organisation affect its efficiency? Now the size of a firm may be determined by the market concentration (that represents a producer's monopoly power), which, in turn, might be governed by product differentiation, and/or the barriers to entry. Two contextual questions are, therefore: Is there any relationship between product differentiation and the market concentration? If yes, how does this relation account for the market performance? And, secondly, do the barriers to entry affect the market performance? We emphasise here that two opposite forces are involved in the determination of overall efficiency. An industry with higher monopoly power usually enjoys technical efficiencies; a more competitive industry, on the other hand, enjoys allocative efficiencies. Overall efficiency of a firm, indeed, depends on the relative weights of these opposite forces.

Bain has empirically tested these questions in the context of the American industries. His findings relating to the relationship between structure and performance are as follows: (i) industries with larger market concentrations (i.e. where there are some large-scale firms enjoying monopoly power) have lower incidence of technically inefficient firms; (ii) industries with low barriers to entry have a substantial group of technically inefficient small firms; and (iii) such industries (having low barriers to entry) are more conducive to competition, and, hence, enjoy more allocative efficiency. Bain[102] reports that 'no evident association' prevails between the market concentration and the inefficiency of small firms, and that inefficient sellers were found in the fringe of markets with high and low barriers to entry alike. Similar results were found for the relationship between the product differentiation and the level of efficiency. Bain stresses that the small inefficient firms

[102] Ibid, p. 437

survive in the market side by side the large firms due to the higher prices that monopolist/oligopolist fixes up in the market.[103]

Bain's hypothesisis, however, criticised on the ground that it does not provide a clear mandate as to what really does determine efficiency. The Chicago school[104] has levelled this hypothesis as being fuzzy suggesting that other methods such as price theory models and game theoretic models should be tried to these ends. It is true that Bain's findings might prima facie appear contradictory in the sense that a monopoly (or competitive) firm may be efficient or inefficient. But if we look into the question segregating efficiency into technical and allocative components, the contradiction disappears to a good extent. If a monopolist is found inefficient, the underlying reason should be that its allocative inefficiency over-compensates its benefit arising out its technical efficiency. For an inefficient competitive firm, on the other hand, technical inefficiency might over-compensate the allocative efficiency.

This hypothesis has, however, many versions and extensions, some of which have culminated to the genesis of the Industrial organisation study. Extending Bain's SCP paradigm, for example, Demsetz has developed the Efficient Structure Hypothesis in 1973,[105] which Peltzman has tested empirically in 1977.[106] They believe that that monopoly profits do not arise because of tacit or explicit collusion among oligopoly firms, but on the strength of their risk-taking behaviour in an uncertain world, and also, of course, the luck.

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[103] Ibid, p. 437

[104] Monti, *EC competition law*, pp. 63-65

[105] Demsetz, 'Industry Structure'

[106] Peltzman, 'The Gains and Losses '

Section III: X-efficiency Theory

One of the important components of technical efficiency that Bain has neglected in his analysis of the SCPP is the 'internal efficiency'[107] of an organisation. This internal efficiency of the organisation has been discussed by Leibenstein as X-efficiency in 1966. The difference between QLH and SCPP is that the latter fails to analyse the factors that lead to (in)efficiency. It is, indeed, more descriptive in deliberation, bearing less flavour of analysis. Leibenstein, on the other hand, explicitly attributes (in)efficiency to subjective factors prevailing at different layers of the organisation. His X-efficiency theory seeks to identify the subjective factors that affect the performance of the individuals, associated with the organisation, and, in so doing, the theory analyses how they affect the performance of the firm. Another unique feature of the theory is the shift of focus from the micro level of the firm to its micro-micro level dealing with the individuals. Since the human factors of production are complex, and also multifarious, such a study should have many abstract dimensions.

Taking cues from Hicks' analysis, Leibenstein builds up his theory on the psychological factors that lead to in/efficiency. Leibenstein's theory of X-efficiency pushes forth the effort to understand the black-box of the human mind. It tries to understand why a person will not work as much as he should; what could be done to propel the individual's wisdom to the level where he moves out of his comfort zone or inertia. The theory of X-efficiency shifts the focus from the allocative and technical efficiency to the study of X-efficiency. According to Leibenstein, an individual in the organisation brings with him certain factors that cannot be assessed or measured, and hence, the production function fails to take those factors into consideration. As a result, the traditional theory only takes into account allocative efficiency and technical

[107] Bain, *Industrial Organization*, p. 376

efficiency of an organisation. In this connection, we may cite the world development report 2015, which puts emphasis on the fact that the existence of an economic man is far from reality, and any policy based on the assumption of an economic man is bound to go astray.[108] This is the spirit of Leibenstein when he tells us that human beings are not rational, and that their behaviour influences the production function which the traditional theory of production ignores. A holistic approach should, therefore, consider the human aspects of the human factors, and incorporate them into the production function so that the efficiency gets maximised.

Among various factors that determine the X-efficiency, Leibenstein stresses on motivation, notably (i) intra-plant motivation and (ii) inter-plant motivation; in addition to what he calls (iii) non-market input efficiency.[109] The efficiency of a firm depends upon the efficiency of the workers employed in the organisation, as well as that of the managers. Its efficiency could, therefore, be augmented by motivating workers and managers, which he calls intra-plant and inter-plant motivations, respectively – the former one emerging from peer pressures, and the latter from external pressures. But a question that arises is that: Why does anyone remain in the inefficient zone? Leibenstein believes that worker and managers cannot be enforced to work efficiently for a variety of reasons, such as (a) that the production function is not known so that individuals inefficiency cannot be identified (the problem of asymmetric information), (b) that the labour contracts is never so exhaustive as to seal out all sources of inefficiency (the moral hazard problem), and (c) that many factors of production (e.g. sincerity, integrity and devotion of workers/managers) are not marketed. While workers/managers can thus afford to be inefficient, they are willing to be so on the ground of what is called 'the selective rationality'. Leibenstein points

[108] World Bank Group, *Mind Society and Behaviour*

[109] Leibenstein, 'Allocative efficiency vs. "X-efficiency"', p. 407

out that the behaviour of an individual is constrained by what is his function in the organisation. In the process of interpreting the job, s/he selects from a subset of 'activity-pace–quality–time' (APQT) bundle. The individual would have to choose from a set of alternative activities, the pace at which those activities are carried out, as also the quality of the activity and the time to be spent on performing the activity. While s/he chooses his APQT bundle s/he is in fact trying to interpret her/his effort position. This effort position comprises of a set of effort points adjacent to one another within which the individual is willing to extend her/his effort. These effort points have the same level of utility. A movement from one effort point to a higher one entails a utility cost. He elaborates, 'A set of effort points where the utility cost of shifting from one point within the set to any point within or outside that is greater than utility gained comprises the inert area.'[110] This inert area is the manifestation of the human inertia. Further, each individual in the organisation has her/his inert area. A discrepancy in the effort position of the individual and the expected effort position of the management leads to an entropy situation. Entropy is the downfall of the organisation as it is not able to move from its inert area. Entropy is a latent force, which every organisation should control. Leibenstein believes that the flow of information from the management to the individuals is an important factor in controlling entropy. Hence, the X-efficient manger faces the task of facilitating this flow of information which is essential for matching the effort points of the individual to the expected one. Any mismatch between them gives rise to inefficiency. This mismatch is present due to the inert area, and is retained because the firms have monopoly position. They can move out of this inertia if it is compelled to do so due to market competition.

[110] Leibenstein, 'Aspects of the x-efficiency', p. 589; see also Leibenstein, 'Organizational or Frictional Equilibria', p. 606

In Leibenstein's analysis of X-efficiency, we can see that the employees and managers in an organisation are considered inefficient due to motivational deficiencies. From those individuals' viewpoint, their actions are efficient in so far as they are in a state of inertia, whereby their utility gains for any movement away cannot outweigh its underlying loss of utility. As utility-maximisers, they are certainly rational, although from the viewpoint of the organisation, the production point that their joint actions yield is inefficient. Leibenstein's X-efficiency theory thus explains the real-life experience of 'rational inefficiency'.

Section IV: Conclusion

All three hypotheses, discussed above, have one thread in common - the prevalence of inefficiency in an organisation. The concept of inefficiency, however, varies across them; so also their interpretations. In Hicks' Quite Life, a monopolist is regarded as inefficient as he does not produce at the optimal level of MR=MC. If we analyse this stand of the monopolist from a micro perspective, we can see that the monopolist makes a rational decision as it is based on the equality of his emotional MR and his emotional MC.

The undertone of Bain's SCPP analysis is that a monopolist may be inefficient from the viewpoint of resource allocation although he might be enjoying technical efficiency. Thus, from the monopolist's standpoint, the organisation is efficient, but it is inefficient in the macro framework as it involves wastage of resources. On the other hand, a competitive firm is surely efficient from the macro viewpoint as there is no wastage of resources for a firm operating at the lowest point of the long run average cost; but it is not efficient as he cannot enjoy profit as high as a monopolist. Both these firms are inefficient – a monopolist from the welfare point of view, and a competitive firm from the individualistic viewpoint.

Leibenstein's X-efficiency theory goes much deeper - from the micro level to the micro-micro level of an organisation. He analyses inefficiency as a motivational deficiency. An individual in an organisation maintains his position of inefficiency as he feels that a movement from this position entails a cost much higher than the benefit that might accrue to him. Thus, the inefficient position of the individual from the point of view of the organisation is rational from his point of view. However, if everyone in the organisation remains static in their own comfort zone, it will ultimately lead to entropy. According to Leibenstein, the only way to get out of this sluggish position is to introduce competition in the system. Thus, Leibenstein's comfort zone is similar to what Hicks considers 'the quiet life'. What Hicks identifies as plausible factors contributing to 'the quiet life' are discussed at length by Leibenstein while deliberating on the comfort zone. The subjective issues are also there in Bain, *albeit* in an implicit tone, especially when he discusses 'wisdom' as an explanation for technical efficiency.

Chapter III

REVIEW OF LITERATURE

The present chapter seeks to review the literature in the context of the central theme of this dissertation, the X-efficiency. In particular, our thrust is on the concept of the term, the methodologies for its measurement and also relevant empirical findings in the literature. These are, however, subject-matters in three subsequent sections that follow. In the section on empirical findings, we concentrate mainly on Indian experiences. Section IV concludes.

Section I: X-efficiency theory and criticism.

Dissatisfied with the neo-classical paradigm, especially its assumption of profit maximization, as apparent in Braithwaite[111], Simon[112] and Cyert and March[113], Leibenstein propounds the idea of X - efficiency in 1966.[114] His idea bridges the gap between neo-classical hypothesis and real-life experiences.

Leibenstein's X-efficiency theory deviates from the traditional theory in the treatment of human resources. The human inputs cannot be treated in the same way as the non-human inputs insofar as a firm cannot purchase human inputs, but human time. Moreover, the human time that the firm buys does not enter into the production process; it is the human effort that matters.[115] The human effort in turn depends upon the motivation. In a multi-person firm, the level of motivation varies, and so the effort level, across the individuals since the motivation for work determines the effort that a worker provides in the work place. Now, the motivation of an individual determines

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[111] Braithwaite, *Theory of Games*
[112] Simon, 'Theories of Decision Making'
[113] Cyert and March, *A Behavioural Theory of the Firm*
[114] Leibenstein, 'Allocative Efficiency Vs "X-Efficiency"', pp.392-415
[115] Leibenstein, 'Organizational or Frictional Equilibria', p.601

how he interprets the job. This is so because, in a real world scenario, (i) all inputs are not traded in the factor market, (ii) there is no fixed correspondence between inputs and outputs as the production function is not exactly known, and (iii) there exist the problems of asymmetrical information leading to the principal agent problem. 'There exist a distinction between agents and principals'[116] and the 'agents may' take 'trade decisions which are not to the mutual benefit of the principal.'[117] Given that motivation determines the level of effort, motivation is a crucial issue in the question of efficiency. Leibenstein, however, argues that any deviation from an optimal effort level can be attributed to: (i) incomplete labour contract, (ii) non-market factor inputs, and/or (iii) incomplete specification of the production function, as the production function guiding the organisations production activity is not known with surety because of the 'experimental element involved'.[118] The deviation from optimal output level can also be explained by the following factors, (i) rationalisation of costs, (ii) innovation, and (iii) introduction of new commodities, of these factors, cost reduction is attributed to increase in X-efficiency.[119]

To explain these factors, we note that each individual who joins an organisation brings into the organization not only his/her idiosyncratic motivation but also his/her utility-effort range. The lowest limit of the range corresponds to the point where the individual prefers to work rather than remaining jobless. Its highest limit corresponds to the point beyond which he does not put any effort. The area between these two points is the individual's inert area. This inert area is constituted by a set of effort points whose associated levels of utility are not the same. The action that is required to move from a lower utility level to a higher utility level involves costs

[116] Leibenstein, 'Aspects of the X-efficiency theory of the firm', p.588
[117] Ibid, p.588
[118] Leibenstein, 'Allocative Efficiency Vs "X-efficiency"', p.407
[119] Ibid, p.408

which may not be compensated by the gain in utility, and thus the inertia prevails. An organization is in a state of equilibrium only when the managers, as well as the workers, are in a state of inertia.

In the theory of X-efficiency, however, an entrepreneur is a person who promotes changes over resistance. The X-efficient entrepreneur or manager is a self-propelled input-gap filler and completer. This is so because he fills prevailing gaps in the input/output market, and covers up the lacuna in the production function.[120] Leibenstein writes that the inert area is a consequence of the discretion that the workers display, and this ultimately leads to 'entropy'[121]. The word entropy is used in the sense 'of a tendency towards disorganization.'[122] He points out, 'If the vertical and horizontal constraints are much weaker than anticipated' then the individual will shift those effort points within his/her effort position that s/he prefers and 'which is less likely to be connected with the objective of the firm.'[123] It is here that an entrepreneur with his motivating skill comes into the picture.

A questionable assumption of the neoclassical economics that Leibenstein seeks to address is the assumption of rationality. This very assumption of rationality, outright ignores the existence of X-efficiency. In the neoclassical economics, the centre of analysis is a firm/ an industry. *Per contra*, in the theory of X-efficiency, the unit of study is the individual, who is governed by his/her motivation, inert area, as well as APQT set (that is, the set of Activity, Pace, Quality and Time). This bundle determines the 'Activity' that the individual chooses; the 'Pace' at which he carries out those activities; the 'Quality' of the activity he performs and the 'Time' spent on

[120] Leibenstein, 'Organisational or Frictional Equilibria', p.612
[121] Leibenstein, 'Aspects of the X-efficiency theory of the firm', p.600
[122] Leibenstein, 'A Branch of economics is missing', p.487
[123] Ibid, p.487

performing the activities. This APQT bundle is partially determined by an individual's work potential set of desires, attitude and the sense of responsibility about the activities of others surrounding him. Individual managers as well as workers have their own APQT set. If the effort levels go down, it leads to entropy, which is a swan song for the organization.[124]

In contrast to complete rationality of neo-classical economic theory, the X-efficiency theory assumes selective rationality for individuals. It signifies that an individual selects the extent of his/her deviation from the maximizing behaviour, which in fact depends on his/her personality. Personality is in turn determined by his/her responsibility standard and unconstrained behaviour - a concept akin to the Freudian concept of id, ego and superego.[125] The responsive behaviour and unconstrained behaviour determine together the internal pressure that an individual faces. Coupled with external pressures, it then determines an individual's deviation from his/her maximizing behaviour.[126]

Taking clues from the management discretion theory, the X-efficiency theory recognises the divergence in objectives between managers and owners of a firm,[127] and argues that it is the cause of X-inefficiency. To keep the objectives of the managers in line with the objectives of the owners, Crew *et al*[128] introduce the concept of policing, which enables the X-efficiency theory to ground on the profit-maximising behaviour. Their logic is that though there is a divergence in the objectives between owners and managers, the latter are compelled to opt for the best

[124] Leibenstein, 'Competition and X-efficiency', p.767
[125] Leibenstein in his article 'Aspects of the X-efficiency theory of the firm' p.583 writes that 'individuals behave on the one hand (a) as they like to and on the other hand, (b) as they feel they must' and 'they strike a compromise between' the two. This is corollary to Freuds' concept of id ego and superego. See Freud '*The Ego and the Id'*.
[126] Leibenstein, 'A Branch of economics is missing', p.485
[127] Crew *et al*, ' X-Theory versus Management Discretion Theory'
[128] Ibid, pp.173-177

use of inputs, and thus to ensure the maximisation of profit. Their theory is labelled as the X-theory.

But Blois[129] contradicts the position, and using the concept of inert area, he explains why firms do not maximise profit. *Prima facie*, owners should not welcome any deviation from profit maximisation, since profit is distributed among them as dividend. But, he argues, the owners may not pressurise the management to go for profit maximisation if the cost of movement from the equilibrium position to the profit-maximising equilibrium is higher than the benefit accruing to the majority of the share-holders. In that case, the owners of the firms will not seek to reduce the X-inefficiency which has crept in due to the differences in the objectives of the owners and managers.[130]

The neo-classical assumption of rationality that generates the objective of profit maximisation is challenged on the question of decision-making unit. This is so because, according to Leibenstein, the neo-classical microeconomics is not micro enough. The unit of analysis in the neo-classical economics is a firm or a household which takes up decisions. But a firm or a household is made up of individuals, and hence the focus of analysis should shift from the firm or household to the individual motivation.[131] In this sense, the X-inefficiency is in-built in the framework of the neoclassical microeconomics. Only when the focus is confined to firms as the decision-making unit, the X-inefficiency is eliminated from the neoclassical theory.[132]

[129] Blois, 'A note on X-efficiency and profit maximization'
[130] Ibid pp. 310-311.
[131] Leibenstein, 'Comment on the nature of X-efficiency', p.327
[132] Leibenstein, 'Competition and X-inefficiency: Reply' p.766

Comanor and Leibenstein[133] relate the vices of monopoly with the X-inefficiency. They point out that competition reduces costs by inculcating 'disciplinary pressure' on all firms in an industry. It eliminates the high-cost producers, and disciplines managements and employees to optimally use the inputs. They thus believe that 'a shift from monopoly to competition has two possible effects: (1) the elimination of monopoly rents, and (2) the reduction of unit costs.'[134]

Stigler,[135] however, re-emphasises the neo-classical assumptions of rationality and profit maximization, and points out that analysing the X-efficiency by the economic behaviour is a 'short gun marriage', which is 'not fertile'.[136] According to Stigler, individuals do not maximise output; rather they maximise utility where output is only a component. If an individual increases output by a higher effort level, this increase should not be regarded as an increase in efficiency. The effort that is required to enforce the contracts cannot be regarded as X-inefficiency as Stigler considers 'New techniques of contract enforcement may be productive as other improvements of technology'[137] rather than increase in X-efficiency.

Stigler also questions the existence of X-efficiency pointing out that it can be assimilated into 'the traditional theory of allocative inefficiency.'[138] He, in particular, challenges 'the property of treating changes in motivation as a source of changes in output',[139] and argues that '[t]he effects of these variations in output are all attributed to specific inputs, and in the present case chiefly to the differences in entrepreneurial

[133] Comanor and Leibenstein, 'Allocative efficiency, X- efficiency '
[134]Ibid, p. 304
[135] Stigler, ' The Xistence of X-Efficiency'.
[136] Ibid, p.214
[137] Ibid, p.214
[138] Ibid, p. 213
[139] Ibid, p.213

capacity.'[140] Moreover, he believes, the removal of motivational deficiencies that exist in monopoly does not improve the level of efficiency; it only changes the composition of output. He stresses that 'in every motivational case, the question is: what is output? Surely no person ever seeks to maximize the output of any one thing: even if the single proprietor, unassisted by hired labor, does not seek to maximize the output of corn: he seeks to maximize utility, and surely other products including leisure and health as well as corn enter into his utility function. When more of one goal is achieved at the cost of less of another goal, the increase in output due to (say) increased effort is not an increase in "efficiency;" it is a change in output,'[141]

Di Lorenzo extends Stigler's criticism on the strength of arguments which he borrows from the literatures on property rights and agency costs. His main argument is that 'managers of private monopoly firms, acting as rational utility maximizing agents, will not pursue profit maximization less arduously than will their counterparts in more competitive industries.'[142] Since managerial reward is tied to profitability, the managers of both monopoly firm as well as competitive firm will not be 'motivationally deficient'[143]. If managers fail to maximize profit then 'it will depress stocks'[144] and make it vulnerable to take-over bids. Inefficient, non profit maximizing managers will face managerial competition both from within and outside, and this will discipline the managers to maximize profit.[145]

[140] Ibid, p.215
[141] Ibid, p.213
[142] DiLorenzo, ' Corporate management, property rights', p.117
[143] Ibid, p.118
[144] Ibid, p.121
[145] Ibid, p.121

Section II: Method of Measurement

Similar to the debate on the concept of efficiency, the measurement of efficiency attracts an intensive controversy among economists and statisticians alike. The earliest method of productivity measurement is the method of average labour productivity.[146] But there is a serious drawback of the method in that the firm's productivity is measured in terms of the productivity of labour alone, ignoring all other factors of production. This drawback has led to the introduction of the efficiency index method in this literature,[147] which takes into account all factors of production. In view of the adding-up problem for different inputs involving various units, it considers them in value terms. But this method is also blurred in view of appropriate input-prices for individual firms. If all the firms face with the same input-prices, the index method is reduced to comparing production costs among different firms. [148]

Farrell overcomes the problems of the earlier methods by applying the concept of production frontier to measure efficiency. Farrell's method splits up the technical efficiency and the allocative efficiency, which the earlier methods are unable to do. His methodology is based on the assumption of an efficient production function for an industry, which is compared with the production function of individual firms to make a judgement on their respective inefficiency levels. This methodology thus requires to properly define the most efficient production function for an industry. The production function may be defined theoretically or empirically and Farrell uses the empirical production function due to the difficulties posed by the theoretical production function.[149] But there are three major criticisms against this approach. First, it requires

[146] Farrell, 'The Measurement of Productive Efficiency', p.263
[147] Ibid, p.264
[148] Ibid, p.264
[149] Ibid, p. 255

a priori knowledge about the needs of a firm; second, as the theoretical production function has been assuming various complex characters over the last decades; and third, it talks about what can best be achieved rather than what is actually achieved. As such, this approach is less preferred in empirical studies. The alternative method is, however, to construct the most efficient production function by taking into account the best input-output combinations in various lines of production in an industry from different firms. Farrell shows that such an efficient production function is 'represented by an isoquant'[150] which is convex to the origin. The technical inefficiency of a firm is derived by comparing the efficient frontier with the 'hypothetical firm which uses the factors in the same proportion' wherein this 'hypothetical firm is constructed as a weighted average of two observed firms' 'its inputs and outputs is the same weighted average of those observed firms'. [151]

Aigner and Chu[152] improve Farrell's methodology by incorporating an error component in the analysis. They, indeed, consider in line with Farrell - that there are two types of production functions, one for the industry and a set of others for different firms in the industry. The former contains only pure random shocks. The latter, however, reflects the differences in technical and economic inefficiencies across the firms. Aigner and Chu argue that differences in technical efficiency arise owing to differences in the holdings of capital equipment, both in quantity and vintage, as also sources of fund, internal and external. Differences in the economic efficiency, however, stem from the adjustment lags in production during the changes in the market situation.

[150] Ibid, p.255
[151] Ibid, p.256
[152] Aigner and Chu, 'On estimating the Industry Production Function'

Aigner and Chu consider a Cobb-Douglas production function:

$$x_0 = Ax_1^{\alpha logR}\, x_2^{\beta \log r} u \qquad (3.1)$$

where x_0 is the output; x_1, x_2 are the inputs; and u is the random shock which is assumed to be one sided; R represents the ratio of the value of equipment to plant and r the ratio of the number of technical personnel to production workers. [153] On the basis of cross-section firm-level data, Equation (3.1) can be estimated to derive the industry production function. They note that 'since r and R vary over firms, the firm production function can be derived from the industry function by appropriately adjusting these proxy variables.'[154] The technological inefficiency for individual firms is then obtained as the difference between the industry production function and the firm production function. To estimate the economic inefficiency, however, Aigner and Chu propose the share equations for inputs in expenditure along with the production function (3.1). Since the firms' deviations lie only on one side, they propose to estimate the function 'within the framework of linear programming',[155] i.e. by minimising the sum of residuals as a linear loss function.

Timmer[156] improves Farrell's method by incorporating a probabilistic production frontier in the place of an average production function. He points out that since only 'extreme observations are used in the estimation of the frontier, it is highly subject to errors in data' and the use of probabilistic production frontier would

[153] Aigner and Chu, 'On estimating the Industry Production Function' pp. 827-831
[154] Ibid, p.833
[155]Ibid, p. 832
[156] Timmer, 'Using a Probabilistic Frontier Production Function'.

solvethe 'problem of spurious errors in extreme observation'.[157] The equation (3.1) can be written as

$$\Pr\left(\hat{A}x_1^{\hat{\alpha}}x_2^{\hat{\beta}} \geq x_0\right) \geq P \qquad (3.2)$$

where P is the specified minimum probability.[158]

Aigner, Lovell and Schimidt[159] (ALS) incorporate both positive and negative disturbances in their model, which is specified as

$$y = x\beta + \varepsilon \ldots\ldots\ldots\ldots\ldots\ldots\ldots.(3.3)$$

where y is nx1 vector of outputs, x is n x k matrix of observation on k fixed regressors and β is k x 1 vector of unknown regression coefficients. The elements of n x 1 disturbance vector ε is determined by

$$\varepsilon_i = \varepsilon_i^*/\sqrt{1-\theta} \text{ if } \varepsilon_i^* > 0$$

$$= \varepsilon_i^*/\sqrt{\theta} \text{ if} \varepsilon_i^* \leq 0$$

where ε_i^* has either a positive or negative truncated normal distributions. [160] There are two components in ε, ε_i^* and θ. The term θ measures random variations due to (i) the firms' inability to implement the best practise technology, and (ii) the problem of measurement in y. The other component,ε_i^*, incorporates the firm-level inefficiency as well as the effects of favourable and unfavourable external factors, which are beyond the control of the firms, and, therefore, purely stochastic. Their stochastic frontier assumes the form of:

[157] Ibid, p.781
[158] Ibid, p.781
[159] Aigner *et al*, 'Formulation and Estimation'.
[160] Ibid, p. 23

$$y_i = f(x_i, \beta) + \varepsilon_i \qquad (3.4)$$

The term ε_i in equation (3.4) represents a composite error comprising of pure white noise and inefficiency. Thus,

$$\varepsilon_i = v_i + u_i \qquad (3.5)$$

where $$v_i \sim \text{IIDN } (0, \sigma^2) \qquad (3.6)$$

$$u_i \sim \text{N } (0, \sigma^2) \qquad (3.7)$$

The term v_i is symmetrically distributed, but u_i belongs to the negative domain, $u_i \leq 0$. These non-positive $u_i's$ signify that each firm's output must lie on or below the frontier. The deviations from the frontier, however, represent the firm-level technical or economic inefficiencies. The stochastic component v_i accounts for situation where the output varies as a result of favourable or unfavourable external factors. Thus the production function in equation (3.4) can be written as

$$y_i = f[(x_i, \beta) + v_i - u_i] \qquad (3.8)$$

In this case, the efficiency measurement is given by the ratio $y_i / [f(x_{i\,,}\beta) + v_i - u_i]$

instead of $y_i / [f(x_i \beta)]$.[161]

Simultaneously with ALS, Mauseen and van Den Broeck[162] put forward a stochastic frontier method for the measurement of efficiency. Similar to the ALS

[161] Ibid, pp. 22-25

method, they propose an efficiency model with a composed multiplicative disturbance term - the 'product of a "true" error term and an inefficiency measure'. The proposed model is:

$$y_t = \emptyset(x_t) k_t u_t t = 1, \dots \dots \dots T \qquad (3.9)$$

Here, k_t is the inefficiency term distributed in (0,1) interval, and the random shock u_t is distributed over $(0,\infty)$.[163]

Battese and Corra[164] also recognise the composite error structure in a firm's production function. They define the production frontier as

$$y_t = x_t \beta + E_t \qquad (3.10)$$

where

$$E_t = U_t + V_t \qquad (3.11)$$

The random error U_t is, by assumption, and 'arise by truncation of the normal distribution with mean zero and positive variance'[165]. The stochastic component V_t is assumed to follow normal distribution with zero mean and positive variance.[166]

These three papers, all published in 1977, enhance the acceptability of the stochastic frontier analysis by virtue of its stochastic component in errors. Its main difficulty – the decomposition of the error term into the random shocks and the inefficiency component – is overcome to some extent in Jondrow *et al*[167] (JLMS) in 1982. The JLMS provides a measure of producer-specific estimates of efficiency, but

[162] Mauseen and van den Broeck, 'Efficiency estimation'
[163] Ibid, p. 436
[164] Battese and Corra, 'Estimation of a Production Frontier Model'
[165] Ibid, p.170
[166] Ibid, p.170
[167] Jondrow *et al*, 'On the estimation of technical inefficiency', 1982.

fails to decompose the *error* term into technical and allocative (economic) efficiencies. Following the prevailing practice, the model is estimated using a two-stage method. In the first stage, the efficiency is estimated, and, in the second, stage the estimated efficiencies are regressed on a vector of explanatory variables.[168]

The JLMS method estimates u_{it} as

$$E[u_{it}|\varepsilon_{it}] = \frac{\sigma\lambda}{1+\lambda^2}\left[\frac{\phi(a_{it})}{1-\Phi(a_{it})} - a_{it}\right] \qquad (3.12)$$

where

$$\sigma = [\sigma_v^2 + \sigma_u^2]^{1/2}$$

$$\lambda = \sigma_u/\sigma_v$$

$$a_{it} = \pm\varepsilon_{it}\lambda/\sigma$$

$$\phi(a_{it}) = \text{standard normal density evaluated at } a_{it}$$

$$\Phi(a_{it}) = \text{the standard normal CDF evluated at} a_{it}$$

A single step method is proposed in Battese and Collie.[169] The explanatory variables in the single stage approach are incorporated in the random variable such that

$$y_{it} = \exp(x_{it}\beta + v_{it} - u_{it}) \qquad (3.13)$$

with the u_{it} term representing 'a function of set of explanatory variables,$z_{it}s$ and an unknown vector of coefficient, δ'.[170] Thus,

$$U_{it} = z_{it}\delta + W_{it} \qquad (3.14)$$

[168] Kumbhakar and Lovell, *Stochastic Frontier Analysis*, p.10
[169] Battese and Coelli, 'A stochastic Frontier production'
[170] Ibid, p.327

The technical efficiency of the ith firm is defined as:

$$TE_{it} = \exp(-U_{it}) = \exp(-z_{it}\delta - W_{it}) \qquad (3.15)^{171}$$

Along with the development in the measurement of efficiency, the literature also witnesses the use of more sophisticated production functions over years. The earliest used production function is the Cobb- Douglas production function of the form,

$$Q = AK^{\alpha}L^{\beta} \qquad (3.16)$$

where 'Q' represents the quantity of output, K and L are capital and labour inputs respectively, and A, α and β the parameters. In this function, the elasticity of substitution is constant, and hence represents only constant returns to scale. It is incapable to measure the U shaped average cost curve. Also, it cannot accommodate multiple outputs. In order to overcome the former problem, the Constant Elasticity of Substitution (CES) production function[172] is used:

$$Q = A[\alpha K^{-\rho} + (1-\alpha)L^{-\rho}]^{\frac{-1}{\rho}} \qquad (3.17)$$

where ρ is a constant but not unity. The improvement that the CES production function provides over the C-D function is that since elasticity of substitution is constant but not unity, this functional form can depict either increasing or decreasing returns to scale. However, the limitation of the CES and C-D function is that both are monotonic function. The C-D function gives monotonically constant returns to scale, and the CES production function gives monotonically either increasing, decreasing or

[171] Ibid, p. 327
[172] Arrow *et al*, 'Capital-labour substitution'

constant returns to scale. Moreover, both of them can analyse only a single-product firm.

Recent studies have been using flexible functional forms to approximate the production technology by the Taylor or Fourier series. The Transcendental Logarithmic (translog) cost function[173] is a Taylor series expansion to accommodate various outputs separately and do not enforce any particular returns to scale. It accommodates multiple outputs without violating the curvature condition; also, it is flexible in the sense of providing a second order approximation to any well-behaved cost frontier at the mean of data. This functional form is now widely used in empirical studies, including those on the decomposition of cost efficiency.

The translog specification of a cost function is

$$LnC = \alpha_0 + \sum_i^n \alpha_i Lny_i + \sum_j^m \beta_j Lnp_j + \frac{1}{2}\sum_i^n \sigma_i Lny_i^2 + \frac{1}{2}\sum_j^m \gamma_j Lnp_j^2 + \sum_i^n \sum_j^m \Omega_{ij} Lny_i Lnp_j + \varepsilon \quad (3.18)$$

Where y_i (i= 1,2, ..., n) represents the ith output, and p_j (j= 1,2, ..., m) its price. The translog cost function, however, assumes certain regularity conditions like homogeneity and the concavity of cost function, and also certain behavioural assumptions like the objective of cost minimisation and the prevalence of perfect competition in both product and factor markets.

[173] Christensen *et al*, 'Transcendental Logarithmic Utility Functions'

The homogeneity condition is satisfied when

$$\Sigma_j \beta_j = 1 \qquad (3.19)$$

$$\Sigma_j \gamma_j = 0 \qquad (3.20)$$

$$\Sigma_i \Omega_i = 0 \qquad (3.21)$$

The major limitation of the translog function is that it gives only local maxima or local minima. The global optimum solution cannot be generated in this method.

Parallel with the increasing application of econometric tools and techniques, the literature also witnesses the growing use of programming-based methodology. Such a development is the Data Envelopment Analysis (DEA), pioneered by Charnes, Cooper and Rhodes (CCR),[174] which is based on mathematical programming, and, hence, non-parametric. This method was originally developed to measure the efficiency of non-profit organisation.[175] The units under study are referred to as the decision Making Units (DMU). The CCR model measures the efficiency of a particular unit (denoted by the subscript 0) as the ratio of its weighted outputs to its weighted inputs given as

$$h_0 = \frac{\sum_{r=1}^{s} u_r y_{r0}}{\sum_{i=1}^{m} v_i x_{i0}} \qquad (3.22)$$

The objective function of the unit is then

$$\max h_0 = \frac{\sum_{r=1}^{s} u_r y_{r0}}{\sum_{i=1}^{m} v_i x_{i0}} \qquad (3.23)$$

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[174] Charnes et al, 'Measuring the efficiency of decision making units'
[175] Ibid, p.429

$Subjectto$

$$\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1$$

$$j = 1 \ldots .. N$$

$$v_r u_i \geq 0; \quad r = 1 \ldots \ldots .. s; \quad i = 1 \ldots \ldots . m$$

where y_{rj} is the output of the jth DMU and x_{ij} its inputs and the v_r, u_i are the weights assigned. The above equation can be transformed into a linear programming problem as follows:

$$MaxZ_0 = \sum_{r=1}^{s} u_r y_{r0}$$

$Subjectto$

$$\sum_{i=1}^{m} v_i x_{i0} = 1$$

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \leq 0$$

$$j = 1 \ldots N$$

$$u_r, \ v_i \geq \epsilon$$

where $\epsilon > 0$ is a small non Archimedean quantity.[176]

The dual of the above equation is given as

[176] Banker et al, 'Some Models for Estimating', p.1083

$$Min w_0 - \epsilon \left[\sum_{i=1}^{m} s_i + \sum_{r=1}^{s} s'_r \right] \qquad (3.24)$$

$subjectto$

$$0 = w_0 x_{i0} - \sum_{j=1}^{n} x_{ij} \lambda_j - s_i , \qquad i = 1, \dots \dots m$$

$$y_{r0} = \sum_{j=1}^{n} y_{rj} \lambda_j - s'_r r = 1, \dots \dots .. s$$

$$\lambda_j , s_i , s'_r \geq 0$$

$Z_0 = w_0 = 1$ if and only if the slack values s_i, s'_r are equal to zero.[177]

The model developed by CCR is based on constant returns to scale, and, therefore, it is not an appropriate measure of efficiency when variable returns to scale prevail. Banker, Charnes and Cooper (BCC)[178] improvise it by incorporating variable returns to scale. For a single input (X), single output (y) model of production, the following diagram gives the essence of the model.

[177] Ibid, p.1083
[178] Ibid, p.1078

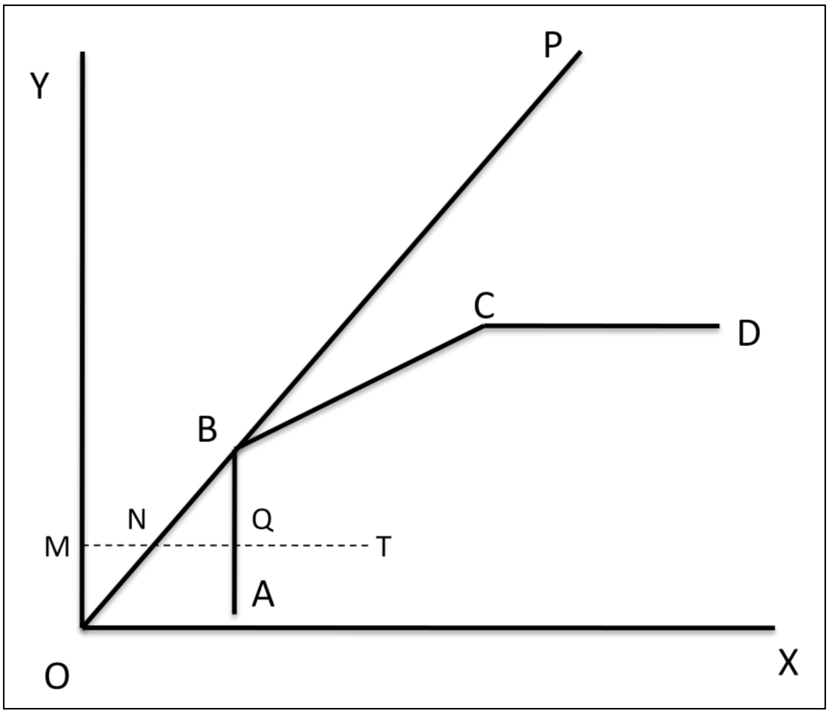

Fig 3.1: Technical and Scale Efficiency

The figure displays the production frontier by ABCD when the technology gives variable returns to scale, and by OBP when the constant returns to scale prevail. For any DMU, the overall technical inefficiency is measured by ${}^{\mathrm{MN}}/_{\mathrm{MT}}$ for the production point at T. Input technical efficiency is measured by the ratio ${}^{\mathrm{MQ}}/_{\mathrm{MT}}$ and the input scale efficiency is measured by the ratio ${}^{\mathrm{MN}}/_{\mathrm{MQ}}$.

The fractional programming problem for BCC is given as

$$\max h_0 = \frac{\sum_{r=1}^{s} u_r y_{r0} - u_0}{\sum_{i=1}^{m} v_i x_{i0}} \qquad (3.25)$$

$subjectto$

$$\frac{\sum_{r=1}^{s} u_r y_{rj} - u_0}{\sum_{i=1}^{m} v_i x_{ij}} \leq 0$$

$$u_r, v_i \geq 0$$

Its linear program form can be written as

$$\max h_0 = \sum_{r=1}^{s} u_r y_{r0} - u_0 \qquad (3.26)$$

$subjectto$

$$\sum_{i=1}^{m} v_i x_{i0} = 1$$

$$-\sum_{i=1}^{m} v_i x_{ij} + \sum_{r=1}^{s} u_r y_{rj} - u_0 \leq 0$$

$$j = 1, \dots \dots ., n$$

$$u_r, v_i \geq \epsilon$$

$u_0$is unconstrained in sign.

The dual of the problem can be written as

$$\min h - \epsilon \left[\sum_{i=1}^{m} s_i^+ + \sum_{r=1}^{s} s_r^- \right] \qquad (3.27)$$

$subjectto$

$$hx_{i0} - \sum_{j=1}^{n} x_{ij} \lambda_j - s_i^+ = 0 \qquad i = 1, \dots \dots .., m$$

$$\sum_{j=1}^{n} y_{rj} \lambda_j - s_r^- = y_{r0} r = 1, \dots \dots \dots . s$$

$$\sum_{j=1}^{n} \lambda_j = 1$$

$$\lambda_j, s_i^+, s_r^- \geq 0$$

A special case of the DEA is the Free Disposal Hull (FDH) approach. In the case of FDH, the main improvement is that 'the production possibility set is composed of DEA vertices'.[179] The specification, however, generates inefficiency which is greater than that generated by the DEA.

In addition to SFA and DEA, the other approaches in the field of parametric method are the Distribution Free Approach (DFA) and the Thick Frontier Approach (TFA). The DFA was introduced by Berger in 1993.[180] It assumes 'that the efficiency of each firm is stable over time'[181] and the random error overtime tends to zero. Therefore, there is no random error or residual in the final analysis. The TFA was developed by Berger and Humphrey in 1991.[182] This method recognises the residuals like the SFA, but groups the data into quartiles and estimates the parameter separately for each quartile. The measurement of efficiency is then made on the basis of highest and lowest quartiles.

[179] Berger and Humphrey, 'Efficiency of financial institutions', p. 5
[180] Berger, 'Distribution-free estimates of efficiency'
[181] Berger and Humphrey, 'Efficiency of financial institutions', p.7
[182]Berger and Humphrey, 'Dominance of inefficiency'

Section IV: Studies relating to efficiency

Literature in the field of efficiency measurement can be classified into two major groups, the DEA from the non-parametric side and the SFA from the parametric side. Other measures are less frequently used. In this section, we first review the efficiency measurement studies, belonging to both DEA and SFA, outside the field of commercial banking. Then we concentrate on similar studies in banking, but our domain of empirics is outside India. Finally, we take up the studies on Indian Banking.

Danilin *et al* [183] use SFA to estimate the inefficiencies in the command economy of the Soviet Union. They analyse the efficiency for a cross-section of 151 cotton refining enterprises in 1974, using the dynamic homothetic CES production function with capital and labour as inputs. Much against the popular belief of the western thinkers that the command economy generates inefficiency, they find that the cotton refining firms are close to the efficiency frontier. The inter-enterprise efficiency score is also very negligible for them.

Stevenson[184] analyzes the X-efficiency of the electricity generating industryin the United States. He studies the effect of competition on efficiency, using the translog cost function with input prices for labour, capital and fuel, as also the utilisation of capacity and competitive pressures. The difference in competitive pressure is found giving rise to different levels of technical efficiency as well as

[183] Danilin *et al*, 'Measuring enterprise efficiency'
[184] Stevenson, 'X-inefficiency and inter firm rivalry'.

dynamic efficiency. The article interchangeably uses the terms technical efficiency and X-efficiency.

Kumbhakar and Heshmati[185] adopt the SFA to analyse the technical efficiency of Swedish dairy farms, decomposing the residuals at multi stages, rather than in a single step. Using fodder and other materials, land, labour and capital as inputs, and also the age of farmers and the time trend as other explanatory variables, they reveal that the persistent technical inefficiency is higher than compared to the residual inefficiency.

The SFA is also used in Liberman and Dhawan[186] for Japanese and the US auto producers using the value added per employee as a proxy for labour productivity, capital stock per employee for Investment per worker, the firm size is proxied by the number of employee, Plant size is represented by the volume per plant, work-in-progress (WIP) represents the shop floor manufacturing capacity, vertical integration by the ratio of value added and sales, final product quality and cumulative output as dependent variables. The study underscores the existence of scale efficiency, and notices that higher efficiency is achieved by firms at higher production levels. The productivity differences among firms are evidently related to the type of organization and the scale of operation.

Further application of SFA is evident in Esho and Sharpe,[187] which measures the X-efficiency of Australia's Permanent Building Societies (PBS) using the cost of fund and wage index. But, the X-efficiency is taken to mean technical as well as

[185] Kumbhakar and Heshmati, 'Efficiency measurement'
[186] Liberman and Dhawan, 'Assessing the resource base'
[187] Esho and Sharpe, 'X-efficiency of Australian'

allocative efficiency. The evidence of X-inefficiency is noticed among Australia's PBSs, which they attribute, by logic, to managers' inefficiency.

The X-efficiency of Taiwan hotels is the area of interest in Chen,[188] where we find three input prices – the price of labour, the price of food and beverage, and the price of materials - total revenue as the output variable, and the room occupancy rate and the value of catering per unit space as control variables. The paper, however, represents the technology by the Cobb-Douglas production function in the SFA framework. His empirical exercise estimates the hotels' efficiency at 80 per cent, and suggests that management exerts a strong effect on the performance of the hotels. Other findings of the study are: (i) the efficiency of the hotel chains is higher than that of the independent hotels, and (ii) the scale of operation and the location of a hotel do not change the efficiency level.

Among other studies in this field, we should mention Olsen and Henningsen[189] who analyse the technical efficiency of commercial pig farms in Denmark using the translog specification. The study seeks to understand the effects of the size and timing of investment, as also the investment utilisation rate on level of efficiency. They observe a growth in farm efficiency in consequence of a higher level of investment and the experience level of farmers.

In the study of X-efficiency among commercial banks in Hong Kong by Simon Kwan[190], X-efficiency is linked to various aspects of the organization, like organizational structure, executive compensation, market concentration, risk-taking, merger and acquisition, and common stock performance. Using labour, physical

[188] Chen, 'Applying the stochastic frontier approach'
[189] Olsen and Hanningsen , 'Investment Utilisation'
[190] Kwan, 'The X-efficiency of Commercial banks'

capital and borrowed funds as inputs and loans as output in a translog cost function, he shows that the banks became more cost efficient overtime, especially after the Asian Financial crisis (1997). The X-efficiency is found decreasing with bank size, deposits-to-asset ratio, loan-to-asset ratio, provision for loan loss and the growth of loan, but increasing with off-balance sheet activities.

The X-efficiency of Australian Banks is studied by Sathye[191] using the data envelopment approach with three inputs - labour, capital and loanable funds - and two outputs, loans and demand deposits. The empirical analysis suggests that the technical efficiency is lower than the allocative efficiency, and that the former pulls down the overall efficiency of the Australian banks much below the world average. The study has also found that domestic banks are more efficient than foreign banks. There is, however, a lack of clarity in the concepts of various forms of efficiency. The allocative efficiency is regarded as X-efficiency, and the overall efficiency as economic efficiency. In fact, the concept of X-efficiency as considered here is not in line with what Leibenstein conceives.

The efficiency in Japanese Banking is studied by Altunbas *et al.*[192]using the Fourier flexible form in a SFA framework of three inputs (labour, fund and physical capital) and three outputs (loans, securities and off-balance sheet activities). The study indicates that the scale inefficiencies are larger than X-inefficiencies, so that overall efficiency could be augmented by way of policy measures relating to scale efficiency, rather than X-efficiency.

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[191] Sathye, ‘ X-efficiency in Australian Banking’
[192] Attanubas *et al*, ‘Efficiency and risk’

Kwan and Eisenbeis [193] investigate two important problems about U.S banking firms: (i) how inefficient firms continue in business, and (ii) whether such inefficient firms cause risks to the banking business. They employ the translog cost function using four output variables – (a) the book value of real estate loan, (b) the commercial and industrial loan, (c) the consumer loan and off balance sheet commitments, and (d) contingencies – and three price variables – (a) the unit price of capital, (b) total expenses and (c) the unit price of labour. Their findings are: (i) the large banks are more efficient than the smaller banks, (ii) The inefficient firms have higher stock return variance, (iii) higher idiosyncratic risk is associated with lower capitalization and higher loan losses, and (iv) the X-inefficiency of the firm brings down the stock returns of the firms.

Clark and Siems[194] delve into the off-balance sheet activities (OBS) to evaluate the X-efficiency of the US banking firms for 1990-1999, using the translog functional form in the SFA and DFA frameworks. In view of measurement problems for OBS, it is proxied by a credit equivalent measure ('standby letters of credit to derivative contracts')[195], an asset equivalent measure ('the rate of return on on-balance-sheet assets to capitalize noninterest income')[196] and a non-interest income measure ('the sum of income from fiduciary activities, service charges on deposit accounts, trading fees and gains or losses from foreign transactions, trading account gains or losses, fee income, and all other noninterest income').[197] These different OBS activities significantly influence the bank performances, especially their cost

[193] Kwan and Eisenbeis, 'An analysis of inefficiency in Banking'
[194] Clark and Seims, 'X-efficiency in Banking'
[195] Ibid p.995
[196] Ibid p.995
[197] Ibid, p.996

efficiency. Their profit efficiency is not, however, significantly augmented in the process.

The X-efficiency and the scale efficiency among the US banking firms also attract a study by Stavros Peristiani.[198] By way of the translog cost function and DFA, it reveals that X-efficiency is constant over banks of all sizes. Their X-efficiency, however, declines after the merger, but their scale efficiency improves.

The efficiency of Greek banking is studied in Christopoulos *et al* [199], who adopt a translog function defined on capital, labour and deposits as inputs, and loan investments and liquid assets as outputs. Their study denies the existence of scale efficiency among those banks. Their explanation is that the extended branch network of larger banks escalates their cost of operation. After entering the European Monetary Union (EMU), the Greek banking system was also highly affected by the cross-country competition that put pressure on bank profitability. The entry into the EMU, increased the liquidity of the banks as a result of the abolition of minimum reserves, reduction in bank investment in government securities to finance public deficit. The large banks are found to be less cost efficient than the small and medium size banks.

The Chinese banks are the subject of Chen *et al*,[200] where their performance is analysed with respect to deregulation. Using DEA they measure the cost efficiency, technical efficiency as well as allocative efficiency. Their empirical evidences include, (i) that the technical efficiency scores higher than allocative and cost efficiencies, (ii) that the allocative and technical efficiencies shot up during the reform period, (iii) that the Asian Financial crisis of 1997 greatly enhanced the efficiency of

[198] Peristiani, 'Do Mergers improve the scale efficiency'
[199] Chiristopoulos *et al*, 'Efficiency of the Greek banking'.
[200]Chen *et al*, 'Banking efficiency in China'

regional joint-equity banks, and (iv) that the medium sized banks were least efficient among banks of various sizes.

The CAMEL methodology is used by DeYoung[201] to categorise the U.S. banks into two groups, well-managed and poorly managed. The underlying methodology is the Thick Frontier Analysis where the translog cost function is used with three outputs, loan, transaction services and fee-based activities, and three input prices, wage rate, price of physical capital and interest on deposits. He finds that the well-managed banks operate with a relatively less number of branches than a poorly managed bank and that the 'well-managed commercial banks out-perform banks with poor management'. [202]

Spong *et al*[203] examine the effects of management and ownership on the efficiency of banks for the Tenth Federal Reserve District. The cost efficiency is measured by a cost efficiency index, and the profit efficiency by adjusted-returns on average assets. Among various findings in this study, we may note: (i) the banks in holding-companies are inefficient than the independent banks, (ii) the efficient banks are characterised by better attendance rate, more board meetings, and active deliberation of the board members on the workings of the banks, (iii) the efficient banks can effectively control their costs of operation, and (iv) managers' compensations in efficient banks are also greater than those in inefficient banks.

Allen and Rai[204] focus on the efficiency of international banks on the premise that international competition would compel the banks to minimise their cost – an idea associated with the X-efficiency. They employ both the SFA and the DFA to

[201] DeYoung , 'Management Quality and X-inefficiency'
[202] Ibid, p.19
[203] Spong *et al*, 'What makes a Bank efficient'
[204] Allen and Rai, 'Operational efficiency in Banking'

measure cost efficiency using the translog cost function. Their study covers fifteen countries, each with 194 banks, for a period of five years. The study underlines that the countries where universal banking is dominant are less X-inefficient than those where commercial and development banking are separated. Their further findings are that, though the bank size is an insignificant variable to control efficiency among universal banks, the X-inefficiency grows up with the size of the banks.

D'Souza and Lia[205] analyse the effect of diversification on the efficiency of the Canadian banks. The efficiency is measured by constructing a risk-return efficient frontier,[206] and the diversification is proxied by four different types of the Herfindahl-Hirschman Index (HHI), namely, the industrial HHI, the regional HHI, the business line HHI and the financing HHI.[207] They report that diversification decreases bankers' risk, and that the banking efficiency is irresponsive to their sizes.

Altunbas *et al*[208] have estimated the scale, technical and X-efficiency of the banks in the European Union. They employ the Fourier functional form in SFA using total loans, total securities and off-balance sheet activities as outputs and labour, physical capital and deposits as inputs. Cross-country variations in efficiency are found significant, and, among them, the banking sector of Austria, Denmark, Germany and Italy are found most efficient. There is no evidence to suggest that large banks are more efficient. The study, however,suggest thatscale efficiencies could be achieved by expanding bank operations, and that the overall changes in the managerial, technological and other factors have an impact on the X- efficiency of those banks.

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[205] D'Souza and Lia, 'Does Diversification Improve the Bank efficiency'
[206] Ibid, p.109
[207] Ibid, p.113
[208] Altunbas *et al*, 'Efficiency in European banking'

Hassan *et al* [209] use the DEA to calculate the allocative, technical, scale and overall efficiency in the US banking. Prices of labour, capital and loanable funds have been taken as inputs and the real estate loans, commercial and industrial loans, consumer loans, all other loans and demand deposits as output. They conclude that the US banks are characterized by low levels of overall efficiency, and that their allocative efficiency is greater than their technical efficiency.

Cebenoyan *et al*.[210] measures the 'agency-related inefficiency problems'[211] or X-inefficiency problems in the thrift industry of Atlanta Federal Home Loan Bank District. They employ the SFA and translog cost function, using construction loans, permanent mortgage loans, mortgage backed securities and other loans as output, and prices of capital, deposits and labour as inputs. They find that the inefficiency scores vary widely amongst the Savings and Loans (S&Ls) and that the inefficiency is not related to the form of ownership.

Mester[212] too analyses the agency related problem in savings and loan industry in the U.S. using translog cost function in SFA. She finds that the stock S&Ls are more efficient than mutual S&Ls and the increase in competition has led to a reduction in X-inefficiency.

In yet another article,[213] Mester analyses the efficiency of the U.S. banks taking into consideration the quality and risk of banks output.Using translog cost function in SFA and the prices of labour, physical capital and borrowed money as the inputs , and loans as the output , she finds that there are significant variations in the efficiencies of various districts.

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[209] Hassan *et al*, 'Technical, Scale and Allocative efficiencies'
[210] Cebenoyan *et al*, 'The relative efficiency'
[211] Ibid, p.152
[212] Mester, 'Efficiency in the Savings and Loan Industry'
[213] Mester, 'Measuring efficiency at US Banks'

Huang[214] measures the X-efficiency of Taiwanese banks using the translog shadow profit function, using two outputs (namely, investment and loans), and two inputs (namely, borrowed fund and labour). He finds that the loss in profit due to X-inefficiencies is high for both private and public banks, and that the technical inefficiency is greater than the allocative inefficiency.

The effect of competition on the efficiency and soundness of the banks in Europe and the U.S have been studied by Schaeck and Cihak.[215] Competition is measured by the Lerners index and the soundness of the banks by the Z score. They employ the translog profit function and the cost function in the SFA framework, with loans and other earning assets as the output, labour cost and other costs as input, and fixed assets, loan loss provision and equity capital as the netputs. They find that the efficiency of the banks increases with the higher level of competition, which, in turn, increases the soundness of the banks.

Similar study has been conducted for the Czech banks by Podipera et al.[216] Employing the SFA, cost efficiency is measured using the translog cost function, where the prices of labour, physical capital and borrowed fund are taken as inputs, and loans as the output. In contrast to the results found in the studies on the US and European banks, a negative relationship are found between efficiency and competition in case of the Czech banks.

For the Italian Banks, the relationship between competition and efficiency is studied in Coccorese and Pellecchia.[217] They use the SFA and the translog cost function to measure the efficiency of the banks. Using the price of labour, deposits

[214] Huang, 'Estimating the X-efficiency'
[215] Schaeck and Cihak, 'How competition affects efficiency'
[216] Podpiera *et al*, 'Banking competition and efficiency'
[217] Coccorese and Pellecchia, 'Testing the Quite Life Hypothesis'

and capital as inputs and the total assets as output, they find that a higher degree of market power is associated with the cost inefficiency.

Similar results are found for the German banks by Koetter and Vins[218] who employ the translog cost and profit functions using the SFA. But, for the profit efficiency, a positive relationship is witnessed with market power.

Casu and Girardone[219] have also analysed the impact of competition on the efficiency of European Union banks. They use both DEA and SFA for estimating the efficiency. The loans and other earning assets are regarded as outputs in both the models. The inputs in SFA include the price of deposits, the price of labour and the price of capital, whereas, in DEA, the total cost is the only input. They infer that the EU banks become less cost efficient as more consolidation takes place.

The effect of managerial ability on the efficiency of banks in Finland is analysed by Kauko.[220] The cost efficiency of the banks has been measured using the translog cost function in SFA. He finds that the managers' ability in containing cost is significant. The age and qualification of the managers are also found to have impact on the their efficiency levels.

Fare *et al*.[221] have applied DEA to analyse the impact of competition on the efficiency of Spanish banks. Labour, capital and purchased funds are taken as input variables while loans, fixed-income securities, other securities and non-traditional output (Non Interest Income) are regarded as the output variables. The inefficiency of the Spanish banks is found to have been growing over time, and, on the efficiency, the effects of competition vary across the banks.

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[218] Koetter and Vins, 'The Quite life hypothesis in Banking'
[219] Casu and Girardone, 'Does competition lead to efficiency'
[220] Kauko, 'Managers and efficiency in Banking'
[221] Fare *et al*, 'Revisiting the quite life hypothesis in banking'

Solis and Maudos[222] evaluate the welfare loss for the market concentration in Mexican banking on the basis of the SFA and the translog cost function. Using the prices of labour and capital as the inputs, and loans and deposits as the output, they observe that the cost efficiency increases with the market concentration.

Chang *et al.* [223] study the efficiency of the U.S owned banks and the foreign owned banks in the U.S. economy. Using the translog cost function in SFA with the prices of labour, physical capital and funds as the inputs, and loans and assets the output, they find that the U.S owned banks are more efficient than their counterparts, i.e. foreign owned banks.

Mitchell and Onvural apply the Fourier functional form to study the cost and scale efficiency of the U.S. banks using SFA. They find that the larger banks are more cost efficient than the small ones, and that there is considerable ray scale economies among them.

In the domain of Indian banking, the studies may be grouped in two categories, DEA and SFA. To the former category belongs the studies of Das *et al*[224], Rammohan and Ray[225], Reddy[226], Ghosh[227], Dash and Charles[228], Varadi et al[229], Kumar and Gulati[230], Mariappan et al[231], Bhatia and Mahendru[232], Jayaraman and Srinivasan[233], Dwivedi and Charyulu[234], and Seshadri et al.[235]

222 Solis and Maudos, 'The social cost of bank market power'
223 Chang *et al*, 'Efficiency of multinational banks'
224 Das *et al*, 'Liberalization, Ownership, and Efficiency'
225 Rammohan and Ray, 'Comparing the performance'
226 Reddy, 'Banking Sector Reforms'
227 Ghosh, 'Financial Deregulation and Profit efficiency'
228 Dash and Charles, 'A study of technical efficiency of banks in India'
229 Varadi *et al*, 'Measurement of efficiency of banks in India'
230 Kumar and Gulati, 'An Examination of technical'
231 Mariappan, *et al*, 'A study on performance efficiency'
232 Bhatia and Mahendru, 'Assessment of technical efficiency'
233 Jayaraman and Srinivasan, 'Performance Evaluation of Banks in India

In the field of SFA, the literature is relatively sparse; it includes Sensarma[236] Shanmugan and Das[237], Srivastava[238], Das and Drine[239], Mahesh[240], Rajan et al.[241] Battachrayya et al[242] and Bhattachryya and Pal[243]have used both DEA and SFA while, Bhaumik and Dimova[244] have used ordinary least square regression (without decomposing errors, thus remaining outside SFA).

The input and output sets, however, vary across these studies, depending upon, *inter allia*, whether banks are considered as producers or intermediaries (to be discussed in the following chapter). In DEA, the inputs that have generally been used are equity capital, borrowed funds, number of employee, number of branches, operating expenses, deposits, interest expenses, physical capital (Jayaraman , Dwivedi and Charyulu, Bhatia and Mahendru, Kumar and Gulati, Ghosh, Rammohan and Ray and Bhattacharyaa et al). The output variables include loans, non-interest income, loans and advances, investment and net interest income. In the studies relating to SFA, more frequently used inputs are labour, capital and purchased fund (Srivastava, Das and Drive, Mahesh, Rajan et al, Shanmugam n Das, Ray and Sanyal) while the dominant outputs are loans and advances, deposits and investments. A further field of difference in SFA concerns about the underlying functional form; it varies from the Cobb-Douglas function as in Bhattachryya and Pal, and Shanmugam and Das to the translog specification as in Sensarma, Ray and Sanyal , Mahesh and Srivastav . Fourier flexible form is used by Das and Drine.

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[234] Dwivedi and Charyulu, Efficiency of Indian banking Industry
[235] Seshadri *et al*, Efficiency of public ‘
[236] Sensarma, ‘Cost and Profit efficiency ‘
[237] Shanmugam and Das, ‘Efficiency of Indian commercial banks’
[238] Srivastava, ‘Size, Efficiency and Financial Reforms’
[239] Das and Drine, ‘Financial Librelization’
[240]Mahesh, ‘Liberalisation and Efficiency’
[241] Rajan *et al*, ‘Efficiency and productivity Growth’
[242] Battachrayya *et al*, ‘The Impact of Liberalisation’
[243]Bhattachryya and Pal, ‘Financial reforms’
[244] Bhaumik and Dimova, ‘How important is Ownership’

The results of the studies are not unanimous. Major reasons for such variations are differences in the time-frame, methodology, type of organisation under study, as well as the concept of efficiency that various studies consider. The public sector banks are found profit efficient in Jayaraman and Srinivas and Das et al, but, according to Mahesh, their profit efficiency is less than that of private domestic banks. A number of studies – such as Das and Drine, Mahesh, Varadi et al., Sensarma and Bhattachryya et al – reveal that the public sector banks are the most cost efficient. But contradictory results are found in Dash and Charles. In an intra public-sector- banks analysis, Shanmugam and Das, however, note that the State Bank group scores the highest level of efficiency, compared to other public sector banks in India. While searching for reasons behind low efficiency among the public sector banks, Bhatia and Mahendru identify that their efficiency is pulled down by their non performing assets.

Taking all banks in India together, Mariappan and Lakshmi carry out the efficiency study. They underscore that their efficiency scores belong to the inner domain of the frontier so that there is much scope for gain in efficiency. In a similar study by Dwivedi and Charyulu, we come across the findings that banks' technical efficiency moved upwards till 2008, but the trend has reversed thereafter.

Section V: Conclusions

Given the Review of Literature, let us now clarify the rationale behind the present study. The first justification relates to the period of investigation which ranges from 1994 to 2012. The choice of period provides an opportunity to assess the impact of the financial sector reforms in India. The period between1994-2012 saw the effect of not only the first generation of economic reforms but also the second generation reform initiated in 1998. By the year 2012 we can capture the effects of the two reforms together.

Although the literature points out that the improvements in technical and allocative inefficiency lead to a very miniscule gain in efficiency,[245] majority of the empirical studies focus on the technical and allocative inefficiencies of the banks. However, the focus of this study is the X-efficiency of the banks. We note in this connection that the financial sector reforms have not only introduced quantitative changes in the working of the banks (such as the reductions in CRR and SLR) but have also brought about changes in the management of the banks. From the year 1994 to 2012 the number of commercial banks rose significantly under the relaxed norms of entry into banking business. The banks now not only face competition from the other banks but also from other financial institutions as the financial products overlap. The effects of those changes can be analysed by studying the X-efficiency of the banks rather than their technical aspect of efficiency.

We add that this study takes into account all commercial banks, save a few for the want of data, irrespective of their ownership pattern. While analyzing the data, we group them in three categories, public sector banks, private domestic banks and private foreign banks, so that the effects of ownership pattern on the level of efficiency are examined. Lastly, the methodology that is used in the study i.e. the stochastic frontier model is relatively less used than the DEA method. The study, therefore, seeks to measure X-efficiency among Indian commercial banks from 1994to 2012 using the SFA.

[245] Leibenstein, 'Allocative efficiency vs "X-efficiency"'

Chapter IV

METHODOLOGY AND DATASET

The deliberation of Chapter III on the review of literature indicates that, in methodology, we should decide upon: (a) the basic approach of the methodology, i.e. whether we opt for the DEA or the EFA as our methodological framework; (b) identification of the variables (both inputs and outputs); and (c) the functional relationship among the variables. These are the subject-matters of the first three sections that follow. Once the model is thus specified and calibrated, Section IV briefly discusses certain issues of estimation relating to time-series data, and Section V gives the details of the source of data and also their descriptions in a summary form. Section VI concludes.

Section I: Methodology: DEA, GLS and MLE

By virtue of being a programming model, as adumbrated in Chapter III, the DEA has the advantage of analysing the data without parameterization, i.e. without any assumption of underlying distribution. Nor does it require any functional concept among the variables under study. It is based first on the identification/estimation of the most efficient production frontier, and then comparing it with the production frontier of a given producer. Its main advantage, however, gives rise to a serious drawback: the absence of parameterisation makes this model deterministic so that there is no room for statistical noises. Thus, any deviation that arises from the most efficient production frontier is regarded as inefficiency, which generates suspicion as to the existence of contaminated efficiency scores. In other words, there is every possibility that the efficiency scores are infested by omitted variables, statistical noises and measurement errors.[246] Moreover, since the DEA is a comparative technique, the efficiency score of a firm depends upon those of others, and hence cannot be further analysed by way of the regression method. This is so because it violates the assumption of independence within the sample.[247]

At the cost of repetition, we note here that the concept of X-efficiency suffers from malapropism in the literature.[248] The problems of asymmetric information, principal agent relationship and model misspecification,[249] that lead to X-efficiency are absent in a deterministic relationship like that of the DEA where every inputs are, by assumption, well defined. The programming approach underlying the DEA entails that all of the outputs that are produced are attributed to the inputs that enter into its production such that that there are no stochastic variations in the process. Every deviation from the optima is regarded as X-inefficiency. In fact, Leibenstein erred on this issue in 1992 in his joint article with Maital on DEA.[250] They advocate the use of DEA as the best method for measuring X-inefficiency on the ground that DEA is capable of taking into consideration 'ordinal measurements'[251] that measure motivation and personality which are proxies for the X-(in)efficiency component of the model. However, in his article in 1966, he points out that X-inefficiency arises due to factors that cannot be marketed and/or cannot be quantified. As to the measurement problem, he writes in the 1992 article that by way of 'ordinal measurements', those factors can be incorporated in a DEA model. But other important points he identified

[246]Greene, 'The econometric Approach ', p.76
[247]Hahn, 'Measuring Performance'
[248] For details of the misinterpretation of the concept, see Ray and Sanyal, pp.156-157
[249]These are same as Leibenstein's three issues underpinning X-inefficiencies. See his article 'Allocative efficiency Vs "X-efficiency"', p. 407.
[250] Leibenstein and Maital, 'Empirical Estimation'
[251] Ibid, p.429

in 1966 – such as incomplete labour contracts, non-market factors of production, unknown production function as also 'interdependence and uncertainty' that 'lead competing firms to cooperate tacitly with each other in some respects, and to imitate each other with respect to technique, to some degree'[252] – are only typical to 'The Residual'[253] in any empirical study, which the DEA cannot account for. The DEA's inability to incorporate the stochastic component is addressed in the methodology of what is termed as Stochastic Data Envelopment Analysis (SDEA). It allows a certain level of uncertainty in the data set, by recognising the 'two sided deviation in addition to the one sided deviation for inefficiency'.[254] But the methodology, as developed by Banker, is less popular in the literature[255] for two major reasons: (a) the judgement on a firm's efficiency level is dependent in this model on a hypothetical weight vector, attached to various input and output variables, and (b) the model gives inconclusive results in some empirical cases (as for some firms in Banker's illustrative application), whereas the MAD (minimum absolute deviations) regression and the OLS model, as tried in the same application, generate conclusive results.[256]

In our attempt to analyse the effects of economic reforms on the banks' X-efficiency, we stay true to the original concept of X-efficiency, as conceived by Leibenstein in 1966, by using the stochastic model. Broadly, there are two methods for measuring X-efficiency in the stochastic frontier approach, both of which assume that X-inefficiency is embedded in the estimated error terms (ε_i):

$$Y = X\hat{\beta} + \varepsilon_i \qquad (4.1)$$

[252] Leibenstein, 'Allocative efficiency Vs "X-efficiency"', p. 407.
[253] Ibid, p. 406
[254] Banker, 'Stochastic Data Envelopment Approach'
[255] Only one empirical paper using a similar methodology has come to my notice. See Chen, A 'Comparison of Chance-Constrained DEA and Stochastic Frontier Analysis: Bank Efficiency in Taiwan'
[256] Banker, 'Stochastic Data Envelopment Approach', pp. 21-24

where $\hat{\beta}$is the vector of estimated parameters. The primitive one, belonging to the error-in-equation model, seeks to further regress $\varepsilon_i$on time t so that the white noise component of ε_i is delineated. The parameters in this model may be estimated using Kmenta's generalised least square method.[257]

The generalised least square model can be specified as

$$Y = X\beta + \varepsilon_i \quad (4.2)$$

where Y is an $(nX1)$ vector of the sample values of Y, X is an (nXk) matrix of sample values of X_{i1}, X_{i2}, ...X_{ik}, β is a $(kX1)$ vector of parameters and ε is n $(nX1)$ vector of disturbance terms. The variance-covariance matrix is denoted as $\Omega = E(\varepsilon'\varepsilon')$ and

$$\Omega = \begin{pmatrix} E(\varepsilon_{11}^2) E(\varepsilon_{11}\varepsilon_{12}) \ldots E(\varepsilon_{11}\varepsilon_{1T}) \ldots E(\varepsilon_{11}\varepsilon_{NT}) \\ E(\varepsilon_{12}\varepsilon_{11}) E(\varepsilon_{12}^2) \ldots E(\varepsilon_{12}\varepsilon_{1T}) \ldots E(\varepsilon_{12}\varepsilon_{NT}) \\ \vdots \quad \vdots \quad \vdots \quad \vdots \\ E(\varepsilon_{NT}\varepsilon_{11}) \quad E(\varepsilon_{NT}\varepsilon_{12}) \ldots E(\varepsilon_{NT}\varepsilon_{1T}) \ldots E(\varepsilon_{NT}^2) \end{pmatrix} \quad (4.3)$$

This Ω- matrix signifies that the model is cross-sectionally heteroskedastic and time-wise autoregressive. That is,

[257]Kmenta, *Elements of Econometrics*, pp.508-513

$$E(\varepsilon_{it}^2) = \sigma_i^2 \qquad (4.4) \qquad \text{[heteroskedacticity]}$$

$$E\left(\varepsilon_{it}\varepsilon_{jt}\right) = 0 \qquad i \neq j \qquad (4.5) \quad \text{[cross sectional interdependence]}$$

$$\varepsilon_{it} = \rho_i \varepsilon_{,t-1} + \epsilon_{it} \qquad (4.6) \qquad \text{[autoregression]}$$

where $$\epsilon_{it} \sim N(0, \sigma_{\epsilon i}^2)$$

$$\epsilon_{i0} \sim N\left(0, \frac{\sigma_{\epsilon i}^2}{1-\rho_i^2}\right)$$

$E\left(\varepsilon_{i,t-1}, \epsilon_{jt}\right) = 0$ for all i, j

It is thus required that we should know **Ω**. Following Kmenta we may estimate the **Ω** matrix as follows. We at first apply OLS on the data, and store their residuals. Those residuals are then regressed on their lag values to get $\hat{\rho}_i$. The $\hat{\rho}_i's$ are used to transform the equation (3.2) as follows

$$Y_{it}^* = \beta_1 X_{it,1}^* + \beta_2 X_{it,2}^* + \ldots \ldots .. + \beta_K X_{it,K}^* + \epsilon_{it}^* \qquad (4.7)$$

where

$$Y_{it}^* = Y_{it} - \hat{\rho}_i Y_{i,t-1}$$

$$X_{it,K}^* = X_{it,K} - \hat{\rho}_i X_{i,t-1,K}$$

$$\epsilon_{it}^* = \epsilon_{it} - \hat{\rho}_i \epsilon_{i,t-1,K}$$

$$t = 1,2,3 \ldots . T$$

$$i = 1,2,3 \ldots . N$$

By doing so we correct for autoregression and make the series non autoregressive. Since the $\hat{\rho}_i$ values are estimates for individual banks, the banks with unit root (i.e. $\hat{\rho}_i \geq 1$) should not be taken into consideration.

Now, to correct for heteroskedacticity, we find out the variance of the $\hat{\epsilon}_{it}^{*}$ terms and correct the series of both $X_{it,K}^{*}$ and Y_{it}^{*} by dividing them by the estimated variance of $\hat{\epsilon}_{it}^{*}$. The variance of $\hat{\epsilon}_{it}^{*}$ is obtained as follows

$$s_{\epsilon i}^{2} = \frac{1}{T-K-1}\sum_{t=2}^{T}\hat{\epsilon}_{it}^{*2} \qquad (4.8)$$

The transformed variables then assume the following form:

$$Y_{it}^{**} = \beta_1 X_{it,1}^{**} + \beta_2 X_{it,2}^{**} + \cdots \ldots \ldots \ldots + \beta_K X_{it,K}^{**} + \epsilon_{it}^{**} \qquad (4.9)$$

where

$$Y_{it}^{**} = \frac{Y_{it}^{*}}{s_{\epsilon i}}$$

$$X_{it}^{**} = \frac{X_{it,K}^{*}}{s_{\epsilon i}}$$

$$\epsilon_{it}^{**} = \frac{\epsilon_{it}^{*}}{s_{\epsilon i}}$$

$$t = 1,2,3 \ldots T$$

$$i = 1,2,3 \ldots . N$$

After the data have been so transformed, the OLS method can be used to fit the translog cost function. The residuals in this stage of estimation represent a composite series of pure white noises and the X-inefficiency. To delineate them, it is customary to use the following model:

$$ln\varepsilon_{i_i} = ln\,\gamma_i + ln\lambda_i t + \; ln\xi_i \qquad (4.10)$$

Equation 4.10 breaks the residual into the time invariant X-efficiency (γ_i), the time variant X-efficiency (λ_i) and the pure white noise component (ξ_i). We may then transform the terms $\ln\gamma_i$ and $\ln\lambda_i$ into normalized X-efficiency measures as follows:

Time invariant X-efficiency (TI-XEF) = exp ($\ln\gamma_i^{\min} - \ln\gamma_i$)

Time variant X-efficiency (TV-XEF) = exp ($\lambda t^{\min} - \lambda_i t$)

where the superscript 'min' indicates the minimum value for all firms over time.

For a specific bank, the coefficients of equation 4.10 are analysed in the following manner.

1) Positive value γ_i implies time invariantly X-inefficiency
2) Negative value γ_i implies time invariantly X-efficiency
3) Positive λ_i implies time variantly X-inefficiency
4) Negative λ_i implies time variantly X-efficiency.

Table 4.1: Logic of inference for alternative values of parameter

Sign of the Intercept	Level of significance	Sign of Slope	Level of Significance	Inference*
Negative	Significant	Negative	Significant	TIX-E
		Positive	Insignificant	TVX-E
		Negative	Insignificant	TIX-E
		Positive	Significant	TVX-IE
Negative	Insignificant	Negative	Significant	TIX-E
		Positive	Insignificant	TVX-E
		Negative	Insignificant	TIX-E
		Positive	Significant	TVX-IE
Positive	Significant	Negative	Significant	TIX-IE
		Positive	Insignificant	TVX-E
		Negative	Insignificant	TIX-IE
		Positive	Significant	TVX-IE
Positive	Insignificant	Negative	Significant	TIX-IE
		Positive	Insignificant	TVX-E
		Negative	Insignificant	TIX-IE
		Positive	Significant	TVX-IE

*TIX-E: Time Invariant X-efficient
TVX-E: Time Variant X-efficient
TIX-IE: Time Invariant X-inefficient
TVX-IE: Time Variant X-inefficient

Two problems are associated with the GLS methodology. One, while transforming data for more than once, the precision of information contained in the data set is lost to a good extent. Two, we have seen that, for removing autocorrelation in the first step, this methodology requires certain banks (for which $\rho \geq 1$) to keep out of analysis. Because of these problems, the GLS methodology is less preferred now-a-days.

An alternative method gains importance in the literature, which involves single-stage estimation. Similar to the previous methodology, it also assumes that the X-efficiency is embedded in the estimated error term; but noting that $\varepsilon_i = u_i + v_i$, it proceeds to estimate the X-efficiency (u_i) from the conditional probability distribution of $u_{i,}$ given ε_i, more precisely, $E(u_i|\varepsilon_i)$, instead of regressing $\varepsilon_i$on time. There are again two methodologies. The first was by Aigner, Lovell and Schimidt[258], which we have already discussed in the previous chapter. The other method is developed in Battese and Coelli,[259] which the study uses along with that of Kmenta's GLS method. This methodology is widely used in the empirical literature on efficiency – for example, in Christopoulos,[260] Shanmugam and Das[261] and Bhattacharyya and Pal[262]. A slightly modified methodology incorporating the underlying factors of inefficiency is also used - in Sensarma,[263] for example. Since we seek here to assess the effects of India's economic reforms on the efficiency of banks (rather than investigating the factors underlying their efficiency/inefficiency), the modified Battese-Coelli[264] method is avoided. Some empirical studies such as Cebenoyan *et al*,[265] Srivastava,[266] Rai and Allen ,[267] and Altunbas et al[268] use the methodology of Jondrow, Lovell, Materov and Schimidt (JLMS) that precedes the Battese-Coelli methodology. The JLMS method decomposes the error term $\varepsilon_i = v_i - u_i$ (where v_i is the white noise and u_i the efficiency component) by way of the conditional distribution of u_i given ε_i. Because of further improvisation of this methodology in Battese and Coelli, as detailed below, we rely on the latter.

[258]Aigner *et al*, 'Formulation and Estimation'
[259]Battese and Coelli, 'Frontier Production function'
[260]Christopoulos*et al*,'Efficiency of the Greek banking system'
[261]Shanmugam and Das, 'Efficiency of Indian Commercial'
[262]Bhattacharyya and Pal , 'Financial Reforms and Technical Efficiency'
[263]Sensarma, 'Cost and Profit efficiency'
[264]Battese and Coelli, 'A Stochastic Frontier Production Function'
[265] Cebenoyan *et al*, 'The Relative efficiency of Stock versus Mutual S&Ls'
[266] Srivastava, 'Size, Efficiency and Financial Reforms in Indian Banking'
[267] Rai and Allen, 'Operational Efficiency in Banking'
[268] Altunbas *et al*, 'Efficiency in European Banking'

The Battese-Coelli methodology defines a production frontier for panel data that accounts for technical efficiencies of firms to vary over time:[269]

$$Y_{it} = f(X_{it};\beta)\exp(v_{it} - u_{it}) \quad (4.11)$$

$$u_{it} = \eta_{it}u_i = \{\exp[-\eta(t-T)])u_i t \in \mathscr{J}(i); i = 1,2, \dots \dots .. N \quad (4.12)$$

where Y_{it} represents the production of the ith firm at the tth period; X_{it} is the input vector that is associated with the production of i^{th} firm at the t^{th} period and β the vector of unknown parameters. The white noise v_{it} is, by assumption, independently and identically distributed $N(0, \sigma_v^2)$ and the efficiency vector u_i is non-negative, independent and identically distributed $N(\mu, \sigma^2)$. η_{it} is an unknown scalar parameter indicating time-variant efficiency for ith firm at tth period. $\mathscr{J}(i)$ represents the set of T_i time periods among the T periods involved for which the observation for the i^{th} firm is obtained.[270] In this method, the effect of u_{it} depends upon the value of η, that is, the technical efficiency of a firm increases, decreases or remains constant according as $\eta > 0$, $\eta < 0$ and $\eta = 0$. In view of the rigidity of this specification, an alternative way is to decompose η_{it} as follows:

$$\eta_{it} = 1 + \eta_1(t-T) + \eta_2(t-T)^2 \qquad (4.13)$$

where η_1 and η_2 are unknown parameters. When, $\eta_1 = \eta_2 = 0$ it represents a case of time invariant model.

Technical efficiency is, however, defined as

$$TE_{it} = \exp(-u_{it}) \qquad (4.14)$$

[269] Battese and Coelli, 'Frontier Production function', p 154
[270] Ibid, p.154

with

$$E[\exp(-u_{it})\,|E_i] = \left\{\frac{1-\Phi[\eta_{it}\sigma_i^* - \left({\mu_i^*}\big/{\sigma_i^*}\right)]}{1-\Phi(-{\mu_i^*}\big/{\sigma_i^*})}\right\} exp\left[-\eta_{it}\mu_i^* + \tfrac{1}{2}\eta_{it}^2\sigma_i^{*2}\right] \quad (4.15)$$ [271]

where $E_{it} \equiv v_{it} - u_{it}$ and E_i represents the $(T_i X\ 1)$ vector of $E_{it}^{'}s$.; and also

$$\mu_i^* = \frac{\mu\sigma_v^2 - \eta_i^{'}E_i\sigma^2}{\sigma_v^2 + \eta_i^{'}\eta_i\sigma^2} \qquad (4.16)$$

$$\sigma_i^{*2} = \frac{\sigma_v^2\sigma^2}{\sigma_v^2 + \eta_i^{'}\eta_i\sigma^2} \qquad (4.17)$$

The mean technical efficiency of the firm at t^{th} time period,

$$TE_t \equiv E[\exp(-\eta_t u_i)] \qquad (4.18)$$

where

$$\eta_t = exp[-\eta(t-T)]$$

$$TE_i = \left\{\frac{1-\Phi[\eta_t\sigma - (\mu/\sigma)]}{[1-\Phi(-\mu/\sigma)]}\right\} exp\left[-\eta_t\mu + \tfrac{1}{2}\eta_t^2\sigma^2\right] \qquad (4.19)$$

Though Battese and Coelli develops the methodology on the basis of production function, this functional specification is rarely used in empirical researches. For one thing, the production function approach requires the specification of inputs and outputs in physical terms, which complicates the measurement issues. Measurement of inputs is specifically difficult since it involves the questions like the

[271]This has been derived from the joint density function of u_i and v_i, which generates a joint density function of u_i and E_i. For details, see Battess and Coelli (1992), Annexure, pp. 163-167

level of skill of individual workers, vintages of different plants and machinery and so on. Coupled with this problem is its drawback that production approach can deal with only one output at a time, although modern banks always go for multi-products. In view of these shortcomings of the production approach, the cost function approach appears more suitable, especially in point of the fact that it can accommodate multiple outputs, along with multiple inputs, in a single equation. Its added advantage is that it considers the input prices, not the inputs, so that the variables are in monetary terms. The use of the cost function is, however, rationalised by the Shepherd's lemma, which establishes, as shown below, a duality between the production function and the cost function. The lemma considers an isoquant $q^0 = f(X_1, X_2)$ and the first- order condition for cost minimisation:

$$\frac{dX_2}{dX_1} = \frac{r_1}{r_2} \qquad (4.20)$$

which yields the input demand functions as:

$$X_1 = \psi_1\left(\frac{r_1}{r_2}, q^0\right) \qquad (4.21)$$

$$X_2 = \psi_2\left(\frac{r_1}{r_2}, q^0\right) \qquad (4.22)$$

Then, from the cost equation $C = r_1 x_1 + r_2 x_2$ and the first-order conditions$r_i = \lambda f_i$, we obtain

$$\frac{\partial C}{\partial r_i} = x_i + \lambda\left(f_1 \frac{\partial \psi_1}{\partial r_i} + f_2 \frac{\partial \psi_2}{\partial r_i}\right) = x_i > 0 \qquad (4.23)$$

where λ is the Lagrange multiplier, and the bracketed term equals to zero along the isoquant . This equation is known as the Shepherds lemma. By virtue of this lemma, we can establish duality between a production function and a cost function.[272]

For the purpose of using the stochastic cost frontier, we can convert the production function into a cost function, which in logarithms, assumes the following form.

$$lnTC_n = f\left(lnQ_i, lnP_j\right) + \varepsilon_n \qquad (4.24)$$

That is,

$$lnTC_n = f\left(lnQ_i, lnP_j\right) + u_n + v_n \qquad (4.25)$$

where $u_n + v_n = \varepsilon_n$.

The cost efficiency of the firm is given as

$$CE = \frac{C^{min}}{C} = \exp(-u_n) \qquad (4.26)$$

Section II: The Variables

The use of SFA requires that we should define the input and output variables, and also the underlying relationship among them. But the identification of the input and output variables warrants a conceptual clarity as to commercial banking. There are two alternative approaches towards the task of commercial banking. It may be regarded as an intermediary institution between the deficit units (the investors) and the surplus units (the savers) in the society. By taking funds from the latter at the deposit rate of interest, it provides the funds to the former at the lending rate of interest, and the

[272]For details, see Henderson and Quandt, pp. 117-119

spread between those interest rates represents its income. This is known as the intermediary approach to the nature of commercial banking. The alternative is what is called the production approach, whereby banks are treated as a producer of financial assets, producing various banking services using various inputs including land, labour and capital in their respective physical units. Note that in the intermediation approach, banks are viewed as facilitating the transformation of the deposits (inputs) into outputs. But, in the production approach, deposits are regarded as output since it is an activity that leads to the increase in operating expenses.[273] Thus, the use of EFA requires us to decide on this issue for the selection of input and output variables. Some authors believe that the bank is a producer while the others consider them as intermediary in the financial market.[274]

We have already seen in the previous chapter that the output variables using the intermediation approach (or the asset approach)are loans, investments, deposits, off-balance-sheet activities; and the input variables are labour, fixed assets and physical capital. Following the intermediation approach we have taken two output variables, (a) loans and advances, and (b) investments, and three input variables, (a) labour, (b) borrowed fund, and (c) capital. These variables are used in Srivastava[275], Das and Drine[276], Mahesh[277], Rajan et al[278], Bhattachryya and Pal[279], Shanmugam and Das[280], Sensarma[281] and Ray and Sanyal[282].

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[273]Srivastava, 'Size Efficiency and Financial Reforms'

[274]According to Sealey and Lindsey, any measure can be used as output and input as long as it is consistent with the researchers' goal.

[275] Srivastava, 'Size, Efficiency and Financial Reforms '

[276] Das and Drine, 'Financial Liberalisation'

[277]Mahesh, 'Liberalisation and Efficiency'

[278]Rajan *et al*, 'Efficiency and Productivity Growth'

[279] Bhattachryya and Pal, 'Financial Reforms and Technical Efficiency'

[280] Shanmugam and Das, 'Efficiency of Indian Commercial Banks'

[281]Sensarma, 'Cost and Profit efficiency'

[282] Ray and Sanyal, 'X-efficiency revisited'

There are also debates in the literature about how these variables should be defined. To this context, following Srivastava, Kwan[283], Altunbas et al [284],[285], Chang et al[286], and Mester[287], we define the variables as follows:

$$\text{Cost (C)} = \text{interest expenses} + \text{operating expenses}$$

Output variables

$$Q_1 = \text{Loans and Advances}$$

$$Q_2 = \text{Investments}$$

Input variables

$$\text{Price of Labour } (r_1) = \frac{\text{Wages}}{\text{Number of employees}}$$

$$\text{Price of fund } (r_2) = \frac{\text{Total Interest Expended}}{\text{Total deposits and borrowings}}$$

$$\text{Price of Capital } (r_3) = \frac{\text{Office Expenses}}{\text{Fixed Assets}}$$

[283] Kwan, 'The X-efficiency'
[284] Altunbas *et al*, 'Efficiency and Risk'
[285] Altunbas *et al*, 'Efficiency in European Banking'
[286] Chang *et al*, 'Efficiency of Multinational banks'
[287] Mester, 'Efficiency in Savings and Loan Industry'

Section III: Functional form

The previous chapter also discusses the alternative functional specifications that are used in the empirical literature on efficiency measurement. We adopt here a translog cost function, which, given our input and output variables, assumes the following form:

$$
\begin{aligned}
&lnC \\
&= \alpha_0 + \alpha_1 lnQ_1 + \alpha_2 lnQ_2 + \alpha_3 lnr_1 + \alpha_4 lnr_2 + \alpha_5 lnr_3 + {}^1/_2\, \alpha_{11} lnQ_1 lnQ_1 \\
&+ {}^1/_2\, \alpha_{22} lnQ_2 lnQ_2 + {}^1/_2\, \alpha_{33} lnr_1 lnr_1 + {}^1/_2\, \alpha_{44} lnr_2 lnr_2 + {}^1/_2\, \alpha_{55} lnr_3 lnr_3 \\
&+ \alpha_{12} lnQ_1 lnQ_2 + \alpha_{13} lnQ_1 lnr_1 + \alpha_{14} lnQ_1 lnr_2 + \alpha_{15} lnQ_1 lnr_3 + \alpha_{23} lnQ_2 lnr_1 \\
&+ \alpha_{24} lnQ_2 lnr_2 + \alpha_{25} lnQ_2 lnr_3 + \alpha_{34} lnr_1 lnr_2 + \alpha_{35} lnr_1 lnr_3 + \alpha_{45} lnr_2 lnr_3 \\
&+ \varepsilon \qquad\qquad (4.27)
\end{aligned}
$$

There are altogether 21 parameters in Equation 4.27. The large number of parameters in such models underscores the need for pooled data in this study. Its time series runs over 19 years so that those parameters cannot be estimated only by the time series data. They can be estimated over the cross-section data as this study takes into account 25 public sector banks, 17 private domestic banks and 15 private foreign banks, that is, 57 banks in aggregate. But two problems crop up to this end. One, the degrees of freedom would be less – only 36. Two, X-efficiency is often conceived as a dynamic phenomenon that varies over time – in fact, the time-variant X-efficiency is current in the literature. A cross-sectional empirical study cannot address these issues. Employing panel data is, therefore, the only option in a study like this. There are 1083 observations in this study so that the degrees of freedom come to 1061.

Section IV: Unit root test

Before the estimation of parameters involved in our model, we should undertake the test for panel unit root to examine whether the panel is stationary.[288] According to Gujarati, a process is said to be 'stationary if its mean and variance is constant over time and the value of the co-variance between the two time periods depends only on the distance or gap or lag between the two time periods and not the actual time at which the covariance is computed.'[289] If a panel is not stationary, the estimated values of the parameters are not reliable. In other words, if the mean and the variance do not remain the same for the series at whatever point in time it is measured, i.e. if the unit root problem prevails, it affects the behavioural properties of the data. A presence of the unit root problem is generally called as 'trending'. If two variables are trending over time, their regression would be spurious. The assumption of asymptotic properties does not hold in such cases, and the t-ratios do not follow the t-distribution. However, stationarity can be of two types, trend stationarity and stochastic stationarity. The commonly used tests to detect the unit root problem are the Dickey-Fuller test (DF), the Augmented Dickey-Fuller test (ADF) and the Levin-Lin-Chu test (LLC).

Dickey-Fuller test is also known as the tau test. The test is conducted under three different null hypotheses relating to the three equations, 4.28 – 4.30.

$$\Delta Y_t = \delta Y_{t-1} + u_t \qquad (4.28)$$

$$\Delta Y_t = \beta_1 + \delta Y_{t-1} + u_t \qquad (4.29)$$

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + u_t \qquad (4.30)$$

[288] This test for the panel data has gained importance after the paper by Levin and Lin in 1992 and in 2002 by Levin Lin and Chu.

[289] Gujarati, *Basic Econometrics*, p.797

where t is the time trend. In each of the above cases, the null hypothesis is that δ = 0, i.e. there is a unit root problem.

The DF test assumes that the error terms are uncorrelated. The ADF is an improvement over the DF in that it assumes the error terms correlated among themselves. The ADF augments the three regression equation of the DF into one

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta Y_{t-1} + \varepsilon_t \qquad (4.31)$$

where the null hypothesis is δ =0. This study adopts the ADF test.

The ADF test cannot, however, find out the unit root problem in a panel data. Rather than performing ADF on individual cross-sectional data, pooling approach yields a better result. One of the pioneers in panel unit root is Levin and Lin who developed the methodology in 1993 and developed further in 2002 as Levin Lin and Chu test. Following Levin, Lin and Chu's approach, as adopted in their paper in 2002, we perform the unit root test. This method is particularly useful when the time dimension is small and the number of cross sections large.[290]

The Levin Lin and Chu method considers the following hypotheses:

H_0 (Null hypothesis): each time series contain a unit root

H_1 (Alternate hypothesis): each time series is stationary

The model rests on the following assumptions:

(i) The y_{it} is generated by one of the following three models

Model 1: $\Delta y_{it} = \rho y_{it-1} + \varepsilon_{it}$ (4.32)

[290]Levin *et al*, 'Unit root test in panel data', p.3

Model 2: $\Delta y_{it} = \alpha_{0i} + \rho y_{it-1} + \varepsilon_{it}$ (4.33)

Model 3: $\Delta y_{it} = \alpha_{0i} + \alpha_{1i}t + \rho y_{it-1} + \varepsilon_{it}$ (4.34)

(ii) The error process ε_{it} is distributed idependently and follows a stationary invertible ARMA process for each individual.

Homoskedacticity (i.e. equal variance for the error terms) is an important assumption of the classical linear regression model. The presence of heteroskedacticity leads the estimator to be best linear and unbiased but it no longer remains the efficient estimator

For the description of the production/cost function in the banking literature, the most widely used functional form is the translog function. We use the standard translog cost function in our analysis.

This study uses panel data for estimation purposes. Many advantages are associated with it. Firstly, panel data give more information as the panels bring in the advantage of both cross section and time series data. This makes the panel data better suited to detect changes than a simple cross section or a simple time series data.[291] Secondly, by pooling the data we increase the degrees of freedom for the estimators we deal with. The translog cost function, as we will see shortly, involves a large number of parameters where the number of observation is critical. This is all the more important since there are a limited number of banks in India so that cross-section data would generate a low degree of freedom. It is also limited in a time-series framework since the financial sector reforms took place only in 1991. Obviously, then, the use of panel data is the only alternative. The additional argument is that both time series and cross section data have certain exclusive advantages. Those advantages are 'pooled'

[291]Gujarati, *Basic Econometric*, p.623

together if we deal with the panel data. Kumbhakar adds that panel data helps us to do away with the assumption of independence between the technical efficiency and the regressors.[292]

This study makes use of the balanced longitudinal panel, that is, the time series for each bank is placed followed by the time series of another bank. Our panel is balanced in the sense that there are equal numbers of observations for each bank.

Section V: Summary and comparison of variables used

Our discussion in methodology suggests that the dataset should include six variables, namely total cost (C), two output variables - (a) loans and advances (Q_1) and (b) investment (Q_2), - and three Input prices - (a) price of labour (r_1), (b) price of fund (r_2), and (c) price of capital (r_3). These variables have already been defined in the previous section. The time period of the study spans over a period of 19 years starting from 1994 to 2012. Since we seek to employ a balanced panel, this study avoids the banks that have missing values in the time span under study, and also those that do not exist prior to 1998. Only 57 banks qualify these criteria. Of these, 25 banks belong to the public sector (PSB), 17 to the private domestic sector (PDB), and the rest 15 to the private foreign sector (PFB). The data are presented in the annexure 2-4, and table 4.3 contains their statistical summaries.

In the statistical summary for each variable, the table is arranged according to the ownership of banks, namely, public sector banks, private domestic banks and private foreign banks. In 2012, there were altogether 26 public sector banks, 44 foreign private banks and 20 private domestic banks. But, in 1994, there were 27 public sector banks, 24 private domestic banks and 23 private foreign banks. For balanced panel and for data constraints – in particular, missing values in the data set -

[292] Kumbhakar and Lovell, *Stochastic frontier analysis*, p.96

we have not considered two public sector banks, three private sector domestic banks and twenty nine private foreign banks. This leaves us with 25 public sector banks, 17 private domestic banks and 15 private foreign banks in this study. The requisite data for estimation of the model are collected from various publications of the Reserve bank of India, namely, the Profile of Banks (various issues) and the Statistical Return of Banks (various issues).[293]

Table 4.2 gives an overview of the activities of different types of banks. Four basic characteristics are discussed here: paid-up capital, branches, employment and deposits. The average paid-up capital amounts to Rs.56,360.46 lakhs for public sector banks, Rs.11,922.43 lakhs for private domestic banks, and Rs. 59,092.96 lakhs for private foreign banks, suggesting that foreign banks run with higher capital base, compared even to public sector banks. The ratio between them stands at 1: 0.95. The gap appears astonishing if private domestic banks are brought under study. Compared to them, private foreign banks' paid-up capital exceeds about five times. These data reflect the problem of the capital adequacy ratio, about which the international banking authority is concerned.[294] The capital adequacy ratio had been as low as 11.28 for public sector banks[295], 12.21 for private domestic banks, and 15.40 for private foreign banks in 2001. It improved to 12.11, 14.50, and 26.81 respectively in 2012.

It is, however, customary to read capital along with labour, which helps us to understand the banking technology, especially as to its capital-intensity. The level of employment stood, on the average, at 31,533 in public sector banks, 5438 in private

[293] www.rbi.org.in on 23rd November 2014

[294] One of the three pillars of Basel III is capital adequacy to meet risk. It is defined as the ratio of Tier1 capital, Tier 2 capital Tier 3 capital to the risk weighted average.

[295] Indian Bank has a negative CAR in March 2002.

domestic banks and 957 in private foreign banks. Therefore, the average capital-labour ratio comes to 1: 0.5594, 1: 0.4561 and 1: 0.0162 for the respective groups of banks. Thus, the banking technology in the public sector appears most labour-intensive. This result confirms the fact that profit maximisation is not the primary objective of those banks;[296] But they continue the practice of social banking that was institutionalised in India in the early 1969 prior to the nationalisation of major banks.[297] The capital intensity is, however, highest among private foreign banks, and they have achieved it by way of mechanising the banking technology at the highest level. Higher capital intensity among foreign banks is also learnt from the fact that the capital per branch was Rs.5211 lakhs for them as against Rs. 33 lakhs for private banks and Rs.27 lakhs for public sector banks. They score high in terms of staff per branch as well. For the respective groups of banks, it comes to 84.469, 15.172 and 15.206.

It is interesting to note that, by the index of deposits per branch, private foreign banks are again the topper. It was about Rs.55,535 lakhs for them - as against Rs.5,728 lakhs for private domestic banks and Rs.3,312 lakhs for public sector banks. Thus, deposits per branch stood at about 10 times higher than that for private domestic banks and at about 17 times than that for public sector banks. This might be explained by the fact that the foreign banks had very few branches in comparison to the private banks and public banks. However, deposits generated per unit of capital are highest among private domestic banks. It was Rs 172.207 lakhs for them, but only Rs. 121.8791 lakhs for public sector banks and Rs 10.657 lakhs for private foreign banks.

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[296]The managerial theories of firm state that such firms should have more employment than a profit maximizing firms.
[297]Natarajan and Parameswaran, *Indian banking,* pp. 24-25

Table 4.2 Paid-up capital, employment, branches and deposits of commercial banks in India (Average for 1994-2012)

(Rs. In Lakhs)

Particulars	Public Sector Banks			Private Domestic Banks			Private Foreign Banks		
	Highest	Lowest	Average	Highest	Lowest	Average	Highest	Lowest	Average
Paid-up Capital	187100.5 $(INDB)$	17993474 (SBH)	56360.46	72417.85 $(ICICI)$	28.36 $(TAMNB)$	11922.43	151442.8 $(BARCB)$	3298.09 $(ADCOMB)$	59092.96
Employment	216982.7 (SBI)	10323.42 (SBM)	31533.16	19499.42 $(ICICI)$	657.68 $(NAINB)$	5438.15	4553.11 $(STANCB)$	50.68 $(OMINB)$	957.88
Branches	10466.79 (SBI)	646.158 (SBM)	2073.72	853.63 $(ICICI)$	71.74 $(NAINB)$	358.43	62.26 $(STANCB)$	1 $(JPMC)$	11.34
Deposits	40516653 (SBI)	1768534 (SBM)	6869163	10094488 $(ICICI)$	118011.8 $(NAINB)$	2053127	2238978 $(STANCB)$	78875.37 $(ADCOMB)$	629769.2

Source: Annexure.5-8

Table 4.3 Annual Average values of the variables under study, 1994-2012
(Rs in Lakhs)

Particulars	Public Sector Banks (no. of banks = 25)	Private Domestic Banks (no. of banks = 17)	Private Foreign Banks (no. of banks = 15)
Cost	564,200 (22,568)	197,123 (11,595)	66,957 (4,464)
Loan and Advances	4,668,683 (186,747) [8.27]	1573728 (92,572) [7.98]	494281 (32,952) [7.38]
Investment	2,427,270 (97,091) [4.30]	889,292 (52,311) [4.51]	377,320 (25,155) [5.64]
Price of Labour	3.3431	2.9473	13.0028
Price of fund	0.0630	0.0659	0.0621
Price of Capital	0.2372	0.2152	0.6850

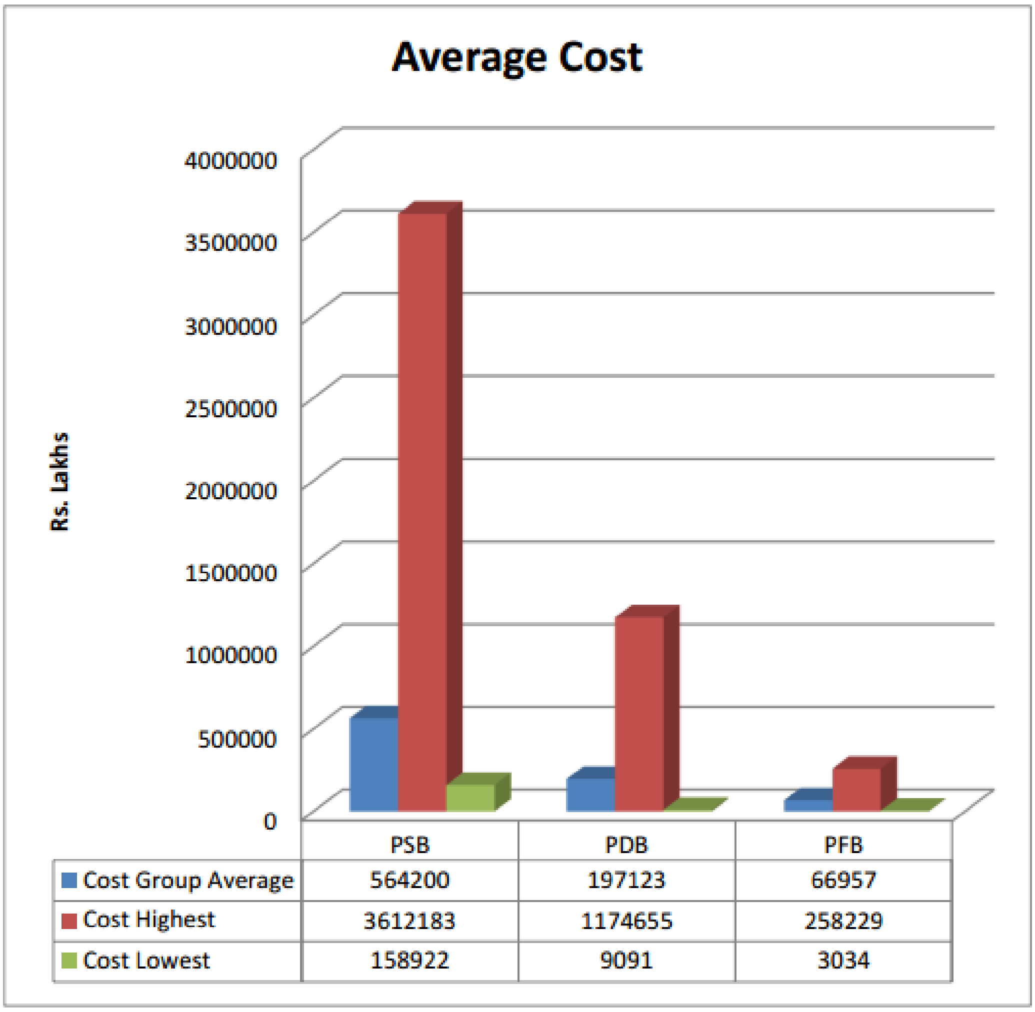
Source: Annexure 9-11

N.B. Figures in the first bracket indicate the respective values per bank, and the third bracket their values per unit of cost.

Table 4.3 represents the annual average values of the variables under study over 1994-2012. Since the banks are not of equal number in all groups, those figures may be misleading. We, therefore, present those average values per bank. Since various outputs are produced by incurring operating costs, interest payments as well as using paid-up capital, we also express the outputs per unit of cost (i.e. operating costs and interest payments) and per unit of capital employed. For the cost and output variables, the intra-group variations are shown by placing the group average side by side the highest and lowest figures in Figures 4.1-4.3.

The cost variable, however, assumes the highest value for public sector banks – Rs 22,568 lakhs per bank – followed by private domestic banks (Rs. 11,595 lakhs), and private foreign banks (Rs. 4,464 lakhs). Among all banks, the State Bank of India (a public sector bank) assumes the highest value, and the Oman International bank (a private foreign bank), the lowest value (Fig. 4.1). Insofar as the cost, by definition, indicates the volume of business (i.e. the scale of operations), these figures entail that public sector banks are by far the largest banking organisations in India – about double in size compared to private domestic banks, and five times than that of private foreign banks. These observations have also been corroborated in the previous table where we have found that, in terms of the number of branches, employees, as well as deposits, public sector banks scored the highest.

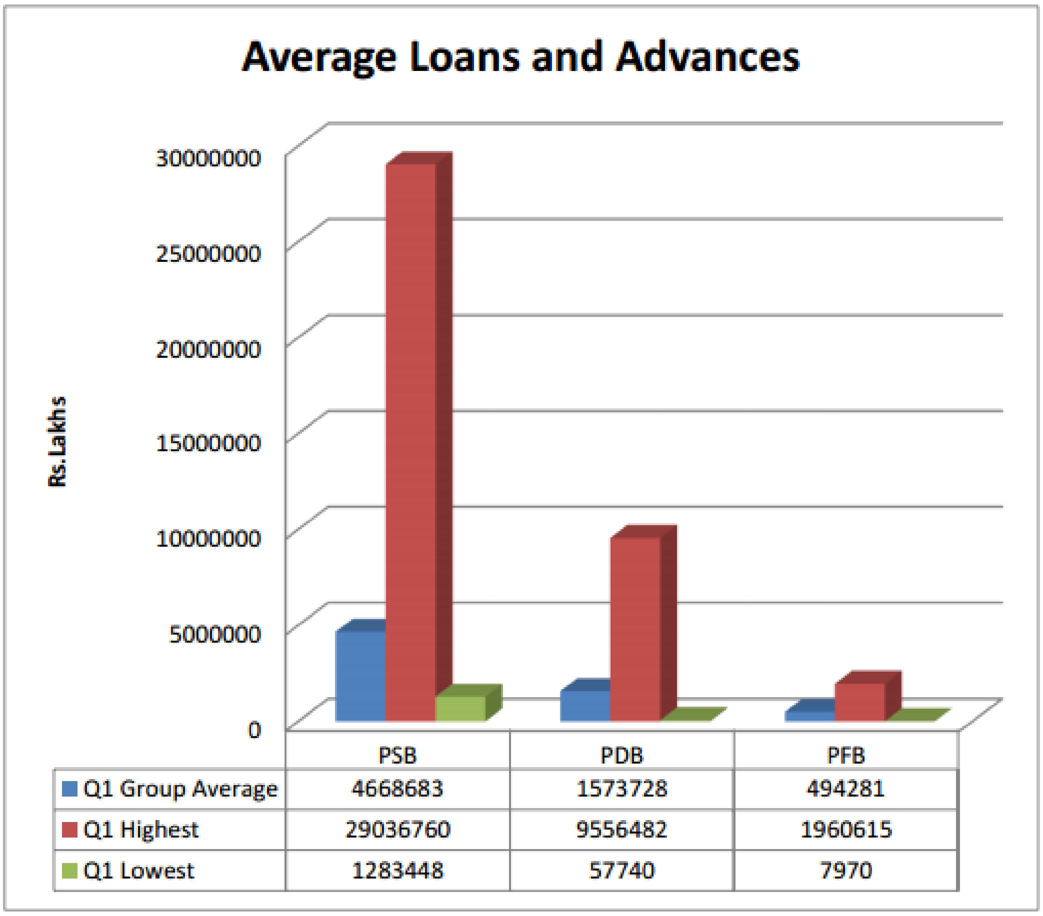
Fig 4.1. The cost variable



Source: Annexure 9

If we look at the output variable, loans and advances, the scale-wise difference among various groups is again confirmed. For each bank, it assumes a value of Rs. 186,747 lakhs for public sector banks, Rs. 92,572 lakhs for private domestic banks, and Rs. 32,952 lakhs for private foreign banks. The bank-specific analysis (Fig. 4.2), however, shows that, for all banks taken together, loans and advances are highest for the State Bank of India, and lowest for the Oman International bank. The extent of scale difference in this case is almost same as we notice in respect of cost. Public sector banks are 2.01 times larger than private domestic banks, and 5.66 times larger than private foreign banks. Larger scale, indeed, generates the economies of scale. This is confirmed in figures relating to the level of this output per unit of cost. Each unit of cost yields this output by Rs. 8.27 for public sector banks, Rs. 7.98 for private domestic banks, and Rs. 7.38 for private foreign banks.

Fig 4.2 Output variable (Q_1): Average Loans and Advances



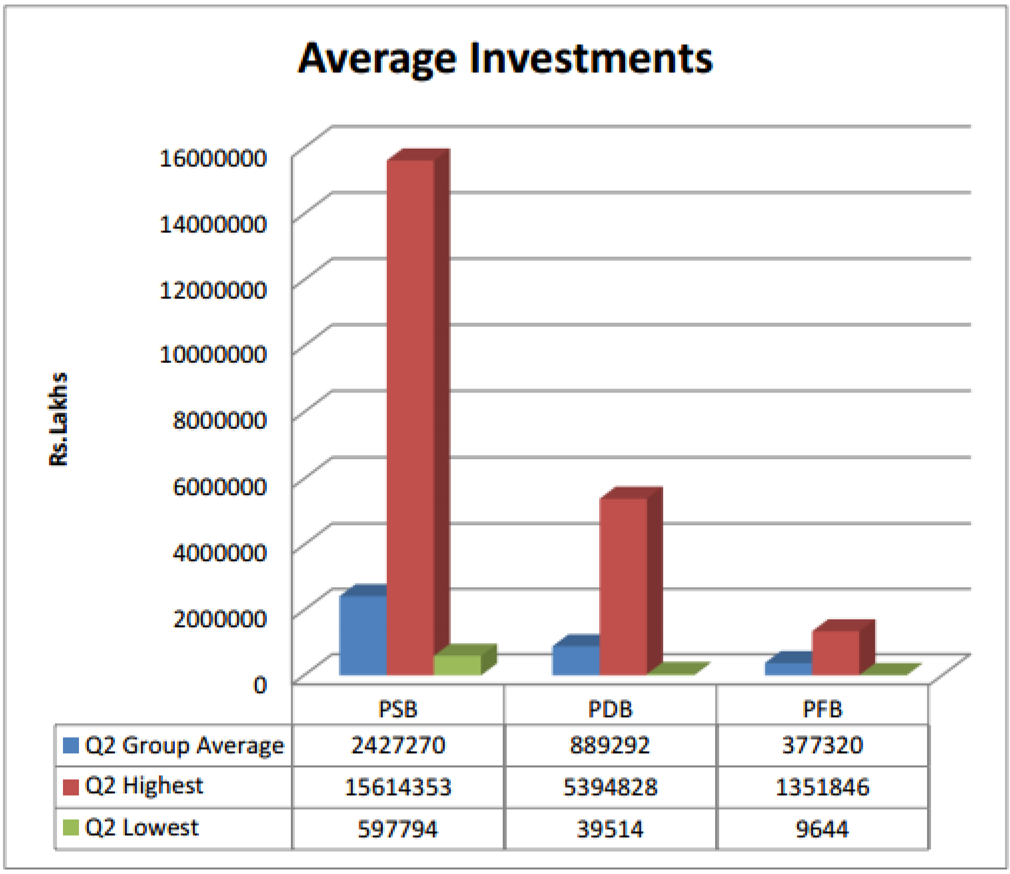
	PSB	PDB	PFB
Q1 Group Average	4668683	1573728	494281
Q1 Highest	29036760	9556482	1960615
Q1 Lowest	1283448	57740	7970

Source: Annexure 10

However, from the standpoint of the other output variable, namely, investment, a different scenario emerges, despite the fact that its ranking per unit of bank remains the same - Rs. 97,091 lakhs for public sector banks, Rs. 52,311 lakhs for private domestic banks and Rs. 25,155 lakhs for private foreign banks. The ranking of banks is also same as before in terms of the extremities - the State Bank of India is the largest and the Oman International bank, the smallest. But the investment per unit of cost comes to Rs. 4.30, Rs. 4.51 and Rs. 5.64 respectively. This is not indeed a case of scale inefficiency, but might be an outcome of scope inefficiency, and/or X- inefficiency. The former case arises due to larger product-mix, and, in the case of private banks (both domestic and foreign), we notice more of off-balance-sheet investments. The issue of X-efficiency becomes relevant in view of the fact that, in the post-reform period, risk elements have multiplied in India's banking business, whereas the risk-absorbing mechanism has not been adequately developed. In such circumstances, the managers in public-sector banks are scared to properly invest the available fund, giving rise to the problem of what is called 'lazy banking'.[298] Managers in the private sector, on the other hand, are to work with risks under the pressure of market competitions - an important component of Leibenstein's X-efficiency concept.

[298] Mohan, 'Economic Growth', p. 1

Fig 4.3 The output variable (Q_2): Average Investment



Source: Annexure 11

Amongst the input price variables, only the price of labour varies widely across the bank groups. It was 3.3431 for public sector banks, 2.9473 for private domestic banks and 13.0028 for private foreign banks. There is no significant difference between the former two groups, only 13.42 per cent. But, compared to public sector banks, private foreign banks provide 3.88 times higher compensation. This may be explained by the marginal productivity theorem, which states that the factors of production are compensated according to their marginal productivities. In this case, we have already noticed that private foreign banks operate with a highly capital-intensive technology so that the marginal productivity of their staff should be much higher than that in other banks. Hence, those banks are able to pay higher salaries. The prices of fund are, however, seen close to each other for different groups. It was Rs. 0.0630 for public sector banks, Rs. 0.0659 for private domestic banks and Rs. 0.0621 for private foreign banks – a variation of only 1.06 per cent between the highest and lowest figures. Perhaps, it is due to RBI's interest rate policy for commercial banking, which has been de-regulated only in the fourth quarter of 2011.

Section VI:

This chapter thus resolves four basic issues regarding the methodology. First, it discusses in detail two alternative methods for the measurement of efficiency, the Data Envelopment Analysis (DEA) and the Stochastic Frontier Analysis (SFA). After a thorough exposition of their comparative efficacies in the measurement of commercial banks' X-efficiency, it appears that the latter tool is better suited for our purpose. Secondly, of various functional forms that are in use in the literature, we decide to employ the translog specification, which can represent multi-product firms, and accommodates, at the same time, various swings in average costs. Thirdly, it deliberates on the question of whether commercial banking is a production agent or an intermediate institution since the identification of inputs and outputs depends on this issue. After a comparative analysis between the production approach and the intermediary approach, we take up the latter for our purpose. Fourthly, among alternative sets of inputs and outputs that various authors adopt, this study develops a model based on two outputs, (i) loans and advances, and (ii) investment, and three input prices, (i) price of labour, (ii) price of fund, and (iii) price of capital. Lastly, the SFA literature also witnesses various methods of estimation. We propose to employ two competing tools, the GLS method and the MLE method so that we can arrive at a better set of judgements.

For the sake of higher degrees of freedom, as also to obtain the advantages of both time series and cross-section data, we propose to use the panel data for the purpose of computation. But its use warrants the test of the existence of unit root in the panel data. We initially propose to apply the augmented Dickey-Fuller (ADF) Test and Levin-Lin-Chu (LLC) Test, but finally advocate the latter for its suitability in the panel data.

This study deals with India's commercial banking institutions. It takes up 57 banks to analyse the effects of the financial sector reforms on their X-efficiencies. Of them, there are 25 public sector banks, 17 private domestic banks and 15 private foreign banks. We discuss in a nutshell four basic features of these organisations – paid-up capital, deposits, branches and employment – categorising them in the above-mentioned groups. We have also presented, and briefly discussed, data relating to model variables - the cost variable, the output variables and the input variables.

Chapter V

MODEL ESTIMATION, EMPIRICAL RESULTS AND THEIR INTERPRETATIONS

The present chapter forms the core of this thesis since it seeks to obtain the empirical evidences regarding the effects of financial sector reforms on the X-efficiency of commercial banks in India. Before we move on with the empirical analysis, we run some preliminary test as discussed in the previous chapter. The first test that we conduct is the test for stationarity. To this end, we undertake the Augmented Dickey-Fuller test and the Levin-Lin-Chu test for panel data in Section I. There are broadly two methods by which we conduct our empirical analysis: one is the Generalised Least Square (GLS) estimation and the other is the Maximum Likelihood Estimation (MLE). Because of the use of the panel data, the presence of heteroskedacticity is imminent, which reduces the reliability of the estimations in the Ordinary Least Square method. To this end, we suitably transform the data, which, in addition to removing heteroskedacticity, neutralises the effects of autocorrelation as well. These are what we do in the GLS method. The questions of heteroskedacticity and serial correlation are of no concern in the MLE since it assumes, similar to other approaches in the stochastic frontier analysis that the error term comprises of white noises and inefficiencies. Hence, the correction of heteroskedacticity in this analysis, indeed, removes the inefficiency component from the error term. By the GLS method, we seek to estimate the parameters for the panel spanning over 1994-2012 while the MLE method is used for two alternative panels, one for 1994-2012 and the other for

2000-2012. The use of the same panel in two alternative methods of estimation enables us to make a comparative study between them. Since the MLE appears superior to the GLS estimation, we carry out the former method for alternative scenarios. First, the use of two sets of panel data, as in the present case, enables us to investigate how the efficiencies of commercial banks changed in the wake of the second-generation financial sector reforms in India that commenced in 1998. Secondly, estimations are made with and without the intercept term in the MLE case for 1994-2012. While the former is customary in the literature, we undertake the latter since the suppression of the intercept term increases the explanatory power of the arguments, on the one hand, and leaves the entire unexplained part of the dependent variable in the residual, on the other hand. For the latter reason, no part of X-efficiency component is lost anywhere.

The organisation of this chapter is such, Section I deals with the issue of the unit root problems for the panel data that we use. In Section II, we reports the results of model estimation based on the GLS method, and in Section III, those based on the MLE method. The results thus obtained are also discussed in the respective sections. Section IV makes a comparison between the results of the GLS method and the MLE method. Section V seeks to identify the shortcomings of the study and to indicate the scope of further study in this field. Section VI concludes.

Section I: Unit Root

The stationarity test that provides an idea about the convergence of the series under study, is carried out here using the add-in 'urca'[299] for ADF, and the package 'plm'[300] for Levin Lin and Chu test, as available in the R-statistical environment.

The ADF test can be conducted under three options in the 'urca'. They are with 'drift', with 'trend', and 'none'. These options correspond to the three equations of Chapter 4 Section IV. The 'urca' package runs the equation as

$$z.diff \sim z.lag.1 + 1 + tt + z.diff.lag \qquad (5.1)$$

This corresponds to the equation of Augmented Dickey Fuller test

$$\Delta y_t = a_0 + \gamma y_{t-1} + a_2 t + \varepsilon_t \qquad (5.2)$$

where the hypotheses are

$$\gamma = 0,$$

$$\gamma = a_2 = 0$$

$$a_0 = \gamma = a_2 = 0$$

These correspond to the test statistics τ_T, φ_3 and φ_2 respectively.[301] Here, $'\gamma'$ is the coefficient of the term 'z.lag'.

The ADF test overlooks the panel structure of the data so that it is less reliable for the panel data. The alternative is the Levin, Lin and Chu (LLC) test. The LLC is conducted by 'purtest' under the 'plm' package in the R environment. This test is more suitable for panel unit root as it takes into account the panel structure of the data. The 'purtest' also runs the unit root test with 'intercept',

[299] Pfaff, 'Analysis of Integrated and Cointegrated Time Series with R'
[300] Croissant and Milo, 'Panel Data Econometrics'
[301] Enders, *Applied Econometric Time series*, p.183

with ‘trend’ and ‘none’. Intercept option captures the individual intercepts whereas the trend option captures both individual intercepts and trend. The acceptance or rejection of the null hypothesis in this case depends upon the p-value. The LLC test is, however, more appropriate when the time period is large. If the time period is considerably smaller than the cross section, as in our panel data, we may not get very reliable estimates of panel root. It may also lead to acceptance of the null hypothesis when there is no unit root.

The results of our ADF test, however, suggest that there is no unit root problem in our panel data. Their calculated values of the variables are -11.5964 for C, -11.8705 for Q_1, -10.1024 for Q_2, -12.451 for r_1,-12.0234 for r_2 and -14.6042 for r_3. The tabulated value of τ with 1076 degrees of freedom is -3.96 at 1 per cent level of significance and -3.14 at 5 per cent level of significance. Since the calculated values are less than the table values we should reject the null hypothesis H_0 that there is unit root, and accept the alternate hypothesis H_1 that there is no unit root.

The Levin Lin and Chu test also rejects the possibility of the unit root in our panel. This test generates a ρ value of -21.96 for C, -24 for Q_1, -48.70 for Q_2, -3.36 for r_1, -15.59 for r_2 and – 18.41 for r_3. The probability value (p values) of ρ statistics are found in the close proximity of 0 suggesting again that the unit root problem is absent in our cases. The non existence of unit root problem suggests that the time series of the variables under study are convergent in their respective populations so that the estimations of the sample statistics from those series are reliable in repeated sampling.

Section II: Generalised Least Square Estimation

We undertake a generalised least square (GLS) estimation[302] to overcome heteroskedacticity and autocorrelation in panel data. In the first step, we run the ordinary least square method of estimation on the panel data for the time period 1994-2012. Table 5.1 presents the estimated values of the parameters of the model along with their relevant statistics like standard errors, t-statistics and their significances. After running the OLS we store the error terms, and report them in the Annexure 12.

Table 5.1 shows that the R^2-value is as high as 0.9915, signifying that the variables under consideration very significantly explain the variations in banking costs. This is also evident in observed value of F-statistic, which is as high as 6282, and, thus attains a significance level of 0.0001. We are thus confirmed about the model's goodness of fit on our panel data. But these inferences should be qualified by that the high R^2-value might also indicate the presence of heteroskedacticity. It should also be noted that all the output and input coefficients assume appropriate signs. Only two squared variables and some joint variables assume negative coefficients in this estimation.

[302]Kmenta, *Elements of Econometrics*, pp.508 - 512.

Table 5.1: The first-stage OLS estimation for the panel 1994-2012

Coefficients	Estimates	SE	t-values	Pr(>|t|)
$Intercept(\alpha_0)$	1.4416	0.3536	4.077	0.0000
$Q_1(\alpha_1)$	0.0440	0.0569	0.774	0.4392
$Q_2(\alpha_2)$	0.6908	0.0738	9.359	0.000
$r_3(\alpha_3)$	0.0953	0.0664	1.435	0.1515
$r_2(\alpha_4)$	0.0261	0.1574	0.165	0.8686
$r_3(\alpha_5)$	0.0883	0.0491	1.798	0.0725
$Q_1^2(\alpha_{11})$	0.0153	0.0082	1.869	0.0619
$Q_2^2(\alpha_{22})$	0.0858	0.0164	-5.235	0.000
$r_1^2(\alpha_{33})$	0.0325	0.0112	2.889	0.0040
$r_2^2(\alpha_{44})$	-0.1075	0.0378	-2.842	0.0046
$r_3^2(\alpha_{55})$	0.0034	0.0070	0.481	0.6307
$Q_1Q_2(\alpha_{12})$	0.0488	0.0115	4.226	0.0001
$Q_1r_1(\alpha_{13})$	-0.0466	0.0072	-6.483	0.0001
$Q_1r_2(\alpha_{14})$	0.1190	0.0136	8.755	0.0001
$Q_1r_3(\alpha_{15})$	0.0041	0.0052	0.782	0.4342
$Q_2r_1(\alpha_{23})$	0.0094	0.0090	1.045	0.2964
$Q_2r_2(\alpha_{24})$	-0.0787	0.0193	-4.087	0.0001
$Q_2r_3(\alpha_{25})$	-0.0158	0.0069	-2.294	0.0220
$r_1r_2(\alpha_{34})$	-0.1042	0.0180	-5.777	0.0001
$r_1r_3(\alpha_{35})$	-0.0191	0.0070	-2.707	0.0069
$r_2r_3(\alpha_{45})$	-0.0148	0.0162	-0.915	0.3603

Of all the variables that enters the first-stage regression equation, fourteen variables (Intercept, lnQ_1, lnQ_2, lnr_1, lnr_2, lnr_3, $SqlnQ_1$,$SqlnQ_2$,$Sqlnr_1$, $Sqlnr_3$, lnQ_1Q_2, lnQ_1r_2, lnQ_1r_3andlnQ_2r_1) assume positive coefficients while seven variables -, $Sqlnr_2$,lnQ_1r_1,LnQ_2r_2,lnQ_2r_3,lnr_1r_2,lnr_1r_3andlnr_2r_3 - have negative slopes. Out of these negative coefficients, two are insignificant at 0.01 per cent level. We are, however, concerned at this stage of estimation only with the residuals which, as the F-statistic and the R^{2-}measure indicate, are free from the effects of any significant variable.

Since the above OLS estimation might suffer from autocorrelation and heteroskedacticity, it no longer stands as an efficient estimator. A correction of these problems is necessary for proper statistical inferences.

We undertake the GLS transformation, *a la* Kmenta,[303] from the residuals of the first-stage regression that have been stored (as discussed in Chapter IV). In the first step, we correct for autocorrelation by taking the estimated values of ρ_i for each bank from the following relationship

$$\varepsilon_{it} = \rho_i \varepsilon_{t-1} + u_{it} \qquad (5.3)$$

where$\varepsilon_{it}$is the residuals obtained from the first step OLS estimation. The estimated values of ρ_i are presented in Annexure 13. The input and output variables are thereafter transformed following the methodology as discussed in the previous chapter. The transformed variables are now free from autocorrelation. In the second step of the GLS transformation, we correct the variables for heteroskedacticity by dividing the variables by their respective

[303] Ibid, p.510

variance terms. For that purpose, the variances of individual variables for each bank are obtained by

$$s_{ui}^2 = \frac{1}{T-K-1}\sum_{t=2}^{T} \hat{u}_{it}^{*2} \quad (5.4)$$

The estimated variances s_{ui}^2 are also reported in Annexure 13. Once these corrections are made, the resultant data series are free from the problems of both autocorrelation and heteroskedacticity. On these transformed data, we undertake the OLS to estimate the model parameters without any loss of the avowed properties of the OLS estimators. The residuals in this stage of regression are again stored as we believe that they contain the effects of X-efficiency along with pure white noise. To segregate the X-efficiency component from random effects, we regress ε_{it} on time (t) as in Equation 5.5.

$$ln\varepsilon_{it} = \alpha_i + \lambda_i t + ln\xi_{it} \qquad (5.5)$$

Equation (5.5) breaks the error term into three components - α_i denoting the time invariant X-efficiency component, $\lambda_i t$ denoting the time variant X-efficiency and $ln\xi_{it}$ representing the pure white noise. The estimated parameters of the above equation are shown in Tables 5.2 – Table 5.4.

Table 5.2. Estimated results of Residual on time for PSB under GLS method

BANK	R^2	F	Sig	α_i	t value	Sig	λ_i	t value	Sig
SBI	0.36	9.0409	0.010	0.6116	5.6993	0.001	-0.0298	-3.0068	0.010
SBJ	0.02	0.3673	0.550	0.0190	0.1294	0.900	0.0082	0.6060	0.550
SBH	0.05	0.8990	0.360	-0.2823	-1.5254	0.150	0.0162	0.9482	0.360
SBM	0.01	0.0937	0.760	-0.2348	-1.5190	0.150	-0.0044	-0.3060	0.760
SBP	0.02	0.3363	0.570	-0.2470	-1.0682	0.300	-0.0124	-0.5799	0.570
SBT	0.03	0.4682	0.500	-0.1084	-0.5925	0.560	-0.0116	-0.6842	0.500
ALLB	0.00	0.0231	0.880	0.0254	0.1315	0.900	-0.0027	-0.1520	0.880
ANDB	0.00	0.0610	0.810	-0.1412	-0.7886	0.440	-0.0041	-0.2470	0.810
BOB	0.49	15.6803	0.000	0.3223	3.0150	0.010	-0.0391	-3.9598	0.000
BOI	0.14	2.5382	0.130	0.2058	1.4377	0.170	-0.0211	-1.5932	0.130
BOM	0.00	0.0347	0.850	-0.0815	-0.5011	0.620	-0.0028	-0.1864	0.850
CANB	0.01	0.1093	0.750	-0.2144	-0.8952	0.380	-0.0073	-0.3306	0.750
CENB	0.04	0.6133	0.440	-0.0320	-0.1800	0.860	-0.0129	-0.7832	0.440
CORPB	0.12	2.1948	0.160	-0.0664	-0.4228	0.680	-0.0215	-1.4815	0.160
DENB	0.10	1.7825	0.200	0.4412	4.2476	0.000	-0.0128	-1.3351	0.200
INDB	0.15	2.8078	0.110	0.3916	2.2288	0.040	-0.0272	-1.6756	0.110
IOB	0.20	4.0139	0.060	0.4245	2.8569	0.010	-0.0275	-2.0035	0.060
OBC	0.00	0.0360	0.850	-0.3103	-1.3600	0.190	0.0040	0.1897	0.850
PNSB	0.00	0.0402	0.840	0.1095	0.4469	0.660	-0.0045	-0.2005	0.840
PNB	0.12	2.2351	0.150	0.1195	0.8223	0.420	-0.0201	-1.4950	0.150
SYNB	0.16	2.9626	0.100	0.0824	0.6205	0.540	-0.0211	-1.7212	0.100
UCOB	0.49	15.4284	0.000	0.4644	3.1367	0.010	-0.0537	-3.9279	0.001
UNIONB	0.13	2.4160	0.140	0.0693	0.3567	0.730	-0.0279	-1.5544	0.140
UNITEDB	0.41	11.2788	0.001	1.6861	5.3329	0.000	-0.0981	-3.3584	0.001
VIJB	0.00	0.0131	0.910	0.0408	0.1546	0.880	-0.0028	-0.1145	0.910

Table 5.3. Estimated results of Residual on time for PDB

BANK	R^2	F	Sig	α_i	t value	Sig	λ_i	t value	Sig
AXISB	0.01	0.0195	0.890	-0.1999	-0.9036	0.380	0.0029	0.1396	0.890
CATSYRB	0.01	0.0443	0.840	0.2113	1.1126	0.280	0.0037	0.2105	0.840
CITYUNIB	0.14	2.5931	0.130	-0.4852	-3.0543	0.010	0.0236	1.6103	0.130
DLAXB	0.20	3.9762	0.060	-0.4272	-2.4491	0.030	0.0321	1.9940	0.060
FEDB	0.02	0.3194	0.580	-0.0766	-0.4669	0.650	-0.0086	-0.5652	0.580
HDFC	0.19	3.6804	0.070	-0.1711	-0.9877	0.340	0.0307	1.9184	0.070
ICICI	0.17	3.2464	0.090	3.0273	1.6507	0.120	-0.3053	-1.8018	0.090
INDUSB	0.01	0.0115	0.920	0.0155	0.1095	0.910	0.0014	0.1071	0.920
INGVYSB	0.01	0.1724	0.680	0.1603	0.8441	0.410	-0.0073	-0.4152	0.680
JKB	0.01	0.0514	0.820	1.0233	1.7960	0.090	-0.0119	-0.2267	0.820
KARB	0.01	0.0276	0.870	-0.0555	-0.2338	0.820	-0.0036	-0.1661	0.870
KVYSB	0.06	1.0606	0.320	-0.3353	-2.4126	0.030	0.0132	1.0299	0.320
LVILB	0.14	2.5171	0.130	0.0337	0.2406	0.810	0.0205	1.5865	0.130
NAINB	0.41	11.2491	0.001	-0.7402	-5.2108	0.001	0.0440	3.3540	0.001
RATNB	0.05	0.8445	0.370	-0.3723	-2.6480	0.020	-0.0119	-0.9190	0.370
SOUINB	0.02	0.3830	0.540	0.2637	1.9818	0.060	0.0076	0.6189	0.540
TAMNB	0.19	3.7885	0.070	-0.2625	-1.5935	0.130	0.0296	1.9464	0.070

Table 5.4. Estimated results of Residual on time for PFB

BANK	R^2	F	Sig	α_i	t value	Sig	λ_i	t value	Sig
ADCOMB	0.11	1.903	0.190	1.3645	0.6786	0.500	-0.2563	-1.3794	0.180
BOA	0.01	0.078	0.780	0.0888	0.3012	0.760	-0.0076	-0.2784	0.780
BBK	0.01	0.012	0.920	-0.1707	-0.1071	0.910	-0.0158	-0.1076	0.910
BNOVA	0.05	0.876	0.360	0.8985	2.1204	0.050	-0.0367	-0.9362	0.360
BOT	0.03	0.415	0.530	-2.8835	-1.1692	0.250	0.1468	0.6443	0.520
BNP	0.42	11.439	0.000	-0.1128	-1.0362	0.310	0.0340	3.3821	0.000
BARCB	0.17	3.364	0.090	-1.3920	-1.5199	0.140	0.1552	1.8340	0.080
CITI	0.23	4.695	0.050	1.6645	4.1237	0.001	-0.0808	-2.1668	0.040
DBS	0.24	4.932	0.040	-1.4034	0.0082	0.001	0.0954	2.2209	0.040
DEUTB	0.02	0.397	0.540	2.1636	0.9169	0.370	-0.1373	-0.6299	0.050
HSBC	0.11	1.901	0.190	2.8571	1.5513	0.140	-0.2346	-1.3787	0.180
JPMC	0.17	3.211	0.090	2.3433	2.2344	0.040	-0.1736	-1.7919	0.090
OMINB	0.06	1.033	0.320	-1.4381	-0.8968	0.380	0.1506	1.0163	0.320
SGB	0.01	0.001	1.000	-0.9197	-0.5218	0.600	-0.0002	-0.0012	0.990
STANCB	0.40	10.480	0.010	2.2202	4.9183	0.001	-0.1350	-3.2373	0.010

The sign and significance of λ_i indicate the temporal variability of X-efficiency. If λ_i is not found significant, we reject temporal variability. A significant λ_i suggests temporal variability of X-efficiency and the sign denotes the direction of this change. If the sign of λ_i is positive, it suggests diminution of X-efficiency, and a negative value its improvement. Similarly, a positive, significant value of α_i indicates the presence of X-inefficiency at the beginning of the study period, and vice versa.

However, the OLS estimates on the transformed data in the second stage generate R^2 at 0.7896. It is indeed in a lower side, but surely confirms that most of the variations in the cost have already been explained in the first step regression. The estimated parameters of the regression of the residuals on time, and also their relevant statistics, are reported in the Table 5.2. – Table 5.4. The R^2-values of bank-wise estimations at this final stage are found in the range of 0.001-0.49. For more than 50 per cent banks, the R^2 values stand at less than 0.1000; it is in between 0.100-0.300 for about 35 per cent of the banks, and in between 0.300 - 0.500 for about 12 per cent.

To assess the X-efficiency among the banks, let us first considerα_i, which ranges between 3.0272.3 to -2.8835. Out of the 57 banks that have been taken into consideration, 30 banks have a positive α_i and the remaining 27 banks have its negative values. These imply that majority of the banks were X-inefficient at the beginning of the study. But many of them are statistically insignificant so that our findings regarding their efficiency levels should not be considered seriously. We note in this connection that out of the 30 banks with a positive α_i, 13 banks have a positive significant α_i while the rest 17 banks assume insignificant estimates. Based on these statistical findings, we infer that only 13 were X-inefficient at the beginning of the study period. Those are SBI, BOB, DENB, INDB, IOB, UCOB, UNITEDB, JKB, SOUINB, BNOVA, CITI, JPMC and STANCB. This list thus includes seven public sector banks (SBI, BOB, DENB, INDB, IOB, UCOB and UNITEDB), and two private domestic banks (JKB and SOUINB) which had been in business for a considerable period of time prior to 1994. The private foreign banks (BNOVA, CITI, JPMC and STANCB) ran inefficiently at the beginning. On the other hand, 27 banks are found X-efficient (i.e. having negative intercept), but only six of them (CITYUNIB, DLAXB, KVYSB, NAINB, RATNB and DBS) are seen statistically significant. The conclusions that follow from this GLS analysis are thus: (a) out of 57 banks under study, 30 banks were X-inefficient and 27 X-efficient at the beginning of the study period; and (b) all these statistical findings are not statistically significant – only 13 values in the former and six in the latter are statistically significant.

The value of λ_i representing the time-variant component of X-efficiency ranges between 0.1551 to - 0.3052. Tables 5.2 - 5.4 show that 19 banks have a positive λ_i and 38 banks have a negativeλ_i so that we infer the majority of the banks to have increased their X-efficiency over the reform period. But the Student's t-statistic indicating the significance level of the relevant estimators disappoints us in that only about 28 per cent of these estimations (31.5 per cent of X-inefficient values and 26 per cent of X-efficient values) are statistically significant. We are thus able to conclude that only ten banks (SBI, BOB, IOB, UCOB, UNITEDB, ICICI, CITI, DEUTB, JPMC and STANCB) improved their level of X-efficiency over time, and six banks (HDFC, NAINB, TAMNB, BNP, BARCB and DBS) became X-inefficient over time.

The terms α_i and λ_i are, however, transformed into the normalised X-efficiency measure following Equations 5.6 and 5.7, and the normalised values are reported in Table 5.5.

$$TIV_{XE} = \exp\left(ln\alpha_i^{min} - ln\alpha_i\right) \qquad (5.6)$$

$$TV_{XE} = exp\left(\lambda_{it}^{min} - \lambda_{it}\right) \qquad (5.7)$$

Table 5.5 Normalised time-variant and time-invariant X-efficiency under GLS method (in percentage)

PUBLIC SECTOR BANKS			PRIVATE DOMESTIC BANKS			PRIVATE FOREIGN BANKS		
BANK	α_{0i}	λ_i	BANK	α_{0i}	λ_i	BANK	α_{0i}	λ_i
SBI	3.03	75.92	AXISB	6.83	73.48	ADCOMB	1.43	95.22
SBJ	5.49	73.09	CATSYRB	4.53	73.42	BOA	5.12	74.25
SBH	7.42	72.51	CITYUNIB	9.09	71.97	BBK	6.64	74.87
SBM	7.07	74.02	DLAXB	8.57	71.36	BNOVA	2.28	76.44
SBP	7.16	74.61	FEDB	6.04	74.33	BOT	100.00	63.63
SBT	6.23	74.55	HDFC	6.64	71.46	BNP	6.26	71.23
ALLB	5.45	73.89	ICICI	0.27	100.00	BARCB	22.5	63.10
ANDB	6.44	73.99	INDUSB	5.51	73.59	CITI	1.06	79.89
BOB	4.05	76.63	INGVYSB	4.77	74.23	DBS	22.7	66.99
BOI	4.55	75.26	JKB	2.01	74.58	DEUTB	0.64	84.54
BOM	6.07	73.90	KARB	5.91	73.96	HSBC	0.32	93.17
CANB	6.93	74.23	KVYSB	7.82	72.72	JPMC	0.54	87.66
CENB	5.78	74.65	LVILB	5.41	72.20	OMINB	23.5	63.39
CORPB	5.98	75.29	NAINB	11.73	70.52	SGB	14.0	73.71
DENB	3.60	74.64	RATNB	8.12	74.58	STANCB	0.61	84.34
INDB	3.78	75.72	SOUINB	4.30	73.13	**Average**	**13.8**	**76.8**
IOB	3.66	75.75	TAMNB	7.27	71.54			
OBC	7.63	73.40	**Average**	**6.2**	**74.5**			
PNSB	5.01	74.03						
PNB	4.96	75.19						
SYNB	5.15	5.26						
UCOB	3.52	77.76						
UNIONB	5.22	75.78						
UNITEDB	1.04	81.29						
VIJB	5.37	73.90						
Average	**5.22**	**72.2**						

It appears from the above table that the Bank of Tokyo (BOT) enjoys the highest level of time-invariant X-efficiency, and the ICICI Bank that of time-variant X-efficiency. But there are great variations in these indices (especially in the former case) across the banks. Compared to the BOT, the time-invariant X-efficiency is seen as low as 3-8 per cent for the public sector banks, and 0.27-12 per cent for private domestic banks. Even the performances of private foreign banks are not at all satisfactory. Only BARCB , DBS and ONINB get scores around 22.5 to 23.5 per cent. The deviations in respect of time-variant X-efficiency are comparatively less. Comparative to the ICICI, the public sector banks score the index at 73-81 per cent, the private foreign banks at 63-95 per cent and the private domestic banks (excepting the ICICI Bank) at 71-75 per cent.

But these inferences are subject to the qualification that they involve a number of estimated parameters, which are statistically doubtful in view of their low t-values. For quite a large number of banks, then, our inferences are inconclusive. In addition to the theoretical issues that we have discussed in Chapter IV, this empirical aspect motivates us to use the MLE method in our study.

Section III: Maximum Likelihood Estimation

The Battese-Collie (1992) method that is based on the MLE technique is adopted in this section to estimate the parameters. The Model 4.35 of Chapter IV is rewritten to incorporate the trend element and is represented as in equation 5.8.

$$
\begin{aligned}
LnC_{it} = {} & \alpha_0 + \alpha_1 lnQ_{1t} + \alpha_2 lnQ_{2t} + \alpha_3 lnr_{1t} + \alpha_4 lnr_{2t} + \alpha_5 lnr_{3t} \\
& + {}^1\!/_2\, \alpha_{11} lnQ_{1t} lnQ_{1t} + {}^1\!/_2\, \alpha_{22} lnQ_{2t} lnQ_{2t} + {}^1\!/_2\, \alpha_{33} lnr_{1t} lnr_{1t} \\
& + {}^1\!/_2\, \alpha_{44} lnr_{2t} lnr_{2t} + {}^1\!/_2\, \alpha_{55} lnr_{3t} lnr_{3t} + \alpha_{12} lnQ_{1t} lnQ_{2t} \\
& + \alpha_{13} lnQ_{1t} lnr_{1t} + \alpha_{14} lnQ_{1t} lnr_{2t} + \alpha_{15} lnQ_{1t} lnr_{3t} \\
& + \alpha_{23} lnQ_{2t} lnr_{1t} + \alpha_{24} lnQ_{2t} lnr_{2t} + \alpha_{25} lnQ_{2t} lnr_{3t} \\
& + \alpha_{34} lnr_{1t} lnr_{2t} + \alpha_{35} lnr_{1t} lnr_{3t} + \alpha_{45} lnr_{2t} lnr_{3t} + \alpha_t t + \alpha_{tt} t^2 \\
& + \alpha_{1t} lnQ_1 t + \alpha_{2t} lnQ_2 t + \alpha_{3t} lnr_1 t + \alpha_{4t} lnr_2 t + \alpha_{5t} lnr_3 t \\
& + \varepsilon \qquad (5.8)
\end{aligned}
$$

This model is estimated with and without intercept term for the reason discussed in the previous chapter. Table 5.6 presents the estimated parameters and their statistics for the model for 1994-2012 without intercept and Table 5.7 presents the estimated parameters for the same with intercept. We also run MLE to estimate the model with intercept for 2000-12 with a view to finding out the effect of the second phase of reforms. The results of this estimation are presented in Table 5.8. If we compare the alternative estimations for 1994-2012 (i.e. with and without intercept) on the basis of the significance levels of the estimates for individual parameters, it appears that the results for the model for the alternative ‘with intercept’ are more significant. It is for the very same reason that we concentrate on the equation with intercept for the period 1994-2012 (Table 5.7) for our analysis.

The significance test for the estimates is based on the p value of $z$distribution rather than the traditional t distribution. It is more suitable in our case with a sample size as large as 1083 since, with the increase in the sample size, a t-distribution tends to a z-distribution.

Table 5.6. Maximum Likelihood Estimates for cost function with trend and without intercept, 1994-2012

Coefficients	Estimates	SE	Z values	Pr(>|z|)
$Q_1(\alpha_1)$	1.0400	0.8627	1.2021	0.2293
$Q_2(\alpha_2)$	1.6590	1.1980	1.3849	0.1661
$r_1(\alpha_3)$	-2.2900	1.0496	-2.1819	0.2910
$r_2(\alpha_4)$	-1.8837	2.0780	-0.9060	0.3646
$r_3(\alpha_5)$	1.5906	0.9425	1.6877	0.0915
$Trend(\alpha_T)$	-2.4350	2.2690	-1.0733	0.2831
$Q_1^2(\alpha_{11})$	0.0117	0.0071	1.6441	0.1000
$Q_2^2(\alpha_{22})$	-0.0810	0.1560	-5.1580	0.0000
$r_1^2(\alpha_{33})$	-0.0147	0.0175	-0.8360	0.4032
$r_2^2(\alpha_{44})$	-0.9660	0.0330	-2.9270	0.0030
$r_3^2(\alpha_{55})$	-0.0121	0.0060	-1.8930	0.0580
$Trend^2(\alpha_{TT})$	1.3120	1.0340	1.2680	0.2050
$Q_1Q_2(\alpha_{12})$	0.0631	0.0100	6.1740	0.0000
$Q_1r_1(\alpha_{13})$	-0.0580	0.0070	-7.4660	0.0000
$Q_1r_2(\alpha_{14})$	0.1035	0.0110	9.2890	0.0000
$Q_1r_3(\alpha_{15})$	0.0050	0.0050	1.0100	0.3130
$Q_1Trend(\alpha_{1T})$	-0.2380	0.1940	-1.2260	0.2200
$Q_2r_1(\alpha_{23})$	0.0110	0.0120	0.9500	0.3420
$Q_2r_2(\alpha_{24})$	-0.0700	0.0170	-3.9530	0.0000
$Q_2r_3(\alpha_{25})$	-0.0090	0.0060	-1.4660	0.1430
$Q_2Trend(\alpha_{2T})$	-0.2640	0.2750	-0.9600	0.3380
$r_1r_2(\alpha_{34})$	-0.0200	0.0179	-1.1260	0.2600
$r_1r_3(\alpha_{35})$	0.0268	0.0100	2.6250	0.0090
$r_1Trend(\alpha_{3T})$	0.6320	0.2390	2.6490	0.0080
$r_2r_3(\alpha_{45})$	0.0480	0.0140	-3.4320	0.0010
$r_2Trend(\alpha_{4T})$	0.4050	0.4680	0.8660	0.3860
$r_3Trend(\alpha_{5T})$	-0.3730	0.2140	-1.7450	0.0810
σ^2	0.1480	0.0250	5.8860	0.0000
γ	0.8840	0.0220	39.9120	0.0000
$time$	-0.0350	0.0090	-3.7210	0.0000

Table 5.7 Maximum Likelihood Estimates for cost function with intercept and trend, 1994-2012

Coefficients	Estimates	SE	Z values	Pr(>|z|)
$Intercept(\alpha_0)$	-299.02	87.365	-3.4227	0.000
$Q_1(\alpha_1)$	1.226	0.862	1.4209	0.155
$Q_2(\alpha_2)$	0.161	1.234	0.1302	0.896
$r_1(\alpha_3)$	-6.679	1.647	-4.0542	0.000
$r_2(\alpha_4)$	-2.278	2.177	-1.0462	0.2954
$r_3(\alpha_5)$	0.660	1.00	0.660	0.5092
$Trend(\alpha_T)$	131.02	39.070	3.3536	0.000
$Q_1^2(\alpha_{11})$	0.014	0.007	2.0316	0.042
$Q_2^2(\alpha_{22})$	-0.085	0.015	-5.5228	0.000
$r_1^2(\alpha_{33})$	-0.045	0.020	-2.2735	0.022
$r_2^2(\alpha_{44})$	-0.101	0.033	-3.0625	0.126
$r_3^2(\alpha_{55})$	-0.010	0.006	-1.5293	0.001
$Trend^2(\alpha_{TT})$	-28.502	8.779	-3.2468	0.000
$Q_1Q_2(\alpha_{12})$	0.062	0.010	6.0460	0.000
$Q_1r_1(\alpha_{13})$	-0.059	0.008	-7.4645	0.000
$Q_1r_2(\alpha_{14})$	0.101	0.011	9.0974	0.000
$Q_1r_3(\alpha_{15})$	0.007	0.005	1.2842	0.199
$Q_1Trend(\alpha_{1T})$	-0.282	0.194	-1.4543	0.145
$Q_2r_1(\alpha_{23})$	-0.002	0.013	-0.1191	0.905
$Q_2r_2(\alpha_{24})$	-0.063	0.018	-3.5156	0.000
$Q_2r_3(\alpha_{25})$	-0.012	0.007	-1.8075	0.070
$Q_2Trend(\alpha_{2T})$	0.080	0.282	0.2848	0.775
$r_1r_2(\alpha_{34})$	-0.017	0.018	-0.9235	0.355
$r_1r_3(\alpha_{35})$	0.019	0.010	1.7546	0.079
$r_1Trend(\alpha_{3T})$	1.626	0.373	4.3564	0.000
$r_2r_3(\alpha_{45})$	-0.044	0.014	-3.0560	0.002
$r_2Trend(\alpha_{4T})$	0.475	0.491	0.9690	0.332
$r_3Trend(\alpha_{5T})$	-0.163	0.227	-0.7188	0.472
σ^2	0.162	0.038	4.2146	0.000
γ	0.895	0.026	34.9618	0.000
$time$	-0.040	0.009	-4.4988	0.000

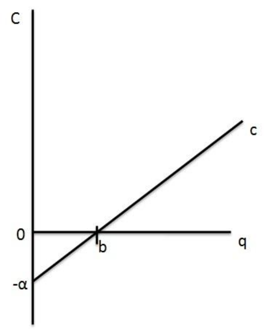
Table 5.8 Maximum Likelihood Estimates for cost function with intercept and trend, 2000-2012

Coefficients	Estimates	SE	Z values	Pr(>|z|)
$Intercept(\alpha_0)$	285.970	133.5100	2.1420	0.0322
$Q_1(\alpha_1)$	2.3941	1.2780	1.8730	0.0610
$Q_2(\alpha_2)$	2.6383	1.5945	1.6550	1.6550
$r_1(\alpha_3)$	2.5371	1.6811	1.5100	0.1310
$r_2(\alpha_4)$	-9.5102	3.5766	-2.6590	0.0080
$r_3(\alpha_5)$	-0.1459	1.2711	-0.1140	0.9070
$Trend(\alpha_T)$	-138.97	58.986	-2.3560	0.0190
$Q_1^2(\alpha_{11})$	0.0477	0.0090	5.2220	0.0000
$Q_2^2(\alpha_{22})$	-0.0397	0.0180	-2.2410	0.0250
$r_1^2(\alpha_{33})$	0.0031	0.0210	0.1500	0.8810
$r_2^2(\alpha_{44})$	0.0367	0.0690	0.5320	0.5940
$r_3^2(\alpha_{55})$	-0.0656	0.0110	-6.0310	0.0000
$Trend^2(\alpha_{TT})$	33.752	13.069	2.5830	0.0100
$Q_1Q_2(\alpha_{12})$	0.0178	0.0130	1.4200	0.1560
$Q_1r_1(\alpha_{13})$	-0.0223	0.0110	-2.0890	0.0370
$Q_1r_2(\alpha_{14})$	-0.0238	0.0210	-1.1320	0.2580
$Q_1r_3(\alpha_{15})$	-0.0282	0.0080	-3.5060	0.0010
$Q_1Trend(\alpha_{1T})$	-0.6057	0.2850	-2.1220	0.0340
$Q_2r_1(\alpha_{23})$	0.0117	0.0150	0.7910	0.4290
$Q_2r_2(\alpha_{24})$	0.0128	0.0220	0.5750	0.5650
$Q_2r_3(\alpha_{25})$	0.0422	0.0100	4.3510	0.0000
$Q_2Trend(\alpha_{2T})$	-0.3927	0.0350	-1.1110	0.2670
$r_1r_2(\alpha_{34})$	-0.0.655	0.0350	-1.8650	0.0620
$r_1r_3(\alpha_{35})$	0.0090	0.0130	0.6730	0.5010
$r_1Trend(\alpha_{3T})$	-0.5447	0.3840	-1.4180	0.1560
$r_2r_3(\alpha_{45})$	-0.0280	0.0210	-1.3850	0.1660
$r_2Trend(\alpha_{4T})$	2.2710	0.4781	2.9080	0.0350
$r_3Trend(\alpha_{5T})$	-0.0490	0.2860	-0.1700	0.8650
σ^2	0.0770	0.0200	3.8820	0.0000
γ	0.8720	0.0360	24.3250	0.0000
$time$	-0.0560	0.0110	-5.1630	0.0000

In Table 5.7, there are 12 positive coefficients (associated with Q_1, Q_2, r_3, $trend$, SqQ_1, Q_1Q_2, Q_1r_2, Q_1r_3, Q_2Trend, r_1r_3, r_3Trend and r_2Trend), and 17 negative coefficients (associated with α_0, r_1, r_2, SqQ_2, Sqr_1, Sqr_2, Sqr_3, $SqTrend$, Q_1r_1, Q_1Trend, Q_2r_1, Q_2r_2, Q_2r_3, r_1r_2, r_2r_3, r_3Trend and $time$). But, theoretically, only the negative values of intercept coefficient and timevariable are relevant. The former's negative valueimplies that the vector of explanatory variables should have a floor, corresponding to which C = 0, below which all the vectors are irrelevant.[304] On the other hand, the negative coefficient of time variable indicates that the cost frontier shifts inward with time, signifying the gain in efficiency in production.

The outputs loans/advances and investment, i.e. Q_1 andQ_2, are both positive, which implies that an increase in those output variables would raise the operating cost. The effect of squared output variable Q_1 on cost is also positive, and so also the combined effect of Q_1 and Q_2. Amongst the input prices, only r_3, the price of capital bears a positive estimated coefficient. Note also that the combined effects of Q_1 and r_2, as also Q_1 and r_3, are positive. Positive coefficient is found associated with the

[304]For a two-variable cost function c = c(q), a negative intercept is represented by a curve like c in the following figure.



Since negative costs are irrelevant, the part bα is irrelevant, and only bc is relevant. Thus, the minimum output level in this cost function is b.

combined variable, the price of labour (r_1) and the price of capital (r_3). These findings are also in line with the theoretical underpinning that higher output in association with higher price of fund and higher price of capital would lead to higher operating costs.

Next we move to the negative coefficients. The price of labour (defined as labour expenses divided by the number of workers) and the price of fund (defined as interest expenditure divided by the total of borrowings and deposits) are seen bearing negative causations with cost. It seems *prima facie* to go against the common reasoning, but, on closer examination, the negative signs may be logical.

Let us first consider r_1. The price of labour (r_1) may fall under three alternative situations: (i) when the labour expenses are constant and the number of workers increases, (ii) when there is an increase in labour expenses but this increase is less than the increase in the number of workers, and (iii) when labour expenses fall along with a constant or rising workforce. Then, in the wake of lower labour price, cost hikes may not be illogical on two grounds. First, the alternatives, noted above, might represent underpayment to employees which leads to discomfort and discontent among the workforce. As a result, workers' productivity might go down, and hence, a hike in cost. The case of underpayment for banking jobs is of special concern in the post-liberalisation period when the mushroom growth of banking jobs in the private sector is associated with a lower band of pay. Secondly, overstaffing at low wage rates is also not uncommon, so that some of the banks might have been passing through the phase of decreasing marginal productivities.

Moving on to r_2, we notice that the price of fund which should bear a positive causation is opposite in the present case. Our argument here again is that price of fund can fall under three situations: (i) when interest expenses rise along with a rise in deposits and borrowings but the former is less than the latter; (ii) when the former is constant but the latter rises; and (iii) when the former falls along with the rise in the latter. The last scenario is most unlikely. The second scenario seems more plausible as the interest rates remain constant over a period of time in India, and the fluctuations, if any, take place across the board so that deposits and borrowing for individual banks remain largely unaltered. In such situations, the fall in the fund price generates surplus fund in banks. Now, if the banks are unable to invest the fund properly, there would be hikes in cost. The case of surplus fund is so prominent in India in the post-reform period that the phrase 'lazy banking' is often associated with their style of functioning.[305]

The rationales of negative impacts of r_1 and r_2, as argued above, possibly explains also the negative influences of the combined variables Q_1 and r_1, Q_2 and r_2, and r_2 and r_3.

However, efficiency questions are often dealt with by the variables time and trend. There is a growing wisdom in the literature that the variable time represents technological progress/regress, depending on whether it is negative or positive.[306]If their interpretation of time variable is correct, the negative coefficient of the variable time, as found in this exercise, certainly suggests that there is technological progress in Indian banking in the post-reform period under study. Indeed, this is what we find in reality. Indian commercial banks have undertaken mechanisation in various banking processes, and have been providing core banking service, ATM services, internet banking, mobile banking and so on. But the overall effect of such technological progress seems to be very insignificant in our estimation. Our empirical

[305] Mohan, Economic Growth, Financial Deepening and Financial Inclusion, p. 1
[306] See, Hunter and Timme (1986), Kauko (2009), Turk Ariss (2010), Coelli et al (2005) and Ray (1982)

work-sheet indicates that such technological progress contributed only 0.0402 (Table 5.7, last row). But we should emphasise that this coefficient is extremely significant.

But, *pari passu* with the time variable, we should also study the trend variable which has multifaceted effects in the model. In the first place, it has a positive coefficient as large as 131- carrying the probability of occurrence at more than 0.001 in its z distribution. However, the quadratic effect of the variable trend, i.e. the coefficient of its squared term, is negative signifying the augmentation of efficiency. With a highly significant value of z (as much as 0.001 level), its estimated coefficient is of the value of -28.50. If we take the linear and quadratic effects together, the net effects comes to 1025 (the average of linear effects for 19 years is 1310, and the equivalent quadratic effect is 285). Therefore, our inference is that there is a fall in efficiency from the variable trend.

Our model has also taken into account the trend effects of all explanatory variables - $lnQ_1, lnQ_2, lnr_1, lnr_2$ and lnr_3, i.e. taking the combine effects of these variables with the variable trend. It appears that, of all these variables, only the variable Q_1 has favourable impact on cost (i.e. a negative coefficient) but this estimated coefficient is grossly insignificant; its significance level is a slow as 0.145. The trend effect of other combined explanatory variables Q_1, r_1, r_2 and r_3 are positive and, those too, as significant as 0.775, 0.000, 0.332 and 0.472. We thus expect that the trend effects of these explanatory variables, save Q_2, were adverse on the efficiency level.

We are thus compelled to conclude that, from the viewpoints of these efficiency measures, Indian commercial banks fail to achieve the expectation of the policy makers. Instead of attaining technical and cost efficiencies, their performance deteriorated, on the average.

If we compare the results obtained for 1994-2012 and 2000-2012 (Tables 5.7 and 5.8), it appears that those are quite similar in certain cases, but different in other instances. The estimated coefficients of $Q_1$and Q_2 are of positive signs in both cases in line with the theoretical cost function. For 2000-2012, the coefficient of r_1 is also positive. Only r_2 andr_3 are with negative coefficients in this case, and the latter is grossly insignificant.

Also the coefficients of the variable 'time' are negative in both cases, which support the hypothesis of technological progress to have taken place during the reform period. However, a comparison between the 1994-2012 and 2000-2012 confirms that the technological progress was accelerated during the second-generation reform. For, as against the coefficient of the variable 'time' at -0.040 for the former period, it is -0.056 for the latter.

But the variable 'trend' gives us a different scenario. For data relating to the second-generation period, the trend value is associated with an estimated coefficient of -138.97, significant at the 0.019 point level. Since the value is negative, it signifies that the second generation reforms bred a higher level of efficiency in the banking system. Indeed, the quadratic effect of the trend variable is positive. Taking the net effect of the trend variable the value is -647.834 (-138.97 x 13 + 33.753 x 13). This negative trend effect signifies a gain in efficiency after the second generation reform. Also, the effects of the variables Q_1, Q_2, r_1 and r_3 combined with 'trend' are also suggestive of growing efficiency as their estimated coefficients are negative.

However, we are so far concerned with different fields of inefficiency other than what we intend to study in this dissertation, namely the X-inefficiency. For the measure of this inefficiency, we should look into the error term ε_i. This term comprises of stochastic noise (v) and inefficiency components (u). The term σ^2 in Tables 5.6-5.8 is the summation of σ_u^2 and σ_v^2; and γ represents the ratio of σ_u^2 and σ^2. Noting that the γ value lies between 0 and 1, we stress that, theoretically, two alternative scenarios might crop up – one, it may be close to zero, signifying that the inefficiency component is virtually absent; two, it stands at the neighbourhood of unity, and thus accounts almost entirely for inefficiency. In our exercise, the value of γ comes to about 0.90. It is 0.870 for 2000-12 and 0.895 for 1994-2012. We are, therefore, inclined to conclude that both the noise and inefficiency components are present in the estimated error term.

Section IV: Efficiency Estimates

As discussed in chapter 4, the cost efficiencies are estimated from the error component. The general specification of the cost frontier is

$$lnC_{it} = lnC(Q_{it},; r_{it}\beta) + u_{it} + v_{it} \qquad (5.9)$$

We estimate the efficiency for two periods, 1994-2012 and 2000-2012. These efficiency estimates are calculated using Farrell's distance function. Let us emphasise that the time variable in equation 5.8 takes into account the technological change so that the u_i term stands for the measure of X-efficiency, not technical efficiency. The averageefficiency estimates of the three categories of banks over the years are shown in table 5.9. Further average is worked out for each category, and presented in the last row. The public sector banks are seen to have the highest efficiency at 80.24, followed very closely by private foreign banks at 79.93, whereas the private domestic banks lag at around 77.3 per cent X-efficiency. Amongst the public sector banks we observe that SBI scores the highest at 98 percent while the least is for the UNITEDB at 68 per cent. In the category of private foreign banks, we have the BBK, the DBS and SGB with the highest score of 98 percent while the least is scored by the CITI and DEUTB at 55 percent. In the private domestic bank category, the ICICI bank scores the highest with 91 percent while the least score is obtained by the CATSYRB at 68 percent.

The Tables 5.10 - 5.12 show the individual X-efficiency scores of the banks from 1994 to 2012. From the tables it transpires that the efficiency for all the banks falls over time. This can be explained by the fact that trend t in the MLE estimation is positive, so that the efficiency frontier goes up year to year. It represents growing inefficiency since we deal with the cost frontier. This study divides the banks into three groups so that there is neutrality in estimation with respect to ownership. The State Bank of India (SBI) is by far the largest banks among them.

Table 5.9: Average X- efficiency scores of banks (in %)

1994-2012

Public Sector Banks	Average X-efficiency	Private Domestic Banks	Average X-efficiency	Private Foreign Banks	Average X-efficiency
SBI	98	AXISB	81	ADCOMB	86
SBJ	74	CATSYRB	68	BOA	87
SBH	82	CITYUNIB	75	BBK	98
SBM	73	DLAXB	71	BNOVA	95
SBP	80	FEDB	82	BOT	81
SBT	82	HDFC	78	BNP	81
ALLB	80	ICICI	91	BARCB	81
ANDB	75	INDUSB	79	CITI	55
BOB	83	INGVYSB	72	DBS	98
BOI	86	JKB	81	DEUTB	55
BOM	74	KARB	81	HSBC	63
CANB	88	KVYSB	77	JPMC	87
CENB	79	LVILB	74	OMINB	71
CORPB	83	NAINB	70	SGB	98
DENB	78	RATNB	79	STANCB	63
INDB	78	SOUINB	77		
IOB	82	TAMNB	78		
OBC	87				
PNSB	72				
PNB	86				
SYNB	76				
UCOB	81				
UNIONB	85				
UNITEDB	68				
VIJB	76				
Average	**80.24**		**77.3**		**79.93**

Of the total banks that have been taken into consideration in this study, six banks are seen belonging to the efficiency slab of 90-99 per cent. Out of those six banks, four banks (BBK, BNOVA, DBS and SGB) are private foreign banks while one bank each is in public sector and private domestic sector, SBI and ICICI respectively.

In the next X-efficiency slab, 80 - 90 per cent, there are altogether 23 banks, with the majority (SBH, SBP, SBT, ALLB, BOB, BOI, CANB, CORPB, IOB, OBC, PNB, UCOB and UNIONB) belonging to the public sector. Only six of them (viz. ADCOMB, BOA, BOT, BNP, BARCB and JPMC) are private foreign banks, and four (AXISB, JKB, FEDB and KARB) are private domestic banks. In the slab of 70 - 80 per cent, there are 22 banks in total. Out of them, 11 banks (DLAXB, INDUSB, CITYUNIB, HDFC, INGVYSB, KVYSB, LVILB, NAINB, RATNB, SOUINB and TAMNB) belong to the private domestic sector, and 10 to the public sector (SBH, SBM, ANDB, VIJB, BOM, PNSB, SYNB, CENB, DENB and INDB). Only OMINB is a private foreign bank. In the slab of 60 - 70 per cent, two banks (HSBC and STANCB) are in the private foreign sector, one each in the public and private domestic sectors, UNITEDB and CATSYRB respectively. To the lowest rung of 50-60 per cent belong two banks, CITI and DEUTB, which are of foreign origin.

The period 1994-2012, however, incorporates two important sub-periods, a part of 1991-1997 (i.e. the first-generation reform period) and 1998 onwards (i.e. the second-generation reform period). To make a comparative study between these sub-periods, we undertake empirical exercises for 2000-12 similar to those for 1994-2012, and present them in Table 4.10.

Table 5.10: Average X- efficiency scores of Banks (in %)

2000-2012

Public Sector Banks	Average X-efficiency	Private Domestic Banks	Average X-efficiency	Private Foreign Banks	Average X-efficiency
SBI	98	AXISB	88	ADCOMB	84
SBJ	82	CATSYRB	79	BOA	96
SBH	91	CITYUNIB	91	BBK	99
SBM	82	DLAXB	82	BNOVA	98
SBP	89	FEDB	91	BOT	93
SBT	90	HDFC	84	BNPB	89
ALLB	87	ICICI	94	BARCB	79
ANDB	85	INDUSB	85	CITI	66
BOB	88	INGVYSB	78	DBS	91
BOI	89	JKB	90	DEUTB	60
BOM	84	KARB	93	HSBC	71
CANB	91	KVYSB	89	JPMC	88
CENB	82	LVILB	88	OMINB	66
CORPB	92	NAINB	83	SGB	99
DENB	85	RATNB	94	STANCB	72
INDB	83	SOUINB	87		
IOB	88	TAMNB	90		
OBC	92				
PNSB	79				
PNB	88				
SYNB	84				
UCOB	88				
UNIONB	89				
UNITEDB	76				
VIJB	87				
Average	**87**		**88**		**83**

A comparison between Tables 5.9 and 5.10 underscores greater efficacy of the second-generation reforms. Group-wise efficiency comparison, however, shows that every group gets higher efficiency scores for the period of the second-generation reform. The efficiency of PSBs is higher by 8.42 percent, from 80.24 percent for 1994-2012 to 87 percent for 2000-2012; that of PDBs by 13.8 per cent i.e. from 77.3 per cent to 88 per cent for respective periods; and that of PFBs by 3.8 percent, from 79.93 percent to 83 per cent respectively. We note that this comparison is based on the period of second-generation reforms and the entire reform period. Had the comparison be made between two distinct time period of the first and second generation reforms, the gain in X-efficiency would have been much higher.

Bank-wise comparison also brings out higher efficacy of the second-generation reform. Tables 5.9 and 5.10 suggest that all the banks in public sector and private domestic sector, save SBI, have improved their X-efficiency during 2000 - 2012. For banks in the former group, the gain in efficiency ranges in 2-16 per cent, and that for the latter in 6-20 per cent in most of the cases. One bank in the latter category, the CITYUNIB, scores more than 20 per cent gain in efficiency. For the private foreign banks, the scenario is not such encouraging. Out of 15 PFBs, only 6 banks gained efficiency in this period, the gain confining largely to the range of 8-16 per cent. Moreover, as many as 4 such banks, representing more than 25 per cent of the group, suffered from the loss of X-efficiency during the spell of the second-generation reform. By and large, however, this empirical exercise corroborates the proposition that the financial sector reforms since 1998 were more powerful than the earlier measures.

It seems that the results that we have obtained so far (that is, results for 1994-2012 and 2000-2012 based on the MLE methodology, and those for 1994-2012 based on the GLS methodology) are quite different. Notwithstanding the differences in numerical values, as also in ranking, an in-depth study of the results reveals that the banks, which score high values of X-efficiency under the MLE methodology for 1994-2012, also belong to the top echelon of estimated marks in alternative calculations. Table 5.11 justifies this proposition.

Table 5.11: Comparative results of X-efficiency under MLE and GLS methods

	Average X-efficiency: MLE		Total X-efficiency*
Banks	1994-2012	2000-2012	GLS
PSB			
SBI	98	98	79
CANB	88	91	82
OBC	87	92	81
BOI	86	89	80
PNB	86	88	80
UNIONB	85	89	81
PDB			
AXISB	81	88	80
FEDB	82	91	80
ICICI	91	94	100
JKB	81	90	77
KARB	81	93	80
PFB			
ADCOMB	86	84	97
BOA	87	96	79
BBK	98	99	79
BNOVA	95	98	82
JPMC	87	88	88
SGB	98	99	88

NB. It is the sum of variant and invariant X-efficiency.

To begin with the public sector banks, Table 5.11 underlines that, for the period 1994-2012 under MLE, there are six banks (SBI, CANB, OBC, BOI, PNB and UNIONB) which score X-efficiency at 85 per cent and above. Indeed, these are the banks which obtain good scores in other estimations as well, 88-98 per cent under the MLE methodology for 2000-2012, and 79-82 per cent under the GLS methodology. Similarly, for the private domestic banks, the best banks securing efficiency scores at 81 per cent and above (AXISB, FEDB, ICICI, JKB, and KARB) under the MLE for 1994-2012 are seen to have obtained 88-93 per cent scores under the MLE for 2000-2012, and 77-100 per cent under the GLS methodology. For the private foreign banks, our findings are that the top six banks under the MLE for 1994-2012 are ADCOMB, BOA, BBK, BNOVA, JPMC and SGB securing 86-98 per cent X-efficiency. Their scores in other estimations are 84-99 per cent and 79-97 per cent respectively. Notwithstanding these similar results between the MLE methodology and the GLS methodology, we recognise the comparative strength of the former vis-a-vis the latter, and finally accept the results of the former.

From Table 5.9 and 5.10 we may infer that, as there is no significant difference in the performance of the banks, be it a public sector bank or a private bank, the ownership pattern does not affect the overall performance of the banks. A further inference is that the private domestic banks could have improved their performance to a good extent in the second generation reforms – from being the lowest scorer for 1994-2012 to the top scorer for 2000-2012. Possibly, this was due to their policy of performance-linked remuneration scheme, and also the competitive environment in the market.

Section V: Shortcomings of the study

The major shortcomings of the empirical exercise are as follows:

(i) In view of data constraints, this study employs proxy variables relating to costs and various input prices. The results we have obtained are subject to the qualification that the proxy variables can not exactly reflect the real variables.

(ii) The time-span of this study appears not to be long enough to capture the impacts of the financial sector reforms in India. The statistical problems associated with a limited time-frame have been sorted out here by way of employing the panel data. But, in India, reforms have not been undertaken by a one-time policy formulation. Rather, those have been undertaken step-by-step. In fact, some of the reforms took place at the close of our study period. In such circumstances, one should not expect that this study has captured the entire effects of India's financial sector reforms.

(iii) The time constraint has also come in the way of the comparison between the impacts of the first- and second-generation reforms. For the shorter time-span, we have not been able to consider explicitly the effects of the first-generation. What this study has done is to consider the effects of entire reforms (1994-2012), and those of the second generation (1998-2012). The difference between them is taken to represent the effects of the first-generation reforms.

(iv) The study employs a balanced panel data-set for empirical analysis. We are, therefore, constrained to exclude the banks with missing values for one or more variables under study, and also those which did not exist at the beginning of our study period.

It should be noted that this study has not sought to identify the reasons for the existence of X-inefficiency. Leibenstein's X-inefficiency should be searched out, as we have discussed, among the micro-micro units of a firm. The study of aggregates like the present one will not be able to identify the causes for such inefficiency. We suggest that there is a bright scope of study at the firm level for the examination of underlying causes for X-inefficiency among India's commercial banks.

Section V: Conclusion

This chapter thus estimates the X-efficiency among Indian commercial banks by two alternative methods, the GLS and the MLE. In the former methodology, there are two types of X-efficiency, the time-invariant X-efficiency (measured by (α_i) and the time-variant X-efficiency (measured by λ_i). Out of the 57 banks that have been taken into consideration, 30 banks have a positive α_{0i} and the remaining 27 banks have its negative values, indicating that majority of the banks were time-invariant X-inefficient at the beginning of the study. But, given their statistical significance, we conclude that only seven banks were X-inefficient at the beginning of the study period. Those are BOA, UNIONB, VIJB, LVILB, ALLB, SBJ and INDUSB. This list thus includes four public sector banks, two private domestic banks and one private foreign bank. Again, 27 banks are found time-invariant X-efficient (i.e. having negative intercept), but only three of them (SBJ, KARB and BBK) are seen statistically significant. The group-wise analysis of normalised time-invariant X-inefficiency, however, indicates that it is, on the average, 5.22 per cent for PSBs, 6.2 per cent for PDBs and 13.8 per cent for PFBs. As to the time-variant X-efficiency, our findings are that the public sector banks score 72.2 per cent, the private domestic banks 74.5 per cent and the private foreign banks 76.8 per cent.

For the MLE, we have considered two alternative periods, 1994-2012 and 2000-12, so that we understand the overall effects of financial sector reforms, and also the specific effects of the second-generation reforms. This model enables to assess the technical efficiency, *pari passu* with the X-efficiency. In this connection, a comparison of statistical results between 1994-2012 and 2000-2012 confirms that the technical progress contributed to cost reductions in the reform period and also that it was accelerated during the second-generation reforms. For, as against the coefficient of the variable ‘time’ at -0.040 for the entire reform period under study, it is -0.056 for the period of the second-generation reforms. Thus, in respect of cost reduction, technical progress contributed by 5.60 per cent during the second-generation reform, as against 4 per cent during the entire period.

The X-efficiency of the three categories of banks – public sector banks, private domestic banks and private foreign banks - are recorded at 80.24 per cent, 77.3 percent and 79.93 per cent respectively for the entire period, 1994-2012. Taking only the second generation reform period, 2000-12, their X-efficiencies are seen to have increased to 87 per cent, 88 per cent and 83 per cent respectively. Bank-wise comparison between these periods, however, suggests that, during the second generation reforms, all the banks (save SBI) in the public banking sector gain in X-efficiency. The highest gain is for the VIJB at 14.5 per cent, and the least is for the PNB at 2.32 per cent. The same is true for the private domestic sector, where we find the efficiency gain ranging from 3.3 per cent for the ICICI bank to 21.3 per cent for CITYUNIB. For the private foreign banking sector, however, there are mixed results. The X-efficiency score is seen lower for some of them during the second generation reforms – such as the ADCOMB (by 2.3 per cent), the BARCB (2.5 per cent), the DBS (7 per cent) and the OMINB (7.1 per cent). On the other hand, the gainers in this group are the CITI bank (20 per cent), followed by the BOT (15 per cent) while the least gainer is the BBK (1.02 percent).

Comparing the alternative methods of analysis of efficiency, MLE and GLS, and also two alternative periods for MLE, we find that bank-wise variations prevail among them. A broad agreement is, however, noticed among them at the group level for the most efficiency banks. In fact, the best six banks in the public sector under the MLE for 1994-2012 are also found to have scored high in other two estimations. Similar results are obtained for five banks in the private domestic sector in the MLE estimates for 2000-12 and six banks in the GLS estimates. In view of the inherent problems of the GLS methodology – such as the loss of information due to their transformation and two stages of regression, we rely on the MLE methodology for final judgement.

Chapter VI

SUMMARY

Chapter one introduces the subject matter of the thesis, measurement of X-efficiency among India's commercial banks after 1991, in three perspectives. The foremost one is the importance of financial sector reform in overall economic development this discussion points out the issue of efficiency. The second one is what types of banking sector reforms had been introduced in different phases since 1991. The discussion here also indicates the question of efficiency in India's policy formulation. The third one relates to various concepts of efficiency that are frequently discussed in the literature.

The question of financial sector efficiency in economic development has been discussed on the basis of Adam Smith's concept of division of labour. We have stressed that, notwithstanding the neo classical perception about the neutrality of money in the functioning of the real sector, Pattinkin's treatment of macroeconomic variables has established a close relationship between the real and monetary sector, which Keynes has further strengthened. Our further discussion in this field shows that the present literature advocates two important lines of argument in support of the relationship between finance and economic development. One, based on the circular flow of income in an economy, Schumpeter argues that economic stagnation can be broken only through the development of financial intermediaries. Two, taking que from Adam Smith's concept of division of labour, Gurley and Shaw discusses how the perpetuation of division of labour between the 'deficit' and the 'surplus' units in the society promotes higher economic growth. For the economic prosperity therefore, the importance of financial sector development has been theoretically established. We have also sought to empirically establish this relationship on the basis of cross country data from UNDP sources in 2013. A further issue of discussion in this context is the line of causation between economic development and financial sector development. In this context we have discussed the views of Patrick, Levine and King, and Levine. This deliberation on the literature however confines that an efficient financial sector is sine qua non for the economic prosperity.

Broadly speaking there had been two types of reformative measures in India’s banking sector since 1991, both of which targeted at enhancement of efficiency. The first set of reforms had sought to enable, commercial banks to properly utilise their mobilised funds for reducing CRR and SLR, rationalisation of the private sector lending, proper development of the government security market etc belong to this category. The other set of reforms had sought to introduce market forces in banking industry so that the efficiency is augmented under the pressure of competition. We have discussed that the privatisation of the nationalised commercial banks, the free entry of private domestic and foreign banks had been most important measure in this field. We have also argued that new accounting practices in banking, classification of assets, the ruling in the capital adequacy ratio etc belong to this category in so far as these measures had enabled the rationalised commercial banks to get privatised. These reformative measures corroborate the idea that India’s policy makers had sought to bring in efficiency amongst the commercial banking institutions. This justifies the central question of the present thesis: had the efficiency of Indian commercial banks improved in the post reform period?

On the question of various concepts of efficiency, the literature embodies several concepts namely allocative efficiency, scale efficiency, scope efficiency and X-efficiency. The present thesis however deals only with the X-efficiency. Without disputing against other sources of efficiency, we have adopted the measure of X-efficiency for two basic reasons (i) the question of competition in the context of efficiency is better measured by the concept of X-efficiency and (ii) there are less study in this field in Indian context.

The various concepts of efficiency prior to 1966 are related with technology – the allocative efficiency referring to proper combination of inputs (i.e. appropriate technology) the scale efficiency (to the appropriate scale of production) and the scope efficiency (to the existence of technical scale additives in production. Leibenstein has first introduced the concept of efficiency on the basis of subjective factors. Before the application of his concept of X-efficiency, chapter two has sought to clarify various aspects of this concept. To do so this chapter has sought to find out its genesis. Its genesis has however been found in Hicks Quite Life Hypothesis (QLH) and Bain's Structure Conduct Performance Paradigm (SCPP). This chapter first discusses these two hypothesises along with the concept of X-efficiency detail and then identifies their inter relationship. The QLH argues that in many cases, a monopolist does not seek to maximise his profit by sticking to MR=MC principle. The deviation from MR=MC point is explained by subjective factors, especially his pleasure for quite life. Thus while taking up the decision, the monopolist takes into account his subjective pleasure in addition to monetary revenue and also the pains to account for cost. He may thus strive for the equality between 'emotional' MR and 'emotional' MC, which indeed represents a rational choice for him. In other words the deviation from conventional MR=MC represents undoubtedly financial inefficiency, but is a case of 'rational inefficiency'.

Bain's Structure-performance hypothesis also discusses the question of efficiency. The underlying tone in the hypothesis is how efficiency is guided by the scale of operation, the pricing policies and the competitive forces. He argues that the barriers to entry enable individual firms to expand their scale, and thus, raise the concentration of a market. But the question is: Are bigger firms more efficient than smaller ones? We note here that Bain defines such efficiencies – as generated through the expansion of scale – as the technical efficiency in the sense of optimal use of resources. This line of argument he juxtaposes against an alternative hypothesis: that smaller firms are more efficient. The theoretical underpinning is that greater competition compels the firms to make all-out efforts to raise productivity – and, hence, more efficient. To Bain, it is the allocative efficiency. Two opposite forces thus prevail in the domain of efficiency: a) the allocative efficiency, varying inversely with the degree of concentration in an industry; and b) the technical efficiency, varying directly with the degree of concentration.

The central theme of Leibenstein's X-efficiency is to account for in/efficiency in terms of subjective factors prevailing at different layers of the organisation. His X-efficiency theory seeks to identify the subjective factors that affect the performance of the individuals associated with the organisation, and, in so doing, the theory analyses how they affect the performance of the firm. Another unique feature of the theory is the shift of focus from the micro level of the firm to its micro-micro level dealing with the individuals. The X-efficiency theory attributes efficiency to psychological factors and tries to understand the black box of the human mind and how it affects performance. His theory deviates from the traditional theory of efficiency on the ground of selective rationality and questions the existence of a rational economic man. X-efficiency is determined by three forms of motivation, inter plant motivation, intra plant motivation and non market input efficiency. The factors that perpetuate X-inefficiency are firstly the production function which is not known with surety, labour contracts that are not extensive to seal out inefficiency and factors inherent in the individual that cannot be marketed. He says that every individual that makes up the organisation comes with his Activity, Pace, Quality and Time bundle which decides the inert area of the individual. The equilibrium of the individual takes place at the point where every individual in the organisation is in his/her inert area. The prevalence of this situation ultimately leads to entropy which is regarded as the death of the organisation.

All three hypotheses have one thread in common - the prevalence of inefficiency in an organisation. The concept of inefficiency, however, varies across them; so also their interpretations. In Hicks' Quite Life, a monopolist is regarded inefficient as he does not produce at the optimal level of MR=MC. If we analyse this stand of the monopolist from a micro perspective, we can see that the monopolist makes a rational decision as it is based on the equality of his emotional MR and his emotional MC.

The undertone of Bain's SCPP analysis is that a monopolist may be inefficient from the viewpoint of resource allocation although he might be enjoying technical efficiency. Thus, from the monopolist's standpoint, the organisation is efficient, but it is inefficient in the sense it involves wastage of resources. On the other hand, a competitive firm is surely efficient from the macro viewpoint as there is no wastage of resources for a firm operating at the lowest point of the long run average cost curve; but it is not efficient as he cannot enjoy profit as high as a monopolist. Both these firms are inefficient – a monopolist from the welfare viewpoint, and a competitive firm from the individualistic viewpoint.

Leibenstein's X-efficiency theory goes further in-depth - from the micro level to the micro-micro level of an organisation. He analyses inefficiency as a motivational deficiency. An Individual in an organisation maintains his position of inefficiency as he feels that a movement from this position entails costs much higher than benefits that might accrue to him. Thus, what is inefficient from the view point of an organisation is rational for an individual. However, if everyone in the organisation remains static in their own comfort zone, it will ultimately lead to entropy. According to Leibenstein, the only way to get out of this sluggish position is to introduce competition in the system. Thus, Leibenstein's comfort zone is similar to what Hicks considers 'the quiet life'. What Hicks identifies as plausible factors contributing to 'the quiet life' are discussed at length by Leibenstein while deliberating on the comfort zone. The subjective issues are also there in Bain, *albeit* in an implicit tone, especially when he discusses 'wisdom' as an explanation for technical efficiency.

The third chapter in the thesis reviews the literature belonging to the field of efficiency measurement, especially the measurement of the X-efficiency, in banking and other sectors. With the advancement in the method of measurement of efficiency there are two competing methodologies, namely the Deterministic methodology represented by Data Envelopment Analysis (DEA) and the Econometric Method represented by the Stochastic Frontier Approach (SFA) or the Econometric Frontier Approach (EFA). The former one was developed by Charnes Cooper and Rhodes in 1978. This method measures the efficiency of a decision-making unit as the ratio of weighted outputs and inputs. This method is, however, appropriate only under condition of constant returns to scale.For variable returns to scale, the Banker Cooper Rhodes method is available. But as the method is deterministic, and hence, there is no room for stochastic element, it is not adept to measure X-efficiency which is attributed to factors beyond that which is marketed.

The econometric method belonging to the stochastic frontier approach was developed by Aigner Lovell and Schimidt, and Mauseen and van den Boreck simultaneously in 1977. The method assumes that the stochastic component, as represented by the error term, comprises of white noises and an inefficiency component. The breaking up of the composite error term is done following the Jondrow-Lovell-Schimidt-Materov (JLSM)method which is a two step process. An improvement over the two step process of JLSM is Battese-Coellie's single-step procedure, proposed in 1995, where the explanatory variables are included in the inefficiency term.

The use of stochastic frontier method requires the use of a production function. The productions that are at our disposal are the Cobb-Douglas production function, CES production function, Translog Production function, Hybrid translog production function and the Fourier Flexible production function. The Cobb-Douglas production is the most simple and was used in early efficiency studies. The Cobb-Douglas production function and the CES production function are monotonic in nature, and therefore, can generate only increasing, decreasing or constant returns to scale. Moreover, those functions are capable of analysing only a single-product firm. Because of these, the recent studies use extensively the Translog production and the Fourier flexible form, both of which can deal with multi-product firms with variable return to scale.

The studies under review are grouped in two categories: one includes the studies pertaining to efficiency measurement of banks outside India; and the other includes those functioning in India. Most of the studies outside India are from America and Europe. These studies deal mostly with technical efficiency using both SFA and DEA. Our review has taken into account20 studies in the SFA methodology and 18 studies in the DEA methodology pertaining to the measurement of banking efficiency in India and abroad.

The treatment of the banks as a producer or an intermediary determines the input- and output- vectors that should be considered in a model. In the studies relating to SFA, the banks are mostly treated as intermediary and the input vector includes labour, capital and purchased fund. The dominant outputs in those models are loans and advances, deposits and investments.

The findings of the empirical studies do not reach at any consensus. The empirical studies relating to banking practices in European and American countries discuss mainly technical efficiency, which is governed by market power, manager's ability, scale of operations and deregulation. In the case of Indian banks, the studies primarily relate to the effects of ownership on the efficiency and how the banks' performance has been changing after the financial sector reforms.

The fourth chapter of the thesis describes the methodology of stochastic frontier analysis and the dataset that has been used. We discuss two methodologies under stochastic frontier process: (i) Generalised Least Squares estimation (GLS) and (ii) Maximum Likelihood Estimation (MLE). The GLS method is discussed in line with here in line with what Kmenta suggests. It differs from the OLS estimation in that it does not rely on the assumptions of homoskedacticity and the absence of autocorrelation. The panel data that have been adopted in this study are very often characterised by heteroskedacticity and autocorrelation. Hence, in the GLS, those are corrected before the ordinary least square process is applied. The methodology then seeks to decompose the residuals into white noises and an inefficiency term. This methodology thus involves two-stage estimations: (a) derivation of residuals in the first stage, and (b) decomposition of the residuals in the second stage. In the second stage, however, the residuals are regressed on the variable ‘time’ so that we obtain time variant X-in/efficiency, time invariant X-in/efficiency and the white noise term.

Since the GLS method suffers from some drawbacks, this study has also adopted the maximum likelihood estimator (MLE) using the ‘sfa’ package from R statistical environment. The MLE method is not affected by heteroskedacticity and hence we need not check for the same. The application of alternative methodologies enables us to make a comparative study on their results.

This thesis has adopted the translog cost function to analyse the behaviour of banks. On the consideration of banks providing intermediary services, the output vector includes: (a) loans and advances, and (b) investment, and the input vector is composed of (a) the price of capital, (b) the price of fund, and (c) the wage rate.

The time period of the empirics in this thesis spans over 1994-2012. It has been so chosen that we can account for the effects of the first- and second-generation reforms initiated in 1991 and 1998 respectively. Of all the banks that are present in India, we have taken 57 banks comprising of 25 public sector banks, 17 private domestic bank and 15 private foreign banks. For the purpose of estimation, however, the banks with missing values for one or more variables are not taken into consideration. Moreover, as we use the balanced panel, banks that did not exist in 1994 are ignored.

On the basis of paid-up capital, employment, number of branches and deposits, a comparison among three categories of banks reveals that public sector banks were the leaders in all four categories, followed by private domestic banks and private foreign banks. However, the average cost of operation was the least for private foreign banks, followed by private domestic banks and public sector banks. The wages per employee are seen highest for private foreign banks, followed by public sector banks and private domestic banks. The price of capital is also found highest for private foreign banks but it is the least for public sector banks. For price of fund, however, least variation is noticed across them.

The use of panel data requires the verification of the unit root problem. This study has adopted the Augmented Dickey Fuller (ADF) test and the Levin-Lin-Chu test (LLC) for panel data. The former test, indeed, rejects the presence of a unit root for all the variables under consideration. But it should be noted that although this test is widely used, it overlooks the panel structure, and, thus, fails to appropriately verify stationarity in case of panel data. The LLC is a good substitute for ADF in case of panel data. By applying the LLC also, however, we reject the null hypothesis of the presence of unit root. The heteroskedacticity test has not been conducted as the application of GLS requires the correction for heteroskedacticity and MLE is not affected by the same.

The study adopts Kmenta's GLS method in the study. The first step of this method corrects the presence of autocorrelation, and in the second step, heteroskedacticity is corrected. After applying the OLS method of estimation for the panel data set, the residuals are saved. The residuals, thus saved, are regressed on their lag values to obtain the estimated slope parameter (ρ_i), which is used to correct for autocorrelation. The OLS is again run on the transformed variable that has been corrected for autocorrelation. The variance estimated from the error term in this step is used for correcting heteroskedacticity. After the data have thus been corrected twice, we run a simple OLS. These represent Kmenta's GLS method. Now, we again save the errors of the GLS method under the belief that X-inefficiency is contained in the error term. Those errors are further regressed on time to break them into time variant X-efficiency and time invariant X-efficiency.

Out of the 57 banks, 30 banks have positive intercepts, and 27 banks have negative intercepts. The coefficient of the intercept value represents the time invariant X-efficiency. Of the 30 banks with positive intercepts, 13 banks are found to be significantly X-inefficient in the beginning of the study. They are SBI, BOB, DENB, INDB, IOB, UCOB, UNITEDB, JKB, SOUINB, BNOVA, CITI, JPMC and STANCB. Six banks (CITYUNIB, DLAXB, KVYSB, NAINB, RATNB and DBS) are found to be time invariantly X-efficient i.e. with a negative significant intercept. Moreover, it has been found that, over the period of the study, 10 banks improved their efficiency level, i.e. those with negative significant slope coefficient. Those are: SBI, BOB, IOB, UCOB, UNITEDB, ICICI, CITI, DEUTB, JPMC and STANCB. On the other hand, banks like HDFC, NAINB, TAMNB, BNP, BARCB and DBS became X-inefficient over this period. The normalised value of the intercept and slope reveal that BOT was the most X-efficient time invariantly while ICICI was most X-efficient time variantly.

The average efficiency scores of the three banks types of banks did not show much of a distance in their score. The highest is scored by the PFB at 76.8, followed by PDB at 74.5 and the least is by PSB at 72.2. If we look at individual scores for PSBs, it appears that the majority of the banks have a score above 70 per cent, while in case of PFBs, the variation is large - ranging from 60 percent to 100 per cent.

But these inferences are subject to the qualification that they involve a number of estimated parameters, which are statistically doubtful in view of their low t-values.

For quite a large number of banks, then, our inferences are inconclusive. These empirical aspects motivate us to use the MLE method in our study.

We use the Battesse-Collie method (1992) to measure the X-efficiency. The estimation is done by the maximum likelihood method rather than the OLS. The MLE is not affected by heteroskedacticity, and hence, is best suited for panel data that very often suffers from the problem of heteroskedacticity. The conventional translog cost function is modified in this method to incorporate the trend component. The trend, representing technological changes, interacts with all variables in the model. This study has considered the trend variable to assess whether technological changes influence the banks' efficiency. Looking at the methodology from this viewpoint, we infer that error terms in this model contains X-efficiency (rather than technical efficiency) and white noises.

The MLE is run for two time periods: a) 1994-2012 and b) 2000-2012. The former represents the entire reform period while the latter, only the period of second generation reforms. The MLE is also run with intercept and without intercept. The logic for the latter is that the suppression of the intercept will increase the power of explanation for the arguments under consideration. However, the estimated values of parameters for the model with intercept are more significant than those for the alternative. Therefore, we rely on its results.

The results of the estimation with the intercept reveal that there are 12 positive coefficients, associated respectively with Q_1, Q_2, r_3, $trend$, SqQ_1, Q_1Q_2, Q_1r_2, Q_1r_3, Q_2Trend, r_1r_3, r_3Trend and r_2Trend, and 17 negative coefficients, associated with α_0, r_1, r_2, SqQ_2, Sqr_1, Sqr_2, Sqr_3, $SqTrend$, Q_1r_1, Q_1Trend, Q_2r_1, Q_2r_2, Q_2r_3, r_1r_2, r_2r_3, r_3Trend and $time$. The negative sign of time component represents technological progress. It indicates that the cost frontier is shifting inwards due to technological advancements, and hence, signifies an increase in the technical efficiency over the period of study. However, the estimated coefficient of the trend component reveals that the overall efficiency of the banks has decreased, belying the expectation of the reforms. On the basis of a comparison of the estimated coefficients of time component for the first and second generation reform, this study also suggests that the second generation reform generated more cost efficiency than the first generation reform.

We, however, save the error component in this model as well to break it down into its constituent parts comprising of efficiency and pure white noise. The efficiency scores are estimated using Jondrow-Lovell-Materov-Schimidt (JLMS) method and the Farrell's distance formula. In the latter, the highest score for the most efficient bank is unity.

. The average efficiency scores for three groups of banks reveal that the most efficient group is the public sector banks with a score of 80.24 per cent, followed closely by the private foreign banks at 79.93 per cent and the private domestic banks at 77.3 per cent. Of the total 57 banks in the study, it is found that six banks, namely SBI, ICICI, BBK, BNOVA, DBS and SGB, belonged to the efficiency category of 90-99 per cent. To the category of 80-90 per cent belong 23 banks, SBH, SBP, SBT, ALLB, BOB, BOI, CANB, CORPB, IOB, OBC, PNB, UCOB, UNIONB, ADCOMB, BOA, BOT, BNP, BARCB, JPMC, AXISB, JKB, FEDB and KARB. Another 20 banks get the efficiency score of 70-80. Those are SBH, SBM, ANDB, VIJB, BOM, PNSB, SYNB, CENB, DENB, INDB, DLAXB, INDUSB, CITYUNIB, HDFC, INGVYSB, KVYSB, LVILB, NAINB, RATNB, SOUINB, TAMNB and OMINB. Among the remaining banks, four banks (UNITEDB, CATSYRB, HSBC and

STANCB) are found in the slab of 60-70 per cent and two banks (CITI and DEUTB) in the lowest rung of 50-60.

Similar analysis for the period 2000-2012 showed that the average efficiency scores of all the banks are than the respective scores for the entire period 1994-2012. The PSB scored 87 per cent (as against 80.24 per cent for 1994-2012), the PDB 88 per cent (as against 77.3 per cent for 1994-2012) and the PFB 83 per cent (as against79.93 per cent for 1994-2012). Bank-wise comparison between these estimates suggests that the PSBs have registered an increase of 2 – 16 per cent, and the PDBs 6-20 per cent. In the case of PFB, six banks have gained efficiency ranging by8-16 per cent while the others experienced a fall in efficiency.

Finally, the comparison between the GLS and the MLE methods indicate that notwithstanding numerical differences, the results are similar insofar as the category of most efficient banks in each category is concerned.

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Annexure 1: Bank Code

Sl No	Bank Code	Name of Bank
1	SBI	State Bank of India
2	SBJ	State Bank of Bikaner and Jaipur
3	SBH	State Bank of Hyderabad
4	SBP	State Bank of Patiala
5	SBM	State Bank of Mysore
6	SBT	State Bank of Travancore
7	ALLB	Allahabad Bank
8	ANDB	Andhra Bank
9	BOB	Bank of Baroda
10	BOI	Bank of India
11	BOM	Bank of Maharashtra
12	CANB	Canara Bank
13	CENB	Central Bank
14	CORPB	Corporation bank
15	DENB	Dena Bank
16	INDB	Indian Bank
17	IOB	Indian Overseas Bank
18	OBC	Oriental Bank of Commerce
19	PNSB	Punjab and Sind Bank
20	PNB	Punjab National Bank
21	SYNB	Syndicate Bank
22	UCO	UCO bank
23	UNIONB	Union Bank
24	UNITEDB	United Bank
25	VIAYAB	Vijaya Bank
26	AXISB	Axis Bank
27	CATSYRB	Catholic Syrian Bank
28	CITYUNIB	City Union Bank
29	DLAXB	Dhanalakshmi Bank
30	FEDB	Federal bank
31	HDFC	HDFC Bank
32	ICICI	ICICI Bank
33	INDUSB	Indus Ind Bank
34	JKB	Jammu and Kashmir Bank
35	KARB	Karnataka Bank
36	KVYSB	Karur Vysa Bank
37	LVILB	Laxshmi Vilas Bank
38	NAINB	Nainital Bank
39	RATNB	Ratnakar Bank

Sl No	**Bank Code**	**Name of Bank**
40	SOUINB	South Indian Bank
41	TAMNB	Tamilnad Mercantile Bank
42	VYSB	ING Vysa Bank
43	ADCOMB	Abu Dhabi Commercial Bank
44	BOA	Bank of America
45	BBK	Bank of Bharain and Kuwait
46	BNOVA	Bank of Nova Scotia
47	BOT	Bank of Tokyo
48	BNP	Banque Nationale de Paris
49	BARCB	Barclays Bank
50	CITI	CITI Bank
51	DBS	Development Bank of Singapore
52	DEUTB	Deutsche Bank AG
53	HSBC	Hong Kong Shanghai Bank of Commerce
54	JPMC	JP Morgan Chase Bank
55	OMINB	Oman International Bank
56	SGB	Societe Generali Bank
57	STANCB	Standard Chartered Bank

Annexure 2: Datasetfor Public Sector Banks (Rs.Lakhs)

Year	Banks	Total cost	Q1	Q2	Price of Labour	Price of Fund	price of capital
1994	SBI	921360	4149824	3742335	0.859143	0.075751	0.463023
1995	SBI	1029859	4853021	4167375	1.137944	0.071155	0.431174
1996	SBI	1268546	5982565	4381898	1.438948	0.075429	0.346769
1997	SBI	1419610	6223320	4682756	1.406805	0.081517	0.294486
1998	SBI	1519409	7423733	5498224	1.484567	0.075247	0.252204
1999	SBI	1894107	8235984	7128652	1.746244	0.073234	0.193991
2000	SBI	2156775	9810197	9187869	1.918268	0.074103	0.190227
2001	SBI	2605440	11359027	12287649	2.798134	0.070028	0.202229
2002	SBI	2793974	12080647	14514203	2.460007	0.074062	0.233825
2003	SBI	2905188	13775846	17234791	2.721902	0.069115	0.268686
2004	SBI	2851949	15793354	18567649	3.114239	0.058046	0.273381
2005	SBI	2855755	20237446	19709791	3.360996	0.047856	0.295198
2006	SBI	3211553	26180093	16253424	4.086571	0.04965	0.325652
2007	SBI	3400765	33733649	14914888	4.278914	0.046681	0.352418
2008	SBI	4453768	41676820	18950127	4.344672	0.054197	0.383918
2009	SBI	6764116	63191415	29578520	6.194705	0.052167	0.360209
2010	SBI	7188340	75671940	29560060	68.23395	0.046386	0.376661
2011	SBI	8929940	86757890	31219760	7.877261	0.054013	0.377829
2012	SBI	10461020	1.05E+08	35092730	8.051346	0.054905	0.348151
1994	SBJ	43098	177586	151446	0.7029	0.082009	0.474384
1995	SBJ	48072	210018	179105	0.866561	0.072647	0.450729
1996	SBJ	60015	244748	187236	1.178818	0.074565	0.504524
1997	SBJ	70784	301182	228177	1.228825	0.084824	0.423492
1998	SBJ	81757	366048	282716	1.426293	0.080895	0.418356
1999	SBJ	96533	384082	380170	1.676954	0.080791	0.232976
2000	SBJ	109817	440111	484551	1.796454	0.080965	0.272485
2001	SBJ	123768	516813	532473	2.450343	0.078173	0.312626
2002	SBJ	126765	593133	630496	2.174528	0.074221	0.349646
2003	SBJ	133726	677333	768200	2.420319	0.065477	0.346491
2004	SBJ	138373	859655	843002	2.762218	0.05272	0.36882
2005	SBJ	149435	1203619	836249	3.426898	0.044366	0.369613
2006	SBJ	173265	1589580	793247	4.087187	0.042472	0.343819
2007	SBJ	218817.6	2052622	873535	4.056778	0.048417	0.438168
2008	SBJ	286249.8	2507594	1049836	3.913405	0.060066	0.42726
2009	SBJ	365616	3517639	1360051	4.386922	0.056404	0.387181
2010	SBJ	429600	4120670	1352070	7.226494	0.053227	0.400334
2011	SBJ	540080	4924430	1666950	6.371833	0.063074	0.458684
2012	SBJ	651160	5753500	2014590	7.696205	0.06327	0.424557
1994	SBH	49419	240772	180075	0.731038	0.06891	0.423423
1995	SBH	58450	330297	202218	0.893188	0.06579	0.352528
1996	SBH	75397	387616	215525	1.249091	0.077507	0.339265

1997	SBH	87237	404100	293092	1.268825	0.082537	0.357538
1998	SBH	91859	463019	369460	1.374308	0.07402	0.308795
1999	SBH	114320	533197	591086	1.914671	0.070754	0.339553
2000	SBH	133748	608758	701022	1.701696	0.075714	0.333399
2001	SBH	153347	709149	875811	2.420256	0.072481	0.355213
2002	SBH	168356	842259	982789	2.101736	0.072574	0.365283
2003	SBH	177091	966260	1251867	2.292645	0.062788	0.373081
2004	SBH	190616	1181368	1501705	2.57102	0.054681	0.293908
2005	SBH	203350	1559974	1455940	3.030594	0.045812	0.356168
2006	SBH	247069	2086302	1425601	4.053479	0.047735	0.310508
2007	SBH	294303.7	2810925	1391916	3.818782	0.050948	0.323243
2008	SBH	408910.5	3584875	1602715	3.661655	0.064443	0.378297
2009	SBH	158634	5282484	2400852	4.390194	0.012644	0.024872
2010	SBH	651560	6472030	2844670	7.030721	0.053268	0.210729
2011	SBH	901800	7705230	2924180	7.653394	0.069546	0.271148
2012	SBH	1063500	8985650	3396800	9.380384	0.071817	0.368254
1994	SBM	32798	137122	115958	0.715829	0.077131	0.67253
1995	SBM	36177	179483	126728	0.794969	0.067569	0.677988
1996	SBM	47477	203885	138662	1.202604	0.073804	0.536713
1997	SBM	55709	240685	177918	1.283163	0.079336	0.511735
1998	SBM	58243	263199	191152	1.377106	0.078364	0.551794
1999	SBM	69670	298609	228293	1.642158	0.076456	0.569164
2000	SBM	80161	349510	302620	1.954287	0.073022	0.610321
2001	SBM	94849	428671	355032	2.816431	0.077271	0.624478
2002	SBM	96959	491450	415884	2.446121	0.076226	0.652018
2003	SBM	97824	526067	476057	2.547983	0.069585	0.644816
2004	SBM	97256	630672	548670	2.735376	0.053374	0.426395
2005	SBM	110214	878125	579619	3.457445	0.044807	0.465199
2006	SBM	124458	1175416	569352	3.038292	0.043366	0.31237
2007	SBM	165513.5	1646554	698975	3.285401	0.047492	0.332126
2008	SBM	234900.6	2102715	840276	3.472845	0.059331	0.54695
2009	SBM	304724	2953586	1149441	4.324889	0.056431	0.097928
2010	SBM	336050	3402980	1292710	5.524884	0.052502	0.117007
2011	SBM	453520	3983530	1473270	6.055225	0.063981	0.227382
2012	SBM	523010	4493260	1677460	5.936573	0.067824	0.119131
1994	SBP	45561	220609	166417	0.617309	0.071838	0.391902
1995	SBP	52333	276815	210452	0.805656	0.065945	0.444444
1996	SBP	69234	330486	217060	1.078905	0.073177	0.438639
1997	SBP	80342	378713	266224	1.176235	0.079586	0.354873
1998	SBP	82988	410542	295087	1.378853	0.075439	0.329924
1999	SBP	89600	481362	358941	1.453311	0.070454	0.370968
2000	SBP	98451	577541	452388	1.604482	0.067851	0.349511
2001	SBP	111538	683339	424011	2.410918	0.063786	0.307234
2002	SBP	120445	867879	570496	2.094204	0.060089	0.358115
2003	SBP	136961	1074640	812206	2.250901	0.053247	0.284697
2004	SBP	151496	1308634	1111022	2.408515	0.046408	0.290094

2005	SBP	163596	1535927	1231241	2.536352	0.042763	0.340197
2006	SBP	207642	2218002	1267811	3.278238	0.04182	0.282317
2007	SBP	271822.1	2876976	1235766	3.530974	0.050327	0.377644
2008	SBP	412660.7	3640004	1437481	3.4406	0.066445	0.3335
2009	SBP	534200	4634723	1816511	4.404487	0.065335	0.373817
2010	SBP	547440	5143320	1727460	0.701489	0.05665	0.421961
2011	SBP	710930	6293450	2204290	6.115081	0.064019	0.302801
2012	SBP	870370	7379980	2395670	6.645197	0.072948	0.419619
1994	SBT	47922	224668	166886	0.660812	0.08921	0.411622
1995	SBT	58253	312641	180994	0.851375	0.085538	0.38479
1996	SBT	74362	334916	187963	1.068456	0.097078	0.344
1997	SBT	88234	365930	262621	1.286143	0.100883	0.362292
1998	SBT	93059	400082	330078	1.161315	0.093964	0.356643
1999	SBT	102154	425190	438401	1.309506	0.088854	0.429515
2000	SBT	117198	513121	487158	1.709874	0.085668	0.403339
2001	SBT	127938	639750	545262	2.275468	0.079259	0.342089
2002	SBT	136280	743551	637215	2.018621	0.076123	0.396024
2003	SBT	142960	917066	803873	2.244065	0.066454	0.431438
2004	SBT	150897	1113243	1077808	2.638128	0.052847	0.356257
2005	SBT	161479	1484834	1059212	2.853737	0.045843	0.415903
2006	SBT	197585	1886640	1063000	3.477581	0.04946	0.300838
2007	SBT	234367.9	2462989	971809	3.721146	0.051645	0.345152
2008	SBT	316376.7	2813662	1135295	3.638477	0.064833	0.408815
2009	SBT	393381	3846126	1584439	5.412582	0.055011	0.367715
2010	SBT	463400	4604420	1792700	5.96847	0.055298	0.38907
2011	SBT	622830	5534600	2243760	6.25387	0.063209	0.447596
2012	SBT	793680	6748360	2722550	7.064271	0.069686	0.41949
1994	ALLB	94026	372216	382518	0.690752	0.080118	0.125175
1995	ALLB	102656	419153	379826	0.858063	0.076232	0.211983
1996	ALLB	113909	481560	427123	1.113715	0.071686	0.228847
1997	ALLB	127492	493790	526754	1.155315	0.075241	0.118741
1998	ALLB	139740	572392	646233	1.207202	0.071663	0.097038
1999	ALLB	157007	698480	716106	1.458895	0.070858	0.107408
2000	ALLB	181689	824006	822061	1.659028	0.072467	0.120852
2001	ALLB	204435	958270	871913	2.288162	0.068723	0.123799
2002	ALLB	224977	1099250	1035803	2.479607	0.067867	0.133404
2003	ALLB	257887	1254360	1237172	2.631309	0.065102	0.144819
2004	ALLB	254223	1534154	1555482	2.899243	0.05002	0.165189
2005	ALLB	289171	2115083	1898827	3.597505	0.044546	0.116518
2006	ALLB	322554	2914777	1798466	3.559632	0.045107	0.150341
2007	ALLB	416035.3	4129003	1874607	3.045865	0.052393	0.117264
2008	ALLB	565646.3	4972047	2340025	3.435831	0.061286	0.126863
2009	ALLB	660550	7160487	3842862	4.272075	0.046695	0.157869
2010	ALLB	933050	9362490	4324710	7.337824	0.050374	0.153754
2011	ALLB	1305200	11114510	5428320	8.213934	0.061419	0.193204
2012	ALLB	1552740	12948970	5830590	8.803919	0.066561	0.219816

1994	ANDB	54735	193243	204165	0.656237	0.074177	0.326556
1995	ANDB	63909	240981	232605	0.916147	0.070925	0.262915
1996	ANDB	68522	258033	262171	1.093516	0.072846	0.305848
1997	ANDB	79807	290734	333885	1.235763	0.07486	0.305764
1998	ANDB	87725	329627	394662	1.327799	0.074555	0.355306
1999	ANDB	104348	452393	495161	1.623045	0.067593	0.386364
2000	ANDB	138390	557360	762606	1.786962	0.070402	0.339853
2001	ANDB	183097	742317	988552	2.647211	0.074425	0.288799
2002	ANDB	190847	967772	841926	2.433968	0.077739	0.337664
2003	ANDB	204383	1151294	1051765	3.054499	0.065392	0.278168
2004	ANDB	197514	1288547	1031735	3.12646	0.055361	0.35047
2005	ANDB	204240	1751684	1064629	4.116036	0.042508	0.437313
2006	ANDB	236410	2210043	1144416	3.513616	0.043429	0.486329
2007	ANDB	283097.2	2788907	1430072	4.227737	0.044985	0.402036
2008	ANDB	377908.5	3423839	1489824	3.805108	0.057369	0.403347
2009	ANDB	485197	5611351	2088100	4.377832	0.044861	0.284063
2010	ANDB	677520	7143540	2420400	7.832317	0.050807	0.318205
2011	ANDB	938360	8364180	2962890	7.615736	0.066432	0.404825
2012	ANDB	1118990	9837330	3763240	7.789142	0.067841	0.479736
1994	BOB	232506	1265148	763072	0.859491	0.072931	0.155552
1995	BOB	260567	1478421	851170	1.096189	0.066703	0.117217
1996	BOB	311910	1601255	959471	1.197333	0.076062	0.133118
1997	BOB	344396	1653163	1092717	1.32422	0.078525	0.149106
1998	BOB	390815	1980349	1335894	1.607837	0.07165	0.16714
1999	BOB	445444	2109153	1590533	1.829606	0.072024	0.182757
2000	BOB	480994	2439291	1855650	1.905152	0.067857	0.19618
2001	BOB	542715	2742068	1985712	2.471376	0.069545	0.23747
2002	BOB	563945	3366299	2383313	2.715391	0.065221	0.210824
2003	BOB	564263	3534808	3017938	2.799568	0.059622	0.235631
2004	BOB	538078	3560088	3801879	3.146798	0.04842	0.20523
2005	BOB	543433	4340038	3707445	3.493764	0.041605	0.200532
2006	BOB	625984	5991178	3511423	3.929927	0.039355	0.204859
2007	BOB	797087	8362087	3494363	4.25879	0.043048	0.20696
2008	BOB	1093596	10670132	4387007	5.109404	0.050664	0.107453
2009	BOB	1354423	17503529	6118238	6.443835	0.03915	0.132119
2010	BOB	1771350	22867640	7139660	7.405865	0.03992	0.131261
2011	BOB	2451540	28737730	8320940	7.203416	0.047391	0.177536
2012	BOB	2982810	32818580	12139370	8.002227	0.047719	0.213526
1994	BOI	205557	1092212	729538	0.786026	0.066885	0.160854
1995	BOI	233261	1220755	899535	1.06843	0.060592	0.17225
1996	BOI	283734	1559580	958396	1.216556	0.066318	0.153746
1997	BOI	342405	1833686	1067100	1.340201	0.071	0.20283
1998	BOI	381857	2202072	1303031	1.467021	0.064825	0.132648
1999	BOI	445929	2432702	1528200	1.741418	0.067087	0.149532
2000	BOI	483954	2523105	1666577	1.905699	0.06939	0.154681
2001	BOI	540676	3182314	1822487	3.039181	0.068498	0.164253

2002	BOI	529989	3831078	2208353	2.503086	0.05977	0.214129
2003	BOI	554059	4263318	2443484	2.609165	0.056834	0.196552
2004	BOI	534602	4585590	2716286	2.753864	0.047594	0.181359
2005	BOI	572695	5552889	2868632	2.991971	0.044757	0.185787
2006	BOI	651185	6517375	3178174	3.14678	0.044044	0.208094
2007	BOI	810424.8	8511589	3549276	3.888119	0.043444	0.233791
2008	BOI	1077094	11347633	4180288	4.08562	0.051697	0.090628
2009	BOI	1394242	16849071	6708018	4.824828	0.043022	0.103733
2010	BOI	1900920	21309620	8587240	8.734794	0.043442	0.098343
2011	BOI	2510790	24883330	8675360	7.351036	0.057566	0.123936
2012	BOI	2821640	28936750	9461340	7.392321	0.054853	0.149751
1994	BOM	53579	180751	222989	0.687388	0.078543	0.175909
1995	BOM	59917	234404	283190	0.954974	0.068736	0.224022
1996	BOM	75272	269217	316669	1.371337	0.073066	0.226001
1997	BOM	83445	311134	372907	1.409744	0.07147	0.252349
1998	BOM	95998	359261	472222	1.60141	0.06668	0.232563
1999	BOM	110655	406184	568665	1.845439	0.066283	0.269392
2000	BOM	142023	525221	747974	2.017953	0.072462	0.281819
2001	BOM	168829	667253	884087	2.975839	0.06608	0.269301
2002	BOM	189054	825512	990919	2.373135	0.072251	0.237719
2003	BOM	192157	950814	1180153	2.523172	0.062487	0.293932
2004	BOM	199213	1173151	1394301	2.619602	0.053191	0.296433
2005	BOM	220647	1306165	1447955	3.63592	0.050263	0.282668
2006	BOM	216161	1646973	1135426	3.021136	0.054861	0.326367
2007	BOM	237389.3	2291938	1129840	3.340074	0.047709	0.32969
2008	BOM	314813	2928581	1228295	3.570971	0.055098	0.355772
2009	BOM	399805.3	4031470	2132385	4.252185	0.045915	0.142329
2010	BOM	523890	4688080	2249110	8.347883	0.051411	0.140777
2011	BOM	633940	5605980	2291140	8.063464	0.058453	0.192942
2012	BOM	837670	7547080	3143030	8.738321	0.061373	0.09283
1994	CANB	206856	828499	927731	0.710179	0.072923	0.20577
1995	CANB	220709	1087826	1005003	0.912558	0.062536	0.207201
1996	CANB	273068	1309584	1070664	1.086485	0.067487	0.217142
1997	CANB	321461	1441283	1228042	1.179873	0.071397	0.236448
1998	CANB	375822	1682468	1603099	1.263368	0.0713	0.255696
1999	CANB	436202	1953011	1735650	1.596875	0.072236	0.219943
2000	CANB	476427	2354673	2002280	1.717916	0.069223	0.238962
2001	CANB	540483	2783177	2144546	2.59666	0.061703	0.22215
2002	CANB	614286	3312671	2322010	2.348565	0.069339	0.247174
2003	CANB	617248	4047160	3045824	2.443342	0.061295	0.265729
2004	CANB	622110	4763862	3579298	2.674081	0.049651	0.302058
2005	CANB	653047	6042140	3805388	2.912385	0.045625	0.307219
2006	CANB	747713	7942570	3697418	3.231399	0.04391	0.338286
2007	CANB	990303.6	9850569	4522554	3.471369	0.050972	0.094427
2008	CANB	1345424	10723804	4981157	3.670527	0.068095	0.103337
2009	CANB	1546649	16933463	6967695	4.257549	0.051015	0.113049

2010	CANB	1966000	21126830	8363600	6.808766	0.049531	0.113644
2011	CANB	2783500	21126830	8363600	7.033261	0.067609	0.139678
2012	CANB	3134090	24217660	12113280	7.620921	0.069652	0.162818
1994	CENB	171572	601708	622402	0.689019	0.073075	0.08059
1995	CENB	179884	780959	731338	0.92886	0.064465	0.176426
1996	CENB	221181	890257	795070	1.217296	0.069829	0.096559
1997	CENB	253619	879031	1185512	1.285536	0.073059	0.115834
1998	CENB	282366	1067794	1276718	1.435395	0.071423	0.065659
1999	CENB	333213	1279984	1526257	1.698629	0.072507	0.069427
2000	CENB	376384	1580492	1708417	2.053108	0.069729	0.079708
2001	CENB	426422	1883338	1927742	2.427055	0.067218	0.087381
2002	CENB	455376	2128751	2109981	2.823043	0.065925	0.099809
2003	CENB	470269	2315922	2604535	3.017188	0.061887	0.111656
2004	CENB	449909	2280411	3140513	3.039761	0.052512	0.121447
2005	CENB	451584	2727732	3083476	3.335405	0.046475	0.133093
2006	CENB	472174	3748348	2863910	3.179494	0.044997	0.15038
2007	CENB	544414.4	5179547	2774189	3.00964	0.044996	0.162642
2008	CENB	751830.6	7299743	3145519	3.239269	0.052113	0.061255
2009	CENB	1008842	10538349	5056287	3.879369	0.048554	0.069428
2010	CENB	1389420	12972540	5450450	8.714391	0.051472	0.067078
2011	CENB	1772990	14751290	5924330	6.980864	0.066865	0.103804
2012	CENB	2035540	17193580	7260380	7.791071	0.065985	0.099263
1994	CORPB	35491	142326	237615	0.710555	0.059185	0.355539
1995	CORPB	44246	206559	250703	0.976175	0.048124	0.29358
1996	CORPB	55921	244211	212788	1.020572	0.068019	0.280041
1997	CORPB	69377	301475	328695	1.220493	0.073603	0.269666
1998	CORPB	86879	430279	415416	1.340094	0.067839	0.243945
1999	CORPB	124883	628620	551069	1.620016	0.076424	0.23541
2000	CORPB	145008	777747	596243	1.674318	0.078629	0.235916
2001	CORPB	156457	866610	686034	1.942691	0.071303	0.252609
2002	CORPB	170470	1098741	805649	2.089275	0.064895	0.235176
2003	CORPB	178176	1202917	1066990	2.385218	0.058167	0.249667
2004	CORPB	181089	1388972	1068504	2.649711	0.051284	0.267453
2005	CORPB	178736	1854637	1026110	3.068046	0.03927	0.276971
2006	CORPB	214642	2396243	1065201	3.209978	0.040527	0.311733
2007	CORPB	285596.4	2994965	1441749	3.184421	0.045228	0.305226
2008	CORPB	396519.1	3918557	1732509	3.562595	0.05339	0.371919
2009	CORPB	542295.5	6320256	3452263	4.115283	0.042985	0.394035
2010	CORPB	783720	8685040	4345270	6.456244	0.046683	0.350547
2011	CORPB	1165450	10046900	4747460	6.611163	0.065635	0.451124
2012	CORPB	1390500	11871660	5816450	6.682637	0.066562	0.425316
1994	DENB	56274	215804	234577	0.795612	0.076988	0.140299
1995	DENB	64449	287124	249986	1.094524	0.067651	0.167502
1996	DENB	77247	340168	276424	1.163054	0.073164	0.127678
1997	DENB	93055	404373	371925	1.355862	0.080275	0.140457
1998	DENB	112695	514724	460138	1.619962	0.07673	0.147135

1999	DENB	142953	639570	564674	1.851421	0.084961	0.099557
2000	DENB	158058	711788	691530	2.033306	0.083268	0.099238
2001	DENB	184736	700190	681604	3.969124	0.084777	0.103566
2002	DENB	172596	752296	764806	3.014673	0.081017	0.114545
2003	DENB	171547	843560	850038	3.468492	0.072023	0.125587
2004	DENB	164231	941179	973642	3.274186	0.061274	0.143037
2005	DENB	165419	1130859	969695	4.121263	0.048917	0.155341
2006	DENB	159879	1423124	857067	3.488086	0.043915	0.104007
2007	DENB	187467.2	1830339	923505	3.795263	0.044887	0.1275
2008	DENB	246758.5	2302398	1028298	3.724503	0.05292	0.167129
2009	DENB	315126.1	3546244	1569423	4.734288	0.045043	0.179238
2010	DENB	434360	4482800	1876890	6.914498	0.049623	0.180827
2011	DENB	584780	5669250	2302760	7.005489	0.057905	0.240531
2012	DENB	781600	6578120	3434310	7.137835	0.061695	0.107544
1994	INDB	141021	678069	388667	0.759275	0.087045	0.121367
1995	INDB	143273	787458	451578	0.870726	0.078001	0.07664
1996	INDB	191799	787346	494612	1.332746	0.090748	0.075993
1997	INDB	191862	686490	535772	1.290351	0.095805	0.084916
1998	INDB	187137	726043	699054	1.449655	0.086284	0.090957
1999	INDB	198720	749652	772793	1.597149	0.081533	0.097554
2000	INDB	214990	820340	854658	1.86876	0.07825	0.104484
2001	INDB	235491	943391	1000048	2.590812	0.073732	0.10315
2002	INDB	248871	1090836	1240807	2.526158	0.072217	0.112974
2003	INDB	246666	1227499	1483901	2.613155	0.062316	0.135068
2004	INDB	261181	1412609	1669621	3.956251	0.050413	0.149211
2005	INDB	248142	1838011	1792100	2.955951	0.0441	0.153256
2006	INDB	293409	2248464	1901700	3.61564	0.043434	0.151399
2007	INDB	365926.7	2905811	2087773	4.205783	0.04921	0.163559
2008	INDB	455937.1	3983871	2191507	4.707975	0.050684	0.184787
2009	INDB	580994.8	6214613	2826833	5.765818	0.047338	0.070121
2010	INDB	725120	7524990	3478380	6.901248	0.049348	0.068966
2011	INDB	1000030	9032360	3797600	7.931587	0.06217	0.096155
2012	INDB	1211930	10564250	4180500	10.50338	0.06468	0.103224
1994	IOB	118111	534013	477002	0.787948	0.0759	0.123515
1995	IOB	129303	662822	533630	0.086623	0.0688	0.140417
1996	IOB	171191	750425	608206	1.31343	0.077469	0.155388
1997	IOB	192163	725402	659265	1.286133	0.087833	0.175451
1998	IOB	203713	866718	738199	1.439553	0.075695	0.193411
1999	IOB	240689	1011747	831606	1.794953	0.077518	0.207293
2000	IOB	258253	1157320	1025046	2.046645	0.074194	0.206186
2001	IOB	278923	1309551	1177066	2.572626	0.0694	0.215298
2002	IOB	308513	1516234	1506917	2.673462	0.068857	0.221334
2003	IOB	321167	1744700	1860301	2.942105	0.061111	0.244949
2004	IOB	316958	2029486	2017165	3.08982	0.051044	0.218004
2005	IOB	325405	2520519	1901472	3.461627	0.046742	0.232143
2006	IOB	360067	3475620	1895229	3.695798	0.045627	0.296588

2007	IOB	465908.4	4706029	2397447	3.902044	0.045665	0.324856
2008	IOB	677408.7	6040182	2847471	3.806809	0.058324	0.369528
2009	IOB	871350.8	7899916	3765056	4.98527	0.056537	0.120307
2010	IOB	1046590	11183300	4861050	6.794271	0.04796	0.121629
2011	IOB	1604400	14072440	5556590	7.657807	0.063752	0.172592
2012	IOB	1883260	16036410	6141730	7.950141	0.068415	0.166649
1994	OBC	53068	256703	252213	0.678049	0.072387	0.707106
1995	OBC	67727	352888	291664	0.87968	0.066517	0.531132
1996	OBC	85062	467178	358376	1.080515	0.067383	0.496216
1997	OBC	105424	488642	438822	1.136303	0.078816	0.473118
1998	OBC	125911	631846	595725	1.299129	0.072852	0.388286
1999	OBC	166036	770756	783915	1.500658	0.076257	0.395459
2000	OBC	217352	932553	1155957	1.606959	0.077194	0.423309
2001	OBC	249234	1107641	1229847	2.319252	0.079015	0.513138
2002	OBC	259729	1415787	1372435	2.122673	0.071065	0.469565
2003	OBC	267259	1567724	1478054	2.573406	0.068354	0.481002
2004	OBC	248922	1968076	1679411	2.696497	0.050716	0.571702
2005	OBC	284395	2529920	1834219	2.725194	0.042163	0.291654
2006	OBC	347969	3357725	1681756	3.344874	0.04922	0.308952
2007	OBC	447146.9	4413847	1980836	3.536024	0.053755	0.342685
2008	OBC	623580.4	5456583	2395068	3.71093	0.064698	0.395344
2009	OBC	825781.5	8348930	3578532	5.261736	0.054816	0.122011
2010	OBC	980280	9590820	4954540	6.180736	0.054669	0.059184
2011	OBC	1391460	11197770	5210130	7.385553	0.071944	0.164919
2012	OBC	1566880	12895510	5855470	8.343126	0.070835	0.215089
1994	PNSB	44835	169640	184378	0.793931	0.075628	0.138771
1995	PNSB	53996	243831	229050	0.910018	0.06877	0.14649
1996	PNSB	71924	278984	246241	1.306866	0.079208	0.568717
1997	PNSB	76706	279120	301224	1.349415	0.082271	0.669695
1998	PNSB	85951	318642	375478	1.487137	0.078775	0.224725
1999	PNSB	100711	409993	427361	1.551591	0.076091	0.255527
2000	PNSB	118694	476482	480902	1.996702	0.078175	0.266765
2001	PNSB	130101	518087	549862	3.025486	0.074991	0.277321
2002	PNSB	133044	557674	574494	2.832695	0.075606	0.309465
2003	PNSB	131046	589209	623748	3.199124	0.067774	0.400906
2004	PNSB	138479	603002	677659	4.91215	0.057513	0.44469
2005	PNSB	124687	632222	708157	4.745328	0.047686	0.443683
2006	PNSB	115199	910747	695559	3.789876	0.039527	0.10798
2007	PNSB	148293.2	1173751	669308	4.044438	0.049164	0.12648
2008	PNSB	199427	1834330	847363	4.66637	0.051549	0.060127
2009	PNSB	293314.9	3263911	1788684	6.037241	0.04229	0.069566
2010	PNSB	435610	4263780	1864370	9.324041	0.05386	0.045932
2011	PNSB	613190	4615140	2006410	10.35195	0.074781	0.066675
2012	PNSB	681840	5143080	2254250	9.064807	0.077876	0.080322
1994	PNB	226589	986784	1029779	0.654841	0.069823	0.264718
1995	PNB	257896	1173147	1137356	0.839718	0.067534	0.073356

1996	PNB	309865	1267989	1193619	1.063441	0.073447	0.024755
1997	PNB	350312	1406689	1397657	1.19945	0.078286	0.026915
1998	PNB	382771	1604264	1590773	1.308488	0.076163	0.108692
1999	PNB	417138	1904737	1857316	1.626862	0.068222	0.116642
2000	PNB	506205	2257172	2209907	1.828542	0.073489	0.121091
2001	PNB	569669	2802905	2512842	2.502324	0.067337	0.130277
2002	PNB	615178	3436942	2820717	2.275048	0.067448	0.139188
2003	PNB	641802	4022812	3403005	2.502636	0.057028	0.135594
2004	PNB	652573	4722473	4212547	2.811163	0.046578	0.148869
2005	PNB	773109	6041275	5067283	4.155703	0.042056	0.159877
2006	PNB	794053	7462737	4105531	3.643547	0.038919	0.168293
2007	PNB	934913.8	9659652	4518984	4.104345	0.042472	0.192053
2008	PNB	1225634	11950157	5399171	4.393652	0.050789	0.097719
2009	PNB	1650151	18660121	7772447	5.338417	0.045777	0.103598
2010	PNB	2154330	24210670	9516230	8.399104	0.044063	0.083845
2011	PNB	3001640	29377480	12262950	7.602975	0.055208	0.114582
2012	PNB	3520190	30872520	12989620	8.965904	0.062704	0.127319
1994	SYNB	112047	398124	496404	0.73618	0.07144	0.154379
1995	SYNB	127117	442065	572402	1.032029	0.063095	0.152441
1996	SYNB	141101	539766	609237	1.123474	0.066142	0.162481
1997	SYNB	165586	583248	745310	1.309091	0.069447	0.188178
1998	SYNB	177806	695998	765961	1.388242	0.067368	0.211699
1999	SYNB	217154	931283	792565	1.648466	0.071209	0.214591
2000	SYNB	246353	1220631	983079	1.935196	0.067763	0.172114
2001	SYNB	277580	1311616	1055009	2.869892	0.067106	0.180979
2002	SYNB	280321	1488466	1191060	3.190379	0.062091	0.189705
2003	SYNB	275147	1630535	1382325	3.135067	0.05418	0.185034
2004	SYNB	280700	2064693	1791660	3.25888	0.038677	0.178329
2005	SYNB	332802	2672921	2037074	3.871024	0.044272	0.196711
2006	SYNB	360437	3646624	1726911	4.212232	0.040201	0.208405
2007	SYNB	527599.1	5167044	2523401	3.671897	0.048621	0.131657
2008	SYNB	732809.6	6405101	2807593	3.767497	0.060466	0.156837
2009	SYNB	876856.8	9040636	3301093	4.468486	0.054007	0.190468
2010	SYNB	961620	10678190	3506760	6.220141	0.048704	0.192868
2011	SYNB	1299740	12362020	4081510	7.030553	0.060424	0.123927
2012	SYNB	1484540	14756900	4564770	8.190634	0.058872	0.132566
1994	UCOB	118741	457758	414340	0.773279	0.08805	0.427986
1995	UCOB	113539	487615	461989	0.867687	0.070611	0.130277
1996	UCOB	137421	498213	534325	1.241544	0.070163	0.061739
1997	UCOB	150299	489586	646465	1.258653	0.077537	0.069938
1998	UCOB	162251	561054	750394	1.34705	0.07364	0.077504
1999	UCOB	184165	622221	873882	1.508321	0.075209	0.080985
2000	UCOB	204957	763026	993395	1.621337	0.075163	0.083075
2001	UCOB	235864	1008544	1084215	2.118734	0.073485	0.089629
2002	UCOB	264880	1280537	1230184	2.686001	0.066509	0.100536
2003	UCOB	277795	1592310	1413751	2.752155	0.060178	0.11696

2004	UCOB	277317	2062644	1761148	2.657549	0.047985	0.119943
2005	UCOB	322578	2765571	1906437	3.457695	0.043008	0.132989
2006	UCOB	396621	3737758	1963631	3.590126	0.049893	0.103364
2007	UCOB	481573.6	4698891	1952487	3.363039	0.053815	0.118914
2008	UCOB	632673.8	5508189	2424963	3.735045	0.061511	0.124529
2009	UCOB	793966.3	8250453	4352143	4.202651	0.050332	0.133316
2010	UCOB	960130	9907080	4292730	6.427951	0.049922	0.128109
2011	UCOB	1278650	11554000	4577150	5.975288	0.06429	0.153213
2012	UCOB	1434680	12828290	5224490	5.77917	0.066532	0.169627
1994	UNIONB	119449	516140	538914	0.709532	0.070986	0.509228
1995	UNIONB	143383	712914	605254	0.885643	0.062947	0.463128
1996	UNIONB	186142	868108	651897	1.173879	0.069438	0.047202
1997	UNIONB	215971	916836	775759	1.347262	0.076478	0.05331
1998	UNIONB	236217	1027619	920504	1.409501	0.072929	0.058815
1999	UNIONB	282165	1130877	1214013	1.667315	0.072227	0.066528
2000	UNIONB	322259	1461323	1147923	2.014288	0.074963	0.071728
2001	UNIONB	353328	1750535	1367160	2.696441	0.071416	0.07543
2002	UNIONB	364559	2138331	1540969	2.659167	0.067233	0.086532
2003	UNIONB	382682	2551484	1937079	2.681203	0.062148	0.097001
2004	UNIONB	386468	2942591	2244203	2.813734	0.053989	0.110578
2005	UNIONB	416273	4010508	2279280	3.144551	0.0455	0.112747
2006	UNIONB	489181	5337995	2591766	3.212356	0.044697	0.13456
2007	UNIONB	606789.1	6238643	2798177	3.172876	0.051367	0.159673
2008	UNIONB	795393.4	7426691	3382263	3.111326	0.058562	0.079099
2009	UNIONB	1028993	11931530	5440353	3.970091	0.045052	0.089133
2010	UNIONB	1418640	15098610	5839910	9.369639	0.04744	0.089624
2011	UNIONB	1822290	17788210	6236360	8.039756	0.059122	0.113066
2012	UNIONB	2209410	20810220	8083040	8.664067	0.061142	0.130254
1994	UNITEDB	78618	252920	326227	0.749967	0.078392	0.121309
1995	UNITEDB	86421	281493	387789	0.942366	0.073099	0.126831
1996	UNITEDB	97161	285113	445602	1.180036	0.071672	0.132164
1997	UNITEDB	115911	302731	613160	1.302677	0.075863	0.147303
1998	UNITEDB	131093	337145	717645	1.403158	0.07701	0.106853
1999	UNITEDB	152121	384432	889112	1.566576	0.075799	0.113868
2000	UNITEDB	175218	456278	1015612	1.81352	0.076125	0.120774
2001	UNITEDB	195885	573935	1135761	2.241747	0.076121	0.124687
2002	UNITEDB	219150	682271	1165643	3.631939	0.072749	0.129176
2003	UNITEDB	199159	735169	1263937	2.712933	0.066372	0.149322
2004	UNITEDB	196514	796334	1391614	2.879801	0.056717	0.169917
2005	UNITEDB	192195	1138968	1440333	2.845424	0.047989	0.171751
2006	UNITEDB	215315	1552231	1412951	3.628154	0.045336	0.187253
2007	UNITEDB	245367.2	2215632	1460181	3.319939	0.044593	0.072139
2008	UNITEDB	355585.4	2785811	1851464	4.007568	0.055112	0.08757
2009	UNITEDB	412549.7	4233004	2606774	4.351573	0.045594	0.105023
2010	UNITEDB	547150	5350240	2625890	5.406984	0.050721	0.08349
2011	UNITEDB	686520	6304330	2905880	5.749677	0.058295	0.116522

2012	UNITEDB	826810	6890870	3346340	6.024291	0.064058	0.127406
1994	VIJB	44071	182558	180702	0.755624	0.066215	0.54174
1995	VIJB	53979	235628	244509	0.934028	0.058427	0.125855
1996	VIJB	72837	244370	282925	1.237902	0.074456	0.134711
1997	VIJB	76134	247528	309917	1.343286	0.07192	0.141368
1998	VIJB	82786	322510	378803	1.41873	0.065747	0.148005
1999	VIJB	99291	376720	444115	1.558345	0.069406	0.17017
2000	VIJB	118890	468761	508887	1.903449	0.069337	0.199081
2001	VIJB	133396	572001	587015	2.452825	0.070126	0.258765
2002	VIJB	147482	619666	736073	2.586624	0.071313	0.267702
2003	VIJB	158447	789134	886161	3.659558	0.059249	0.263379
2004	VIJB	160014	1104530	1083699	2.852632	0.051627	0.246941
2005	VIJB	164820	1433579	1206874	2.774519	0.042263	0.23084
2006	VIJB	196257	1666401	1117970	3.467326	0.047441	0.282187
2007	VIJB	240187.9	2422355	1201841	3.461071	0.046324	0.354393
2008	VIJB	375969.2	3168922	1661732	3.539789	0.061327	0.137981
2009	VIJB	503772.4	4150668	2110745	4.989302	0.064396	0.158346
2010	VIJB	533060	4871860	2513860	9.119957	0.051775	0.160679
2011	VIJB	728560	5790370	2864380	6.250211	0.068773	0.205997
2012	VIJB	853690	6976580	3128500	6.734386	0.069374	0.230124

Annexure 3: Dataset Private Domestic Bank (Rs. Lakhs)

Year	Banks	Total cost	Q1	Q2	Price of Labour	Price of Fund	price of capital
1994	AXISB	2118	35889	12204	0.9800	0.0331	0.3920
1995	AXISB	2195	35889	12369	0.9800	0.0331	0.5575
1996	AXISB	11967	55685	22124	2.1289	0.1008	0.1495
1997	AXISB	14848	63945	52239	0.2987	0.0862	0.2255
1998	AXISB	26195	162730	97138	2.0121	0.0770	0.2108
1999	AXISB	35166	216979	110102	2.3071	0.0844	0.2169
2000	AXISB	45826	350662	206515	2.0880	0.0628	0.3110
2001	AXISB	92012	482112	419262	2.4068	0.0773	0.1536
2002	AXISB	118547	535230	663022	2.8803	0.0724	0.1862
2003	AXISB	146526	717992	784102	3.6454	0.0646	0.2154
2004	AXISB	144066	936295	779275	3.5176	0.0476	0.1997
2005	AXISB	177434	1560292	1504802	3.7146	0.0356	0.2193
2006	AXISB	262461	2231423	2152735	3.6655	0.0423	0.2802
2007	AXISB	420791.6	3687648	2689716	3.8211	0.0468	0.3757
2008	AXISB	657488.9	5966114	3370510	4.5475	0.0474	0.4013
2009	AXISB	1000749	8155677	4633035	4.8374	0.0538	0.4624
2010	AXISB	1337120	14240780	7199160	6.1270	0.0399	0.2991
2011	AXISB	1998400	16975950	9319210	6.5543	0.0550	0.2905
2012	AXISB	2443050	19696600	11373750	6.2716	0.0591	0.3186
1994	CATSYRB	10537	48913	29209	0.6657	0.0765	0.2308
1995	CATSYRB	12764	63125	38989	0.8183	0.0751	0.2190
1996	CATSYRB	16977	83361	41617	1.0748	0.0829	0.1254
1997	CATSYRB	22212	95507	48144	1.1265	0.1027	0.1440
1998	CATSYRB	24978	101036	60743	1.2232	0.0999	0.1727
1999	CATSYRB	27405	94998	80716	1.4000	0.0949	0.1767
2000	CATSYRB	30006	106071	99476	1.8775	0.0872	0.2183
2001	CATSYRB	31261	126297	109734	1.9888	0.0826	0.2869
2002	CATSYRB	34516	121093	135733	2.2250	0.0798	0.3408
2003	CATSYRB	36042	147070	180930	2.6910	0.0734	0.3985
2004	CATSYRB	35272	189824	181893	2.9384	0.0602	0.3767
2005	CATSYRB	33588	228933	132301	2.6745	0.0552	0.2978
2006	CATSYRB	36856	269487	143159	3.9169	0.0509	0.2873
2007	CATSYRB	38892.4	301264	155329	3.3144	0.0529	0.2721
2008	CATSYRB	46827.61	331356	181943	3.6132	0.0596	0.2603
2009	CATSYRB	57739.27	368384	218397	4.4552	0.0553	0.2563
2010	CATSYRB	80300	622000	269030	7.5284	0.0568	0.3064
2011	CATSYRB	106740	766350	314510	8.0422	0.0687	0.3369
2012	CATSYRB	131340	885150	330110	8.3032	0.0783	0.1909

1994	CITYUNIB	3662	19040	9411	0.6302	0.0694	0.1797
1995	CITYUNIB	4545	27206	14045	0.6977	0.0659	0.1995
1996	CITYUNIB	6748	38526	16641	0.8989	0.0759	0.0978
1997	CITYUNIB	9303	47641	23010	0.9195	0.0884	0.0942
1998	CITYUNIB	12101	57552	32752	1.0400	0.0932	0.0973
1999	CITYUNIB	15260	66644	47528	1.2169	0.0977	0.1156
2000	CITYUNIB	15991	76939	53094	1.4593	0.0938	0.1352
2001	CITYUNIB	16438	87642	65029	1.5170	0.0801	0.1594
2002	CITYUNIB	19510	101105	91120	1.6995	0.0794	0.1981
2003	CITYUNIB	20704	121447	109920	1.6705	0.0718	0.2567
2004	CITYUNIB	22488	154697	127901	1.7880	0.0626	0.1983
2005	CITYUNIB	24244	201296	110223	2.1591	0.0577	0.2599
2006	CITYUNIB	25679	254953	105747	2.2621	0.0519	0.2851
2007	CITYUNIB	32265.31	332923	130700	2.3715	0.0493	0.3502
2008	CITYUNIB	50609.55	453706	171796	2.2605	0.0616	0.3557
2009	CITYUNIB	70136.2	683346	321043	2.6804	0.0544	0.3046
2010	CITYUNIB	101480	925550	361620	3.5775	0.0609	0.3698
2011	CITYUNIB	147680	1213750	458620	3.6540	0.0717	0.4033
2012	CITYUNIB	193890	1524610	526680	3.9868	0.0753	0.3992
1994	DLAXB	3284	16326	11114	0.7194	0.0678	0.3759
1995	DLAXB	4899	28589	14810	0.8861	0.0739	0.3901
1996	DLAXB	7910	44859	19910	1.2871	0.0784	0.2151
1997	DLAXB	12053	56241	30070	1.2122	0.0863	0.2840
1998	DLAXB	12919	54927	35453	1.3545	0.0951	0.2804
1999	DLAXB	14251	60523	42723	1.4000	0.0893	0.3517
2000	DLAXB	15773	77631	56370	1.6418	0.0857	0.2713
2001	DLAXB	18594	88010	56045	2.1534	0.0903	0.1920
2002	DLAXB	18927	91771	65131	2.6809	0.0827	0.1966
2003	DLAXB	19586	108049	67506	3.0161	0.0725	0.2274
2004	DLAXB	18230	113860	89485	2.8958	0.0563	0.2661
2005	DLAXB	18842	141015	70799	3.0023	0.0508	0.2804
2006	DLAXB	20870	159435	70960	3.0195	0.0501	0.2073
2007	DLAXB	23753.06	183706	86519	3.1560	0.0484	0.2432
2008	DLAXB	31002.11	210203	107506	3.3570	0.0591	0.2955
2009	DLAXB	39986.98	500626	202779	4.4623	0.0387	0.2718
2010	DLAXB	98580	906520	363970	5.4980	0.0487	0.3417
2011	DLAXB	163520	875810	436020	7.9008	0.0847	0.2703
2012	DLAXB	137090	777710	468450	7.1819	0.0806	0.3321

1994	FEDB	21113	119734	80747	0.6819	0.0638	0.4194
1995	FEDB	29971	163151	105779	0.9170	0.0745	0.0705
1996	FEDB	42198	222845	114631	1.1541	0.0799	0.0489
1997	FEDB	58485	299941	145617	1.1060	0.0965	0.0668
1998	FEDB	70138	392117	236595	1.3727	0.0847	0.0738
1999	FEDB	92304	422777	260172	1.4378	0.1061	0.0904
2000	FEDB	87860	403571	266601	1.8396	0.1025	0.1055
2001	FEDB	85723	485413	303550	1.7567	0.0852	0.1318
2002	FEDB	95741	518911	375583	1.9385	0.0829	0.1578
2003	FEDB	99440	621752	455168	2.2427	0.0700	0.1557
2004	FEDB	105319	770053	550739	2.8014	0.0566	0.1818
2005	FEDB	100260	882259	579916	2.8696	0.0448	0.1739
2006	FEDB	120130	1173647	627237	3.7965	0.0453	0.2162
2007	FEDB	149105.9	1489910	703266	4.3200	0.0485	0.2435
2008	FEDB	211604.4	1890466	1002659	3.9054	0.0617	0.2714
2009	FEDB	257138	2695011	1305465	4.1936	0.0532	0.2455
2010	FEDB	314150	3195320	1453770	5.8089	0.0513	0.2747
2011	FEDB	458430	3775600	1740250	6.2196	0.0678	0.2907
2012	FEDB	537240	4409670	2115460	6.2283	0.0668	0.3338
1994	HDFC	1072	9800	22134	11.0000	0.0070	0.0946
1995	HDFC	1072	9800	22134	1.5714	0.0070	0.3335
1996	HDFC	9351	36862	31428	1.5973	0.0969	0.0350
1997	HDFC	12936	57526	72972	2.1363	0.0590	0.1123
1998	HDFC	20026	84198	112133	2.2466	0.0612	0.1288
1999	HDFC	31797	140056	190380	2.2419	0.0681	0.1687
2000	HDFC	54567	336227	574828	2.4362	0.0380	0.1834
2001	HDFC	106334	463666	714514	2.8353	0.0585	0.1993
2002	HDFC	149169	681372	1200402	2.9193	0.0551	0.2082
2003	HDFC	178379	1175486	1338808	2.6785	0.0483	0.1862
2004	HDFC	202105	1774451	1925679	2.7764	0.0370	0.1941
2005	HDFC	240096	2556630	1934981	3.0639	0.0320	0.2376
2006	HDFC	362059	3506126	2839396	3.2721	0.0329	0.2268
2007	HDFC	560025	4694478	3056480	3.6172	0.0447	0.2675
2008	HDFC	863273.1	6342689	4939354	3.4809	0.0464	0.4318
2009	HDFC	1444391	9888305	5881755	4.2481	0.0586	0.3287
2010	HDFC	1653800	15998270	7092940	5.0868	0.0421	0.2885
2011	HDFC	2357970	19542000	9748290	5.1454	0.0554	0.3051
2012	HDFC	3048990	23972060	11161360	5.7138	0.0585	0.3110

1994	ICICI	2547	12122	14496	2.3125	0.0392	0.0741
1995	ICICI	2547	12122	14496	1.4231	0.0392	0.2336
1996	ICICI	11237	65075	26277	1.5118	0.0904	0.0257
1997	ICICI	16995	79800	43535	1.3711	0.0899	0.0800
1998	ICICI	24429	112787	102339	2.0348	0.0662	0.0619
1999	ICICI	50849	211012	286123	2.0461	0.0678	0.0902
2000	ICICI	82026	365734	441668	2.7061	0.0644	0.1643
2001	ICICI	117196	703146	818686	1.1514	0.0481	0.1739
2002	ICICI	218150	4703487	3589108	1.9050	0.0192	0.0263
2003	ICICI	995569	5327941	3546230	3.4912	0.0963	0.0368
2004	ICICI	958648	6209551	4274287	4.0125	0.0710	0.0457
2005	ICICI	987003	9140515	5048735	4.0901	0.0493	0.0581
2006	ICICI	1459860	14616311	7154740	4.2637	0.0471	0.0781
2007	ICICI	2304905	19586560	9125784	4.8520	0.0581	0.1317
2008	ICICI	3163842	22561608	11145434	5.1096	0.0757	0.1523
2009	ICICI	2977105	21831085	10305831	5.6992	0.0730	0.1558
2010	ICICI	2357440	21636590	13468600	4.9446	0.0506	0.1378
2011	ICICI	3065890	25372770	15956000	6.0322	0.0576	0.1464
2012	ICICI	3522210	29024940	17139360	6.2729	0.0598	0.1586
1994	INDUSB	4631	80336	22380	3.8000	0.0328	0.0380
1995	INDUSB	4631	53829	18803	1.1400	0.0487	0.2025
1996	INDUSB	16170	112119	35750	1.6277	0.0857	0.1989
1997	INDUSB	36623	192766	105454	1.7377	0.0981	0.1398
1998	INDUSB	50477	245083	169625	2.1282	0.0989	0.1291
1999	INDUSB	56596	266227	209507	2.2185	0.0883	0.1454
2000	INDUSB	59136	367705	273176	2.8231	0.0706	0.1669
2001	INDUSB	67253	423688	249426	2.3064	0.0749	0.1993
2002	INDUSB	64195	557420	248489	2.7493	0.0591	0.1829
2003	INDUSB	67640	534785	253507	2.3267	0.0632	0.1887
2004	INDUSB	88638	730116	448276	2.9752	0.0495	0.0834
2005	INDUSB	98393	899975	406917	2.8965	0.0524	0.0879
2006	INDUSB	118981	931047	540990	3.5852	0.0562	0.0893
2007	INDUSB	157280.3	1108420	589166	3.6850	0.0674	0.0990
2008	INDUSB	198205.3	1279531	662970	4.2487	0.0785	0.0794
2009	INDUSB	239747.6	1577064	808341	4.4024	0.0742	0.1104
2010	INDUSB	322140	2616560	1355080	5.4595	0.0555	0.1498
2011	INDUSB	499790	3506400	1457190	5.1814	0.0716	0.1669
2012	INDUSB	650680	4432060	1965420	5.7512	0.0747	0.2201

1994	INGVYSB	30543	163190	142170	0.7189	0.0640	0.1293
1995	INGVYSB	42523	270928	163015	0.8160	0.0607	0.0405
1996	INGVYSB	54786	254181	135452	1.1279	0.0974	0.0546
1997	INGVYSB	62884	262366	190342	1.2245	0.0987	0.0615
1998	INGVYSB	66870	257065	208612	1.2748	0.0927	0.0679
1999	INGVYSB	77522	278212	245305	1.4102	0.0920	0.0844
2000	INGVYSB	85994	393775	273565	1.6056	0.0885	0.0587
2001	INGVYSB	89877	431631	269511	1.8388	0.0824	0.0615
2002	INGVYSB	99949	441833	359720	2.5935	0.0799	0.0657
2003	INGVYSB	102096	561161	364054	3.6262	0.0679	0.0791
2004	INGVYSB	102562	704651	408524	3.5141	0.0594	0.0848
2005	INGVYSB	101392	908058	419590	3.8393	0.0473	0.1115
2006	INGVYSB	126003	1023152	437234	4.8009	0.0513	0.0955
2007	INGVYSB	132705.9	1197617	452781	4.4020	0.0505	0.1138
2008	INGVYSB	179153.7	1464955	629332	5.2966	0.0545	0.1496
2009	INGVYSB	236274	1850719	1047292	6.4446	0.0538	0.1544
2010	INGVYSB	271350	2360210	1105830	8.7668	0.0491	0.1619
2011	INGVYSB	375870	2873670	1271550	6.7517	0.0648	0.1953
2012	INGVYSB	459580	3177200	1827820	8.0023	0.0695	0.2202
1994	JKB	17437	124092	58861	0.6755	0.0612	0.3714
1995	JKB	20858	120790	79157	0.9665	0.0575	0.3766
1996	JKB	24998	136413	106789	0.8573	0.0618	0.3117
1997	JKB	33010	169398	159273	0.9738	0.0686	0.2641
1998	JKB	42689	215824	206068	1.0345	0.0672	0.1900
1999	JKB	56484	295096	295063	1.3601	0.0648	0.1664
2000	JKB	75764	351807	425432	1.4310	0.0634	0.1160
2001	JKB	88448	476290	542495	1.4811	0.0634	0.1041
2002	JKB	114961	642389	575254	2.2203	0.0699	0.0969
2003	JKB	116083	801095	673782	2.2282	0.0605	0.1234
2004	JKB	119453	928493	845110	2.3766	0.0475	0.1125
2005	JKB	127579	1151714	903190	2.6018	0.0434	0.1124
2006	JKB	138778	1448311	899384	2.8157	0.0439	0.1371
2007	JKB	150392.2	1707994	739219	3.2141	0.0438	0.1470
2008	JKB	202740.6	1888261	875766	2.9872	0.0553	0.1602
2009	JKB	245872.2	2305723	1395625	3.6551	0.0519	0.1696
2010	JKB	292840	2619360	1969580	6.5961	0.0474	0.0961
2011	JKB	379940	3307740	2162430	5.6319	0.0549	0.0980
2012	JKB	480980	3920040	2574110	6.9394	0.0585	0.1103

1994	KARB	11885	60604	38335	0.7505	0.0742	0.3817
1995	KARB	14297	81229	46688	0.9380	0.0671	0.3326
1996	KARB	20119	118542	59121	1.1431	0.0712	0.1218
1997	KARB	28825	144969	83364	1.3997	0.0834	0.1020
1998	KARB	37569	181829	125826	1.5419	0.0833	0.0983
1999	KARB	46741	204663	177506	1.6060	0.0833	0.0949
2000	KARB	56948	245143	206279	1.8474	0.0874	0.1199
2001	KARB	60730	282822	278701	1.7573	0.0809	0.1176
2002	KARB	73338	341755	346715	2.1470	0.0849	0.1495
2003	KARB	79733	389970	443261	2.0650	0.0776	0.1609
2004	KARB	78893	466791	487891	2.1872	0.0662	0.1531
2005	KARB	72037	628744	455571	2.8491	0.0472	0.1918
2006	KARB	85657	779157	554858	2.6723	0.0486	0.2547
2007	KARB	107393.6	955268	504816	2.8969	0.0578	0.3178
2008	KARB	140729.8	1084197	632652	3.8698	0.0642	0.3648
2009	KARB	179033.8	1443568	999205	3.8491	0.0591	0.3339
2010	KARB	230740	1734810	1150630	5.9551	0.0619	0.4414
2011	KARB	293710	2072070	1284120	5.3392	0.0723	0.3482
2012	KARB	352660	2520770	1343250	5.9173	0.0760	0.3629
1994	KVYSB	7416	31302	39940	0.6876	0.0559	0.2394
1995	KVYSB	11530	64924	43069	0.9242	0.0609	0.0976
1996	KVYSB	16601	82430	40783	1.1094	0.0899	0.0449
1997	KVYSB	19515	95626	57517	1.1541	0.0843	0.0636
1998	KVYSB	24930	115470	76762	1.5728	0.0829	0.0776
1999	KVYSB	31670	144788	101904	1.5407	0.0890	0.1016
2000	KVYSB	36673	180730	118431	1.9693	0.0848	0.1261
2001	KVYSB	40450	225415	123439	1.7307	0.0812	0.0809
2002	KVYSB	42526	246003	153891	1.8534	0.0708	0.0898
2003	KVYSB	45065	334440	185017	2.1214	0.0643	0.1086
2004	KVYSB	50732	402324	217301	2.7683	0.0583	0.1167
2005	KVYSB	50469	461981	221903	2.7165	0.0494	0.1312
2006	KVYSB	54281	555544	229813	3.0041	0.0473	0.1596
2007	KVYSB	71277	704048	287395	2.8211	0.0544	0.2029
2008	KVYSB	98157.06	942153	352633	2.8431	0.0594	0.2117
2009	KVYSB	129327.7	1344700	660216	3.1174	0.0524	0.2120
2010	KVYSB	188140	1781450	773180	5.0197	0.0575	0.1716
2011	KVYSB	289480	2394920	1050610	4.6607	0.0690	0.1957
2012	KVYSB	384620	2948010	1383730	5.1055	0.0723	0.2276

1994	LVILB	5825	26573	21437	0.7210	0.0597	0.2080
1995	LVILB	9157	44983	41719	0.9002	0.0594	0.1756
1996	LVILB	12313	49282	39376	1.1929	0.0850	0.0909
1997	LVILB	15090	60838	46988	1.2752	0.0882	0.1124
1998	LVILB	16195	75791	49406	1.4692	0.0772	0.1415
1999	LVILB	20120	90943	59209	1.6520	0.0864	0.2408
2000	LVILB	22672	115005	76757	1.9959	0.0788	0.1844
2001	LVILB	24986	148023	78204	1.9726	0.0787	0.2198
2002	LVILB	28011	156525	90421	2.0688	0.0835	0.2197
2003	LVILB	27516	176370	103658	2.1678	0.0715	0.2251
2004	LVILB	28182	203871	133817	2.3777	0.0609	0.2344
2005	LVILB	28182	231771	118086	2.4466	0.0537	0.2266
2006	LVILB	31707	295281	127987	3.1874	0.0499	0.2553
2007	LVILB	40140.27	361270	130930	2.9180	0.0587	0.2755
2008	LVILB	49836.77	385879	169368	3.0338	0.0673	0.3292
2009	LVILB	65575.87	627750	298322	3.2243	0.0536	0.2584
2010	LVILB	92790	809440	351890	4.4288	0.0589	0.1247
2011	LVILB	144170	1018870	439510	4.6234	0.0781	0.1681
2012	LVILB	170640	1170280	432450	5.0048	0.0850	0.2018
1994	NAINB	1719	5272	5418	0.6561	0.0724	0.5941
1995	NAINB	1792	5761	6373	0.7898	0.0657	0.6667
1996	NAINB	2186	6880	8052	1.0589	0.0629	0.7333
1997	NAINB	2719	7427	10451	1.0842	0.0660	0.2500
1998	NAINB	3245	7341	11791	1.1768	0.0685	0.2624
1999	NAINB	3677	8754	16421	1.3155	0.0669	0.2971
2000	NAINB	4215	10327	21655	1.6090	0.0619	0.2955
2001	NAINB	4913	12038	28438	1.6734	0.0641	0.3226
2002	NAINB	5452	13080	33241	1.9457	0.0619	0.3614
2003	NAINB	6056	17238	34862	2.6378	0.0583	0.3313
2004	NAINB	6254	23551	41046	3.2351	0.0488	0.4033
2005	NAINB	6186	36321	42108	2.8779	0.0391	0.4000
2006	NAINB	7692	60347	37172	4.3974	0.0355	0.3276
2007	NAINB	8934.58	79507	38786	3.5450	0.0370	0.3690
2008	NAINB	12525.33	99486	48348	3.0638	0.0513	0.4406
2009	NAINB	15535	128842	70665	3.9906	0.0463	0.4426
2010	NAINB	19660	167840	79070	4.2770	0.0497	0.3711
2011	NAINB	27340	191520	113310	5.7932	0.0577	0.4109
2012	NAINB	32620	215520	103560	6.4819	0.0660	0.4848

1994	RATNB	1467	6781	4652	0.6289	0.0782	0.1066
1995	RATNB	1695	8693	5622	0.6916	0.0691	0.1574
1996	RATNB	2194	9157	6500	0.9923	0.0820	0.1614
1997	RATNB	2715	12299	8316	1.2303	0.0800	0.1429
1998	RATNB	3201	14978	9758	1.1297	0.0783	0.1064
1999	RATNB	3937	16367	14741	1.3664	0.0808	0.1414
2000	RATNB	5029	18736	19000	1.8092	0.0795	0.1328
2001	RATNB	5928	24535	22952	1.7993	0.0789	0.1648
2002	RATNB	6576	27037	25339	2.5743	0.0731	0.1911
2003	RATNB	6412	31205	27101	2.1038	0.0699	0.2114
2004	RATNB	6312	34601	25840	2.2953	0.0599	0.2159
2005	RATNB	6098	42376	26464	2.4275	0.0494	0.2295
2006	RATNB	6362	49083	27664	2.6691	0.0460	0.1983
2007	RATNB	7458.56	53052	31583	3.9920	0.0484	0.2194
2008	RATNB	8212.95	58579	36132	3.1479	0.0476	0.2462
2009	RATNB	10769.11	117044	50722	3.6220	0.0469	0.2256
2010	RATNB	18850	190520	89250	7.9713	0.0459	0.1652
2011	RATNB	41740	413230	233380	6.3328	0.0469	0.2937
2012	RATNB	84910	637620	557140	6.7294	0.0561	0.3436
1994	SOUINB	13710	60305	48891	0.6850	0.0762	0.4071
1995	SOUINB	17396	74277	66771	0.8852	0.0780	0.3970
1996	SOUINB	22244	102840	63196	1.1994	0.0858	0.2194
1997	SOUINB	27966	115436	82327	1.2249	0.1007	0.2451
1998	SOUINB	33482	146323	100613	1.4313	0.0944	0.2936
1999	SOUINB	40161	166466	119971	1.6851	0.0965	0.2864
2000	SOUINB	46322	202108	174883	2.3071	0.0881	0.2826
2001	SOUINB	50597	246836	199830	2.2806	0.0826	0.2965
2002	SOUINB	58110	323105	218058	2.2829	0.0769	0.2574
2003	SOUINB	62126	361294	299932	2.6580	0.0689	0.2563
2004	SOUINB	67346	419682	396208	3.6989	0.0574	0.2315
2005	SOUINB	63915	536526	313342	3.3032	0.0532	0.2407
2006	SOUINB	67719	637023	273938	3.7576	0.0471	0.2166
2007	SOUINB	82794.68	791891	343013	3.4444	0.0496	0.2428
2008	SOUINB	116316.5	1045375	457222	3.4654	0.0603	0.2406
2009	SOUINB	149251.5	1582292	715561	4.7353	0.0499	0.2023
2010	SOUINB	211740	2048870	892380	5.1575	0.0551	0.1069
2011	SOUINB	317900	2728070	939990	6.6448	0.0691	0.1327
2012	SOUINB	392070	3181550	1252350	7.7624	0.0692	0.1714

1994	TAMNB	7003	43210	20912	0.6914	0.0558	0.1882
1995	TAMNB	9616	63412	29306	0.8558	0.0579	0.1680
1996	TAMNB	12590	69580	34100	1.0704	0.0697	0.1379
1997	TAMNB	15192	74619	49698	1.1702	0.0819	0.1542
1998	TAMNB	18278	82547	66238	1.2914	0.0826	0.1490
1999	TAMNB	22864	97147	88605	1.5894	0.0822	0.1734
2000	TAMNB	28917	125504	123900	1.8890	0.0828	0.2057
2001	TAMNB	32466	158835	148532	1.9408	0.0791	0.2398
2002	TAMNB	37482	177266	181572	2.2792	0.0770	0.1676
2003	TAMNB	39523	195998	214211	2.5109	0.0727	0.1885
2004	TAMNB	43567	211398	235371	2.9497	0.0726	0.1840
2005	TAMNB	40646	262624	228556	3.1942	0.0582	0.2086
2006	TAMNB	43201	312639	236194	3.3152	0.0578	0.2256
2007	TAMNB	48964.42	404672	231641	3.9959	0.0563	0.2787
2008	TAMNB	66731.59	533132	255354	4.2496	0.0650	0.3384
2009	TAMNB	84771.6	828761	349919	5.3211	0.0550	0.3703
2010	TAMNB	112520	1075870	376710	7.7045	0.0598	0.4034
2011	TAMNB	158100	1377890	489030	7.4571	0.0701	0.3458
2012	TAMNB	202930	1625600	534830	7.6411	0.0787	0.3614

Annexure 4: Dataset Private Foreign Banks (Rs.Lakhs)

Year	Banks	Total cost	Q1	Q2	Price of Labour	Price of Fund	Price of Capital
1994	ADCOMB	1797	10161	9163	1.2623	0.0548	0.2283
1995	ADCOMB	2035	7792	17294	1.6500	0.0599	0.1982
1996	ADCOMB	3381	13499	11969	1.9344	0.1174	0.5183
1997	ADCOMB	4896	22538	11405	2.5432	0.1031	0.3844
1998	ADCOMB	4326	21625	11133	3.2405	0.0864	0.2993
1999	ADCOMB	5136	22761	21805	3.7246	0.0759	0.3398
2000	ADCOMB	6727	23662	24367	4.0423	0.0997	0.1241
2001	ADCOMB	11351	26643	127551	4.8873	0.0603	0.0137
2002	ADCOMB	17643	29913	128272	4.6098	0.0993	0.1319
2003	ADCOMB	18260	27370	132734	5.6282	0.0942	0.1515
2004	ADCOMB	15805	16758	135385	11.4324	0.0810	0.1728
2005	ADCOMB	18527	8985	125735	20.6750	0.0774	0.1700
2006	ADCOMB	11507	11861	14208	8.5263	0.1706	0.1584
2007	ADCOMB	5116.6	20345	14356	14.6944	0.0472	0.1832
2008	ADCOMB	5335.45	16209	16167	14.9103	0.0601	0.2070
2009	ADCOMB	3316.86	13731	19470	13.5168	0.0394	0.2350
2010	ADCOMB	3900	18030	22020	19.5349	0.0313	0.2586
2011	ADCOMB	5790	28920	22110	20.4255	0.0459	1.0435
2012	ADCOMB	9390	51980	23260	27.2549	0.0551	0.2609
1994	BOA	17900	81038	104745	6.2686	0.0599	0.3327
1995	BOA	21426	147636	81301	3.4925	0.0647	0.5046
1996	BOA	34466	202113	74908	3.9876	0.0780	0.2836
1997	BOA	43103	294259	131964	4.5640	0.0804	0.2583
1998	BOA	57759	384409	191697	5.3960	0.0770	0.2976
1999	BOA	73832	363314	220287	6.1544	0.0978	0.3409
2000	BOA	58727	365749	130146	31.8136	0.0864	0.2395
2001	BOA	47797	351673	129210	11.5288	0.0848	0.2411
2002	BOA	40040	293259	133206	13.0678	0.0736	0.2612
2003	BOA	30258	329814	130049	10.0382	0.0562	0.3009
2004	BOA	24195	305930	138144	12.3852	0.0395	0.2827
2005	BOA	21857	321913	159926	15.7746	0.0339	0.4519
2006	BOA	25968	336907	166375	19.6277	0.0413	0.6513
2007	BOA	30884.19	291621	188617	27.4993	0.0466	0.7007
2008	BOA	33057.95	345244	287771	28.7542	0.0315	0.6367
2009	BOA	32704.14	335594	367030	27.4533	0.0235	0.6410
2010	BOA	55600	585910	486060	67.2755	0.0250	0.5585
2011	BOA	82940	620540	822580	64.6037	0.0376	5.0095
2012	BOA	100380	762300	883350	61.6203	0.0438	0.5673

1994	BBK	1496	8118	9321	1.3261	0.0575	1.9841
1995	BBK	1591	11512	8348	1.1127	0.0567	0.6968
1996	BBK	2284	18045	5916	1.4935	0.0779	0.0594
1997	BBK	4265	22751	9002	1.4583	0.1143	0.2372
1998	BBK	4878	19910	12578	2.2073	0.1228	0.2511
1999	BBK	5194	21464	15362	2.7654	0.1181	0.3055
2000	BBK	5779	25496	15977	3.9222	0.1080	0.3013
2001	BBK	6174	31519	15975	4.3977	0.0933	0.3900
2002	BBK	6053	29019	23590	4.7473	0.0870	0.2927
2003	BBK	5648	35276	25483	5.5778	0.0771	0.2741
2004	BBK	4555	30374	31706	5.8889	0.0564	0.2929
2005	BBK	3497	26351	18948	6.3375	0.0423	0.3263
2006	BBK	3154	16898	12935	7.3971	0.0577	0.5272
2007	BBK	2801.2	17090	10893	5.6941	0.0471	0.6444
2008	BBK	3096.71	28032	12325	5.2793	0.0452	0.8766
2009	BBK	4177.63	28682	14902	6.0331	0.0526	0.6251
2010	BBK	4100	38290	23320	8.3000	0.0388	0.7063
2011	BBK	4750	64350	33950	8.9796	0.0324	1.7255
2012	BBK	6120	69260	32540	9.1579	0.0494	0.8364
1994	BNOVA	2058	19667	4124	1.8367	0.0799	0.2590
1995	BNOVA	2994	22053	4179	3.5606	0.0907	0.4263
1996	BNOVA	5464	30565	7756	2.6197	0.1190	0.6581
1997	BNOVA	6076	43188	11672	3.2000	0.0886	0.8502
1998	BNOVA	6995	50479	18104	3.4375	0.0767	0.6550
1999	BNOVA	9145	61442	17387	4.1146	0.0950	0.4591
2000	BNOVA	8839	87527	20683	4.3231	0.0642	0.5170
2001	BNOVA	16732	145141	60197	4.5364	0.0744	0.5468
2002	BNOVA	21190	188737	72523	4.6243	0.0708	0.5727
2003	BNOVA	19100	145977	65272	5.3351	0.0807	0.6728
2004	BNOVA	12910	201920	77244	6.3262	0.0358	0.7400
2005	BNOVA	14216	205320	89470	6.9733	0.0363	0.6846
2006	BNOVA	16353	244045	98071	7.1005	0.0408	0.8510
2007	BNOVA	21905.43	296907	109503	7.9726	0.0481	0.7544
2008	BNOVA	29816.32	477381	164440	8.3270	0.0416	0.8396
2009	BNOVA	42959.93	480528	172615	9.1688	0.0616	1.3137
2010	BNOVA	29210	629910	243850	12.0305	0.0299	0.7172
2011	BNOVA	45370	660560	348310	13.6923	0.0401	2.7526
2012	BNOVA	53950	776610	484220	15.9487	0.0382	1.3908

1994	BOT	5514	44666	22103	1.8367	0.0656	0.2531
1995	BOT	6102	54422	25381	2.3735	0.0625	0.7279
1996	BOT	12791	96160	29094	2.8764	0.0839	0.6358
1997	BOT	14530	109340	35405	3.2911	0.0870	0.2271
1998	BOT	13653	70552	31158	4.4138	0.0980	0.2359
1999	BOT	49033	49786	30419	4.8492	0.0810	0.1452
2000	BOT	18724	39105	21992	4.8147	0.0868	0.1885
2001	BOT	8292	51200	19811	6.3082	0.0613	0.2153
2002	BOT	11311	69872	30518	6.3135	0.0510	0.2877
2003	BOT	9967	43886	20510	14.5893	0.0840	0.3288
2004	BOT	6156	42751	32300	14.7006	0.0330	0.4523
2005	BOT	4968	55886	34246	9.3396	0.0243	0.3164
2006	BOT	7198	103351	44876	16.1887	0.0281	0.2664
2007	BOT	8938.11	158857	52237	16.6583	0.0301	0.2953
2008	BOT	10736.67	230707	58874	11.5019	0.0339	0.3198
2009	BOT	21513.6	299132	87511	19.6884	0.0558	0.2245
2010	BOT	13600	526730	90590	14.8431	0.0177	0.3805
2011	BOT	29840	645250	342950	20.5861	0.0229	1.8548
2012	BOT	46070	683950	446080	23.8730	0.0310	0.3736
1994	BNPB	5011	25105	19169	1.6794	0.0868	0.0368
1995	BNPB	6120	29513	11351	2.2023	0.1186	0.0294
1996	BNPB	8909	52985	16754	5.5087	0.0825	0.0587
1997	BNPB	8804	59920	35217	3.8032	0.0587	0.0840
1998	BNPB	12698	58197	67347	4.7166	0.0561	0.0913
1999	BNPB	16767	59539	96710	6.1672	0.0641	0.0999
2000	BNPB	21049	67511	105928	7.0378	0.0800	0.1343
2001	BNPB	26798	106194	104007	7.7077	0.0840	0.1274
2002	BNPB	34196	152142	148524	11.1047	0.0635	0.0966
2003	BNPB	27959	142271	91786	12.1685	0.0745	0.0627
2004	BNPB	18678	131490	100141	12.6555	0.0421	0.0689
2005	BNPB	18727	171876	86065	14.7580	0.0408	0.1149
2006	BNPB	21732	185382	110810	16.5050	0.0413	0.1416
2007	BNPB	30180.07	234172	111965	20.0951	0.0601	0.2660
2008	BNPB	43213.96	377161	269027	26.5141	0.0496	0.3251
2009	BNPB	46569.45	370988	356175	26.2653	0.0396	0.1255
2010	BNPB	52650	545070	380650	33.9702	0.0324	0.3425
2011	BNPB	76180	618420	338660	37.5146	0.0507	0.3795
2012	BNPB	79640	773730	456430	40.9009	0.0439	0.4089

1994	BARCB	3214	15509	4568	2.4545	0.1596	0.3891
1995	BARCB	4163	19679	5923	5.2419	0.1337	0.1146
1996	BARCB	6815	21930	6201	6.9155	0.1944	0.1086
1997	BARCB	5838	17606	16959	8.9189	0.1198	0.1511
1998	BARCB	5913	7173	14320	13.9846	0.1690	0.1144
1999	BARCB	5145	5093	26438	13.0000	0.0992	0.1148
2000	BARCB	4023	4763	20009	10.8182	0.1045	0.1818
2001	BARCB	3730	1086	24659	14.1500	0.0669	0.2049
2002	BARCB	4396	685	31879	20.4000	0.0636	0.2199
2003	BARCB	4006	230	48389	30.7647	0.0577	0.3994
2004	BARCB	3216	256	44687	55.4706	0.0368	0.2522
2005	BARCB	3993	242	41792	46.7436	0.0416	0.4397
2006	BARCB	7999	433	58457	75.6889	0.0605	2.8639
2007	BARCB	19910.56	17270	134205	31.3708	0.0425	0.9769
2008	BARCB	101543.7	763552	285663	12.1199	0.0435	0.5706
2009	BARCB	187096.9	1055051	788312	17.2633	0.0660	0.5128
2010	BARCB	159300	831130	1255340	32.5153	0.0475	1.1452
2011	BARCB	164030	865700	1160000	53.0328	0.0556	1.5206
2012	BARCB	150010	847230	1382320	69.5652	0.0566	2.2685
1994	CITI	66226	225762	319758	3.5291	0.0613	0.1476
1995	CITI	65307	279130	260875	3.0437	0.0629	0.1728
1996	CITI	82422	347864	231655	3.5643	0.0737	0.0064
1997	CITI	102985	398438	232872	4.9297	0.0845	0.0076
1998	CITI	112677	476683	255652	5.0891	0.0809	0.1724
1999	CITI	135843	499955	377379	6.5947	0.0836	0.0717
2000	CITI	134601	662017	423012	8.1040	0.0715	0.0760
2001	CITI	157956	927288	560328	9.4322	0.0585	0.0864
2002	CITI	186022	1138520	600686	11.0571	0.0604	0.1052
2003	CITI	186703	1262869	703593	11.6983	0.0487	0.1083
2004	CITI	193327	1525913	668960	12.4916	0.0385	0.1501
2005	CITI	197498	1811092	811984	8.8566	0.0276	0.1536
2006	CITI	253036	2445528	1055575	10.5914	0.0279	0.1559
2007	CITI	354902.5	3286111	1602115	10.8159	0.0336	0.1506
2008	CITI	449079.4	3837652	1845008	14.7895	0.0403	0.1946
2009	CITI	501606.7	3991994	2451935	18.3653	0.0345	0.1577
2010	CITI	493970	4059700	3039850	18.7937	0.0287	0.1702
2011	CITI	568890	4710300	4316670	20.4965	0.0308	0.1803
2012	CITI	663300	5203550	4407660	19.6668	0.0380	0.0905

1994	DBS	79	10	1762	1.0000	0.0013	0.2185
1995	DBS	79	10	1762	1.0000	0.1587	0.2781
1996	DBS	872	7733	821	4.0000	0.0636	17.7059
1997	DBS	1138	4975	1057	4.9333	0.1160	24.1019
1998	DBS	1496	7046	4771	4.8065	0.1142	0.3796
1999	DBS	2381	3811	11549	5.3226	0.1198	1.0242
2000	DBS	2169	18748	9806	6.0625	0.0633	1.8773
2001	DBS	3476	18361	10434	8.0313	0.0721	1.3701
2002	DBS	3390	23833	12400	10.8333	0.0579	1.4157
2003	DBS	2509	19174	7630	12.6897	0.0703	0.7500
2004	DBS	2054	10873	24542	12.1724	0.0357	1.3554
2005	DBS	2698	55997	25022	16.7742	0.0120	0.8143
2006	DBS	9949	89165	55132	17.4231	0.0291	0.5830
2007	DBS	31658.42	122978	107847	24.7117	0.0555	0.6474
2008	DBS	48157.06	236414	451238	24.1105	0.0538	2.0124
2009	DBS	65874.12	272285	781066	25.4918	0.0459	1.2526
2010	DBS	86340	752420	1031310	20.1936	0.0327	1.0649
2011	DBS	145710	1284430	1478060	24.7201	0.0377	1.1262
2012	DBS	202400	1385810	1816730	25.7594	0.0475	1.3239
1994	DEUTB	7683	48257	38233	3.3239	0.0648	0.1372
1995	DEUTB	13042	93290	37536	3.2219	0.0709	0.0421
1996	DEUTB	20096	114122	35058	4.6593	0.0953	0.0057
1997	DEUTB	22958	169349	62997	5.0611	0.0624	0.0037
1998	DEUTB	29587	164335	105836	6.9798	0.0761	0.0625
1999	DEUTB	36542	163514	166626	9.1098	0.0591	0.0743
2000	DEUTB	41953	176212	209930	11.1043	0.0638	0.0782
2001	DEUTB	47071	209668	242958	12.4242	0.0555	0.0990
2002	DEUTB	43129	188803	186132	14.2045	0.0543	0.0842
2003	DEUTB	34102	160764	245874	15.1926	0.0379	0.1271
2004	DEUTB	40027	209806	227718	10.4984	0.0316	0.1337
2005	DEUTB	57943	254058	225387	20.0842	0.0355	0.2271
2006	DEUTB	83443	258178	326085	24.0000	0.0393	0.2517
2007	DEUTB	121145.7	494506	620353	16.9340	0.0336	0.3768
2008	DEUTB	159095.8	896013	1017124	14.0778	0.0288	0.4571
2009	DEUTB	174300.9	879763	870486	26.5297	0.0331	0.2468
2010	DEUTB	158500	1429380	859840	37.6118	0.0237	0.3630
2011	DEUTB	164500	1254890	842150	36.6321	0.0326	0.3089
2012	DEUTB	181770	2237410	1060120	30.5731	0.0245	0.3710

1994	HSBC	29587	114384	151047	1.4292	0.0686	0.0253
1995	HSBC	34763	160479	141625	1.8846	0.0592	0.0305
1996	HSBC	44434	214590	146063	2.2792	0.0732	0.0124
1997	HSBC	54796	221923	186048	2.3878	0.0847	0.0141
1998	HSBC	58031	280847	222113	2.8774	0.0644	0.0738
1999	HSBC	77340	279481	346477	3.5909	0.0687	0.0830
2000	HSBC	94294	430237	491856	3.6211	0.0603	0.0876
2001	HSBC	126374	624609	579219	4.8932	0.0643	0.0953
2002	HSBC	149945	783582	627441	4.6078	0.0623	0.0893
2003	HSBC	149234	820214	886955	7.0144	0.0550	0.0924
2004	HSBC	134707	962808	1039538	7.3949	0.0384	0.0928
2005	HSBC	134292	1262061	916888	6.7489	0.0318	0.1053
2006	HSBC	185311	1681230	1214193	8.4658	0.0295	0.1518
2007	HSBC	279787.2	2314168	1413083	9.3986	0.0306	0.1483
2008	HSBC	416104	2994440	1928993	11.4896	0.0396	0.1584
2009	HSBC	485567.1	2758869	3115382	11.7417	0.0455	0.1712
2010	HSBC	405000	2740060	3727910	13.7204	0.0314	0.1460
2011	HSBC	486880	3551230	4032380	18.1940	0.0341	0.1599
2012	HSBC	546520	3570870	4517870	23.0703	0.0402	0.1587
1994	JPMC	764	10	1079	8.8065	0.0394	0.1865
1995	JPMC	764	10	1079	8.8065	0.0394	0.3005
1996	JPMC	920	10	275	11.9231	0.0060	3.5279
1997	JPMC	493	10	4028	2.8571	0.0079	11.6536
1998	JPMC	1350	10	5150	7.6129	0.0660	1.8169
1999	JPMC	2341	461	6686	4.4561	0.1575	1.9153
2000	JPMC	3339	1150	28097	9.5192	0.0525	0.3378
2001	JPMC	3343	1674	22563	13.2381	0.0711	0.4609
2002	JPMC	3862	324	14520	37.7097	0.0751	1.1818
2003	JPMC	2442	7662	52939	21.7955	0.0194	1.9750
2004	JPMC	3232	7662	29537	22.1607	0.0216	1.8095
2005	JPMC	4321	15000	38023	19.5224	0.0161	1.2134
2006	JPMC	9405	7565	216343	24.0610	0.0226	1.4444
2007	JPMC	19791.71	79925	436670	25.4779	0.0259	2.8055
2008	JPMC	33152.92	105933	614277	48.7082	0.0350	1.8015
2009	JPMC	36860.74	70255	669440	44.7057	0.0328	3.0918
2010	JPMC	45150	346270	994040	58.3258	0.0241	2.0300
2011	JPMC	65330	452930	1330380	50.2344	0.0299	4.2581
2012	JPMC	95600	534450	1769130	52.2222	0.0407	7.8500

1994	OMINB	1745	13184	5152	1.1077	0.0661	0.3681
1995	OMINB	2105	16230	5198	1.4286	0.0721	0.6667
1996	OMINB	3077	15778	5414	1.7627	0.0935	0.4076
1997	OMINB	3984	21700	7413	2.4462	0.0977	0.0114
1998	OMINB	4460	17119	8582	2.3766	0.1285	0.0120
1999	OMINB	4999	20318	13635	2.2895	0.1124	0.0156
2000	OMINB	6061	22410	13751	2.5949	0.1215	0.0158
2001	OMINB	4935	11639	11045	3.4242	0.0949	0.0173
2002	OMINB	4976	4828	13398	4.0923	0.0926	0.0210
2003	OMINB	4118	2789	11049	8.4103	0.0883	0.0209
2004	OMINB	2871	1744	14171	4.4000	0.0698	0.0182
2005	OMINB	2004	1273	12757	3.9429	0.0592	0.0253
2006	OMINB	1935	771	11453	5.7308	0.0589	0.0253
2007	OMINB	1859.21	177	10444	4.5854	0.0576	0.0302
2008	OMINB	1798.52	147	9320	4.6514	0.0576	0.0327
2009	OMINB	1529.19	192	9435	4.4387	0.0425	0.0361
2010	OMINB	1550	220	9270	6.2162	0.0383	0.0402
2011	OMINB	1740	410	7730	7.1053	0.0498	0.0092
2012	OMINB	1900	510	4010	11.2121	0.0510	0.0123
1994	SGB	2581	15264	29420	1.6167	0.0416	2.4222
1995	SGB	6706	32182	34239	2.1282	0.0830	3.1954
1996	SGB	12266	59909	24307	3.3111	0.1049	0.0147
1997	SGB	13213	55898	24506	4.1683	0.1376	0.0185
1998	SGB	10782	45951	30253	4.6273	0.1077	0.0225
1999	SGB	10115	28954	23632	7.4105	0.1364	0.0236
2000	SGB	7826	23305	31575	8.4607	0.1043	0.0276
2001	SGB	5827	18636	21020	8.7126	0.0723	0.0323
2002	SGB	5125	14944	14620	9.1558	0.0769	0.0303
2003	SGB	3714	8681	27616	14.3636	0.0514	0.0296
2004	SGB	3057	17083	45939	10.9492	0.0284	0.0333
2005	SGB	3815	15920	59332	13.0000	0.0406	0.0661
2006	SGB	8216	27085	108742	15.0000	0.0360	0.1087
2007	SGB	16546.67	38487	145672	25.3117	0.0472	0.1772
2008	SGB	22623.48	38454	251649	28.1656	0.0608	0.2963
2009	SGB	14569.47	36584	153975	27.8854	0.0460	0.2940
2010	SGB	16860	69950	207750	32.0482	0.0438	0.2458
2011	SGB	17730	105640	184620	26.2766	0.0571	0.1758
2012	SGB	19450	175690	113540	33.5354	0.0537	0.1243

1994	STANCB	37471	85830	134524	1.8708	0.1035	0.0584
1995	STANCB	34262	103512	94667	2.5084	0.0859	0.0632
1996	STANCB	45934	201846	88336	4.4307	0.0730	0.0552
1997	STANCB	59865	259471	143311	4.0728	0.0787	0.0618
1998	STANCB	72810	317974	152760	3.0284	0.0901	0.0788
1999	STANCB	83652	338122	271977	3.3747	0.0839	0.0731
2000	STANCB	86057	431886	314007	4.5391	0.0759	0.1008
2001	STANCB	103888	518690	540126	5.9946	0.0623	0.1092
2002	STANCB	138296	903290	701715	8.6209	0.0564	0.1946
2003	STANCB	173238	1304179	1022296	4.4947	0.0505	0.0675
2004	STANCB	184557	1615226	1007870	4.9399	0.0411	0.1000
2005	STANCB	194963	1997032	1016018	5.4622	0.0384	0.0914
2006	STANCB	239126	2407673	1063173	6.3008	0.0327	0.0501
2007	STANCB	305556.5	3010380	1190229	8.8667	0.0408	0.1088
2008	STANCB	418052.8	3335153	1278726	8.8502	0.0485	0.0849
2009	STANCB	498932.2	3748913	1555156	13.4469	0.0485	0.0634
2010	STANCB	494750	4920080	2308820	16.1359	0.0339	0.0594
2011	STANCB	643120	5557000	2732390	17.7747	0.0482	0.0476
2012	STANCB	697330	6195430	3074710	17.8855	0.0508	0.0463

Annexure 5: Paid Up Capital of Banks

PSB	CAPITAL	PDB	CAPITAL	PFB	CAPITAL
SBH	1799	TAMNB	28	ADCOMB	3298
SBM	3518	CATSYRB	1357	BBK	5740
SBT	4526	NAINB	2118	OMINB	10634
SBJ	4760	CITYUNIB	2390	BNOVA	17628
SBP	9476	KVYSB	3079	SGB	20387
CORPB	13129	LVILB	3335	BNPB	34363
OBC	21703	DLAXB	3475	BOA	36316
DENB	25417	JKB	3866	DBS	44107
PNB	30441	INGVYSB	5420	BOT	56453
BOB	38710	SOUINB	5463	STANCB	59978
ALLB	39175	RATNB	5910	JPMC	75512
PNSB	44435	FEDB	6887	CITI	101492
UNIONB	44460	KARB	7202	DEUTB	122525
ANDB	45747	AXISB	23510	HSBC	146517
CANB	48615	INDUSB	25532	BARCB	151443
SBI	55092	HDFC	30691		
BOM	57799	ICICI	72418		
VIJB	62210				
IOB	63261				
BOI	65724				
SYNB	67732				
UNITEDB	147944				
UCOB	162592				
CENB	163646				
INDB	187100				

Annexure 6: Employment in Banks

BANKS	NO. OF EMPLOYEES	BANKS	NO. OF EMPLOYEES	BANKS	NO. OF EMPLOYEES
SBM	10323	NAINB	658	OMINB	51
PNSB	10358	RATNB	669	ADCOMB	57
CORPB	11037	DLAXB	1601	BBK	86
SBT	12255	CITYUNIB	1785	SGB	89
DENB	12258	LVILB	2115	JPMC	94
SBP	12551	TAMNB	2257	BNOVA	150
VIJB	12664	INDUSB	2530	DBS	184
SBJ	13352	CATSYRB	2960	BOT	238
SBH	13802	KVYSB	3255	BNPB	331
ANDB	14348	SOUINB	4155	BARCB	342
OBC	14540	KARB	4420	BOA	394
BOM	15091	INGVYSB	5929	DEUTB	937
UNITEDB	18814	FEDB	6684	CITI	2806
ALLB	21236	JKB	6782	HSBC	4056
INDB	23072	AXISB	8690	STANCB	4553
IOB	26503	HDFC	18457		
UCOB	27930	ICICI	19499		
UNIONB	29126				
SYNB	30136				
BOB	42049				
CENB	42881				
BOI	46126				
CANB	48904				
PNB	61990				
SBI	216983				

Annexure 7: Branches

BANKS	BRANCHES	BANKS	BRANCHES	BANKS	BRANCHES
SBM	646	NAINB	72	JPMC	1
SBT	743	RATNB	78	ADCOMB	2
SBP	771	INDUSB	139	BBK	2
PNSB	841	CITYUNIB	164	OMINB	2
SBJ	863	DLAXB	192	SGB	3
CORPB	884	TAMNB	197	BOT	3
SBH	1016	LVILB	244	BARCB	4
VIJB	1022	KVYSB	285	DBS	4
DENB	1148	CATSYRB	327	BNOVA	4
OBC	1194	KARB	408	BOA	5
ANDB	1255	INGVYSB	422	DEUTB	8
BOM	1348	JKB	451	BNPB	8
UNITEDB	1414	SOUINB	468	CITI	25
INDB	1597	AXISB	498	HSBC	36
IOB	1777	FEDB	548	STANCB	62
UCOB	1957	HDFC	747		
SYNB	2076	ICICI	854		
ALLB	2139				
UNIONB	2331				
CANB	2740				
BOI	2923				
BOB	2930				
CENB	3416				
PNB	4344				
SBI	10467				

Annexure 8: Bank Deposits

BANKS	DEPOSITS	BANKS	DEPOSITS	BANKS	DEPOSITS
SBM	1768534	NAINB	118012	ADCOMB	78875
PNSB	2201915	RATNB	129270	BOA	321649
SBJ	2255901	DLAXB	355654	BBK	38937
SBT	2575017	CATSYRB	430314	BNOVA	190425
DENB	2742561	LVILB	462580	BOT	122999
SBP	2971503	CITYUNIB	484653	BNPB	208171
VIJB	3010334	TAMNB	591772	BARCB	208296
BOM	3020266	KVYSB	960272	CITI	2600097
UNITEDB	3336407	SOUINB	1163284	DBS	283119
SBH	3478013	KARB	1180882	DEUTB	608605
ANDB	3624887	INGVYSB	1411071	HSBC	2253810
CORPB	4256918	INDUSB	1448677	JPMC	198994
INDB	4461330	FEDB	1791282	OMINB	25299
ALLB	5170963	JKB	2039800	SGB	68284
OBC	5433483	AXISB	5638782	STANCB	2238978
UCOB	5556000	HDFC	6602363		
SYNB	5823526	ICICI	10094488		
IOB	6007617				
CENB	7626594				
UNIONB	7902535				
BOI	11342658				
CANB	11739984				
BOB	12407905				
PNB	12497567				
SBI	40516653				

Annexure 9: Average values for different indices: Public Sector Banks

Banks	C	Q_1	Q_2	r_1	r_2	r_3
SBI	3612183	29036760	15614353	6.711296	0.063344	0.314212
SBJ	202470.1	1602124	769163.2	3.149997	0.066241	0.389692
SBH	275208.8	2376540	1295122	3.238825	0.062841	0.320274
SBM	158921.7	1283448	597793.5	2.874294	0.065151	0.457687
SBP	250400.5	2122786	957922.9	2.522721	0.062533	0.356435
SBT	227492.4	1861673	931106.5	2.927047	0.072151	0.384873
ALLB	415946.7	3338158	1891547	3.195151	0.063071	0.148047
ANDB	299736.8	2505430	1208569	3.325217	0.062974	0.355451
BOB	857676.6	8264261	3602937	3.515799	0.057759	0.177077
BOI	856579.6	8033404	3397438	3.30769	0.056927	0.161942
BOM	250234.6	1892062	1167961	3.334208	0.061912	0.243306
CANB	940599.9	7554109	3867307	3.028215	0.061868	0.210038
CENB	634052.1	4742093	2799317	3.197073	0.061215	0.102707
CORPB	326602.9	2914564	1570880	2.869446	0.058829	0.305572
DENB	224906.9	1753364	1004279	3.397971	0.065633	0.140564
INDB	375921.1	2853795	1676205	3.549601	0.0667	0.112831
IOB	514388.1	4118044	2147392	3.278267	0.064255	0.205555
OBC	437537.7	3565837	1954051	3.0727	0.065403	0.386835
PNSB	194581.5	1383243	816026.2	3.967851	0.06587	0.24757
PNB	999158.9	8622133	4473565	3.432429	0.059334	0.12302
SYNB	467227.2	4001887	1838638	3.318914	0.058636	0.174914
UCOB	443584.3	3635460	1939901	2.913857	0.064096	0.127507
UNIONB	619978.5	5508377	2610254	3.302243	0.061454	0.134086
UNITEDB	269933.9	1871521	1421153	2.934649	0.063769	0.125966
VIJB	249665.4	1876007	1128879	3.212609	0.062079	0.224119

Annexure 10: Average values for different indices: Private Domestic Banks

Banks	C	Q_1	Q_2	r_1	r_2	r_3
AXISB	470366.3	4005679	2389541	3.304399	0.058897	0.287642
CATSYRB	42855.44	260537.8	144840.2	3.151423	0.073318	0.257779
CITYUNIB	41722.85	336240.7	146151.6	1.920489	0.071631	0.234713
DLAXB	35793.17	236621.6	120822.1	2.990786	0.070508	0.278565
FEDB	154544.7	1259587	653852.9	2.873172	0.070641	0.186963
HDFC	594600.6	4803684	2782104	3.582486	0.047724	0.223222
ICICI	1174655	9556482	5394828	3.433157	0.061203	0.106909
INDUSB	147432	1048165	516866.6	3.212778	0.068439	0.140938
INGVYSB	141996.6	993398.6	523773.6	3.581838	0.069708	0.104739
JKB	143647.7	1190044	815083.6	2.634012	0.057101	0.171776
KARB	103738.9	722994.8	485199.5	2.670104	0.070875	0.234103
KVYSB	83834.73	687171.4	321975.5	2.458954	0.06759	0.139938
LVILB	43847.84	318355	147870.3	2.455813	0.070236	0.204846
NAINB	9090.574	57739.6	39514.06	2.716272	0.056832	0.408654
RATNB	12098.24	92941.75	64324.02	2.816487	0.064039	0.192293
SOUINB	96903.51	777382.6	366235.6	3.084692	0.071533	0.248787
TAMNB	53966.45	406352.8	204983.1	3.21668	0.069224	0.236238

Annexure 11: Average values for different indices: Private Foreign Banks

Banks	C	Q_1	Q_2	r_1	r_2	r_3
ADCOMB	8117.89	20672.79	46758.1	9.710165	0.076786	0.267294
BOA	43836.54	353643.3	254071.9	22.17395	0.056905	0.661054
BBK	4190.186	28549.36	17530.06	4.846089	0.070249	0.597524
BNOVA	19225.46	250945.1	108927.3	6.585678	0.063812	0.824265
BOT	15733.55	177663.3	76634.5	10.47611	0.054635	0.406771
BNPB	29256.92	219035	152985.1	15.33025	0.061545	0.157571
BARCB	44439.06	235506.2	281585.3	27.39046	0.085206	0.66048
CITI	258229	1952124	1271872	10.62681	0.051883	0.124099
DBS	32233.14	227056.4	306996.8	13.15978	0.062482	3.121116
DEUTB	75625.71	494858.9	388444.4	15.90645	0.048563	0.181596
HSBC	204893	1356110	1351846	7.621561	0.051682	0.099797
JPMC	17497.97	85858.46	328118.7	24.84962	0.041205	2.613713
OMINB	3034.048	7970.457	9643.528	4.327143	0.076434	0.093988
SGB	10580.14	43611.41	80652.97	14.53299	0.069976	0.386217
STANCB	237466.3	1960615	983726.9	7.505143	0.060153	0.079718

Annexure 12: Residuals of the First step OLS

Bank	Residual	Bank	Residual	Bank	Residual	Bank	Residual
SBI	-0.2367	SBJ	0.0203	SBH	0.0284	SBM	0.0569
SBI	-0.2002	SBJ	0.0632	SBH	0.0112	SBM	0.0813
SBI	-0.1927	SBJ	0.1701	SBH	0.0292	SBM	0.1780
SBI	-0.1535	SBJ	0.0550	SBH	0.0000	SBM	0.1055
SBI	-0.1770	SBJ	0.0278	SBH	-0.0257	SBM	0.1011
SBI	-0.0710	SBJ	0.0698	SBH	-0.0303	SBM	0.1693
SBI	-0.1247	SBJ	0.0505	SBH	-0.0302	SBM	0.1559
SBI	-0.0539	SBJ	0.0743	SBH	-0.0276	SBM	0.1138
SBI	-0.0549	SBJ	0.0190	SBH	-0.0464	SBM	0.0362
SBI	-0.0589	SBJ	0.0270	SBH	-0.0378	SBM	0.0381
SBI	-0.0328	SBJ	0.0628	SBH	-0.0487	SBM	0.0598
SBI	-0.0455	SBJ	0.0838	SBH	0.0148	SBM	0.1263
SBI	-0.0677	SBJ	0.1681	SBH	0.0108	SBM	0.1350
SBI	-0.0818	SBJ	0.1300	SBH	-0.0088	SBM	0.0858
SBI	-0.1392	SBJ	0.0486	SBH	-0.0485	SBM	0.0791
SBI	-0.1207	SBJ	0.0518	SBH	-0.0487	SBM	-0.0494
SBI	-0.0546	SBJ	0.1979	SBH	0.0203	SBM	0.0058
SBI	-0.0584	SBJ	0.1208	SBH	0.0035	SBM	0.0549
SBI	-0.0730	SBJ	0.1520	SBH	0.0447	SBM	-0.0190
SBT	-0.1175	ALLB	-0.0351	ANDB	0.1609	BOB	-0.1641
SBT	-0.1112	ALLB	0.0433	ANDB	0.1635	BOB	-0.1057
SBT	-0.0022	ALLB	0.0757	ANDB	0.1425	BOB	-0.1042
SBT	-0.0276	ALLB	0.0624	ANDB	0.1280	BOB	-0.0681
SBT	-0.0400	ALLB	0.0369	ANDB	0.1139	BOB	-0.0372
SBT	-0.0183	ALLB	0.0129	ANDB	0.0950	BOB	0.0153
SBT	-0.0016	ALLB	0.0069	ANDB	0.0804	BOB	0.0187
SBT	-0.0335	ALLB	0.0564	ANDB	0.0428	BOB	0.0496
SBT	-0.0554	ALLB	0.0346	ANDB	-0.0187	BOB	-0.0463
SBT	-0.0983	ALLB	0.0801	ANDB	-0.0107	BOB	-0.0504
SBT	-0.0937	ALLB	0.0863	ANDB	0.0565	BOB	0.0027
SBT	-0.0523	ALLB	0.0253	ANDB	0.1269	BOB	0.0359
SBT	-0.0578	ALLB	-0.0100	ANDB	0.1312	BOB	0.0606
SBT	-0.0137	ALLB	-0.1105	ANDB	0.0604	BOB	0.0353
SBT	-0.0163	ALLB	-0.1245	ANDB	0.0314	BOB	-0.0685
SBT	0.0259	ALLB	-0.1217	ANDB	0.0447	BOB	-0.0438
SBT	0.0520	ALLB	-0.0486	ANDB	0.0927	BOB	-0.0081
SBT	0.0696	ALLB	-0.0323	ANDB	0.0588	BOB	-0.0091
SBT	0.0514	ALLB	-0.0157	ANDB	0.0630	BOB	-0.0048

Bank	Residual	Bank	Residual	Bank	Residual	Bank	Residual
SBP	0.0110	BOM	0.0917	CANB	-0.0355	CENB	0.1242
SBP	-0.0057	BOM	0.0525	CANB	-0.0488	CENB	0.0628
SBP	0.0896	BOM	0.1082	CANB	-0.0210	CENB	0.0867
SBP	0.0265	BOM	0.1054	CANB	0.0168	CENB	0.0866
SBP	0.0251	BOM	0.1322	CANB	0.0096	CENB	0.0522
SBP	0.0047	BOM	0.1567	CANB	0.0315	CENB	0.0399
SBP	-0.0565	BOM	0.1120	CANB	0.0075	CENB	0.0326
SBP	0.0448	BOM	0.1357	CANB	0.0954	CENB	0.0488
SBP	-0.0604	BOM	0.0496	CANB	0.0254	CENB	0.0437
SBP	-0.0958	BOM	0.0555	CANB	-0.0685	CENB	0.0279
SBP	-0.1037	BOM	0.0446	CANB	-0.0190	CENB	0.0942
SBP	-0.0657	BOM	0.1090	CANB	-0.0545	CENB	0.1096
SBP	-0.0384	BOM	0.0145	CANB	-0.0272	CENB	0.0387
SBP	-0.0324	BOM	0.0446	CANB	-0.1644	CENB	0.0145
SBP	-0.0445	BOM	0.0482	CANB	-0.1815	CENB	-0.1181
SBP	0.0162	BOM	-0.0188	CANB	-0.1964	CENB	-0.1606
SBP	0.0896	BOM	0.0497	CANB	-0.1239	CENB	-0.0464
SBP	0.0788	BOM	0.0647	CANB	-0.0039	CENB	-0.0921
SBP	0.0908	BOM	-0.0560	CANB	-0.0860	CENB	-0.1019
BOI	-0.0894	INDB	-0.1073	IOB	-0.0982	OBC	-0.1005
BOI	-0.0193	INDB	-0.1444	IOB	0.0327	OBC	-0.0393
BOI	-0.0624	INDB	-0.0013	IOB	-0.0228	OBC	-0.0591
BOI	-0.0440	INDB	0.0463	IOB	0.0266	OBC	-0.0389
BOI	-0.0473	INDB	-0.0122	IOB	0.0655	OBC	-0.0664
BOI	-0.0189	INDB	0.0574	IOB	0.0906	OBC	-0.0268
BOI	0.0095	INDB	0.0921	IOB	0.0518	OBC	0.0093
BOI	-0.0399	INDB	0.0867	IOB	0.0683	OBC	0.0174
BOI	-0.0961	INDB	0.0177	IOB	0.0197	OBC	-0.0391
BOI	-0.0941	INDB	0.0144	IOB	0.0139	OBC	-0.0514
BOI	-0.0417	INDB	0.1017	IOB	0.0304	OBC	-0.0531
BOI	-0.0385	INDB	0.0190	IOB	0.0370	OBC	0.0258
BOI	-0.0068	INDB	0.0637	IOB	-0.0016	OBC	-0.0248
BOI	0.0353	INDB	0.0094	IOB	0.0027	OBC	-0.0563
BOI	-0.1381	INDB	0.0171	IOB	-0.0224	OBC	-0.0550
BOI	-0.1296	INDB	-0.1129	IOB	-0.0943	OBC	-0.1377
BOI	-0.0674	INDB	-0.1173	IOB	-0.0731	OBC	-0.2175
BOI	-0.1087	INDB	-0.1009	IOB	-0.0423	OBC	-0.1067
BOI	-0.0431	INDB	-0.0494	IOB	-0.0478	OBC	-0.0597

Bank	Residual	Bank	Residual	Bank	Residual	Bank	Residual
CORPB	0.0069	DENB	0.0122	SYNB	0.0848	UCO	-0.0197
CORPB	0.1360	DENB	0.0540	SYNB	0.1857	UCO	0.0181
CORPB	0.1115	DENB	0.0504	SYNB	0.1301	UCO	0.1293
CORPB	-0.0190	DENB	-0.0435	SYNB	0.1536	UCO	0.1096
CORPB	-0.0244	DENB	-0.0352	SYNB	0.1540	UCO	0.1073
CORPB	-0.0804	DENB	-0.0870	SYNB	0.1302	UCO	0.1161
CORPB	-0.0928	DENB	-0.0979	SYNB	0.0483	UCO	0.0661
CORPB	-0.0412	DENB	0.0569	SYNB	0.1149	UCO	0.0217
CORPB	-0.0750	DENB	-0.0263	SYNB	0.0828	UCO	0.0316
CORPB	-0.0860	DENB	-0.0371	SYNB	0.0827	UCO	-0.0016
CORPB	-0.0363	DENB	-0.0465	SYNB	0.1507	UCO	-0.0378
CORPB	0.0365	DENB	0.0394	SYNB	0.0238	UCO	0.0075
CORPB	0.0572	DENB	0.0296	SYNB	0.0925	UCO	-0.1041
CORPB	0.0097	DENB	0.0216	SYNB	-0.0662	UCO	-0.0886
CORPB	-0.0106	DENB	0.0091	SYNB	-0.0776	UCO	-0.0993
CORPB	-0.0536	DENB	-0.0223	SYNB	-0.0532	UCO	-0.1587
CORPB	-0.0400	DENB	0.0164	SYNB	0.0272	UCO	-0.0609
CORPB	-0.0008	DENB	-0.0001	SYNB	-0.0330	UCO	-0.0857
CORPB	0.0006	DENB	-0.0636	SYNB	-0.0072	UCO	-0.0890
PNSB	0.0420	PNB	-0.0591	UNIONB	-0.0210	UNITEDB	0.1066
PNSB	0.0104	PNB	-0.0751	UNIONB	0.0135	UNITEDB	0.1292
PNSB	0.1149	PNB	-0.0464	UNIONB	0.0020	UNITEDB	0.2091
PNSB	0.1088	PNB	-0.0854	UNIONB	-0.0127	UNITEDB	0.2185
PNSB	0.0692	PNB	-0.0297	UNIONB	0.0014	UNITEDB	0.2175
PNSB	0.0770	PNB	-0.0066	UNIONB	0.0421	UNITEDB	0.3837
PNSB	0.0984	PNB	-0.0227	UNIONB	0.0159	UNITEDB	0.3545
PNSB	0.1214	PNB	-0.0112	UNIONB	-0.0226	UNITEDB	0.1866
PNSB	0.1123	PNB	-0.0793	UNIONB	-0.0862	UNITEDB	0.0939
PNSB	0.1410	PNB	-0.0487	UNIONB	-0.1444	UNITEDB	0.1282
PNSB	0.2639	PNB	-0.0161	UNIONB	-0.1344	UNITEDB	0.1626
PNSB	0.2703	PNB	0.0182	UNIONB	-0.0972	UNITEDB	0.2032
PNSB	0.1205	PNB	0.0941	UNIONB	-0.1202	UNITEDB	0.2010
PNSB	0.0967	PNB	0.0044	UNIONB	-0.1261	UNITEDB	0.3344
PNSB	-0.0273	PNB	-0.1217	UNIONB	-0.1917	UNITEDB	0.0894
PNSB	-0.1141	PNB	-0.1483	UNIONB	-0.1659	UNITEDB	0.0657
PNSB	-0.1190	PNB	-0.0971	UNIONB	-0.0584	UNITEDB	-0.0751
PNSB	-0.0824	PNB	-0.1449	UNIONB	-0.0960	UNITEDB	-0.0684
PNSB	-0.0949	PNB	-0.1103	UNIONB	-0.0983	UNITEDB	-0.0465

Bank	Residual	Bank	Residual	Bank	Residual	Bank	Residual
VIJAYAB	0.1047	AXISB	-0.2189	CATSYRB	0.1182	CITYUNIB	0.1690
VIJAYAB	0.1240	AXISB	-0.1957	CATSYRB	0.0577	CITYUNIB	0.0526
VIJAYAB	0.1612	AXISB	0.1268	CATSYRB	0.1054	CITYUNIB	0.1088
VIJAYAB	0.2058	AXISB	0.0303	CATSYRB	0.0791	CITYUNIB	0.0393
VIJAYAB	0.1406	AXISB	-0.1560	CATSYRB	0.0872	CITYUNIB	-0.0100
VIJAYAB	0.1499	AXISB	-0.1212	CATSYRB	0.1243	CITYUNIB	-0.0649
VIJAYAB	0.1636	AXISB	-0.1574	CATSYRB	0.1287	CITYUNIB	-0.1076
VIJAYAB	0.1172	AXISB	-0.1126	CATSYRB	0.0947	CITYUNIB	-0.1160
VIJAYAB	0.0973	AXISB	-0.0319	CATSYRB	0.1606	CITYUNIB	-0.1526
VIJAYAB	0.0855	AXISB	0.0383	CATSYRB	0.0509	CITYUNIB	-0.1751
VIJAYAB	-0.0405	AXISB	0.1209	CATSYRB	0.0384	CITYUNIB	-0.1808
VIJAYAB	-0.0260	AXISB	0.0216	CATSYRB	0.1192	CITYUNIB	-0.0903
VIJAYAB	0.0187	AXISB	-0.0321	CATSYRB	0.1556	CITYUNIB	-0.0263
VIJAYAB	0.0260	AXISB	0.0066	CATSYRB	0.1026	CITYUNIB	0.0315
VIJAYAB	-0.1002	AXISB	0.0730	CATSYRB	0.0801	CITYUNIB	0.0225
VIJAYAB	-0.0837	AXISB	0.1058	CATSYRB	0.2133	CITYUNIB	-0.0393
VIJAYAB	0.0005	AXISB	0.0991	CATSYRB	0.1903	CITYUNIB	0.0449
VIJAYAB	-0.0332	AXISB	0.0415	CATSYRB	0.1746	CITYUNIB	0.0531
VIJAYAB	-0.0054	AXISB	0.0517	CATSYRB	0.1568	CITYUNIB	0.1096
DLAXB	0.0083	FEDB	-0.0051	KVYSB	0.0082	LVILB	0.1377
DLAXB	-0.0351	FEDB	-0.0639	KARB	0.0341	LVILB	0.0154
DLAXB	0.0530	FEDB	0.0197	KARB	0.0385	LVILB	0.0338
DLAXB	0.0918	FEDB	-0.0731	KARB	0.0033	LVILB	0.0302
DLAXB	0.0254	FEDB	-0.1511	KARB	-0.0391	LVILB	0.0748
DLAXB	0.0428	FEDB	-0.1174	KARB	-0.0284	LVILB	0.0483
DLAXB	-0.0780	FEDB	-0.1014	KARB	-0.0145	LVILB	-0.0067
DLAXB	-0.0148	FEDB	-0.1232	KARB	-0.0826	LVILB	-0.0225
DLAXB	-0.0289	FEDB	-0.0962	KARB	-0.1070	LVILB	-0.0416
DLAXB	0.0152	FEDB	-0.1006	KARB	-0.1076	LVILB	-0.0586
DLAXB	-0.0264	FEDB	-0.0628	KARB	-0.1318	LVILB	-0.0958
DLAXB	0.1239	FEDB	-0.0037	KARB	-0.0849	LVILB	0.0099
DLAXB	0.1849	FEDB	-0.0052	KARB	-0.1005	LVILB	0.0424
DLAXB	0.1861	FEDB	-0.0069	KARB	-0.0634	LVILB	0.0555
DLAXB	0.1393	FEDB	-0.1121	KARB	-0.0189	LVILB	0.0206
DLAXB	0.0355	FEDB	-0.1040	KARB	-0.0481	LVILB	-0.0285
DLAXB	0.2003	FEDB	0.0049	KARB	0.0415	LVILB	-0.0007
DLAXB	0.2178	FEDB	0.0086	KARB	0.0162	LVILB	0.0167
DLAXB	0.1359	FEDB	0.0400	KARB	0.0443	LVILB	0.0709

Bank	Residual	Bank	Residual	Bank	Residual	Bank	Residual
INGVYSB	-0.0700	JKB	-0.0239	KVYSB	0.0390	NAINB	0.1065
INGVYSB	-0.0216	JKB	0.0672	KVYSB	0.0548	NAINB	0.0746
INGVYSB	-0.0345	JKB	0.0192	KVYSB	0.0379	NAINB	0.0884
INGVYSB	-0.0655	JKB	-0.0655	KVYSB	0.0035	NAINB	0.1288
INGVYSB	0.0345	JKB	-0.0264	KVYSB	0.0220	NAINB	0.2153
INGVYSB	0.0926	JKB	-0.0473	KVYSB	-0.0268	NAINB	0.1188
INGVYSB	-0.0268	JKB	0.0204	KVYSB	-0.0196	NAINB	0.0878
INGVYSB	0.0405	JKB	-0.0861	KVYSB	-0.0205	NAINB	0.0400
INGVYSB	0.0379	JKB	-0.1096	KVYSB	-0.0010	NAINB	0.0511
INGVYSB	0.0567	JKB	-0.1510	KVYSB	-0.0981	NAINB	0.0326
INGVYSB	0.0116	JKB	-0.0936	KVYSB	-0.0653	NAINB	-0.0306
INGVYSB	0.0681	JKB	-0.0885	KVYSB	0.0044	NAINB	-0.0335
INGVYSB	0.1384	JKB	-0.1188	KVYSB	0.0215	NAINB	0.1285
INGVYSB	0.1295	JKB	-0.0259	KVYSB	-0.0293	NAINB	0.1637
INGVYSB	0.1286	JKB	-0.0412	KVYSB	-0.0209	NAINB	0.0638
INGVYSB	0.0727	JKB	-0.0827	KVYSB	-0.0977	NAINB	0.0557
INGVYSB	0.1415	JKB	-0.0880	KVYSB	-0.0290	NAINB	0.0717
INGVYSB	0.1048	JKB	-0.1006	KVYSB	-0.0280	NAINB	0.0587
INGVYSB	0.0775	JKB	-0.0640	KVYSB	0.0135	NAINB	0.1466
RATNB	-0.0423	TAMNB	0.1978	SOUINB	0.0220	ADCOMB	-0.2175
RATNB	-0.0239	TAMNB	0.1331	SOUINB	-0.0043	ADCOMB	-0.4503
RATNB	-0.0179	TAMNB	0.1323	SOUINB	0.0311	ADCOMB	-0.3237
RATNB	-0.0418	TAMNB	-0.0273	SOUINB	-0.0222	ADCOMB	-0.0453
RATNB	-0.0144	TAMNB	-0.0316	SOUINB	0.0011	ADCOMB	-0.0352
RATNB	-0.1049	TAMNB	-0.0163	SOUINB	0.0313	ADCOMB	-0.1958
RATNB	-0.0535	TAMNB	-0.0575	SOUINB	-0.0262	ADCOMB	-0.1708
RATNB	-0.0793	TAMNB	-0.0922	SOUINB	-0.0392	ADCOMB	-0.2974
RATNB	-0.0338	TAMNB	-0.0815	SOUINB	-0.0234	ADCOMB	-0.0474
RATNB	-0.1016	TAMNB	-0.0983	SOUINB	-0.0628	ADCOMB	0.0285
RATNB	-0.0280	TAMNB	-0.0757	SOUINB	-0.0546	ADCOMB	0.0391
RATNB	-0.0069	TAMNB	-0.0715	SOUINB	-0.0459	ADCOMB	0.3461
RATNB	0.0086	TAMNB	-0.0924	SOUINB	0.0969	ADCOMB	0.5679
RATNB	0.0041	TAMNB	-0.0489	SOUINB	0.0581	ADCOMB	0.2545
RATNB	0.0209	TAMNB	-0.0089	SOUINB	-0.0282	ADCOMB	0.1203
RATNB	-0.1261	TAMNB	0.0085	SOUINB	-0.0463	ADCOMB	-0.2015
RATNB	-0.0723	TAMNB	0.0812	SOUINB	-0.0496	ADCOMB	-0.0771
RATNB	-0.0575	TAMNB	0.0504	SOUINB	0.0120	ADCOMB	0.0700
RATNB	-0.0502	TAMNB	0.0978	SOUINB	0.0458	ADCOMB	0.2381

Bank	Residual	Bank	Residual	Bank	Residual	Bank	Residual
BOA	-0.3033	BBK	-0.4356	BNOVA	-0.0348	BOT	-0.2844
BOA	-0.1888	BBK	-0.3554	BNOVA	0.1964	BOT	-0.3223
BOA	0.0870	BBK	-0.0834	BNOVA	0.0951	BOT	-0.0702
BOA	-0.1846	BBK	-0.1085	BNOVA	0.0240	BOT	-0.1247
BOA	-0.1683	BBK	-0.1612	BNOVA	-0.0569	BOT	-0.0071
BOA	-0.0903	BBK	-0.2123	BNOVA	0.0330	BOT	1.5375
BOA	0.0266	BBK	-0.1453	BNOVA	0.0498	BOT	0.8165
BOA	-0.1124	BBK	-0.0604	BNOVA	-0.2337	BOT	0.2059
BOA	-0.1202	BBK	-0.2362	BNOVA	-0.1600	BOT	0.2827
BOA	-0.2222	BBK	-0.3492	BNOVA	-0.1698	BOT	0.2027
BOA	-0.2024	BBK	-0.4519	BNOVA	-0.2025	BOT	-0.0176
BOA	-0.2910	BBK	-0.2004	BNOVA	-0.2030	BOT	-0.0511
BOA	-0.2731	BBK	-0.1704	BNOVA	-0.2407	BOT	-0.1382
BOA	-0.1975	BBK	-0.0462	BNOVA	-0.1965	BOT	-0.1576
BOA	-0.1823	BBK	-0.0938	BNOVA	-0.1728	BOT	-0.2062
BOA	-0.1146	BBK	-0.0344	BNOVA	-0.0817	BOT	-0.2324
BOA	-0.0471	BBK	-0.2064	BNOVA	-0.2593	BOT	0.0894
BOA	0.0277	BBK	-0.2578	BNOVA	-0.1502	BOT	-0.2262
BOA	-0.1192	BBK	-0.3084	BNOVA	-0.2066	BOT	-0.2425
BNP	-0.2313	BARCB	-0.0640	CITI	0.0183	DBS	-0.2074
BNP	0.0066	BARCB	-0.0530	CITI	0.0297	DBS	-1.1412
BNP	0.1581	BARCB	0.0885	CITI	0.0868	DBS	0.5118
BNP	-0.1213	BARCB	0.3090	CITI	0.1313	DBS	0.3476
BNP	-0.1075	BARCB	-0.1648	CITI	0.1942	DBS	-0.4299
BNP	-0.1290	BARCB	0.0521	CITI	0.1246	DBS	-0.2805
BNP	-0.1096	BARCB	-0.1356	CITI	0.0363	DBS	-0.4418
BNP	-0.0676	BARCB	-0.1902	CITI	0.0447	DBS	-0.0838
BNP	-0.0127	BARCB	0.0361	CITI	0.0738	DBS	-0.1723
BNP	-0.0218	BARCB	0.0862	CITI	0.1241	DBS	-0.2186
BNP	-0.0650	BARCB	-0.0785	CITI	0.3113	DBS	-0.6956
BNP	-0.0169	BARCB	-0.6157	CITI	0.4726	DBS	-0.0220
BNP	-0.0507	BARCB	-0.2396	CITI	0.4429	DBS	0.0503
BNP	-0.0255	BARCB	0.3119	CITI	0.2865	DBS	0.3281
BNP	-0.2048	BARCB	0.4002	CITI	0.2497	DBS	-0.0769
BNP	-0.1727	BARCB	0.4981	CITI	0.3244	DBS	0.0042
BNP	-0.0445	BARCB	0.1811	CITI	0.3731	DBS	-0.0593
BNP	0.0835	BARCB	0.1743	CITI	0.2488	DBS	-0.0061
BNP	-0.0117	BARCB	0.1553	CITI	0.1576	DBS	0.1089

Bank	Residual	Bank	Residual	Bank	Residual
HSBC	-0.0556	JPMC	0.3637	OMINB	-0.0969
HSBC	0.0739	JPMC	0.3453	OMINB	-0.0639
HSBC	-0.0010	JPMC	1.2221	OMINB	0.1294
HSBC	-0.0385	JPMC	-0.2531	OMINB	0.1165
HSBC	0.0461	JPMC	0.4928	OMINB	-0.0103
HSBC	0.0863	JPMC	0.5502	OMINB	-0.1543
HSBC	0.0133	JPMC	0.0210	OMINB	-0.0694
HSBC	-0.0105	JPMC	-0.0852	OMINB	0.2110
HSBC	0.0485	JPMC	0.2715	OMINB	0.3435
HSBC	-0.0501	JPMC	-0.8164	OMINB	0.2987
HSBC	-0.0284	JPMC	-0.2245	OMINB	0.1104
HSBC	0.0838	JPMC	0.0245	OMINB	-0.0476
HSBC	0.2066	JPMC	-0.1262	OMINB	-0.0459
HSBC	0.3749	JPMC	-0.2778	OMINB	0.2324
HSBC	0.2978	JPMC	-0.2426	OMINB	0.2418
HSBC	0.2229	JPMC	0.0784	OMINB	0.1130
HSBC	0.2422	JPMC	-0.3618	OMINB	0.0191
HSBC	0.2014	JPMC	-0.1840	OMINB	-0.0282
HSBC	0.1569	JPMC	-0.0034	OMINB	0.2501
SGB	-0.5575	STANCB	0.0839		
SGB	-0.3350	STANCB	0.1862		
SGB	0.0427	STANCB	0.3164		
SGB	-0.0560	STANCB	0.1561		
SGB	-0.1464	STANCB	0.1500		
SGB	-0.0570	STANCB	0.0367		
SGB	-0.2651	STANCB	-0.0448		
SGB	-0.0489	STANCB	-0.0623		
SGB	0.0620	STANCB	-0.0943		
SGB	-0.3884	STANCB	-0.1369		
SGB	-0.6366	STANCB	0.0182		
SGB	-0.7677	STANCB	0.0275		
SGB	-0.3954	STANCB	0.2471		
SGB	-0.1267	STANCB	0.1638		
SGB	-0.1224	STANCB	0.2488		
SGB	-0.2207	STANCB	0.2609		
SGB	-0.4045	STANCB	0.2223		
SGB	-0.5380	STANCB	0.0477		
SGB	-0.3369	STANCB	-0.0120		

Annexure 13: Variance and ρ value of Banks

BANKS	ρVALUE	VARIANCE	BANKS	ρVALUE	VARIANCE
SBI	-0.0053	0.3685	FEDB	0.7848	0.6244
SBJ	0.6756	0.2714	HDFC	-0.1924	0.3850
SBH	0.6780	0.4406	ICICI	0.8912	4.9403
SBM	0.7901	0.5647	INDUSB	0.7520	0.7568
SBP	0.3537	0.5341	INGVYSB	0.6880	0.4457
SBT	0.7295	0.4598	JKB	0.8898	1.8621
ALLB	0.7334	0.2885	KARB	0.8817	0.7052
ANDB	0.8017	0.4183	KVYSB	0.6910	0.4544
BOB	0.5252	0.4181	LVILB	0.4436	0.3301
BOI	0.4829	0.4042	NAINB	0.7029	0.4193
BOM	0.6727	0.3854	RATNB	0.7695	0.5593
CANB	0.7121	0.6279	SOUINB	0.4011	0.3235
CENB	0.7728	0.4359	TAMNB	0.7579	0.2620
CORPB	0.6011	0.5166	ADCOMB	0.6273	5.4617
DENB	0.1414	0.4877	BOA	0.5648	0.8452
INDB	0.4649	0.4968	BBK	0.8344	3.9722
IOB	0.3346	0.4732	BNOVA	0.8161	1.4475
OBC	0.7973	0.4237	BOT	0.5183	6.3806
PNSB	0.8486	0.9181	BNPB	0.3015	0.7294
PNB	0.6106	0.4169	BARCB	0.4942	2.3890
SYNB	0.7758	0.3956	CITI	0.9444	1.4483
UCOB	0.8230	0.7395	DBS	0.1014	1.5466
UNIONB	0.8313	0.4664	DEUTB	0.9549	5.8558
UNITEDB	0.9187	1.6190	HSBC	0.8862	4.8622
VIJB	0.7990	0.7955	JPMC	0.1425	3.0350
AXISB	0.2968	0.5724	OMINB	0.7024	4.2505
CATSYRB	0.8662	1.0964	SGB	0.8376	4.1842
CITYUNIB	0.8108	0.3624	STANCB	0.8410	1.7173
DLAXB	0.6712	0.5280			

Rational Inefficiency: A Discourse on John Richard Hicks, Joe Staten Bain and Harvey Leibenstein

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Abstract

Rationality and efficiency are often considered two sides of a same coin. Often we argue that in the absence of market failures, rationality always generates efficiency. The present paper, however, goes against this current of wisdom. It argues that rationality reflects the state of mind that determines the course of decision-making for an individual. Efficiency, on the other hand, conventionally reflects the financial results of an economic activity. But the human mind always desires more than what those financial outcomes provide. Therefore, rationality should not be identical to efficiency. This is the concept of 'rational inefficiency', or equivalently, 'irrational efficiency', which is theme of this article. It discusses in this context three important hypotheses, as developed in the literature on efficiency. Those are (a) the Quiet Life Hypothesis, (b) the Structure-Conduct-Performance Hypothesis, and (c) the x-efficiency Hypothesis.

JEL classification
D01,D03, L10, L25

Key words
Industrial Organisation, Efficiency, Rationality, Market Structure

In an emerging market economy, efficiency is the kingpin for survival and development. Inefficient productive units cannot survive domestically in the face of competition from multi-national corporations; nor could it grow based on global markets, thanks again to more competitive firms. The question of efficiency is, therefore, taken up very seriously in the context of economic reforms in many countries, including India. But the theme has its genesis at the dawn of European economic thought – in the writings of the so-called Physiocrats. In the Physiocartic era, however, 'efficiency' was interpreted in the macro-economic framework. Quesnay's '*Tableau Economique*' is an example in point.[1] It continues down to the classical tradition, and dominated the writings of Adam Smith and David Ricardo.[2] A paradigm shift is, however, noticed in the neo-classical era, as the focus shifts to the micro economic level – more specifically, at the firm - or the industry- level. Here we find new concepts emerge, for example, allocative efficiency, scale efficiency, and later on, scope efficiency, which determine the efficiency score of a firm. The contribution of Alfred Marshall,[3] W.S. Jevons, C. Menger[4] and W. Baumal[5] may be cited in this context. One of the conclusions that the neo classical writers have established is that monopoly is inefficient from the viewpoint of resource allocation; suboptimal level of production leads to higher average cost of production, and hence, a wastage of resources. The earlier Neo-classical economists, especially Marshallians, however, believe that perfect competition is the natural state of a market. Under the weight of Sraffa's concept of 'Laws of returns', which invalidates the continuance of perfect competition[6], they use the concept of 'externalities' in support of their belief about the competitive market, as Marshall himself did. But gradually the monopoly, as conceived by Cournot, is accepted as 'the natural case'. Hicks writes, 'With this assumption, this cardinal difficulty of increasing returns disappeared, since a firm might still be in equilibrium under conditions of diminishing cost.' From this field of study has emerged an interesting branch of literature where monopoly has been discussed from different angles - mainly, the reasons thereof and the consequences thereto. These form the central theme of this article. We take up three important hypotheses in this field, namely, (a) the Quite Life Hypothesis (QLH) that Hicks developed in 1935; (b) the Structure-Conduct-Performance Paradigm (SCPP), as proposed by Bain in 1959; and (c) the x-efficiency theory, where, following the deliberation of Leibenstein in 1969, a number of economists have contributed to. These three hypotheses

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[1] Robbins, A history of economic thought, pp.77-113
[2] Dobb, Theories of Value, pp. 38-95
[3] Marshall, Principles of Economics, Book IV
[4] For Jevons and Menger, see Robbins, A history of economic thought, pp. 258-284
[5] Baumol *et al*. Contestable Markets and Industry
[6] Hicks, 'Annual survey of Economics', p. 2

are discussed in three sections that follow. In section IV we, however, seek to develop a logical thread amongst them.

I

In the neoclassical tradition, a competitive firm maximises its profit when the ruling price equals the long-run marginal and average costs. That is the lowest point of the long-run average cost curve so that the utilisation of resources gets optimised. Thus, in a competitive equilibrium, the profit maximising point coincides with the optimal resource utilisation point. In monopoly, however, the profit maximising (MR = MC) point does not so behave, giving rise to wastage of economic resources. Thus, from the societal viewpoint, it is an inefficient point, though efficient from the monopolist. Moreover, as Hicks argues, a monopolist is often found to produce away from the MR = MC point, though in its neighbourhood. The question that now arises is: Is it irrational to belong to a point away from MR=MC? To Hicks, it is not irrational. In the conventional analysis, revenue and cost are measured in financial or monetary terms. More specifically, revenue is defined as the money value of all the products a firm produces, and the cost as the money value of all resources it employs. But, in essence, revenue should represent what he gets, not only in terms of money, but the pain and discomfort as well which he suffers in the process.[7] Hence, the inequality between MR and MC in monetary terms should not be taken to represent the inequality between MR and MC in the true sense of the term. This is especially true since, as a human being, a monopolist is affected by a host of qualitative factors, or the so-called 'subjective factors, *pari pasue* with the monetary factors of production. Thus, guided by his subjective and objective factors, a monopolist equates his 'emotional' MR = 'emotional' MC, where emotional MR is defined as the monetary MR plus the subjective gain; and emotional MC is defined as the monetary cost plus the subjective cost. This idiosyncratic emotional MR = emotional MC may not be abreast with the financial MR= financial MC. The monopolist will not make an attempt to move to the theoretical utopia of financial MR=MC as he takes up his subjective costs into consideration. This propensity of the monopolist to maintain his position away from the profit maximising MR= MC is referred to as 'the Quite Life' by Hicks in his article in 1935. It should be noted that Hicks has not analysed the subjective gains and losses in detail; nor how they counterbalance each other. We will see shortly that Leibenstein delves into these questions in a theoretical framework.

[7] These issues were first discussed by Jevons. See his Theory of political economy, especially the Chapter on 'Theory of pleasure and pain'.

Hicks argues that the monopolist will not exert himself to reach the point of MR=MC as he enjoys 'the Quite life', the greatest reward of monopoly power. This behaviour of a monopolist goes against the conventional assumption of rationality as underlying the neo classical tradition. While refuting this conventional sense of the term, Hicks argues that the monopolist will not try to reach the level of MR= MC due to his 'highly rising subjective cost'. It is indeed the maiden effort of considering subjective factors as an explanation of the so-called irrational behaviour of a firm. He believes that if the monopolist has a 'sharply rising subjective cost', he would verily dedicate himself to maintaining his monopoly position rather than moving to the point where MR=MC. Another question that arises in this context is whether such an act of the monopolist, though technically inefficient, should be considered rational from the viewpoint of resource allocation as well. This brings us to the contention that a monopolist, or for that matter any producer, would be rational not to move to the profit maximising position. Fare *et. al.*, so also Bogetoft and Hougaard, explain this behaviour of the monopolist by describing it as 'rational inefficiency'. This concept signifies that it would be perfectly rational to maintain a point of inefficiency if the cost of reducing this inefficiency outweighs the gains arising out of a movement towards efficiency. Rational inefficiencies are said to exist in markets where firms enjoy a certain amount of market power. Fare *et al.* suggest that a monopolist does not maximise his revenues, but optimises a quite life that he enjoys situating himself in a monopoly position.[8] According to Bogetoft, the term 'inefficiency', which he describes as the 'slack', could be a part of the 'fringe benefits' that stakeholders enjoy - it could be in the form of compensation paid to employees so that a loyal group of workers is generated. Thus, inefficiency may not be completely irrational and waste. This kind of slack would be a part of the long run plan of a monopoly producer.[9]

The Hicksian concept of 'the quite life' and its implications, as narrated above, has many offshoots in the literature. This idea is recurrent in the rationales for economic reforms in many countries, including India. In his quest of maintaining a quite life, a monopolist affords to remain inefficient without going for technological up gradation and/or exploring new markets. Organisational inefficiencies are also not infrequent in this type of market. Such an application of 'the quite life' is dominant in the writings of Vins and Koetter[10] , Berger and Hannan[11], Casu and

[8] Fare *et al* , 'Rational Inefficiency: The quite life', p. 2
[9] Bogetoft, 'Rational Inefficiencies', pp.1-30
[10] Vins, 'The Quite Life in Banking'
[11] Berge, 'The efficiency cost of market power in banking and industry', pp 454-465

Girardone[12]. In India's economic reform this idea of quite life has been a guiding light. This is evident in that the thrust of India's economic reforms rests on the promotion of competition by way of repealing the MRTP Act, liberal import policies, and easy entry of private banks, both domestic and foreign origin.

Prima facie, though the above line of thought is apparently in line with Hicksian concept of quiet life, it is not really so in the final analysis. Monopoly and inefficiency are analysed there from the view point of the economy. The existence of the quiet life leads to inefficiency and this is reflected by the welfare loss for the economy. But Hicks discusses the issue from the micro perspective, especially from the viewpoint of a monopolist, and to him, monopoly is not at all inefficient.

II

At the time when Hicks' idea of a monopolist enjoying 'the quite life' had been at the centre of discussion, Edward Mason, a contemporary of Hicks, brought forward the idea of the Structure-Conduct-Performance paradigm. The idea that remained fluid with Mason was later crystallised, and that too, with due empirical supports, by J.S Bain in 1959. The underlying tone in the theory, which Bain has elaborated, is how efficiency is guided by the scale of operation, the pricing policies and the competitive forces. His line of argument is that the barriers to entry (including product differentiations) enable individual firms to expand their scale, and thus, raise the concentration of a market (i.e. higher market-share of individual firms). But the question is: Are bigger firms more efficient than smaller ones? We note here that Bain defines such efficiencies – as generated through the expansion of scale – as the technical efficiency in the sense of optimal use of resources. This line of argument he juxtaposes against an alternative hypothesis: that smaller firms are more efficient. The theoretic logic underpinning the proposition is that greater competition compels the firms to make all-out efforts to raise productivity – and, hence, more efficient - as the 'survival of the fittest' is the rule of game in competition. To Bain, it is the allocative efficiency. Two opposite forces thus prevail in the domain of efficiency: a) the allocative efficiency, varying inversely with the degree of concentration in an industry; and b) the technical efficiency, varying directly with the degree of concentration.

Before deliberating on Bains' question of efficiency, let us discuss his concepts of 'structure, 'conduct' and 'performance', the three legs on which his

[12] Casu, 'Does competition lead to efficiency?'

hypothesis is built. 'Structure' in the SCPP hypothesis denotes the 'organisational characteristic of a market'[13], which indeed reflects sellers' concentration therein. The concentration determines whether the market is 'atomistic' or oligopolistic. In an atomistic market structure, a single seller can not affect the ruling price to his own advantages (or, for that matter, the quantities he sells). In an oligopoly market, on the other hand, he can do so, after duly anticipating 'the reaction of the rival in the industry'. In such markets, higher the degree of seller concentration, higher is the probability that the sellers enjoy a greater monopoly power in the market, and hence, more profit efficiency; conversely, lower market concentrations leads to less profit efficiency. Equally important component of a market structure is the product differentiation, which generates monopoly power for a firm, giving him flexibility in setting the prices. Bain, however, points out that, because of product differentiation, a large number of small firms exist in such markets producing goods similar to those differentiated products. Bains' oligopoly market is thus constituted by a small number of big firms side by side a large number of small firms. The oligopoly market is also characterised with, according to Bain, the barriers to entry, which explain the degree of competition, in general, and the relationship between new entrant and old producers, in particular. Higher barriers to entry are associated with monopolistic pricing policy, while moderate barriers to entry lead to limit pricing. When the barriers are low, the market structure is often found unstable.

Market conduct refers to the profit seeking activities of the firms. It includes how (i) different sellers react against their 'intrinsically rivalrous decision and action'[14] so that they make successful rational decisions; (ii) the pricing policies adopted by the sellers and (iii) the use of 'predatory tactics'[15] and 'exclusionary tactics'[16]. An oligopolist's conduct, just as it is in other markets, is guided by its ultimate goal. Bain, however, considers the maximisation of profit as the goal of a firm. In this context, he considers four alternative concepts of profit that an oligopolist might pursue: (a) joint profit maximization, (b) individuals' profit maximization, (c) hybrid profit maximization[17]; or else, (d) maximization of fair profit.

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[13] Bain, Industrial organization, p. 7

[14] Ibid p. 302

[15] Predatory tactics are used by established firms in the industry to weaken or eliminate established competitors.

[16] Exclusionary tactics are aimed to discourage potential new competitors

[17] Hybrid profit maximization entails both joint profit maximization and independent profit maximization. In markets where there are significant seller concentration and seller inter-

Of all these concepts of market conduct, only the third one can be tested empirically.

Market Performance encompasses the strategically end results of market conducts. For the seller it is measured by how well do they adjust their outputs to the changes in effective demand; and for the buyers, by their ability to adjust to the changing supply in the market. Though performance is multi-dimensional with variations across industries, this performance determines the efficiency of a firm. Bain, however, takes into account both technical efficiency and allocative efficiency to measure performance. Technical efficiency is constituted of the efficiency arising out of technical aspects of the organisation and internal efficiency of individual members. The efficiency of the organisation is measured by the scale of operations (scale efficiency), degree of vertical integration (scale efficiency) and the efficient utilisation of plant resources. Internal efficiency is the efficiency of the managers in minimizing cost, which, in turn, depends on their degree of wisdom to this end. Allocative efficiency is concerned with the rate of output in the industry. This is measured by the long run relationship between its selling price and marginal cost.

The synthesis of these concepts leads to various questions. The basic one is: How does the size of an organisation affect its efficiency of? Now the size of a firm may be determined by the market concentration (that represents a producer's monopoly power), which, in turn, might be governed by product differentiation, and/or the barriers to entry. Two contextual questions are, therefore: Is there any relationship between product differentiation and the market concentration? If yes, how does this relation account for the market performance? And, secondly, do the barriers to entry affect the market performance? We emphasise here that two opposite forces are involved in the determination of overall efficiency. An industry with higher monopoly power usually enjoys technical efficiencies; a more competitive industry, on the other hand, enjoys allocative efficiencies. Overall efficiency of a firm, indeed, depends on the relative weights of these opposite forces.

Bain has empirically tested these questions in the context of the American industries. His findings relating to the relationship between structure and performance are as follows: (i) industries with larger market concentrations (i.e. where there are some large-scale firms enjoying monopoly power) have lower incidence of technically inefficient firms; (ii) industries with low barriers to entry have a

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dependence, the sellers are motivated to pursue individual profit maximization at the expense of the rival. Bain, Industrial organization , p. 319

substantial group of technically inefficient small firms; and (iii) such industries (having low barriers to entry) are more conducive to competition, and, hence, enjoy more allocative efficiency. Bain[18] reports that 'no evident association' prevails between the market concentration and the inefficiency of small firms, and that inefficient sellers were found in the fringe of markets with high and low barriers to entry alike. Similar results were found for the relationship between the product differentiation and the level of efficiency. Bain stresses that the small inefficient firms survive in the market with large firms due to the higher prices that monopolist/oligopolist fixes up in the market.[19]

Bain's hypothesis is, however, criticised on the ground that it does not provide a clear mandate as to what really does efficiency depend upon. The Chicago school[20] has levelled this hypothesis as being fuzzy suggesting that other methods such as price theory models and game theoretic models should be tried to these ends. It is true that Bain's findings might prima facie appear contradictory in the sense that a monopoly (or competitive) firm may be efficient or inefficient. But if we look into the question segregating efficiency into technical and allocative components, the contradiction disappears to a good extent. If a monopolist is found inefficient, the underlying reason should be that its allocative inefficiency over-compensates its benefit arising out its technical efficiency. For an inefficient competitive firm, on the other hand, technical inefficiency might over-compensate the allocative efficiency.

This hypothesis has, however, many versions and extensions, some of which have culminated to the genesis of Industrial organisation study. Extending Bain's SCP paradigm, for example, Demsetz has developed the Efficient Structure Hypothesis in 1973, which Peltzman has tested empirically in 1977. They believe that that monopoly profits does not arise because of tacit or explicit collusion among oligopoly firms, but on the strength of their risk-taking behaviour in an uncertain world, and also, of course, luck.

III

One of the important components of technical efficiency that has been neglected by Bain in his analysis of the SCPP is the 'internal efficiency'[21] of an organisation.

[18] Ibid, p. 437
[19] Ibid, p. 437
[20] Monti, EC competition law, pp. 63-65
[21] Bain, Industrial Organization, p. 376

This internal efficiency of the organisation has been discussed by Leibenstein as x-efficiency in 1969. The difference between QLH and SCPP is that the latter fails to analyse the factors that lead to (in)efficiency. It is, indeed, more descriptive in deliberation, bearing less flavour of analysis. Leibenstein, on the other hand, explicitly attributes (in)efficiefncy to subjective factors prevailing at different layers of the organisation. His x-efficiency theory seeks to identify the subjective factors that affect the performance of the individuals, associated with the organisation, and, in so doing, the theory analyses how they affect the performance of the firm. Another unique feature of the theory is the shift of focus from the micro level of the firm to its micro-micro level dealing with the individuals. Since these human factors of production are complex, and also multifarious, such a study should not be simple. Taking a cue from Hicks' analysis, Leibenstein buiids up his theory on the psychological factors that lead to efficiency. Leibenstein's theory of x-efficiency pushes forth the effort to understand the black box of the human mind. It tries to understand why a person will not work as much as he should; what could be done to propel the individuals' wisdom to the level where he moves out of his comfort zone or inertia. The theory of x-efficiency shifts the focus from allocative and technical efficiency to the study of x-efficiency. According to Leibenstein, an individual in the organisation brings with him certain factors that cannot be assessed or measured, and hence, the production function fails to take those factors into consideration. As a result, the traditional theory only takes into allocative efficiency and technical efficiency of an organisation. In this connection, we may cite the world development report (2015), which put emphasis on the fact that the existence of an economic man is far from reality, and any policy based on the assumption of an economic man is bound to go astray. This is the spirit of Leibenstein when he tells us that human beings are not rational and that their behaviour influences the production function which the traditional theory of production ignores. A holistic approach should, therefore, consider the human aspects of the human factors, and incorporate them into the production function so that the efficiency gets maximised.

Among various factors that determine the x-efficiency, Leibenstein stresses on motivation, notably (i) intra-plant motivation and (ii) inter-plant motivation; in addition to what he calls (iii) non-market input efficiency.[22] The efficiency of a firm depends upon the efficiency of the workers employed in the organisation, as well as that of the managers. Its efficiency could, therefore, be augmented by motivating workers and managers, which he calls intra-plant and inter-plant motivations, respectively – the former one emerging from peer pressures, and

[22] Leibenstein, 'Allocative efficiency vs. X-efficiency', p. 407

the latter from external pressures. But a question that arises is that: Why does anyone remain in the inefficient zone? Leibenstein believes that worker and managers cannot be enforced to work efficiently for a variety of reasons, such as (a) that the production function is not known so that individuals inefficiency cannot be identified (the problem of asymmetric information), (b) that the labour contracts is never exhaustive to seal out all sources of inefficiency (the moral hazard problem) and (c) that many factors of production (e.g. sincerity, integrity and devotion of workers/managers) are not marketed. While workers/managers can thus afford to be inefficient, they are willing to be so on the ground of what is called 'the selective rationality'. Leibenstein points out that the behaviour of an individual is constrained by what is his function in the organisation. In the process of interpreting the job, s/he selects from a subset of "activity-pace–quality–time' (APQT) bundle. The individual will have to choose from a set of alternative activities, the pace at which these activities are carried out, as also the quality of the activity and the time to be spent on performing the activity. While s/he chooses his APQT bundle s/he is in fact trying to interpret her/his effort position. This effort position comprises of a set of effort points adjacent to one another within which the individual is willing to extend her/his effort. These effort points have the same level of utility. A movement from one effort point to a higher one entails a utility cost. He elaborates, 'A set of effort points where the utility cost of shifting from one point within the set to any point within or outside that is greater than utility gained comprises the inert area.'[23][24] This inert area is the manifestation of the human inertia. Further, each individual in the organisation has her/his inert area. A discrepancy in the effort position of the individual and the expected effort position of the management leads to an entropy situation. Entropy is the downfall of the organisation as it is not able to move from its inert area. Entropy is a latent force, which every organisation should control. Leibenstein believes that the flow of information from the management to the individuals is an important factor in controlling entropy. Hence, the x-efficient manger faces the task of facilitating this flow of information which is essential for matching the effort points of the individual to the expected one. Any mismatch between them gives rise to inefficiency. This mismatch is present due to the inert area, and is retained because the firms have monopoly position. They can move out of this inertia if it is compelled to do so due to competition.

In Leibenstein's analysis of x-efficiency, we can see that the employees and managers in an organisation are considered inefficient due to motivational de-

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[23] Leibenstein, 'Aspects of the x-efficiency', p. 589

[24] Leibenstein, 'Organizational or Frictional Equilibria', p. 606

ficiencies. From those individuals' viewpoint, their actions are efficient in so far as they are in a state of inertia, where by their utility gains for any movement away cannot outweigh its underlying loss of utility. As a utility-maximiser they are certainly rational, although from the viewpoint of the organisation, the production point that their joint actions yield is inefficient. Leibenstein's x-efficiency theory thus explains the real-life experience of 'rational inefficiency'.

IV

All three hypotheses, discussed above, have one thing in common - the prevalence of inefficiency in an organisation. The concept of inefficiency, however, varies across them; so also their interpretations. In Hicks' Quite Life a monopolist is regarded as inefficient as he does not produce at the optimal level of MR=MC. If we analyse this stand of the monopolist from a micro perspective, we can see that the monopolist makes a rational decision as it is based on the equality of his emotional MR and his emotional MC.

The undertone of Bain's SCPP analysis is that a monopolist may be inefficient from the viewpoint of resource allocation although he might be enjoying technical efficiency. Thus, from the monopolist's standpoint, the organisation is efficient, but it is inefficient in the macro framework as it involves wastage of resources. On the other hand, a competitive firm is surely efficient from the macro viewpoint as there is no wastage of resources for a firm operating at the lowest point of the long run average cost; but it is not efficient as he cannot enjoy profit as high as a monopolist. Both these firms are inefficient – a monopolist from the welfare point of view, and a competitive firm from the individualistic viewpoint.

Leibenstein's x-efficiency theory goes much deeper - from the micro level to the micro-micro level of an organisation. He analyses inefficiency as a motivational deficiency. An Individual in an organisation maintains his position of inefficiency as he feels that a movement from this position entails a cost much higher than the benefit that might accrue to him. So the inefficient position of the individual from the point of view of the organisation is rational from the individual's point of view. However, if everyone in the organisation remains static in their own comfort zone, then it will ultimately lead to entropy. As per Leibenstein the only way to get out of this sluggish position is to introduce competition in the system. Thus, Leibenstein's comfort zone is similar to what Hicks considers 'the quiet life'. What Hicks identifies as plausible factors contributing to 'the quiet life' are discussed at length by Leibenstein while deliberating on the comfort zone. The subjective issues are also there in Bain, *albeit* in an implicit tone, especially when he discusses 'wisdom' as an explanation for technical efficiency.

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