AN ECONOMETRIC STUDY ON THE RELATIONSHIP BETWEEN OUTPUT & MONEY SUPPLY IN INDIA UNDER RATIONAL EXPECTATIONS
(With Special Reference to the Period 1950-91)

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By

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To

My Father

Late Dr. Thakurdas Mandal

Whose inspiration I feel always in me.

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TO WHOM IT MAY CONCERN

This is to certify that Sri Ram Krishna Mandal did his research work under my supervision and has completed his Ph. D. thesis entitled,' An Econometric Study on the Relationship between Output and Money Supply in India under Rational Expectations (with special reference to the period, 1950-~~1991~~ 1991)'. He is honest and hardworking TO the best my knowledge and information he bears a good moral character.

15/7/97

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Ram Krishna Mandal

Dated : N. B. U.
15th July, 1997.

Mr. Ramkrishna Mandal

CONTENTS

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ABBREVIATIONS

AC	=	Auto - Correlation
AR (I)	=	First Order Auto - Regression
BLU	=	Best Linear Unbiased
DF	=	Degree of Freedom
DW	=	Durbin - Watson
GLS	=	General Least Square
GNP	=	Gross National Product
IFS	=	International Financial Statistics
LS	=	Least Square
OLS	=	Ordinary Least Square
RE	=	Rational Expectations
REH	=	Rational Expectations Hypothesis
REV	=	Rational Expectations Variables
REFV	=	Rational Expectations Fixed Variable
RBI	=	Reserve Bank of India

CHAPTER - I

INTRODUCTION

1.1 CHARACTERISTICS IN INDIAN ECONOMY :

Indian Economy, over the last few decades, since Independence, has been experiencing three remarkable features. First, India, through her ambitious plans for achieving self-sufficiency in agriculture and industrial production, attained spectacular development in agriculture. Moreover, India transformed herself from a pure agrarian economy to an outstanding industrial country amongst the developing countries in the world. As a result thereof, India's national income displayed almost steady growth since 1973 with some occasional ups and downs since 1980[1].

Second, output growth is marked by simultaneous growth of money supply. With phenomenal monetization of the economy, India has undergone a remarkable process of transformation from the barter economy to an exchange economy.

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1. The association between structural change and the process of economic development is one of the extensively explored themes and is well documented in the literature of economic development. The foremost researches in this field are those of Fisher (1960), Clark (1940) Kuznets (1956-67, 1971), Chenery (1960), Chenery and Taylor (1968) and Chenery and Syrquin (1975). The central thesis emerging from their studies is that there is a necessary structural transformation with rising per capita income. The general pattern of transformation, as observed from these studies, is that "The main characteristics of the transformation, that emerged from the long term experience, were a shift in the production of commodities from primary to manufacturing activities and a mild increase in the share of services in total output. In the case of employment a shift away from primary was also observed but with a lag, implying an intial drop in relative labour productivity in that sector. Part of the transfer of labour from the primary sector went into industry but, on average the main beneficiary was the service sector - perceived by Clark, Kuznets and others.

The Indian Economy during this period has experienced a change of production structure with a shift of emphasis from agriculture to service, the sector shares being 50:20:30 in 1960, 45:22:33 in 1970, 37:26:37 in 1980 and 31:29:40 in 1990 for agriculture, industry and services respectively. During this period, the service sector witnessed a very high rate of growth of its share in GDP (1960-70 = 4.6 ; 1970-80 = 5.2 ; 1980-90 = 6.5) *[from the Indian Economic Journal Vol. No. 43 No. 2, p. 103].*

Growing monetization of the economy coupled with lower interest rate policy in the early phases of the planning led to the spurt in investment. Consequently, output registered an noticeable growth which evidently added to the purchasing capacity in the economy. Thus, the expansion of money supply is marked by concurrent growth of output level.[2]

Third, now-a-days, 'expectations' about some important economic variables like money supply, investment or price levels have emerged as a significant factor behind economic activities in the economy. With the improvement in the depth, breadth and resilience of the capital markets, expectations have emerged as a significant economic factor affecting major macro-economic variables like output, money supply and price level[3].

It has also been observed very recently that stock exchange market becomes bearish when people expect a change in Government. Mere expectations about the take-over of some companies by any business group causes spectacular fluctuations in stock prices of some related companies. Even some unrelated companies also feel the tremor.

It has, therefore, been pertinent to a researcher to see if there exists any link among these three phenomenal features. More specifically, researchers sought to find if output variations were related to the growth of money supply.

However, expectation about money supply and thereby, unanticipated part of money supply also emerged as important macro-economic variables. Lucas, Sargent and other rational expectationists suggest that unanticipated part of money supply plays a significant role in shaping output growth in the short run. It is, therefore, pertinent to see how far output growth in Indian Economy has been related to variation in different parts of money supply, namely, anticipated and unanticipated parts.

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2. Shrivastaba & Saxena - "A Role on the theory of Money", Indian Economic Journal, Oct, Sec. 1968.

3. Chatterjee, S. - "Price, Output & Money Supply in India - An Econometric Study" An unpublished M.Phil Dissertation submitted to the Deptt. of Economics, North Bengal University, 1990.

1.2 GRAPHICAL REPRESENTATION :

Figs. 1.1 and 1.2 depict the time plots of money-supply (M_t) and output level (GNP = Y_t) respectively over the period, 1950-91. Fig.1.1 represents an exponential rise of money supply, though with a little downward movement up to 1953, throughout the period . But there are frequently so many little ups and downs from the very beginning to the end. It tells us that money supply increases year by year but not at a fixed rate. The economy with its growing money supply has got herself transformed from barter economy to exhchange economy i.e. monetized economy. Fig. 1.2 also represents the same characteristics as the Fig. 1.1 does. It shows that output level rises exponentially, though at the very beginning it rises very slowly or with a little downward movement at 1954. Since then it rises very sharply with a few ups and downs throughout the period .

Fig. 1.3 represents the time plots of both the output level and money supply over the period concerrned. It is observed from the Fig. 1.3 that

(i) variation in output level is in conformity with that in money supply over the period concerned ;

(ii) it is examined that the curve of money supply is steeper than that of output level ; and

(iii) the curve of output level shows more ups and downs from the very beginning to the end in comparison to that of money supply.

It may, however, be noted in this connection that these graphs show the time plots of non-stationary[4] data set. For better explanation, we seek to examine the time plots of stationary[5] data set for this variable concerned.

Figs 1.4 and 1.5 represent the time plots of stationary data set for money supply and output level respectively. These graphs exhibit fluctuations in indicating varying rates of growth for both the variables concerned. In order to understand the nature of associations between these two variables, time plots of both the variables are presented together in Fig. 1.6. It is observed from the Fig. 1.6 that

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4. The non-stationary series, either in GNP (Y_t) or in money supply (M_t) has been subject to first order differencing in order to ensure stationarity in the data set.

5. Stationary series indicate that the data set for (Y_t-Y_{t-1}) or for (M_t - M_{t-1}) represent the variation in Y_t or in M_t over the previous period.

(i) variation in output level over some years is broadly positively related to that in money supply. Both the curves exhibit fluctuations in the same direction though with varying extents over some years of the period concerned ; and

(ii) over some years the variation in output level is found to be either negatively related or unrelated to that in money supply.

Consequently, the exact nature and extent of the association of output level with money supply cannot be determined and established. This is what usually happens with visual observation. Visual observation has several short-comings. First, it suffers from subjective bias. Second, it fails to give exact nature of association among the variables concerned. So, graphical representation calls for quantitative study to overcome the short-comings. We seek to address this issue in this study.

1.3 OBJECTIVE OF THE STUDY :

The present work is devoted to the study of output - money supply relationship in the line suggested by the Rational Expectationists over the period 1950-91. More specifically, we seek to study if output variation were in any way related to variation in money supply. In the event of such relationship being present, we seek to see how far and to what extent the variation in output level is related to changes in anticipated and unanticipated part of money supply.

More explicitly, the study is undertaken to examine the Rational Expectationist's proposition that output growth in the short run is not responsive to variation in anticipated part of money supply. According to them, variation in unanticipated part of money supply generates significant variation in output level.

However, we are aware that historical data set may embody several structural changes in such relationship. Therefore, it becomes pertinent on our part to examine if the relationship is stable over the period of study. If not, the period of study, may consist of several sub-periods embodying structural changes. We seek to dentify such sub-periods where structural changes have occurred in such relationship. We then seek to examine, under different sub-periods, the relation between output variation and variation in different parts (anticipated and unanticipated) of money supply.

1.4 THE PLAN OF THE STUDY :

This paper is accordingly divided into nine chapters.

Chapter-II presents the review of literature.

Chapter-III deals with methodology and data resource.

In Chapter-IV output-money supply relationship over the period 1950-91 is analysed. We seek to find out the appropriate model among the alternatives.

In Chapter-V, we have sought to isolate the anticipate and unanticipated parts of money supply through the estimation of appropriate money supply equation. Several alternative models have been estimated for this purpose and the appropriate one has been presented.

Chapter-VI has been devoted to study the relationship of output variation with the anticipated and unanticipated parts of money supply over the period 1950-91.

In Chapter-VII, we have sought to identify several sub-periods in which structural changes in output-money supply relations have occurred.

Chapter-VIII is devoted to study the relation between output and different parts of money supply over the sub-periods identified.

In Chapter-IX, observations in different chapters have been presented for review along with a discussion on public policy implications of the findings.

TIME PLOT OF MONEY SUPPLY (M_t)

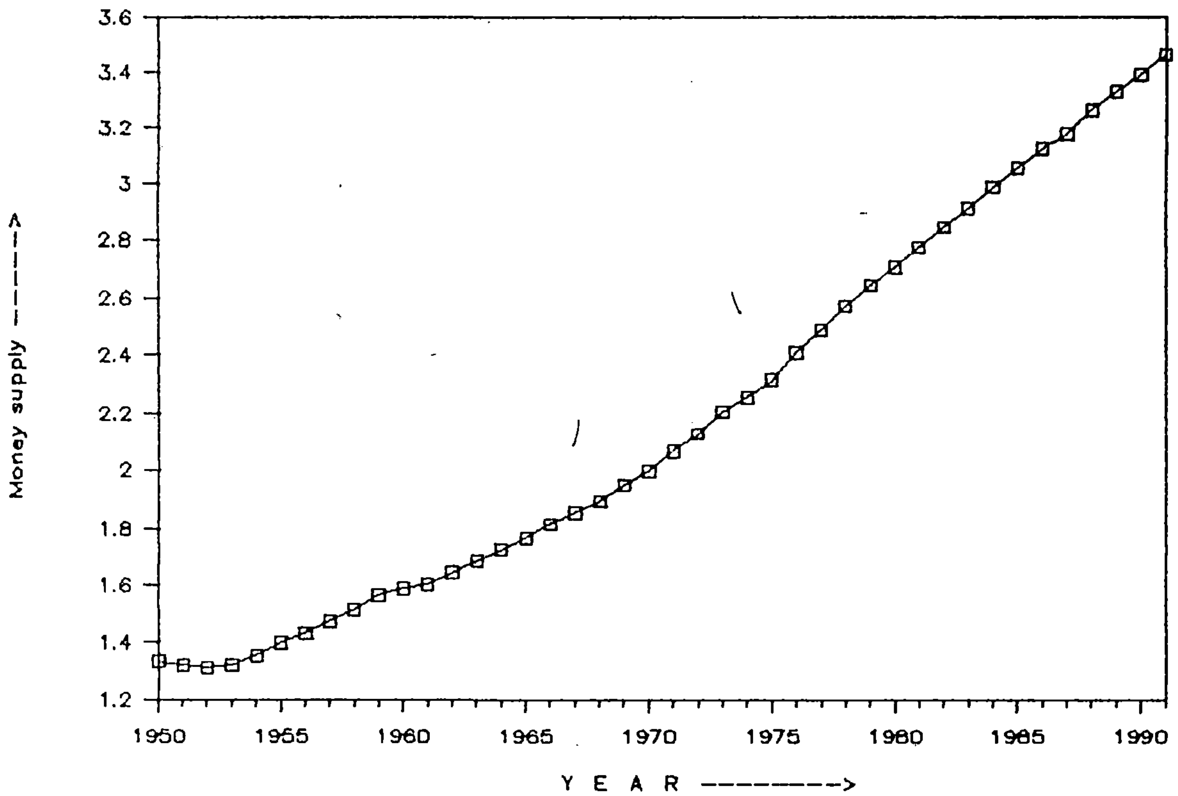

Fig . 1.1

TIME PLOT OF G N P (Y_t)

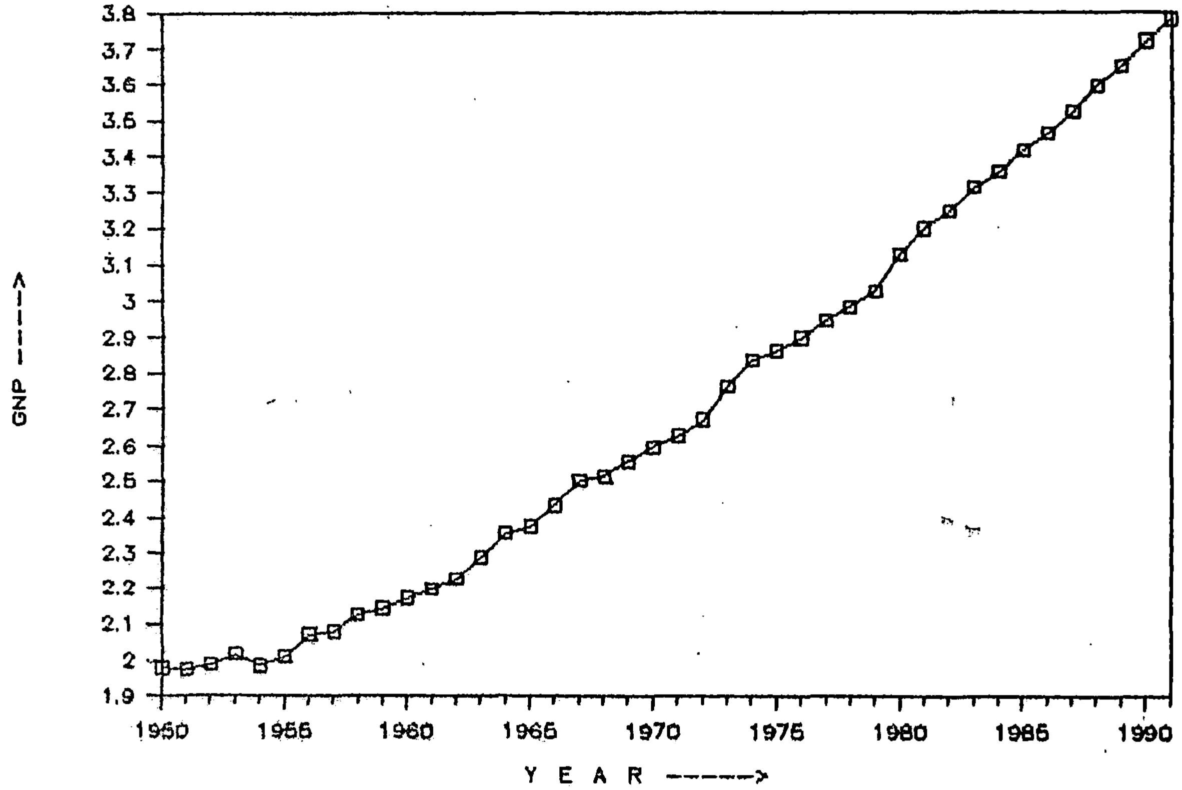

Fig . 1.2

TIME PLOT OF G N P (Y_t) AND MONEY SUPPLY (M_t)

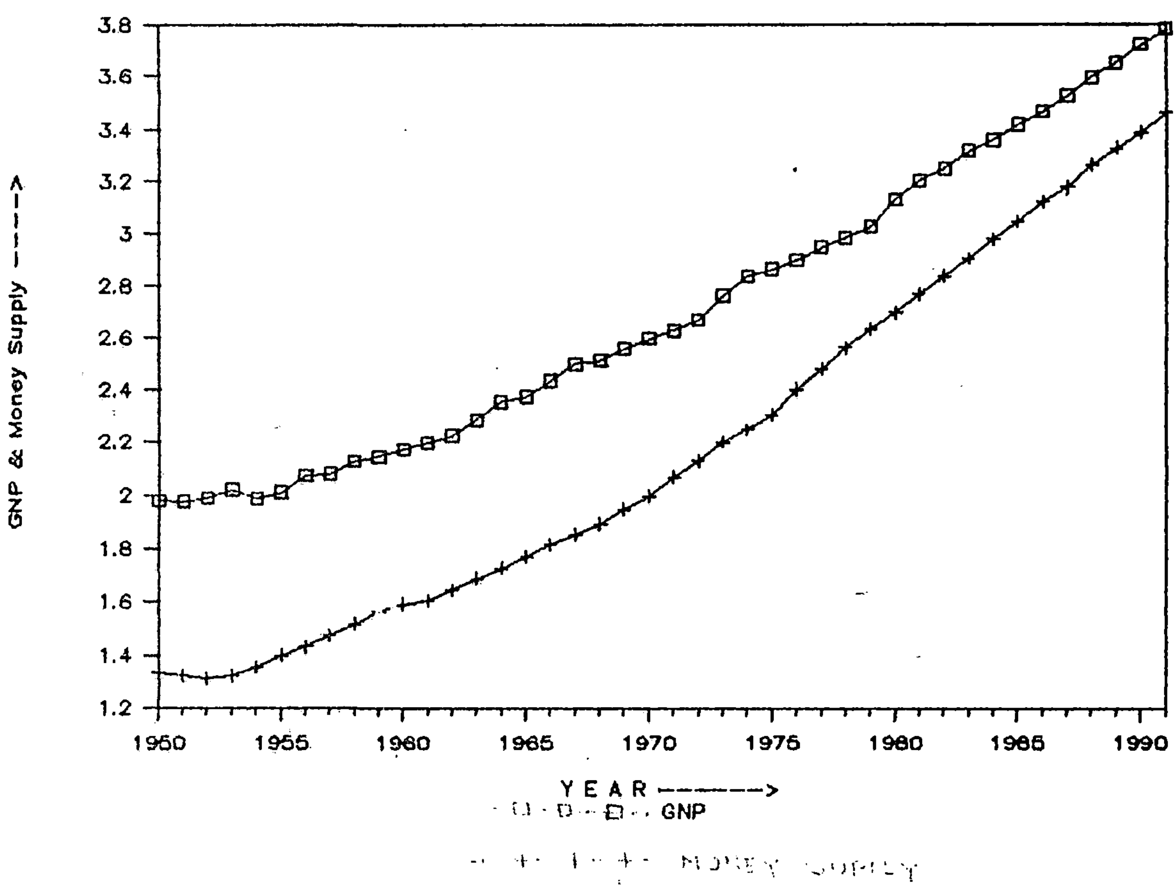

Fig . 1.3

TIME PLOT OF MONEY SUPPLY (M_t)

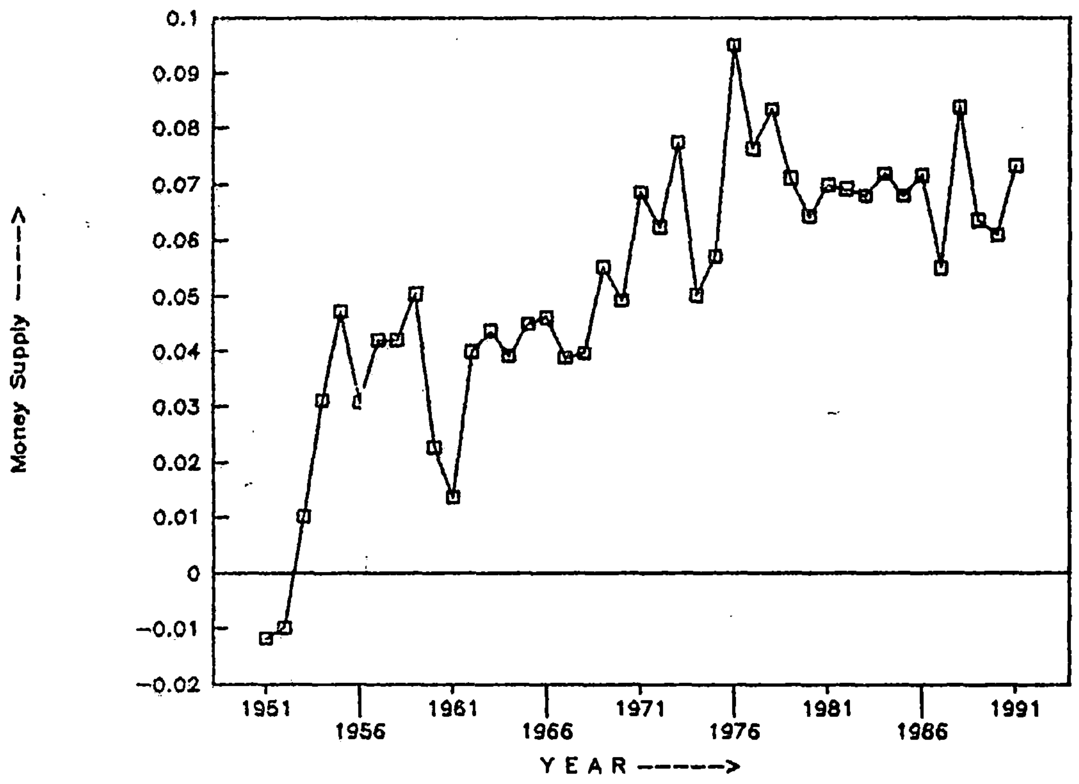

Fig . 1.4

TIME PLOT OF G N P (Y_t)

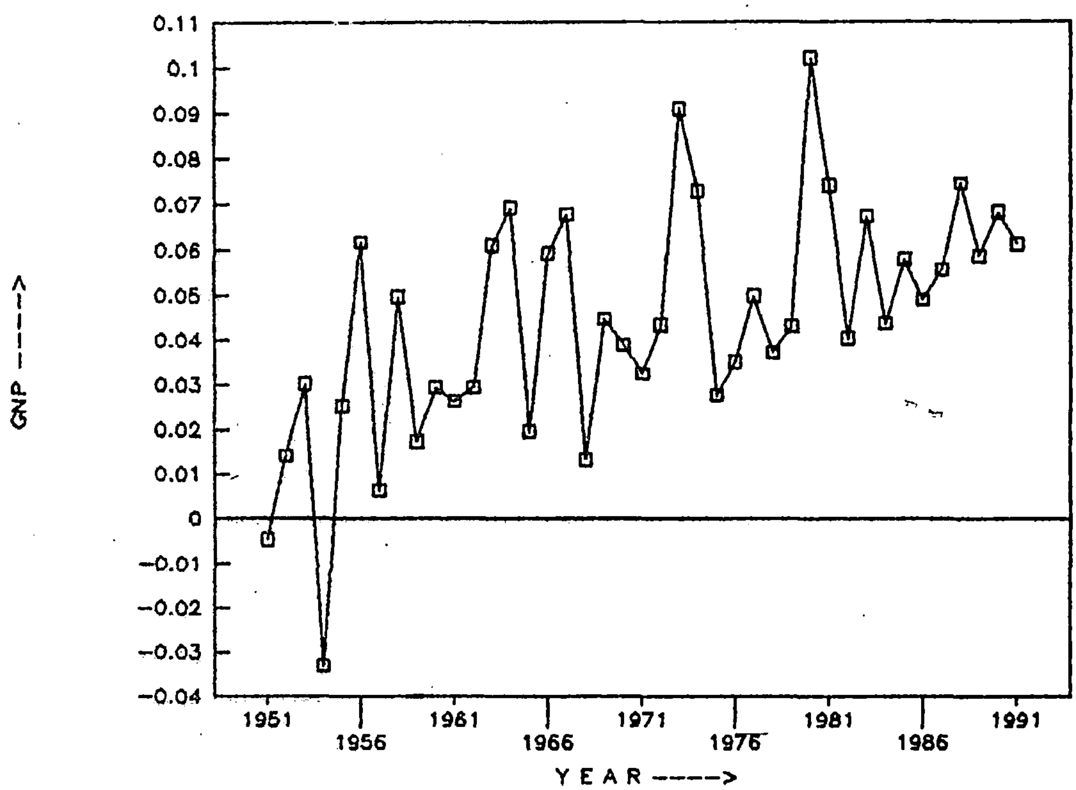

Fig . 1.5

TIME PLOT OF G N P (Y_t) AND MONEY SUPPLY (M_t)

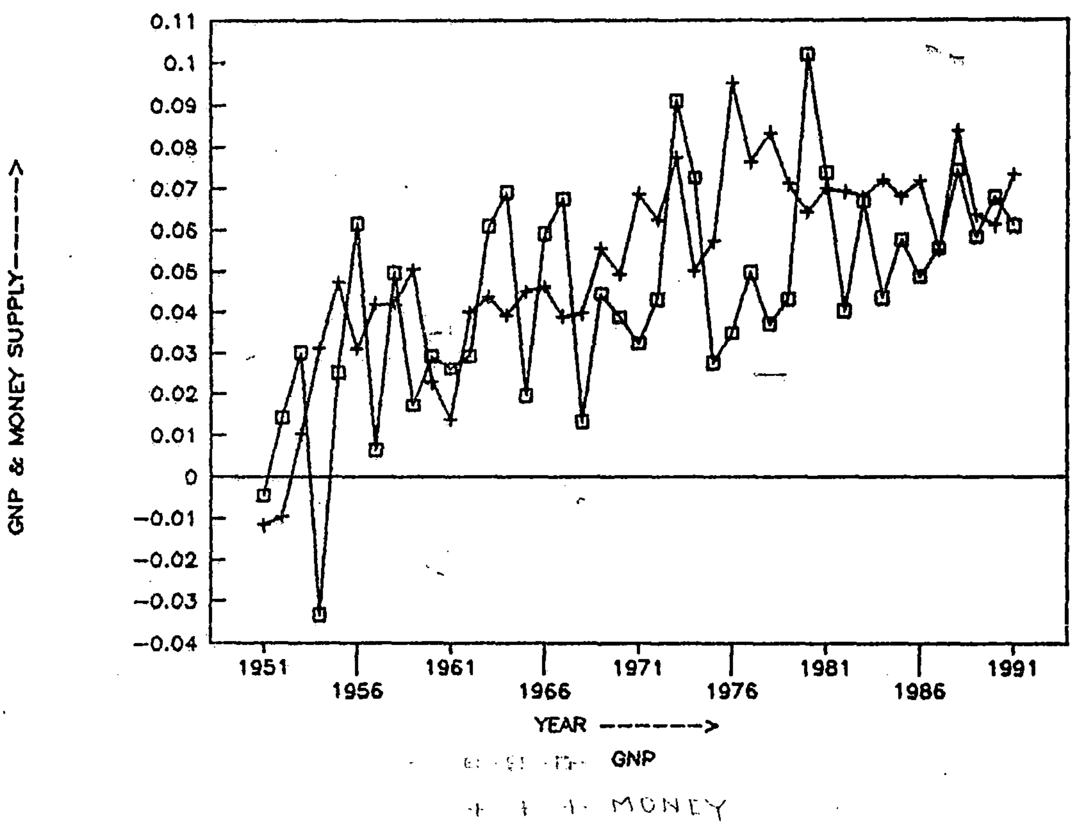

Fig . 1.6

CHAPTER - II

LITERATURE SURVEY

The monetary debate has provided a critical analysis regarding association of "price and output with money supply." The discussion reached a peak at the beginning of 1970's in Milton Friedman's two articles "Theoretical Framework for Monetary Analysis" (1970) and "A Monetary Theory of National Income" (1971).

The debate centres around the role of monetary policy in the matter of influencing real output. Can money supply be tutored so as to affect output ? This is the central issue of the debate. The Quantity Theory of Money at the very outset assumes full employment level of output or at best fixed level of output in the short run.

Therefore, $MV = PT$

where T is always assumed to be fixed for all practical purposes, V, being constant, leads to proportionate change in price level(P) following change in Money Supply(M), since

$$P = \frac{MV}{T}$$

It, therefore, appears that price level rises with the rise in money supply and relative price level remains unchanged. Entrepreneurs find no reason for changing their production. Consequently , output level remains unchanged. Money is, therefore, neu ral and it works like a veil.

According to Keynes (1936), the economy can not always remain at the full employment level. Even with underemployment equilibrium is allso a possibility . In such case there remains a scope for pushing the output level further towards full employment level. According to him, money suppply affects rates of interest. But it is not sure that this will promote investment. If MEC exceeds rates of interes., there may be spurt in investment. On the other hand, Keynes holds that additional money supply in the situation will only put pressure on prices. He even refers to the case of liquidity trap when entire additional money supply goes to match the additional demand for money. As a result, rate of interest remains unchanged at bare minimum level, and investment as well as output level also remain unchanged.

Friedman (1970,71) holds that Monetary policy is not as ineffective as Keynes suggests. He holds that money supply may affect output level in the short run. Monetary policies can influence output and employment only to the extent that they cause price changes that are not foreseen by agents in the private sector. In the long run, the effect on real variables peter out but the higher price level prevails.

Friedman's idea can be explained through the following simple model. Fiscal policy is assumed to be held constant, and monetary policy is the only policy variable affecting the demand for output. For expositional purposes, only the velocity of money is also taken to be constant. With these as options, the aggregate demand for output can be written as

$$M_t + \overline{V}_t = P_t + Y_t \text{ .... } (2.1) \text{ (Aggregate demand)}$$

where M_t = log of money supply
$\overline{V}_t$ = log of the constant velocity of money
P_t = log of the price level
Y_t = log of real output.

The assumption of a constant velocity of money requires that the demand for money is not responsive to interest rate, but the assumption is not crucial for the subsequent analysis.

The aggregate supply equation can be written as

$$Y_t = Y_p + \beta \; (P_t - {}_{t-1}P_t^{e}) \text{ .... } (2.2)$$

where Y_p = natural (or given) level of output
${}_{t-1}P_t^{e}$ = log of the price level that the people expect for the period t at the end of period t-1.

Output will deviate from capacity output (Y_p) only when actual price level differs from that people anticipate at period t-1 that some price level will prevail at period t. If the actual price level at period ,t exceeds the anticipated price level, representative producers will attribute part of this to an increase in their relative price level and output will be above the trend. On the other hand, if the actual price level is below the level anticipated by the producers, the producers believe that relative price is lower and output will fall below the trend value.

Friedman proceeds further to establish that

(i) in the long run equilibrium, the actual rate of growth of nominal income is equal to the anticipated rate and these are equal to the rate of growth of money supply, and

(ii) the deviation of the actual rate of growth of nominal income from the anticipated rate is proportional to the difference between the rate of growth of the money supply and the rate of growth of anticipated nominal income.

Friedman then proceeds to explain why an unanticipated change in the rate of growth of the money supply produces deviation in the rate of growth of nominal income from its anticipated trend rate of growth. In an equilibrium, economic agents hold an optional level of real cash balances. If, through an unexpected change in the money supply, the actual level of real cash balances deviates from the optimal level, economic agents will alter their expenditure behaviour.

The excess supply of money appears as an excess demand for a broad spectrum of real assets, securities, investment goods, and consumer durables. This leads to an increase in the prices of goods and securities. Consequently, there is an equivalent decline in the effective yields of securities. As a result thereof, a new equilibrium higher level of income is established at which the supply of money again equals the demand for money.

Rational expectationists like Sargent (1975), Lucas (1976) amd N.Wallace (1980)do not support Friedman's idea that money supply can affect output in the short tun. On the other hand, they hold that change in money supply, if it is already anticipated by the agents, affects only inflation. Real output or employment remain unaltered. Thus, they put forth the famous "Invariance proposition" which asserts that any predictable part of money supply should have no effect on output, employment or any other real variables in the economy. Only unpredictable change in money supply can have effect on output level. The behaviour of price level and inflation rate will be affected by both anticipated and unanticipated parts of money supply. Only those changes in money supply which are not anticipated can affect output level.

In rational expectations models, price expectations are not fixed or predetermined but respond to anticipated movements in the money supply. To illustrate this, we must provide a monetary rule that is utilized by the policy authorities. An example of the rule is given below :

$$M_t = \alpha_1 \ Y_{t-1} + \varepsilon_t \quad \text{.................................} \ (2.3)$$

where $E(\varepsilon_t \ / \ I_{t-1}) = 0$

Here money supply at time t is a function of the last period's level of output, plus a random, unpredictable stock (ε_t), which neither the policy authorities nor the public can predict. The portion of the money stock based on last periods output ($\alpha_1 Y_{t-1}$) is known to the public and can be thought of feedback policy because it depends on past values of observed variables. The invariance proposition states that the parameter α_1 of the feedback rule that is set by the authorities has no effect on the behaviour of output in the economy.

Only the unanticipated part of money stock (ε_t) will cause output to deviate from its full employment (or capacity or existing) level.

Under rational expectations hypothesis, the price expectations are determined within the model in the light of future developments of the money supply. This can be expressed as

$${}_{t-1}P_t^e = E(P_t / I_{t-1}) \quad \text{.............................} \ (2.4)$$

Now from (2.1) and (2.2) we have,

$$M_t + \bar{V}_t = P_t + Y_p + \beta \ (P_t - {}_{t-1}P_t^e) \ \text{.........}(2.5)$$

Taking the mathematical expectations of both sides of the equation (2.5), and using (2.3) and (2.4) we have

$$E(M_t) + \bar{V} - E(P_t / I_{t-1}) = Y_p + \beta \ [E(P_t / I_{t-1}) - {}_{t-1}P_t^e]$$

$$\text{or, } E[\alpha_1 Y_{t-1} + \varepsilon_t] + \bar{V} - {}_{t-1}P_t^e = Y_p + \beta \ ({}_{t-1}P_t^e - {}_{t-1}P_t^e)$$

$$[\because E(P_t / I_{t-1}) = {}_{t-1}P_t^e]$$

$$\text{or, } \quad \alpha_1 Y_{t-1} + \bar{V} - {}_{t-1}P_t^e = Y_p \quad \text{................} \ (2.6)$$

$$[\because E(\varepsilon_t) = 0]$$

$$\therefore \ {}_{t-1}P_t^e = \alpha_1 Y_{t-1} + \bar{V} - Y_p \ \text{.............} \ (2.7)$$

Again, from equation (2.5)

$$M_t + \bar{V}_t = P_t + Y_p + \beta \ (P_t - {}_{t-1}P_t^e)$$

$$\text{or } \ \alpha_1 \ Y_{t-1} + \varepsilon_t + \bar{V} - P_t = Y_p + \beta \ P_t - \beta \ ({}_{t-1}P_t^e)$$

$$[\therefore\ M_t = \alpha_1 Y_{t-1} + \varepsilon_t]$$

$$\text{or, } \alpha_1 Y_{t-1} + \varepsilon_t + \overline{V} - P_t(1+\beta) = Y_p - \beta\,(\alpha_1 Y_{t-1} + \overline{V}) - Y_p$$

$$\text{or, } (\alpha_1 Y_{t-1} + \overline{V} - Y_p) + \beta\,(\alpha_1 Y_{t-1} + \overline{V} - Y_p) - P_t(1+\beta) + \varepsilon_t = 0$$

$$\text{or, } (1+\beta)P_t = (1+\beta)(\alpha_1 Y_{t-1} + \overline{V} - Y_p) + \varepsilon_t$$

$$\text{or, } P_t = \alpha_1 Y_{t-1} + \overline{V} - Y_p + \frac{\varepsilon_t}{(1+\beta)} \quad \text{..........} (2.8)$$

Therefore, the gap between the actual price and the expected price is

$$P_t - {}_{t-1}P_t^e = \frac{\varepsilon_t}{(1+\beta)} \quad \text{.......................} (2.9) \quad (\text{From } 2.7)$$

Now substituting eqn.(2.9) in eqn. (2.2), we have,

$$\therefore\ Y_t = Y_p + \frac{\beta}{(1+\beta)}\varepsilon_t \quad \text{............................} (2.10)$$

The equation (2.10) shows clearly that $Y_t = f(\varepsilon_t)$ i.e. output is a function of unanticipated part of money supply (ε_t). So, the unanticipated part of money supply (ε_t) affects output. The predictable part of money supply [i.e.α_1 Y_{t-1}) affects prices [vide equation (2.8)] but not the level of output. Thus, output fluctuates randomly around the existing level (Yp) with the fluctuations owing to unanticipated movements in the money stock. Therefore, the variation of output level is independent of any predictable counter cyclical (or even pro-cyclical) policy by the monetary authorities. The behaviour of prices will, however, reflect the choice of the feedback rule.

Many studies have taken a time series approach to test the basic postulates of the R.E Hypothesis. Barro (1977) provided some initial evidence that indicated that the R.E. Hypothesis could not be dismissed simply as a theoretical curiousum. His approach was to use past values for money growth and other lagged variables to forecast money growth. These forecast equations were then identified explicitly with agents' expectations of money growth rates. In other words, Barro assumed that economic actors in the economy acted as if they used regression analysis on readily-available data to forecast money growth rates. The forecast errors from the regressions predicting money growth were termed, "anticipated money growth" and used to test the hypothesis that fluctuations in unemployment around the natural rate depended only on unanticipated money growth. The natural rate of unemployment was allowed to be affected by variables reflecting minimum wage laws and the draft.

Barro tested his hypothesis by entering the actual money growth rates into the equation to determine if they added significant explanatory power to the regression explaining unemployment in terms of unanticipated money growth. However, it did not happen. So Barro argued that he could not reject the hypothesis that only unanticipated money growth causes unemployment to deviate from its natural rate.

J. Grossman (1979) used nominal Gross National Product (GNP) as a proxy for policy instruments to test the hypothesis that only unanticipated money growth causes unemployment to deviate from its natural rate.Grossman's study used quarterly data as a contrast to Barro's original study on annual data. His study lends support to the invariance proposition.

Mishkin's (1982) own emperical results somewhat support the assumption of rational expectations but generally throw doubt on the neutrality of money assumptions. In addition, Mishkin also found that, with rise in lag-structure, tests of the invariance proposition on longer support the hypothesis.

Gordon (1981) has forcefully challenged the studies claiming to have found support for the invariance proposition. He developed a model of gradual price adjustment. In it the invariance proposition may be obtained as a special case. Money is neutral in Gordon's alternative model in the long run but anticipated money growth may be non-neutral in the short run.

Gordon's empirical work on quarterly data covered the period 1890-1980. His basic finding was that prices did not move one for one with anticipated changes in nominal income as required by the invariance propositions. This finding was also true for the 1890-1930 period during which prices of commodities were more volatile than in the post-war era.

Under rational expectations the real sector of the model is completely independent of anticipated monetary policy. The expected rate of inflation fully reflects any change in the systematic component of the growth of the money supply and this directly raises the actual rate of inflation without any repercussions in the real sector. This result of the R.E. School is known as the "Policy ineffectiveness" proposition and has been the subject of heated dispute (McCallum, 1980).

After a slow start the concept of rational expectations became widely accepted, primarily because it seems to be the 'natural' rate hypothesis in the neo-classical model (McCallum, 1980, p. 917). But many economists disagree with some conclusions of R.E. School. The controversial issue is the policy ineffectiveness postulate, according to which anticipated demand management policy will be ineffective in influencing unemployment and real output when expectations are formed rationally. However, it was soon pointed out that the policy ineffectiveness is based on not one but two assumptions (Tobin 1980 ; Buiter 1980 ; Frydman 1981 ; Gordon, 1981) ; rational expectations and market clearing prices.

Fischer (1977) constructs a model in the spirit of Sargent and Wallace. It was assumed in the model that expectations were rational but we replaced the market-clearing hypothesis in the labour market by the assumption of multi-period contracts negotiated in nominal terms. These contracts inject an element of short-run wage stickiness in the model. In this context the policy ineffectiveness proposition is found to be invalid. Monetary policy can affect output and employment if the length of the period of the labour contracts is larger than the time it takes the monetary authority to react to changing economic circumstances.

For instance, if the monetary authority increases the money supply (reacting to some recent economic disturbances) during the negotiated time period, this will affect the price level and therefore, the real wage (for the contract period) and in turn employment and real output will be affected. In this model public and private agents have the same information set at any time but the public agent has the larger opportunity set.

W. Pruiter (1980), in surveying R.E. debate, distinguished two types of models : the Walrasian model with frictionless markets and market-clearing prices and non-Walrasian model with sluggish wage and price adjustments. If the Walras type is combined with R.E., the policy ineffectiveness proposition will result. If, on the other hand, a non-Walrasian model is combined with R.E., demand management policy will have real consequences. Such policy will influence employment and output rates.

Clearly, the expectations of future monetary policy do affect wage and price decisions in this model so that it shares some features of the R.E. approach. It also shares some features of the alternative news because it allows some scope for the exercise of market power by big firms and unions. The policy advice based on this theory is similar to the policy advice coming from R.E. models - set money growth targets to maintain a desired long-run inflation rate and stick to it.

Srivastav and Saxena (1968) have taken the indices of money supply and price level for the period 1951-68. They have reported very high correlation between them in India over the period. They argued that money supply has mostly affected price level. Output level was found to be affected insignificantly by the growth of money supply over the period 1951-68.

Sushil Kumar (1972) constructed index numbers taking quotations of uncontrolled prices in the period 1901-1960. He found that quantity theory of money was applicable in India.

Guru (1987) found mixed response of output level and price level changes in money supply over the period 1970-1985. He reported that output level over some short period exhibited positive response to money supply. However, money supply variation over the period affected price level mostly.

Sinha (1990) analysed causal relationships between money supply, nominal income and prices in India during the planning era. He has observed that increase in money supply and nominal income lead to upward pressure on prices. The real income is reported to have negative effect on prices.

Devraj (1993) studied the role of monetary policy in India. He reported an important role of expectations in ensuring effectiveness of monetary policy over the period 1975-85. However, an adaptive expections process has been adapted in the study.

CHAPTER -III

METHODOLOGY AND DATA

3.1. INTRODUCTION :

METHODOLOGICAL ISSUES ON TESTING OF RATIONAL EXPECTATIONS HYPOTHESIS

In rational expectations model, the usual problems are 'how to test the rational expectations hypothesis when the expected variable is not directly observed or measured'. The central distinctive idea is that the rational expectations hypothesis can be seen as imposing restrictions on what we should observe in the world, and so the validity of rational expectations can be tested by testing for the validity of those restrictions.

There are several methods for such testing available in the literature. We seek to explain three such methods which are used in studies frequently. These methods have been used in our study with REFV models. These delineate the underlying methodological approach for the testing of Rational Expectations Hypothesis in our study. However, we seek to provide details of additional methodological issues whenever necessary in the appropriate text.

Here we will discuss three different methods namely, the Basic Method, the Sargent Method of Forward substitution and the Muth Method of `undetermined coefficients'[6]. These methods are explained with the following models which serve as the basis of our present study.

$$m_t = P_t + y_t - \alpha (E_t P_{t+1} - P_t) \quad (\alpha > 0) \quad \text{.......... (3.1)}$$

$$y_t - y^* = 1 / \delta \ (P_t - E_{t-1} P_t) + \mu (y_{t-1} - y^*) \quad \text{.................. (3.2)}$$

$$= 1 / \delta (P_t - E_{t-1} P_t) / (1 - \mu L) \quad \text{.................. (3.3)}$$

$$m_t = \overline{m} + \varepsilon_t \quad \text{.................. (3.4)}$$

where we have used the backward lag operator, L in (3.3) to facilitate explanation of the relevant aforesaid methods in subsequent sections.

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6. Minford, P. "Rational Expectations Macroeconomics" Blackwell, Oxford, UK, 1996, P. 30 - 36.

3.2 BASIC METHOD :

The Basic Method for solving REFV models requires the following steps :

Step - (1) Solve the model treating expectations as exogenous.

Step (2) Take the expected value of this solution at the date of expectations. If the model generates a unique stable path for the expectational variables, impose the stability condition, and derive this solution for the expectations.

Step (3) - Substitute the expectations- solution into the solution obtained in Step (1) and obtain the complete solution.

In step - (1), substituting (3.3) and (3.4) in to (3.1) We get ,

$$\bar{m} + \varepsilon_t = (1 + \alpha) P_t + y^* + 1/\delta \; (P_t - E_{t-1} P_t) / (1 - \mu L) - \alpha E_t P_{t+1} \quad \text{........ (3.5)}$$

Rearranging and multiplying through by (1-μL) yields :

$$(\bar{m}-y^*)(1-\mu) + \varepsilon_t - \mu\, \varepsilon_{t-1} = -\alpha E_t P_{t+1} + (1 + \alpha + 1/\delta) P_t + (\alpha\mu - 1/\delta) E_{t-1} P_t - (\mu + \alpha\mu) P_{t-1} \quad \text{.......... (3.6)}$$

In step (2) taking expectations at t-1 we have,

$$(\bar{m}-y^*)(1-\mu) - \mu\varepsilon_{t-1} = -\alpha E_{t-1} P_{t+1} + (1 + \alpha + \alpha\mu) E_{t-1} P_t - (\mu + \alpha\mu) P_{t-1} \quad \text{... (3.7)}$$

and

$$(\bar{m}-y^*)(1-\mu) = -\alpha E_{t-1} P_{t+i+1} + (1 + \alpha + \alpha\mu) E_{t-1} P_{t+i} - (\mu + \alpha\mu) E_{t-1} P_{t+i-1}$$

$$(i \geq 1) \quad \text{..............} \quad (3.8)$$

The solution of (3.8) is

$$E_{t-1} P_{t+i} = (\bar{m}-y^*) + A\,[\,(1 + \alpha)/\alpha\,]^i + B\mu^i \quad (i \geq 0) \text{ ...... (3.9)}$$

Here A and B are determined by the initial values $E_{t-1}P_{t+1}$ and $E_{t-1}P_t$.

However, we have only one equation (3.8) to determine both $E_{t-1}P_{t+1}$ and $E_{t-1}P_t$. So, there are infinite paths, all but one unstable.

The model, therefore, has the saddlepath property. Consequently, imposing the stability condition where $A = 0$ with $B = E_{t-1} P_t - (m - \overline{y}^*)$

We get from (3.7)

$$E_{t-1} P_t = (\overline{m} - y^*)(1 - \mu) - [\mu / (1 + \alpha)]\, \varepsilon_{t-1} + \mu P_{t-1} \quad \text{......} (3.10)$$

From (3.10) again we have,

$$E_t P_{t+1} = (\overline{m} - y^*)(1 - \mu) - [\mu / (1 + \alpha)]\, \varepsilon_t + \mu P_t \quad \text{......} (3.11)$$

In step - 3, substituting $E_{t-1} P_t$ and $E_t P_{t+1}$ as given in (3.10)and (3.11) respectively into (3.6) and on collecting terms, we have

$$P_t = (\overline{m} - y^*)(1 - \mu) - [\mu / (1 + \alpha)]\, \varepsilon_{t-1} + \mu P_{t-1} + (1 + \alpha - \alpha\mu) / [(1 + \alpha)(1 + \alpha - \alpha\mu + 1/\delta)]\, \varepsilon_t \quad \text{......} (3.12)$$

3.3. MUTH METHOD :

In the Muth method we start with the general solution for P such that

$$P_t = \bar{P} + \sum_{i=0}^{\infty} \pi_i \, \varepsilon_{t-i} \quad \text{......} (3.13)$$

and it remains that $\overline{P} = \overline{m} - y^*$

Substituting (3.13) in (3.6) and dropping constants we obtain

$$\varepsilon_t - \mu\, \varepsilon_{t-1} = - \alpha \sum_{i=0}^{\infty} \pi_{i+1}\, \varepsilon_{t-i} + (1 + \alpha + 1/\delta) \sum_{i=0}^{\infty} \pi_i\, \varepsilon_{t-i} + (\alpha\mu - 1/\delta) \sum_{i=0}^{\infty} \pi_i\, \varepsilon_{t-i} - (\mu + \alpha\mu) \sum_{i=0}^{\infty} \pi_{i-1}\, \varepsilon_{t-i} \quad \text{......} (3.14)$$

The identities emerge as

(ε_t) $\quad 1 \quad = - \alpha \pi_1 + (1 + \alpha + 1/\delta)\, \pi_0$ ...... (3.15)

(ε_{t-1}) $\quad - \mu \quad = - \alpha\pi_2 + (1 + \alpha + \alpha\mu)\, \pi_1 - (\mu + \alpha\mu)\pi_0$ ...... (3.16)

$(\varepsilon_{t-i},\ i \geq 2)$ $\quad 0 \quad = - \alpha\pi_{i+1} + (1 + \alpha + \alpha\mu)\, \pi_i - (\mu + \alpha\mu)\, \pi_{i-1}$ ...... (3.17)

Applying the stability condition to the solution of (3.17)

$$\pi_i = A\left(\frac{1+\alpha}{\alpha}\right)^{i-1} + B\mu^{i-1} \quad (i \geq 1) \qquad \text{.........................} \quad (3.18)$$

Set $A = 0$, so that

$$\pi_i = \pi_1 \mu^{i-1}, \quad (i \geq 1) \qquad \text{.............................} \quad (3.19)$$

Substituting this into (3.15) and (3.16) we have

$$\pi_o = (1+\alpha-\alpha\mu) \,/\, \{(1+\alpha)(1+\alpha+1/\delta-\alpha\mu)\} \qquad \text{..................} \quad (3.20)$$

$$\pi_1 = -\mu \,/\, \{\delta(1+\alpha)(1+\alpha+1/\delta-\alpha\mu)\} \qquad \text{........................} \quad (3.21)$$

3.21 gives the solution to the model.

3.4 SARGENT METHOD :

The Sargent Method parallels the Basic Method up to (3.8) which Sargent writes as -

$$-1/\alpha\,(\bar{m}-y^*)(1-\mu) = [\,B^{-1} - \{\left(\frac{1+\alpha}{\alpha}\right) + \mu\} + \{\left(\frac{1+\alpha}{\alpha}\right)\mu B\}]\, E_{t-1}\, P_{t+i}$$

$$= \{\,1 - \left(\frac{1+\alpha}{\alpha} + \mu\right)B + \left(\frac{1+\alpha}{\alpha}\right)\mu B^2\}\, B^{-1}\, E_{t-1} P_{t+i}$$

$$= \{1 - \left(\frac{1+\alpha}{\alpha}\right)B\}\,(1-\mu B)\,B^{-1}\, E_{t-1}\, P_{t+i} \quad (i \geq 1) \qquad \text{................} \quad (3.22)$$

B is the backward operator. (3.22) can, therefore, be written as

$$(-1/\alpha)(\bar{m}-y^*)(1-\mu) \,/\, \{1-\left(\frac{1+\alpha}{\alpha}B\right)^{-1}\}$$

$$= [\,(1-\mu B)B^{-1} /- \left(\frac{1+\alpha}{\alpha}B\right)^{-1} E_{t-1}\, P_{t+i} \qquad (i \geq 1) \text{ ....} \quad (3.23)$$

Now imposition of stability condition generates an infinite forward expansion.

$$-1/\alpha\,(\bar{m}-y^*)(1-\mu)\,[\,1 + \frac{\alpha}{1+\alpha} + \left(\frac{\alpha}{1+\alpha}\right)^2 + \text{.................}\,]$$

$$= -1/\alpha\,(\bar{m}-y^*)(1-\mu) \,/\, [1-\left(\frac{1+\alpha}{\alpha}\right)]$$

Cancelling and rearranging terms and setting i = 1 yields

$$E_{t-1}P_{t+1} = \mu\ E_{t-1}P_t + (\bar{m} - y^*)(1 - \mu) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.24)$$

In this infinite forward expansion the remainder term

$$[\alpha/(1+\alpha)]^N E_{t-1} P_{t+N+1} - \mu$$

Here the remainder $[\alpha/(1+\alpha)]^N E_{t-1} P_{t+N+1} - \mu E_{t-1_1} P_{t+N}$ $(N \to \infty)$ is forced to be zero by the stability condition as $N \to \infty$. The Sargent Method thus represents a convenient extension of operator technique to REFV models. Stable roots are projected backward while unstable roots are projected forward. This procedure, under stability condition, gives the same result but in a very compact manner.

3.5 ISSUE ON EXOGENEITY/ENDOGENEITY OF EXPECTATIONS

In the Basic Method expectations are considered to be exogenous. In the Sargent and Muth Method, expectations, on the other hand, are taken to be endogenous. These two approaches differ initially and hold opposite views in this respect.

However, the difference narrows down when the nature of the equation for the anticipated variable is taken into consideration. If the structural equation for the anticipated variable turns out to be a reduced form equation itself or if the anticipated variable defines a random walk process, then endogenous expectations virtually emerge as exogenous ones.

In this present study this issue has been given due consideration. Econometric procedure for capturing the anticipated money supply has been specified and explained in Chapter-V.

3.6 SOURCE AND NATURE OF DATA :

We have taken Net National Expenditure (GNP) (1980 = 100) to measure output and M_2 for money supply in our economy. It is a yearly data set shown in table 3.1. We have taken the data set for the period, (1950-91)[7].

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7. Data sets are taken from International Financial statistics (IFS).

In our study, we have used M_2 instead of M_1 because of our concern function greater stability in the data set. M_2 shows very often greater stability than M_1. When new kind of checking accounts is introduced, M_1 behaves very erratically on many useful monetary operations. M_2 is considered to be a better barometer of economic activities. M_2 in International Financial Statistics (IFS) is captured through the sum of lines 34 and 35. The line 34 represents M_1 while the line 35 represents Quasi - Money comprising time, savings and foreign currency deposits of resident sectors other than Central Govt. M_2, therefore gives a broader measure of money supply.

The data on GNP and M_2 have been taken from International Financial Statistics (IFS). The IFS data set for the relevant variables have been collected for the period, 1950 to 1959 from 1979 IFS Year Book, for the period 1960 to 1985 from 1988 IFS Year Book and for the period 1986 to 1991 from IFS September 1993.

We seek to specify here the reason for which the IFS data have been found preferable to RBI data.

"The Reserve Bank of India collects detailed data which it does not release in India. It does, however, make these data available to the World Bank and the International Monetary Fund so that the foreigners with access to these institutions can easily get hold of them. It is the common place for Indian researcher to realise that for the 'correct' data on the Indian Economy whether it is the state of the external or internal debt, an actual payments made on total defence amount, one has to turn to foreign publications which use data made available by the Indian Government.[8] This has motivated our choice of the I.F.S. as the source of our data set.

3.7 METHODOLOGY ADOPTED :

We have adopted Econometric and Statistical methods for the processing of the data. We have used the OLS and GLS methods of Regression for estimating the relations among the variables concerned. We have taken adequate care for detecting the presence of the 'Single Equation Problems' like Auto-Correlation and Multicollinearity. D.W. Statistic has been shown along with each estimated regression equation.

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8. The Front Line : July 20; August 1991, Vol.8 , No.15; p.11.

The goodness of fit of the estimated relation among the variables concerned has been measured through R^2 and it has further been corroborated by F - Test. The significance of the values of Regression Constants and Regression Co-efficients have been determined through the `Standard Errors' of these estimates and their corresponding t-statistics.

Some hypotheses have been taken up for testing in our analysis. We have used `t - tests' at 5% and 1% levels of significance. These t - tests are essentially `One - Tail Test'.

'CHOW TESTS' have been undertaken for window finding in time series data set. For this purpose, a series of iterative regression (OLS & GLS) have been done and results have been subject to 'battery of tests'. The relevant formulae and forms are given in the appropriate part of the study.

3.8 DATA TRANSFORMATION :

In appropriate cases in our study, Logarithm of the original data set has been taken in order to suit the estimation of the models involved.

In case of the presence of Auto-Correlation in estimated regression equation under OLS Method, we have introduced appropriate transformation of data set for the estimation with Cochrance - Orcutt Method and then Generalized Least Square Method (GLS).

Data set for expected and unexpected money supply has been generated through an appropriate equation of money supply. These vectors of anticipated and unanticipated money supply have been used for the estimation of models thereafter.

TABLE-3.1

DATA

Year	Y_r (in billions of Rs.)	M_2 (in billions of Rs.)
1950	95.4	21.64
1951	94.4	21.07
1952	97.5	20.60
1953	104.5	21.09
1954	96.8	22.66
1955	102.6	25.26
1956	118.2	27.12
1957	119.9	29.87
1958	134.4	32.90
1959	139.8	36.94
1960	149.5	38.92
1961	158.8	40.17
1962	169.9	44.03
1963	195.4	48.69
1964	229.0	53.27
1965	239.5	59.07
1966	274.3	65.69
1967	320.4	71.84
1968	330.2	78.68
1969	365.8	89.32
1970	399.8	100.1
1971	430.7	117.1
1972	475.6	135.2
1973	586.2	161.5
1974	693.0	181.3
1975	738.3	206.7
1976	799.7	257.4
1977	896.2	306.7
1978	975.9	371.5
1979	1077.0	437.4
1980	1362.0	506.9
1981	1595.0	595.3
1982	1769.0	697.7
1983	2063.0	815.6
1984	2281	962.3
1985	2603	1125
1986	2911	1326
1987	3306	1505
1988	3921	1825
1989	4483	2112
1990	5240	2430
1991	6027	2875

Source : IFS - Year Book, 1979, 1988 and Sept. 1993.

CHAPTER - IV

OUTPUT-MONEY SUPPLY RELATIONSHIP OVER THE PERIOD (1950-91)

4.1. INTRODUCTION :

India, since Independence, has been trying to be self-sufficient in both agricultural and industrial production. Several ambitious economic plans have been undertaken since 1950 in order to usher in a planned growth in both the spheres. As a result thereof, India achieved a spectacular development in agriculture. Again India could transform herself from a pure agrarian economy to a thriving and outstanding industrial country among the developing countries in the world. National income has been growing over the last few decades almost steadily though since 1973 the growth seems to be shy and is occasionally marked by prominent ups and downs since 1980.

Output growth is marked by simultaneous growth of money supply along with growing monetization of the Indian Economy. With such growing monetization, Indian economy underwent a transformation from the barter economy to exchange economy. Because of this transformation, money could rise above its traditional position of medium of exchange and gradually assume more suphisticated roles day by day. In addition to its traditional role of medium of exchange, it has started playing the roles of store and standard of payments in the economy. Growing monetization of the economy, coupled with lower interest rate policy following cheap money policy [9] in the earlier phase of the economy, stimulated investment. Consequently, output registered an upward growth which evidently added to the purchasing capacity in the economy. Thus, expansion of money supply resulted in the growth of output level in the economy.

The figure 4.1 represents the time plot of output level (GNP) over the period 1950-91. The plot deliniates a rising pattern of GNP though at a very lower rate since 1950 to 1972. With a sudden jump in 1985 GNP describes a pattern of steep rise in the following years.

---

9. Monetory authorities followed cheap money policy in the first plan (1951-56) and con trolled expansion policy in the second plan (1957-62).

It may, however, be noted that the figure 4.1 presents the time plot of a non-stationary [10] series for GNP. A better picture of the movement in GNP may, therefore, be obtained from the time plot of the stationary series of GNP as given in figure 4.2. It is observed from the figure 4.2 that variation [7] in the GNP was not noticeable until 1962. The variation in GNP since 1963, though very insignificant, was noticeable until 1972. Since 1972 variation became spectacular. GNP displayed significant rise with some occasional ups and downs until 1985. Since then, there was a steep rise in GNP for subsequent years (1985 - 1991).[11]

Another important feature of the Indian economy over the period 1950-91 is that the economy with its growing monetization has transformed herself progressively from a barter economy, as initially in 1950, to the state of exchange economy. During the process of transformation money played an important role in economic activities. Cheap money policy followed by the monetary authority in the very early phase of economic development reduced interest rates and stimulated investments. This helped the output level grow. On the other hand, with rise in money supply, purchasing power capacity grew. This supported the growth of output level. Thus, expansion of money supply is usually considered to be a stimulating factor for output level over the past few decades. Nevertheless, whether income growth has really been related to the growth of money supply still remains an issue of debate.

An idea about the nature of association between output level (Y_t) and money supply (M_t) can be obtained from the examination of the time plots of GNP and money supply as given in Fig. 4.3. Fig. 4.3 presents the time plots of non-stationary series of output level and money supply. It appears that

(i) Money supply (M_t) describes an exponentially rising pattern over the period, 1950-1991.

(ii) Exponential rise in output level over this period exhibits a positive association between Y_t and M_t. It may, however, be noted that Y_t registered a steeper rise than M_t since 1985.

---

10. Estimated AR(1) process for GNP shows that co-efficient of GNP (Y_{t-1}) exceeds 1. So the process is non-stationary.

11. A very little fall was observed in 1989.

Fig. 4.4 represents the time plots of stationary series for Y_t and M_{t-1}. Some interesting features of the association between these two variables are as follows :

(i) There exists very high and positive degree of association between these variables until 1979 ;

(ii) Since 1980 output level is found to exhibits higher variation than that in lagged [12] money supply until 1984 ;

(iii) Since 1986 the variation in output level is far more spectacular than that in the lagged money supply. It may also be noted that variations in these variables show somewhat different patterns with extent of variations being different over time. Consequently, the association between Y_t and M_{t-1} seems to be weak over the period 1986-1991.

This graphical analysis gives only a tentative idea about the relation between these macro-economic variables.For the precise and conclusive idea about the relationship between money supply and output level, we seek to undertake an investigation in this direction with bivariate data set on money and income. An attempt in this direction has been undertaken. The model has been specified below together with the subsequent estimation and explanation of the findings.

4.2 THE MODEL :

The model for estimation in this present chapter is

$$Y_t = Y_p + \beta M_t + W_t \quad \ldots\ldots (4.1)$$

where Y_t = (log of) output at period t

M_t = (log of) Money supply at period t.

t = 1950 .... 1991.

Y_p = Capacity Output.

$W_t \sim$ i i d N $(0, \sigma_u^2)$

---

12. Exertion of monetary influence on output level is a time-lag phenomenon. However, in rational expectationists model M_t i.e. instantaneous money supply is usually taken in the vector of regressors.

Y_p, the capacity output needs further explanation. Lucas, in his supply function, holds that it is the trend value of Y_t where Y_t is the co-variance stationary Time Series variable.

However, Durnbusch holds that in stationary process the long-run trend value may be approximated by the mean of the variable. Hence, in our model Yp is approximated by $\bar{Y}$. Therefore, the model is

$$Y_t = \bar{Y} + \beta M_t + W_t \quad \text{.........................} \quad (4.2)$$

$$\text{or } Y_t - \bar{Y} = \beta M_t + W_t \quad \text{.........................} \quad (4.3)$$

$$\text{or } y_t = \beta M_t + W_t \quad \text{.........................} \quad (4.4)$$

where y_t represents the deviation of Y_t form $\bar{Y}$.

It may however, be noted that the software package available for estimation does not allow estimation of the equation without regression constant. Because of these exigencies the estimable model becomes -

$$y_t = \alpha + \beta M_t + W_t \quad \text{..................} \quad (4.5)$$

4.3 ESTIMATION :

The equation has been estimated with GLS Method.[13]

The estimated equation is

$$\hat{y}_t = -0.027964 + 0.5403\, M_t \quad \text{..............} \quad (4.6)$$

(0.0086166) (0.1517)[14]

[-3.2454] [3.5624]

$R^2 = 0.2455115$ D.F. = 39

F* = 12.691 D.W. = 2.03

---

13. The OLS estimation suffers from autocorelation. So, the GLS Method has been used as an alternative appropriate method of estimation. This removes autocorelation from the estimated equation.
14. Values in the parentheses indicate corresponding S.E. values while those in brackets represent corresponding t -values of the estimates.

From the equation (4.6), it is observed that

(i) the equation is good fit and the joint estimation is significant at 5% level since F* = 12.691;

(ii) both the regression constant [15] ($\hat{\alpha}$) and regression coefficient [16] ($\hat{\beta}$) are significant at 5% level; and

(iii) the equation is free from auto-corelation since D.W.[17] = 2.03

This estimated model has been found to be the best fit one compared to other alternative estimated models presented below.

4.4 ESTIMATION OF ALTERNATIVE MODELS: COMMENTS :

Alternative Model-1

$y_t = \alpha + \beta M_t + V_t$

The OLS estimation of the equation is

$$\hat{y}_t = -992.85 + 2.0952M_t$$
$$(18.230) \quad (0.021351)$$
$$[-54.461] \quad (98.143]$$

D. F = 40 $\quad$ R^2 = 0.9958644

F* = 9632 $\quad$ D.W. = 0.2538

---

15. Significance of $\hat{\alpha}$ is determined by the t - test where

$H_0 \ \alpha = 0$

against

$H_{A,} : \alpha > 0$

It is a one - tail test where

$t = \hat{\alpha}/s(\hat{\alpha})$

16. Significance of $\hat{\beta}$ is also determined by the t-test where

$Ho : \beta = 0$

against

$H_A : \beta > 0$

It is a one-tail test where

$t = \hat{\beta}/s(\hat{\beta})$.

17. D.W. statistics = 2.03 indicates that 4 - D.W.= 4 - 2.03 = 1.97. This testifies for the absence of A.C. in the estimated equation.

Here we have taken non-stationary data set on GNP (Y_t) and Money supply (M_t) without log-transformation . y_t represents the deviation of Y_t from its mean $\overline{Y}$ such that $y_t = Y_t - \overline{Y}$.

It is observed that

(i) regression constant ($\hat{\alpha}$) and regression co-efficient ($\hat{\beta}$) are significant even at 5% level ;

(ii) the euqation is good fit since $R^2 = 0.995$ and $F^* = 9632$; and

(iii) the equation suffers from A.C.since D.W. = 0.2538.

so, the equation is omitted.

Alternative Model - 2

$$\log y_t = \alpha_1 + \beta_1 \log M_t + v_t$$

$$\text{i.e. } y'_t = \alpha_1 + \beta_1 M'_t + v_t$$

The OLS estimation of the equation is

$$\hat{y}'_t = -2.0166 + 1.0380 M'_t$$

(0.01598) (0.0079236)

[-126.19] [131.0]

D. F. = 40 $\quad$ $R^2 = 0.99767$

$F^* = 17160$ $\quad$ D.W. = 1.037

We have taken non-stationary data set with log - transformation of the variables concerned in the alternative model-1. Here $\log y_t$ represents the deviation of $\log Y_t$ from its mean such that $\log y_t = \log Y_t$ - mean ($\log Y_t$). It is observed that

(i) regression constant ($\hat{\alpha}_1$) and regression co-efficient ($\hat{\beta}_1$) are found significant even at 5% level ;

(ii) the equation is good fit since $R^2 = 0.997$ and $F^* = 17160$; and

(iii) the equation suffers from A.C. even at 1% level since D.W.= 1.03. so, the equation is ignored.

The alternative models (1) and (2) are shown in table-4.1.

TABLE-4.1

Results of estimation of alternative models

Sl.No.	Model	Method	Estimation	DF	R^2	F*	D.W.
1	2	3	4	5	6	7	8
1.	$y_t = \alpha + \beta M_t + u_t$	OLS	$\hat{y}_t = -992.85 + 2.0952 M_t$ (18.230) (0.021351) [-54.461] [98.143]	40	0.9959	9632	0.2538
2.	$\text{Log } y_t = \alpha + \beta \log M_t + v_t$ i.e. $y'_t = \alpha + \beta M'_t + v_t$	OL S	$\hat{y}'_t = -2.0166 + 1.0380 M'_t$ (0.01598) (0,0079236) [-126.19] [131.0]	40	0.9977	17160	1.0376

4.5 FINDINGS :

The $\hat{\beta}$ co-efficient of the estimated equation (4.6) is significant at 5% level. Again $\hat{\beta} > 0$ indicates that output registered a significant rise following on increase in the money supply over the period concerned. So variation in money supply is found to lead to a significant variation in output level. Output level exhibits a rise significantly in response to a rise in money supply over the period concerned (1950-91) .[18]

It may again be interpreted in the following way with reference to the equation (4.4). Since $y_t = Y_t - Y_p$, the variation in output level represents the variation from its capacity level. This variation seems to be positive so long as money supply rises. Thus, increase in money supply leads to a rise in output level over its capacity level, or the long-run trend level over the period of our study.

4.6 SOME RELEVANT ISSUES :

It may be noted that the estimated equation represents the variation of output level to change in overall money supply. This money supply has two parts - (1) the anticipated and (2) un-anticipated or surprize part. Consequently we face an immediate question - which part of money supply is responsible for the observed variation in output level? This needs further investigation. The next chapter is devoted to address this issue.

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18. The purpose of estimation is not to test causality and Econometric Exogeneity. We are not seeking to know if money supply caused income growth. It is an attempt to see if variations in output level could be explained through variation in money supply. Sim's approach, therefore, has not been adopted in the study.

    It may again be noted that Sim's approach has tacitly been undertaken into consideration while formulating the capacity income (Yp). In many works capacity income is defined as Y_{t-1} and in such case the variation in Y_t over Y_{t-1} is the object of study.

    The stationary or capacity income as defined in our study tacitly involves the case of Y_{t-1} and therefore, tacitly inconformity with Sim's Approach.

TIME PLOT OF GNP

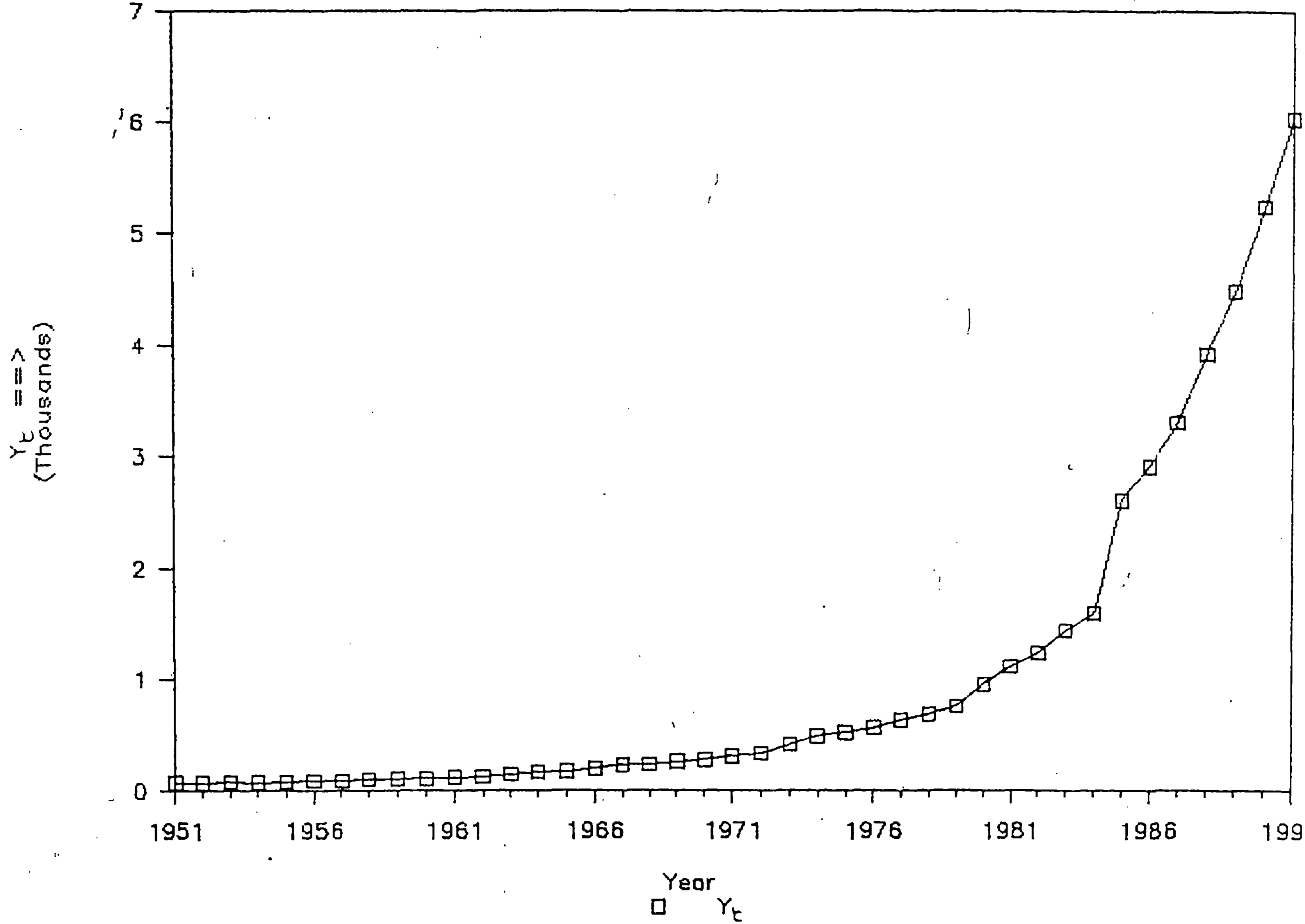
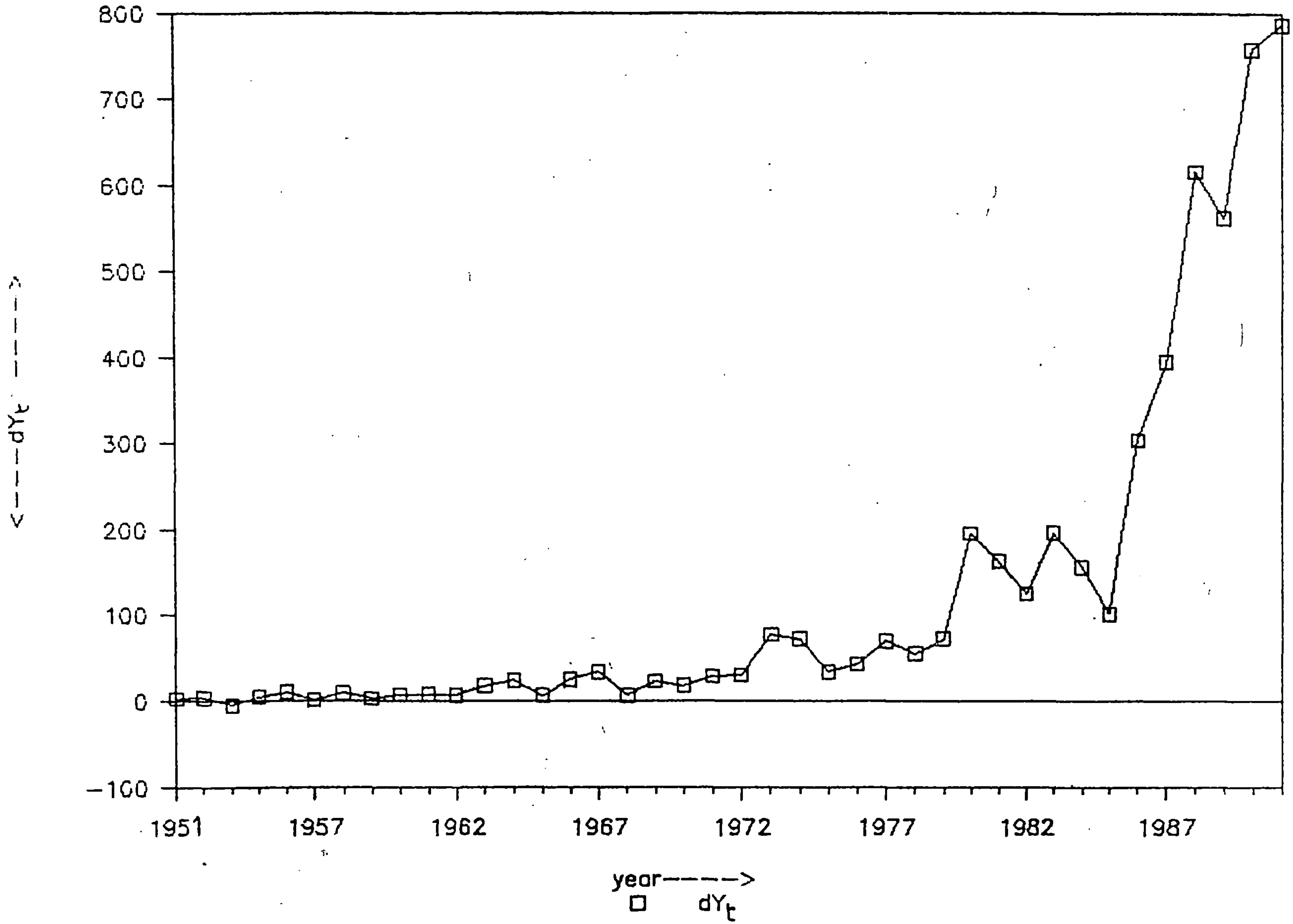


Fig . 4.1



800
700
600
500
400
300
200
100
0
−100
<---dYt --->
1951
1957
1962
1967
1972
1977
1982
1987
year---->
dYt

Fig . 4.2

TIME PLOT OF G N P (Y_t) AND MONEY SUPPLY (M_t)

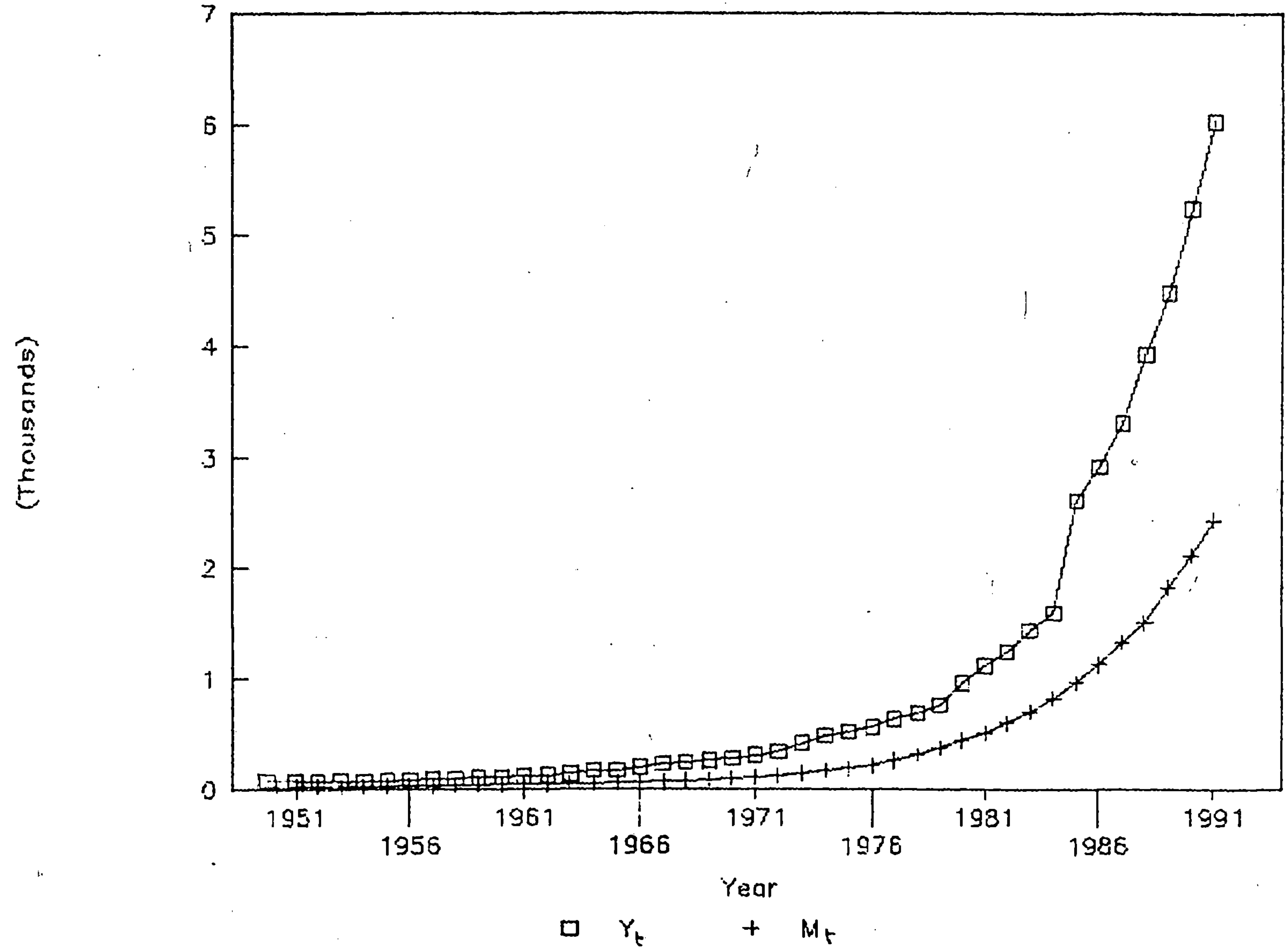


Fig . 4.3

TIME PLOT OF G N P (Y_t) AND MONEY SUPPLY (M_{t-1})

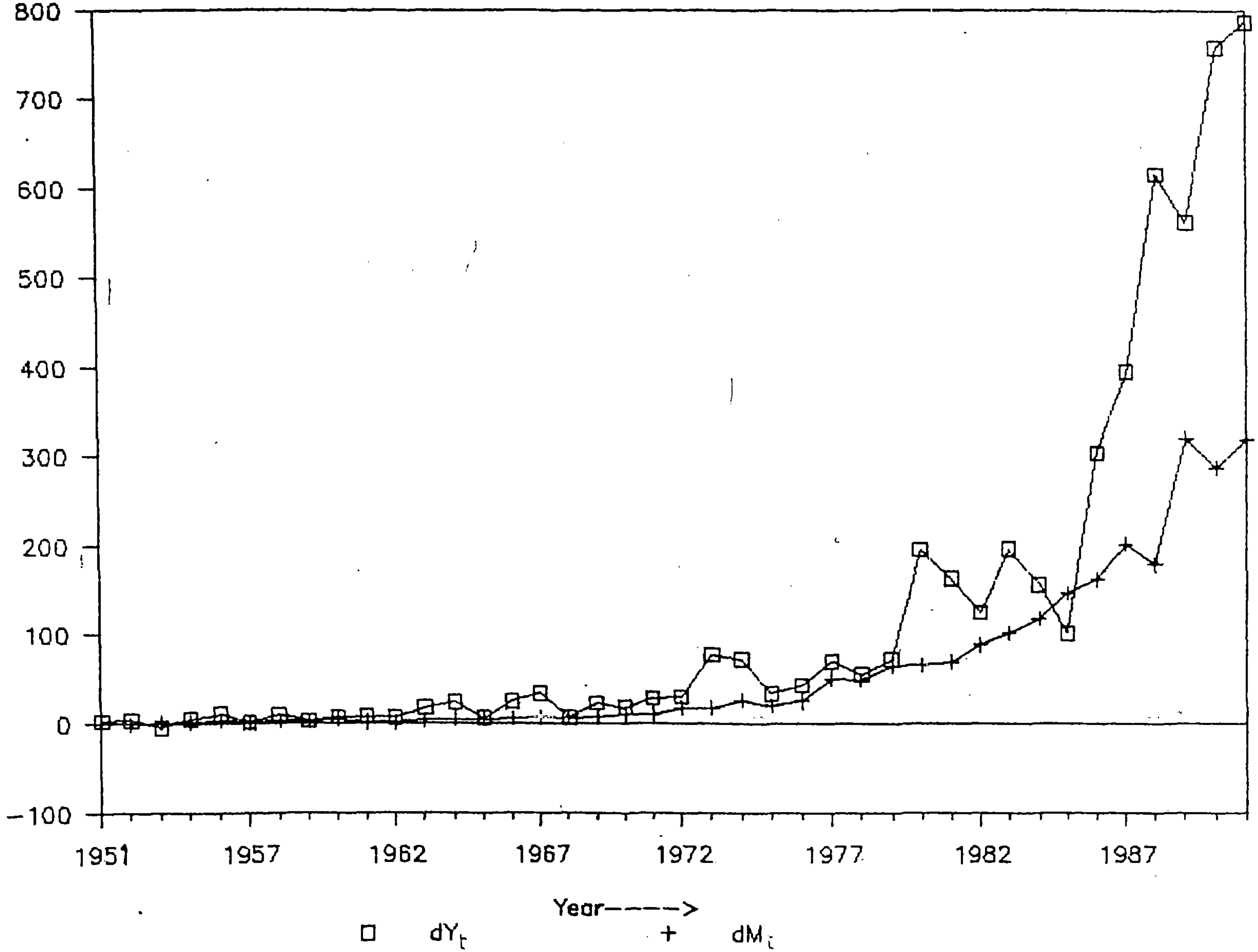


Fig . 4.4

CHAPTER - V

ANTICIPATED MONEY SUPPLY : ESTIMATION UNDER RATIONAL EXPECTATIONS PROCESS

5.1 INTRODUCTION :

In all economic activities involving the future, any economic plan which people may make, is affected by expectations. The fundamental difficulty in the analysis of expectations lies in their very nature. Expectations are psychological phenomena and these cannot be observed directly in the way that quantities and prices can be watched. S.A. Ozga [19] says, "Expectations Proper" are attitudes, dispositions or states of mind which determine our behaviour or at least accompany it.

For the analysis of expectations, any of the two methods can be used - (1) introspection or (2) proxy formulation. In 'introspection', one projects one's own subjective expérience on to other economic agents. In 'proxy formulation' one establishes a relationship between the unobservable expectations and empirically observable magnitudes. The modern theories use the second method exclusively for the analysis of expectations.

In modern theories , there exist three elements in the matter of formation of expectations - (1) individual (ii) information and (iii) the expectations proper. The individual plays the role of information processor. Continuous process of receiving and processing of information results in a succession of expectations over time.

However, the precision of expectations depends on the quality and nature of information available and the model through which the information set is processed. The agent has very limited set of informations. He forms his expectations on the basis of less informations - intensive model. In such case 'Adaptive Expectations' are very suitable where future value of a variable is related to a set of some past values.

If, on the other hand, agent receives enough of informations, "Adaptive Expectations" model becomes inappropriate, since it would lead to 'waste;' of

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19. Ozga, S.A. - "Expectations in Economic Theory" , London, Weidenfeld and Nicolson , 1965, pp.23.

the extra information elements.[20] This constitutes the heart of "Rational Expectations Process". Sargent and Wallace, therefore, hold, "Expectations about a variable are said to be rational if they depend, in the proper way, on the same things, that economic theory says actually determine the variable.[21]

5.2 EXPECTED MONEY SUPPLY UNDER ADAPTIVE EXPECTATIONS:

Under 'Adaptive Expectations Model', expectations are directly related to past observations. Consequently, for expected money supply in period t, i.e $[M^e_t]$ we have,

$$M^e_t - M^e_{t-1} = \theta\ [M_{t-1} - M^e_{t-1}]\ ; \quad .... \quad 0 < \theta < 1 \ ...... \ (5.1)$$

The equation states that the change in the expected money supply $[M_{t-1} - M^e_{t-1}]$ is proportional to the forecast error $[M_{t-1} - M^e_{t-1}]$. Forecast error is defined as the discrepancy between the actual and the expected money supply for the previous period, (t-1). If the present money supply were anticipated exactly, then the expected money supply for the next period will remain unchanged. If the present money supply is greater than (or smaller than) the expected one, then the money supply expected in the next period will be derived upwards (downwards) by an amount equal to a percentage θ of the forecast error, $[M_{t-1} - M^e_{t-1}]$.

Through a simple transformation of the equation (5.1), we obtain

$$M^e_t = \theta M_{t-1} + (1 - \theta) M^e_t \ .... \ (5.2).$$

The expected money supply at time, t, is a weighted average of the actual money supply and the expected money supply at time, t-1, where the adjustment parameter θ and $(1 - \theta)$ serve as weights.

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20. Muth, J.F. - "Rational Expectations and the Theory of Price Movements" E.C. (July) 29(3), 1961, pp. 315-35.

21. Sargent, T.J. and Wallace, N. - "Rational Expectations and the Dynamics of Hyper inflation" IER (June) 4(2), 1973, pp. 328-50.

Through substitutions we, therefore, get from ...... (5.2)

$$M^e_t = \theta\, M_{t-1} + \theta(1-\theta)M_{t-2} + \theta(1-\theta)^2 M_{t-3} + \ldots\ldots + \theta(1-\theta)^{n-1} M_{t-n} + \theta(1-\theta)^n M^e_{t-n-1} \ldots (5.3)$$

As n approaches to infinity, it follows that

$$M^e_t = \theta \sum_{i=1}^{\infty} (1-\theta)^{i-1} M_{t-i} \qquad \ldots\ldots\ldots \qquad (5.4)$$

In equation (5.4), the unobserved expected money supply at time, t, is linked to the already known past level of money supply viz. M_{t-1}, M_{t-2} .... and so on, which are weighted by the parameters, θ, $\theta(1-\theta)$, $\theta(1-\theta)^2$........ and so on. The weighting scheme can be considered a 'memory'. If θ is closed to zero, then the weights decline slowly and the economic agent (or society at large) has a long 'memory'. In contrast, if θ is closed to unity, then the weights decrease quickly and the económic agent (or society at large) has short ' memory'.

The weighting scheme corresponds to a geometric series with elements that decrese $1, (1-\theta), (1-\theta)^2, (1-\theta)^3$ .... It holds that

$$\sum_{i=1}^{\infty}(1-\theta)^{i-1} = \frac{1}{1-(1-\theta)} = 1/\theta \ldots\ldots\ldots \qquad (5.5)$$

So we get

$$M^e_t = \theta \sum_{i=1}^{\infty}(1-\theta)^{i-1} M_{t-i}$$

$$= \sum_{i=1}^{\infty} W_i M_{t-i}$$

where $\sum_{i=1}^{\infty} W_i = \theta \sum_{i=1}^{\infty} (1-\theta)^{i-1} = \theta.\ 1/\theta = 1$ .... (5.6)

However, the problem arises with the determination of weights. Arbitrary determination of the value of θ would make the entire range of weights arbitrary and completely subjective. Thus, the objective estimation of the weights requires that the estimation of θ and , therefore, of other weights be left free from subjective arbitrariness. Thus, the empirical estimation of expected money supply under "Adaptive Expectations Model"[22] may be done through the estimation of the following money supply equation.

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22. Solow, R.M. - "Price Expectations and the Behaviour of the Price Level" Manchester University Press, 1969, pp.4.

$$M_t = \alpha + \beta_1 M_{t-1} + \beta_2 M_{t-2} \dots\dots\dots\dots + \beta_k M_{t-k} + w_t \dots\dots\dots \quad (5.7)$$

where $w_t \sim$ i i d N $(0, \sigma_w^{\,2})$

The estimated equation in such case would be

$$\hat{M}_t = \hat{\alpha} + \hat{\beta}_1 M_{t-1} + \hat{\beta}_2 M_{t-2} + \dots\dots\dots\dots \hat{\beta}_k M_{t-k} \quad \dots\dots\dots\dots \quad (5.8)$$

where $\hat{\beta}_1, \hat{\beta}_2 \dots\dots \hat{\beta}_k$ are the OLS estimators of $\beta_1, \beta_2 \dots\dots \beta_k$ respectively with BLU properties. (5.8) may be used to obtain different values of M_t for t = 1,2 .... n provided that the estimated equation contains only significant regressors.

5.3 RATIONAL EXPECTATIONS AND EXPECTED MONEY SUPPLY:

J.F.Muth[23] developed the concept of Rational Expectations as an alternative to Adaptive Expectations in 1961. Muth holds that there exists a relevant economic theory and forcasts derived from this theory are the best possible ones. Expectations are rational when they coincide with forcasts derived from the relevant economic theory. In 1973 Sargent repeated exactly the idea of Muth to describe 'Rational Expectations'. He said, "This (RE) amounts to supposing that the public's expectations depend, in the proper way, on the things that economic theory says, they ought to.[24]

Thus rational expectation is the unbiased estimates of endogenous variable in which all information concerning the values of the exogenous and predetermined variables are known and used for the prediction. Let M^e_t and M_t be the expected and actual money supply at period, t. Let I_{t-1} be the set of information availables at the end of the period, t-1. Then rational expectations imply the following two assumptions.

(1) $E[M_t / I_{t-1}] = M^e_t$

and (2) $M_t - M^e_t = M_t - E[M_t/I_{t-1}] = \varepsilon_t$

where $\varepsilon_t \sim$ iidN $(o, \sigma_\varepsilon^2)$

Assumption (1) states that rationally expected money supply depends on the amount of relevant information, I_{t-1} available before the forecast at time, t-1. This is conditional expectation used for forecast. The value of the forecast is the mathematical expectation that results from the reduced form of the variable.

23. Muth, J.F., - "Rational Expectations and the theory of Price Movements" EC (July) 29(3) ,1961, pp. 315-35.

24. Sargent, T.J. - "Rational Expectations, the real rate of interest and the Natural rate of Unemployment", BPEA 21 , 1973 , pp. 429-72.

Assumption (2) states that rational expectations do not imply perfect forecast. Instead, it allows for a random error $\varepsilon_t = M_t - E[M_t / I_{t-1}]$ which cannot contain systematic component. Thus, rational expectations produce an unbiased estimate of the future values of the endogenous variable.

5.4 EXPECTED MONEY SUPPLY : THE MODEL

Several models[25] have been specified in Macro-economics for capturing expected or anticipated money supply. The essence of these models is that, while specifying the money supply equation, the two-way linkage between money and income must be given due weightage. Sims[26] has done extensive work on such relationship along the line of 'Granger causality'.

Apart from this, money supply is considered to have an extended AR (Auto-Regressive) process. However, the exact lags can be determined through empirical estimation only.

On the basis of these observations in macro - economic modelling, the following model, as suggested by Dornbusch, has been used for estimation.

$$M_t = \alpha + \beta Y_{t-1} + \gamma_1 M_{t-1} + \gamma_2 M_{t-2} + \dots + \gamma_K M_{t-k} + V_t \dots\dots\dots (5.9)$$

where, $V_t \sim \text{i i d } N(0, \sigma_v^2)$

M_t = (log) money supply at time, t

M_{t-1} = (log) money supply at time, t-1

Y_t = (log) output level (GNP)

Here the exact number of lagged money regressors (i.e. the value of k) is determined through estimation.

25. Dornbusch, R. - "Inflation, Growth and Unemployment : An Expository Frame Work" (Mimeograph), 1975.

26. Sims . C.A.-"Money, Income and Causality". The American Economic Review. Vol. LXII, No. 4, 1972, pp. 540-552.

5.5 ESTIMATION OF THE MODEL :

The estimated model (GLS) is as follows :

$$\hat{M}_t = \underset{\substack{(0.005103) \\ [3.2099]}}{0.016380} + \underset{\substack{(0.090562) \\ [7.9702]}}{0.7218}\, M_{t-1} \quad \text{.........................} \quad (5.10)$$

$R^2 = 0.6257038$ $\overline{D.F.} = 38$

$F^* = 63.524$ D.W. = 2.47.

From the equation (5.10), it appears that

(i) the equation is good fit since $R^2 = 0.625$ and the joint estimation is significant at 5% level since $F^* = 63.524$;

(ii) both the regression constant ($\hat{\alpha}$) and regression co-efficient ($\hat{\beta}$) are significant at 5% level; and

(iii) the equation is free from auto-correlation since D.W.[27] = 2.47.

This estimated model is the best fit one among all the alternative estimated models shown in Table - 5.1, 5.2, 5.3, 5.4 and 5.5.

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27. D.W.Statistics = 2.47. So 4- D.W. = 4-2.47 = 1.53, indicates the absence of A.C. in the estimated equation.

TABLE-5.1

Results of estimation of alternative models

Sl. No.	Model	Method	Estimation	D.F.	R^2	F*	D.W.
1	2	3	4	5	6	7	8
1.	$m_t = \alpha + \beta m_{t-1} + v_t$[28]	OLS	$\hat{m}_t = -1.5598 + 1.1714\, m_{t-1}$ (3.0876) (0.0041816) [-0.5052] [280.12]	39	0.9995	78467	2.87
2.	$\log m_t = \alpha + \beta \log m_{t-1} + v_t$[28] i.e. $M_t = \alpha + \beta M_{t-1} + v_t$	OLS	$\hat{M}_t = -0.0043823 + 1.0261\, m_{t-1}$ (0.008844) (0.00039337) [-0.4955] [260.85]	39	0.99942	68044	0.845

28. Small scripts for the variables represents the data set without any transformation used for the variables concerned. Both the estimated motels (1) and (2) with non-stationary data set suffer from A.C.

TABLE-5.2

Results of estimation of alternative models

Sl. No.	Model	Method	Estimation	D.F.	R^2	F*	D.W.
1	2	3	4	5	6	7	8
3.	$m_t = \alpha + \beta_1 m_{t-1} + \beta_2 y_{t-1} + u_t$[29]	OLS	$\hat{m}_t = -6.1284 + 1.114 m_{t-1} + 0.028292 y_{t-1}$ (3.6519) (0.027216) (0.013276) [-1.6782] [40.931] [2.1311]	38	0.9995	42792	2.83
4.	$\log m_t = \alpha + \beta_1 \log m_{t-1} + \beta_2 \log y_{t-1} + u_t$ i.e. $M_t = \alpha + \beta_1 M_{t-1} + \beta_2 Y_{t-1} + u_t$[29]	OLS	$\hat{M}_t = -0.1303 + 0.9082 M_{t-1} + 0.1416 Y_{t-1}$ (0.068441) (0.063697) (0.076346) [-1.9044] [14.257] [1.8550]	38	0.9994	36153	0.898
5.	$M'_t = \alpha + \beta_1 M'_{t-1} + \beta_2 Y'_{t-1} + u'_t$[30]	GLS	$\hat{M}'_t = 0.01610 + 0.7125 M'_{t-1} + 0.17441 Y'_{t-1}$ (0.005391) (0.1049) (0.095244) [2.9865] [6.7893] [0.1831]	37	0.62603	30.97	2.47

29. Both the estimated models (3) and (4) with non-stationary data set suffer from A.C.

30. The estimated model (5) with stationary data set shows that the co-efficient, $\hat{\beta}_2$ is insignificant even at 1% level.

TABLE-5.3

Results of Estimation of Alternative Models

Sl. No.	Model	Method	Estimation	D.F.	R^2	F*	D.W.
1	2	3	4	5	6	7	8
6.	$m_t = \alpha + \beta_1 m_{t-1} + \beta_2 y_t + v_t$[31]	OLS	$\hat{m}_t = -7.0839 + 1.1235 m_{t-1} + 0.1345 y_t$ (1.1340) (0.02836) (0.93453) [-6.2468] [39.6156] [2.3819]	38	0.9998	69432	2.79
7.	$\log m_t = \alpha + \beta_1 \log m_{t-1} + \beta_2 \log y_t + u_t$, i.e. $M_t = \alpha + \beta_1 M_{t-1} + \beta_2 Y_t + u_t$[31]	OLS	$\hat{M}_t = -0.1463 + 0.8879 M_{t-1} + 0.1612 Y_t$ (0.060303)(0.058051)(0.067675) [-2.4253] [15.296] [2.3820]	38	0.9994	37408	0.954
8.	$M'_t = \alpha + \beta_1 M'_{t-1} + \beta_2 Y'_t + w_t$[32]	GLS	$\hat{M}'_t = 0.017307 + 0.7287 M'_{t-1} + 0.029815 Y'_t$ (0.0054872)(0.1122) (0.1068) [3.1540] [6.4953] [0.2792]	37	0.61258	29.253	2.52

31. Both the estimated models (6) and (7) with non-stationary data set suffer from A.C.

32. In estimated model (8) with the stationary data set, the co-efficient, β_2 is not significant at 1% level.

TABLE-5.4

Results of estimation of alternative models

Sl. No.	Model	Method	Estimation	D.F.	R^2	F*	D.W.
1	2	3	4	5	6	7	8
9.	$m_t = \alpha + \beta_1 m_{t-1} + \beta_2 y_{t-1} + \beta_3 y_t + v_t$ [33]	OLS	$\hat{m}_t = -9.2287 + 1.031 m_{t-1} - 0.038803 y_{t-1} + 0.090676 y_t$ (5.0642) (0.060956) (0.069233) (0.06376) [-1.8223] [16.914] [-0.05605] [1.4222]	37	0.9995	26498	2.57
10. 0.999	$\log m_t = \alpha + \beta_1 \log m_{t-1} + \beta_2 \log y_{t-1} + \beta_3 \log y_t + u_t$ i.e. $M_t = \alpha + \beta_1 M_{t-1} + \beta_2 Y_{t-1} + \beta_3 Y_t + u_t$ [33]	OLS	$\hat{M}_t = -0.1527 + 0.8831 M_{t-1} - 0.012763 Y_{t-1} + 0.1799 Y_t$ (0.068796) (0.064672)(0.1253) (0.1170) [-2.2191] [13.655] [-0.1018] [1.5373]	37	0.9995	24968	
11.	$M'_t = \alpha + \beta_1 M'_{t-1} + \beta_2 Y'_{t-1} + \beta_3 Y'_t + w_t$ [34]	GLS	$\hat{M}'_t = 0.016499 + 0.7286 M'_{t-1} + 0.017217 Y'_{t-1} - 0.026898 Y'_t$ (0.0056834) (0.1238) (0.096476) (0.1063) [2.9030] [5.8840] [0.1785] [-0.2531]	36	0.6267	20.146	2.48

33. Both the estimated models (9) and (10) with non-stationary data set suffer from A.C.

34. In estimated model with stationary data set, the co-efficients, $\hat{\beta}_2$ and $\hat{\beta}_3$ are not significant at 1% level.

TABLE-5.5

Results of estimation of alternative models

Sl. No.	Model	Method	Estimation	D.F.	R^2	F*	D.W.
1	2	3	4	5	6	7	8
12.	$m_t = \alpha\ \beta_1 m_{t-1} \beta_2 m_{t-2} \beta_3 m_{t-3} + v_t$[35]	OLS	$\hat{m}_t = -2.7847 + 0.4113m_{t-1} + 0.3450m_{t-2} + 0.6352m_{t-3}$ (2.5503) (0.1497) (0.1806) (0.1912) [-1.0527] [2.748] [1.9107] [3.3221]	35	0.9997	41021	1.90
13.	$\log m_t = \alpha + \beta_1 \log m_{t-1} + \beta_2 \log m_{t-2} + \beta_3 \log m_{t-3} + u_t$ $M_t = \alpha + \beta_1 M_{t-1} + \beta_2 M_{t-2} + \beta_3 M_{t-3} + u_t$[35]	OLS	$\hat{M}_t = 0.0079934 + 1.4075m_{t-1} - 0.3858m_{t-2} - 0.010006m_{t-3}$ (0.0070963) (0.1348) (0.1416) (0.042144) [1.1264] [10.441] [-2.7247] [-0.2374]	35	0.9996	36133	2.18
14.	$M_t = \alpha + \beta_1 M_{t-1} + \beta_2 M'_{t-2} + \beta_3 M'_{t-3} + w_t$[36]	GLS	$\hat{M}'_t = 0.019808 + 0.3818M'_{t-1} + 0.1165M'_{t-2} + 0.1858M'_{t-1}$ (0.006436) (0.1696) (0.1756) (0.1491) [3.0777] [2.2508] [0.6631] [1.2464]	34	0.5299	12.778	2.01

35. In both the estimated models (12) and (13) with non-statioinary data set, the constant co-efficient, $\hat{\alpha}$ is not significant.

36. The estimated modeld (14) with stationary data set implies that the co-efficients , $\hat{\beta}_2$ and $\hat{\beta}_3$ are not significant.

5.6 FINDINGS & IMPLICATIONS OF THE ESTIMATED MODEL :

The estimated model (5.10) is found to be free from auto-correlation. So, given the vectors for M_{t-1}, vector of unbiased forecast (one period) can be generated from the equation. These forecasts are nothing but the fitted values for $\hat{M}_t$. Again $\hat{M}_t = E[M_t / I_{t-1}]$ where $\{I_{t-1}\} = [M_{t-1}]$. Therefore, the vector for $\hat{M}_t$ represents the vector for rationally anticipated (expected) money supply. This part of the money supply is predictable on the basis of M_{t-1}. Any decision/ activity of the monetary authority which affects $\hat{\beta}$ will immediately be known to the market aprticipants. This they do through 'Signal Extraction' from the flow of information.

It may again be noted that

$$M_t = \hat{M}_t + \varepsilon_t \text{ where } \varepsilon_t \sim \text{i i d } N(0, \sigma_\varepsilon^2).$$
$$\text{where } \varepsilon_t \sim \text{i i d } N(0, \sigma_\varepsilon^2)$$

ε_t is the surprize or random part of M_t. Market participants cannot guess or predict ε_t. At best, the participants know that

$$E(\varepsilon_t) = 0$$
$$\text{and } \operatorname{cov}(\hat{M}_t, \varepsilon_t) = 0$$

However,once the equation (5,10) generates the vector for $\hat{M}_t$, we can also get, a posteriori, the vector for ε_t . The vectors have been obtained with reference to equation (5.10) shown in the next chapter. The estimated equation delineates an AR (1) process for money supply. The money supply is not related to any other variable like income level. The equation itself represents a final form of equation. Any forecast on the basis of this estimated model is a rational forecast. Consequently, such forecast, though based on the estimated single equation moedl, is not devoid of the property of endogeneity of expectations.

The vector for $\hat{M}_t$ can now be used as the vector for anticipated money supply'. Similarly, vector for ε_t can be used for 'un-anticipated money supply'. Consequently, it becomes possible for us to investigate the effects of change in anticipated and unanticipated money supplies on output level in Indian Economy over the period concerned.

The vectors of anticipated (expected) and unanticipated (unexpected) money supplies with GNP have been plotted to depict the time trend in graph 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8 and 5.9.

5.7 GRAPHICAL EXAMINATION OF RELATIONS BETWEEN GNP AND DIFFERENT PARTS (EXPECTED & UNEXPECTED) OF MONEY SUPPLY.

Graphs 5.1, 5.2 and 5.3 represent the time plots of GNP, Expected Money Supply and Unexpected Money Supply respectively. It is observed that both the GNP and expected money supply (figs. 5.1 & 5.2) exhibit almost an exponential rise over the period concerned. However, the time plot of the unexpected money supply (Fig.5.3) delineates almost an unchanging pattern over the period of study.

Again the graph 5.4 represents both the GNP and expected money supply. It is observed that variation in GNP is in conformity with that in expected money supply over the period concerned. Moreover, the graph 5.5 represents that variation in GNP is in no way related to that in unexpected money supply.

It may, however, be noted that these graphs represent time plots of non-stationary data set for the variables concerned. Consequently, these plots fail to represent the intimate relationships among the variables concerned. That is why, we seek to examine the time plots of stationary data set for these variables. Graphs 5.6, 5.7, 5.8 represent the time plots of stationary data set for GNP, Expected Money Supply and Unexpected Money Supply respectively. These graphs exhibit several fluctuations in the variables under study. More of the variables exhibit exponential rise over the period concerned.

The graph 5.9 represents time plots of all the stationary data set simultaneously. It is observed that variations in output level exhibit

(i) positive association with that in expected money supply since[37] 1951 till 1970 ;

(ii) insignificant association with that in expected money supply over the period 1981-91;

(iii) almost no association with those in unexpected money supply since 1951 till the beginning of 1980 ;and

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37. For stationary data set the period begins from 1951 though our period of study starts from 1950.

(iv) noticeable association with those in unexpected money supply since 1981 till the period of study.

However, these visual findings suffer from some shortcomings :

First, the graphical interpretations suffer from subjective bias.

Second, these interpretations fail to represent any definite and exact strength of associations among the variables concerned.

So, these graphical examinatioins call for the objective verification of the relationship through quantitative study. An attempt in this direction is taken up in the following Chapter.

TIME PLOT OF G N P (Y_t)

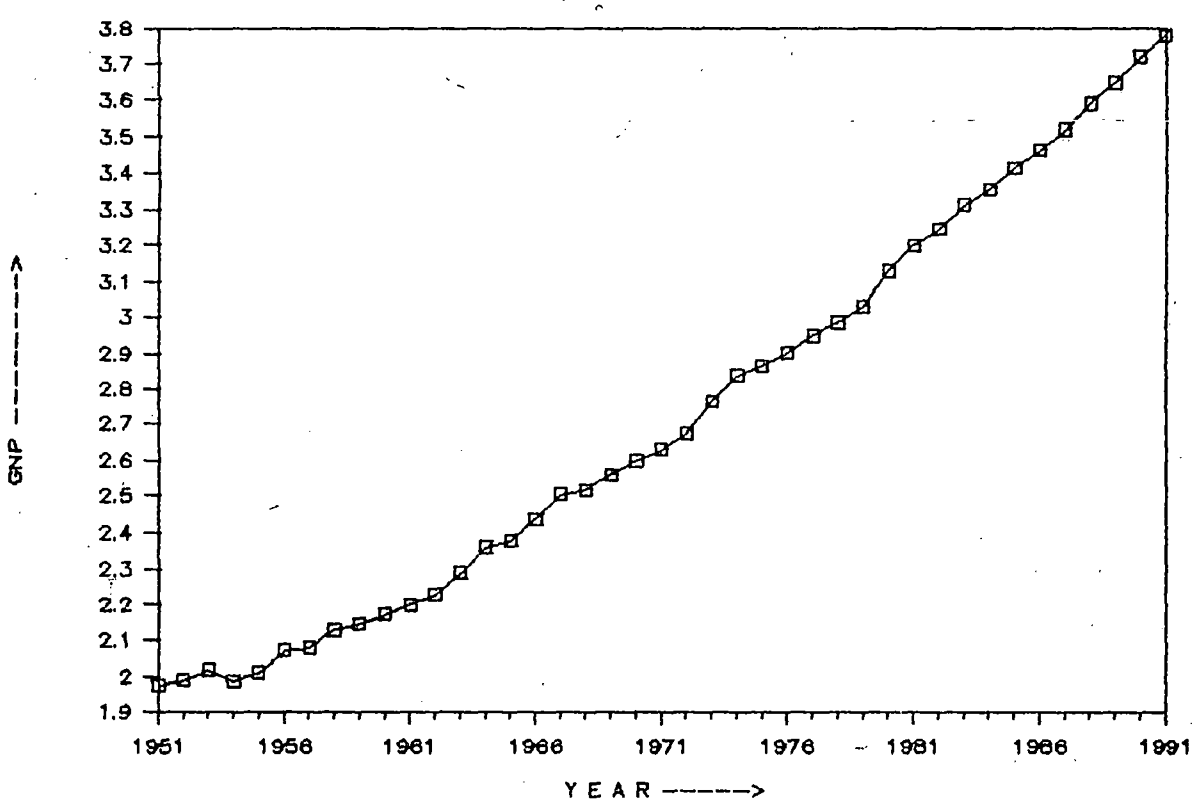

Fig . 5.1

TIME PLOT OF EXPECTED MONEY SUPPLY (M^e_t)

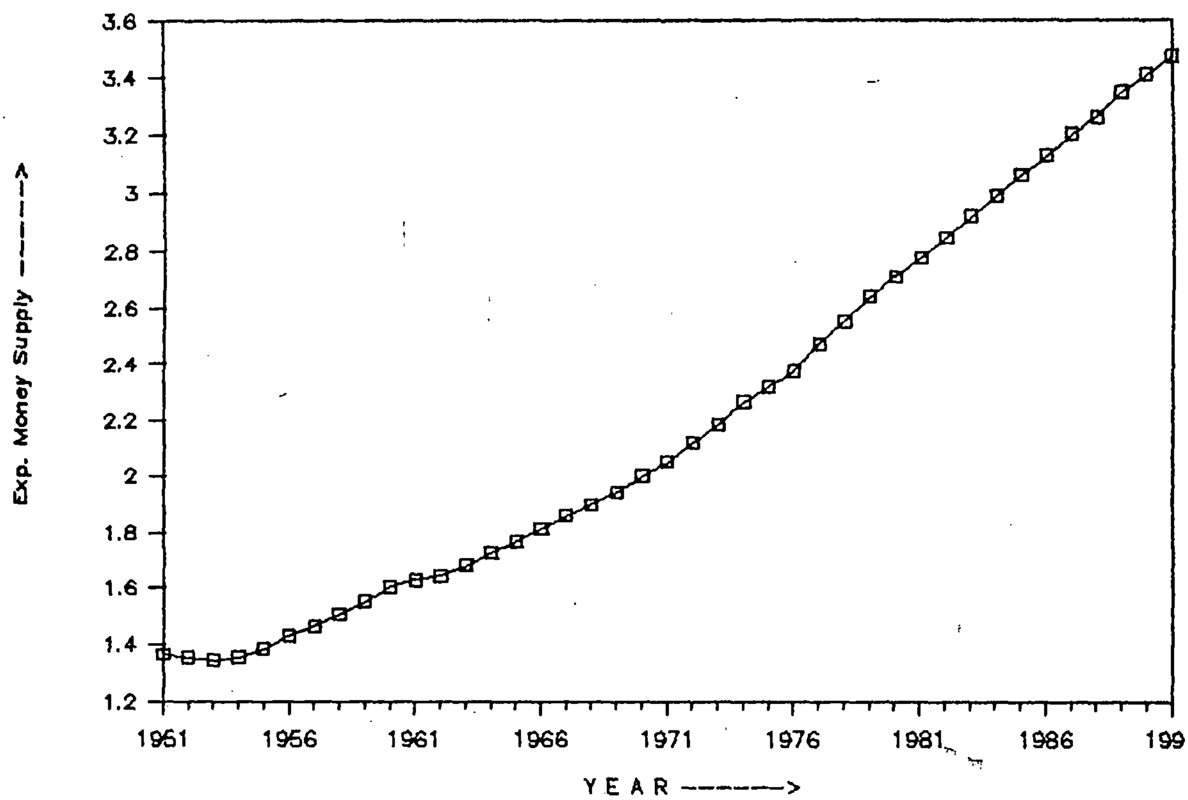

Fig . 5.2

TIME PLOT OF UNEXPECTED MONEY SUPPLY (UM_t)

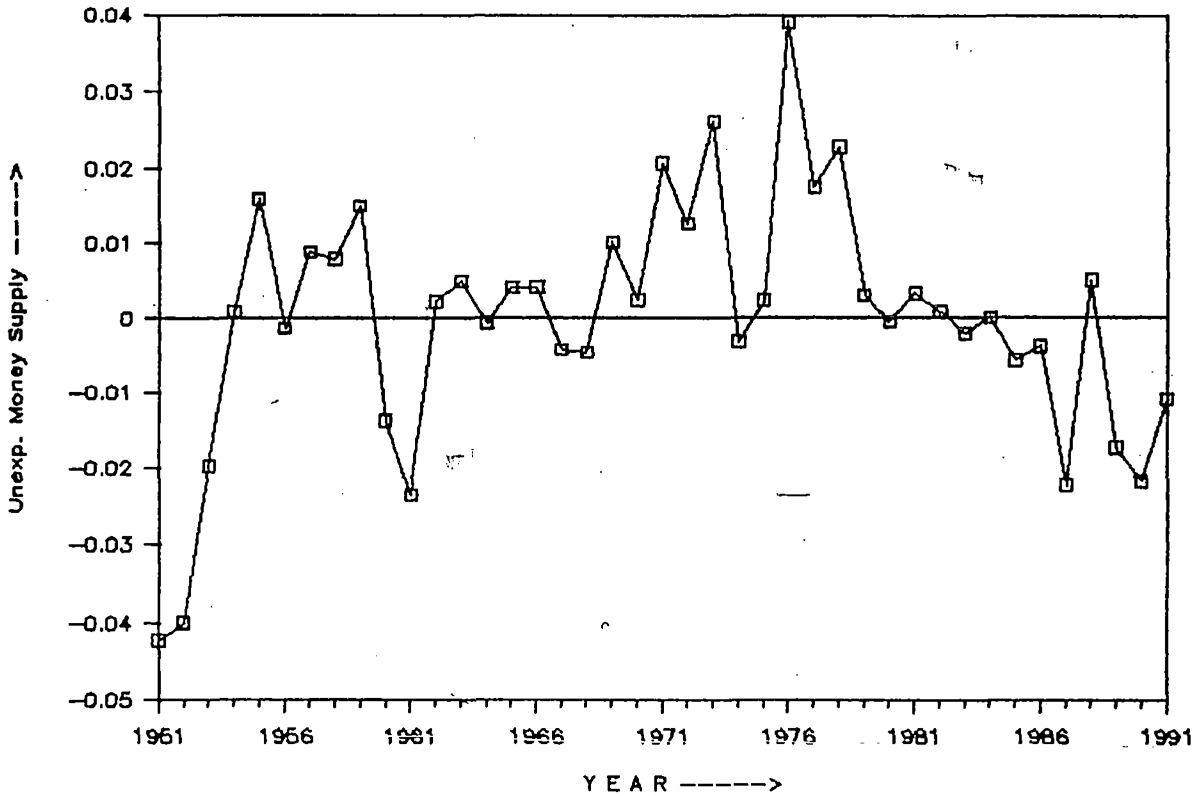

Fig . 5.3

TIME PLOT OF G N P (Y_t) & EXP. MONEY SUPPLY (M^e_t)

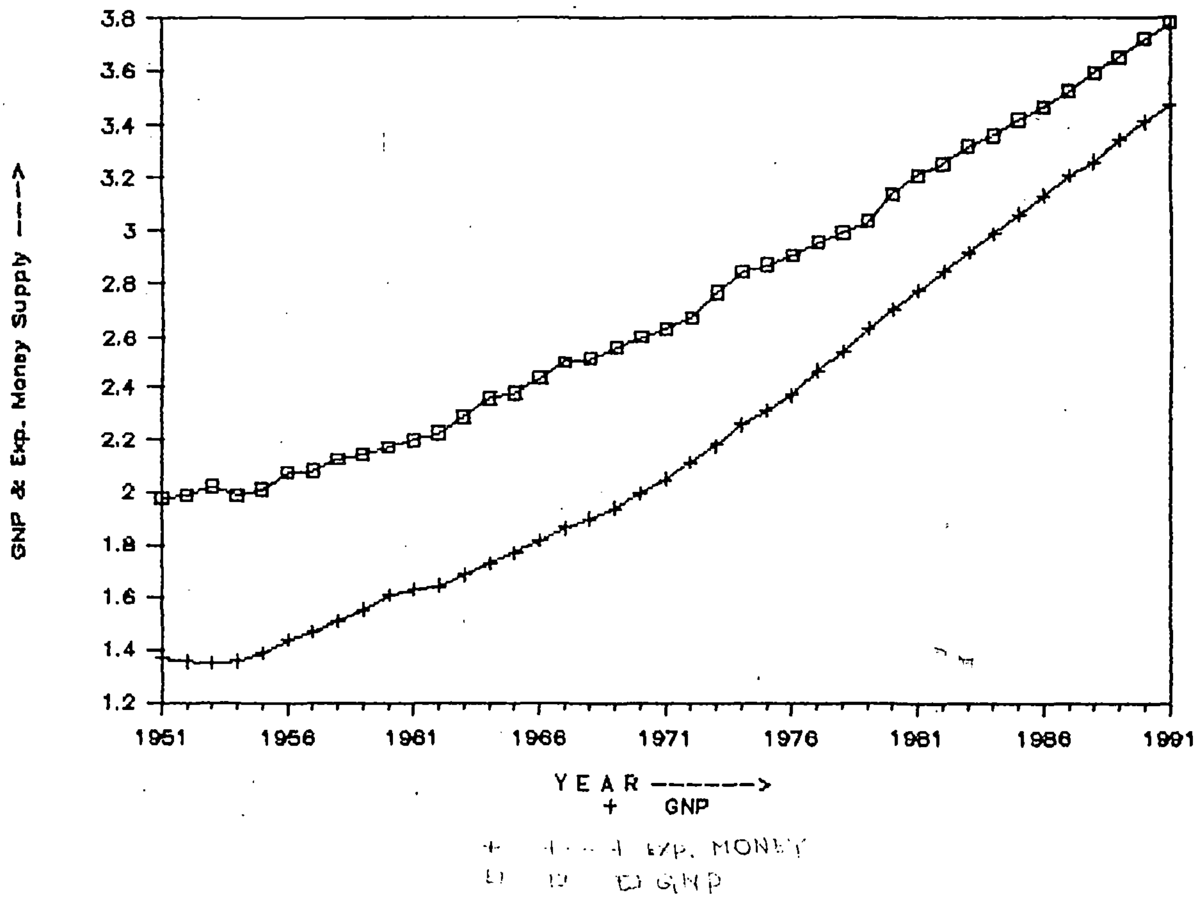

Fig . 5.4

TIME PLOT OF G N P (Y_t) AND UNEXPECTED MONEY SUPPLY (UM_t)

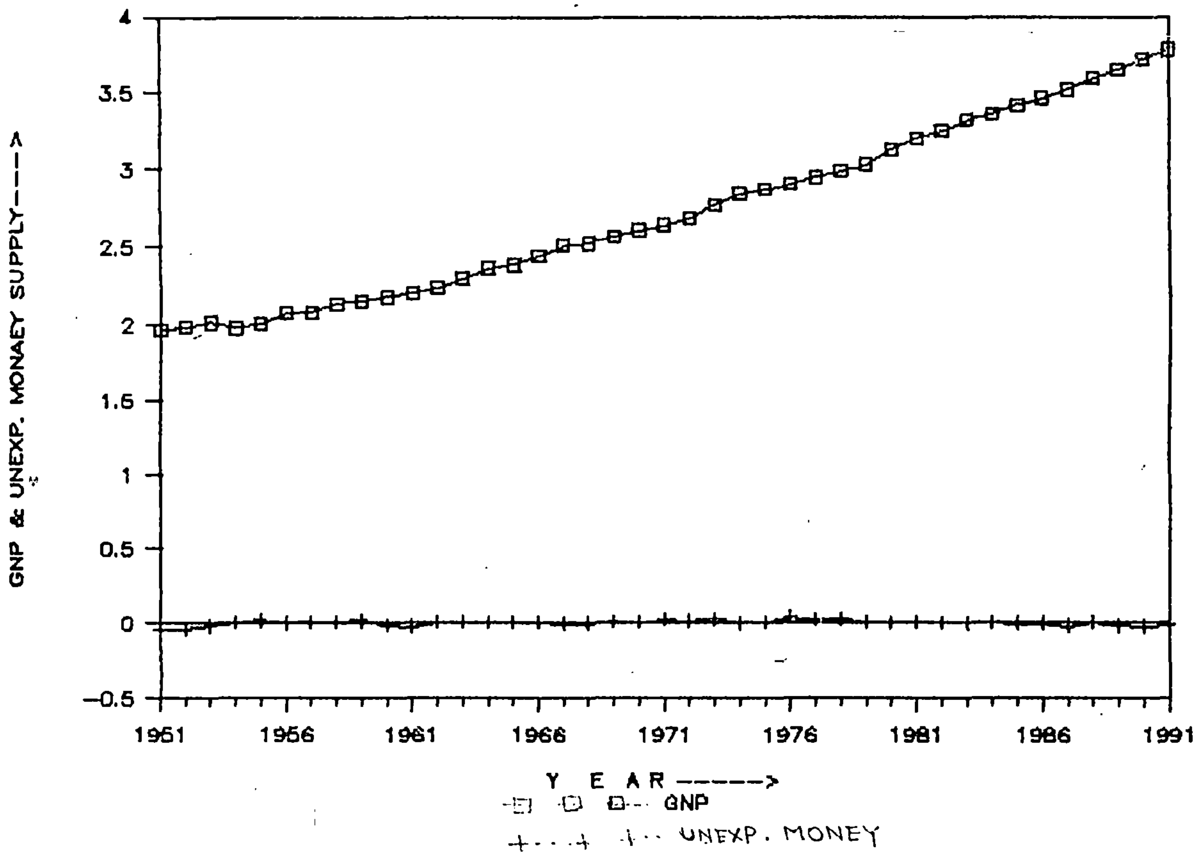

Fig . 5.5

TIME PLOT OF G N P (Y_t)

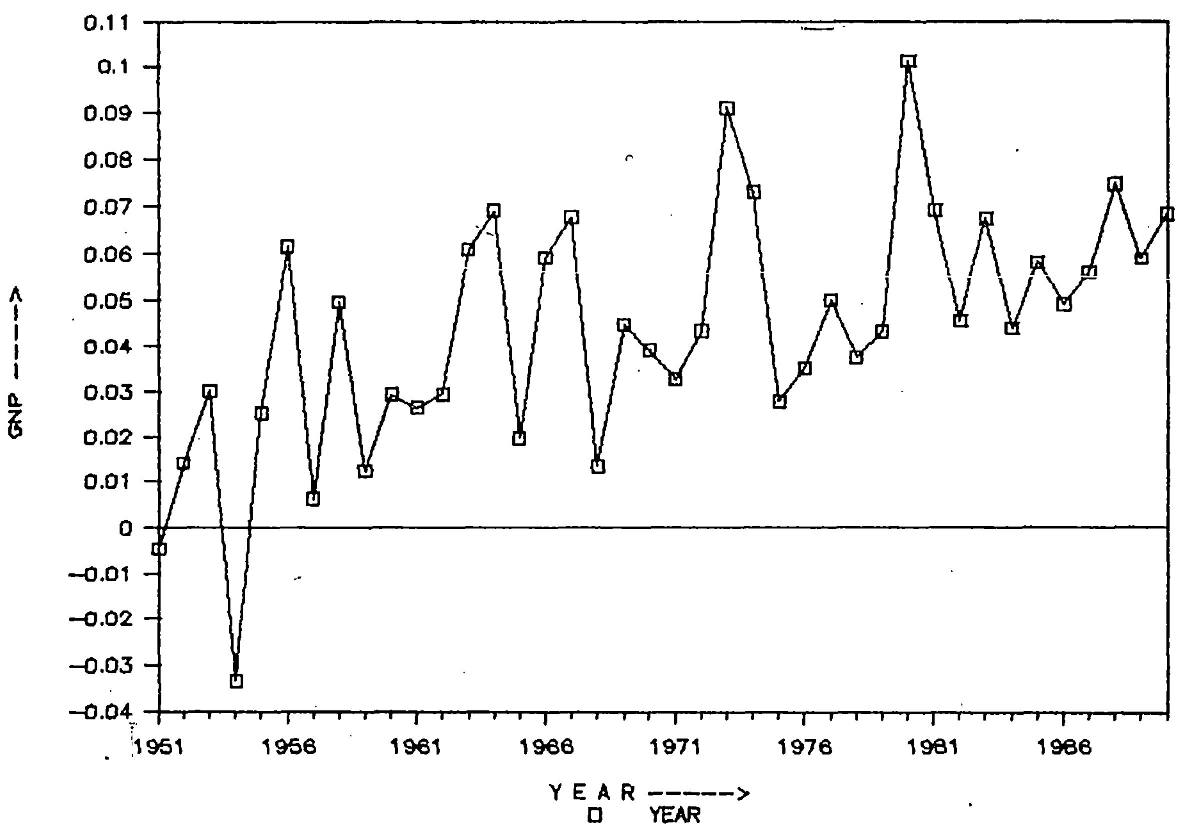

Fig . 5.6

TIME PLOT OF EXPECTED MONEY SUPPLY (M^e_t)

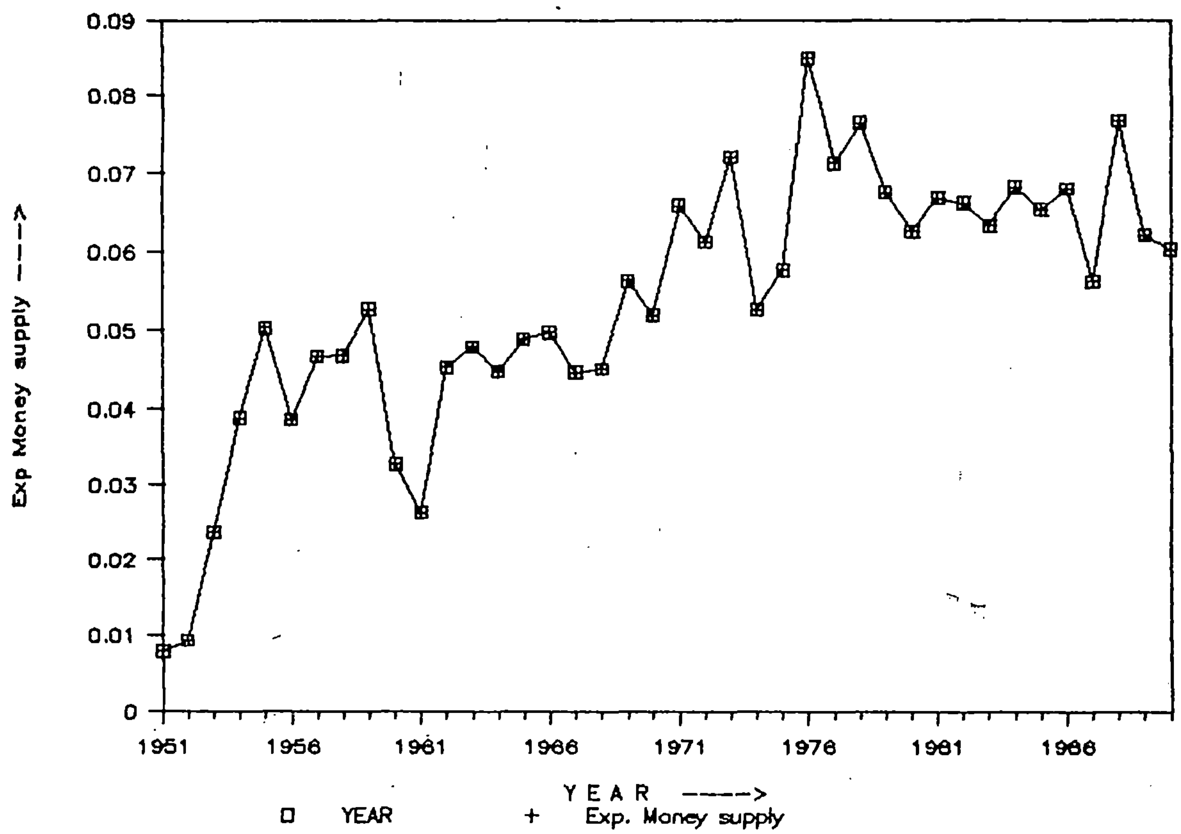

Fig . 5.7

TIME PLOT OF UNEXPECTED MONEY SUPPLY (UM_t)

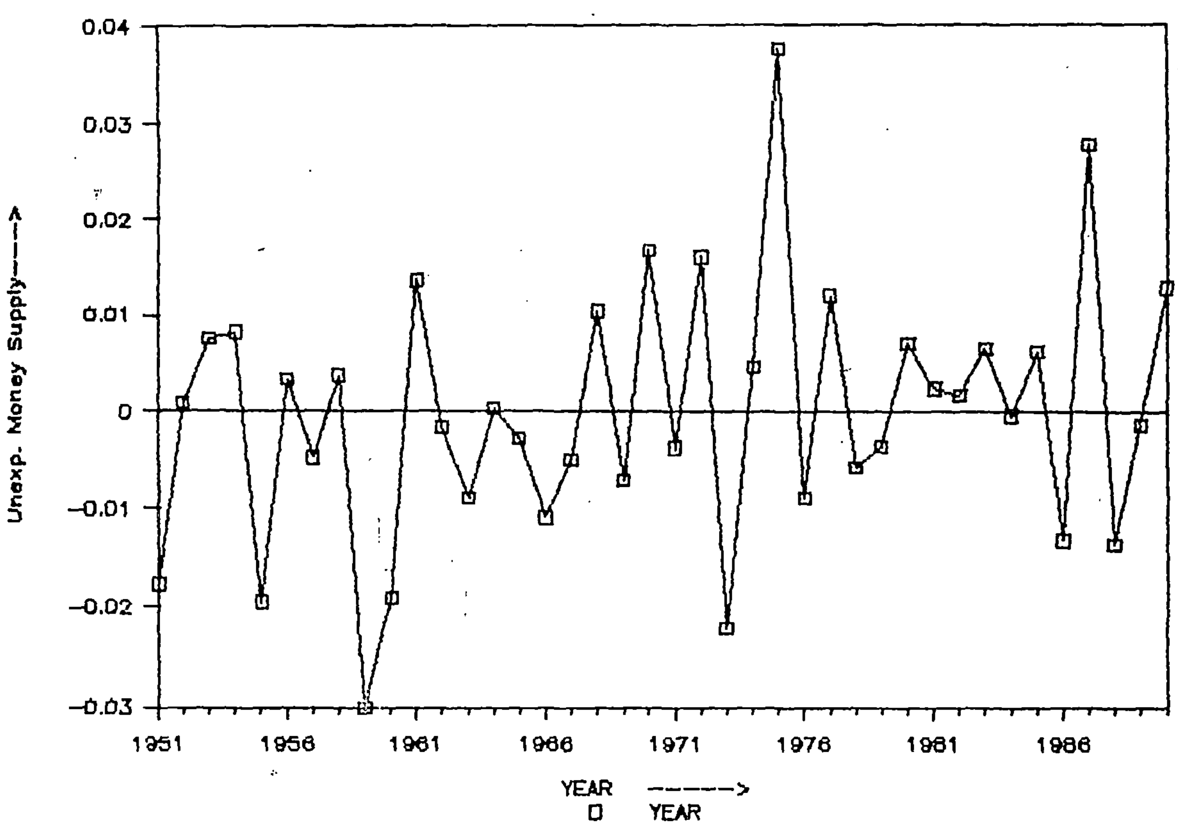

Fig . 5.8

TIME PLOT OF G N P (Y_t), EXP. (M_t) & UNEXP. MONEY SUPPLY (UM_t)

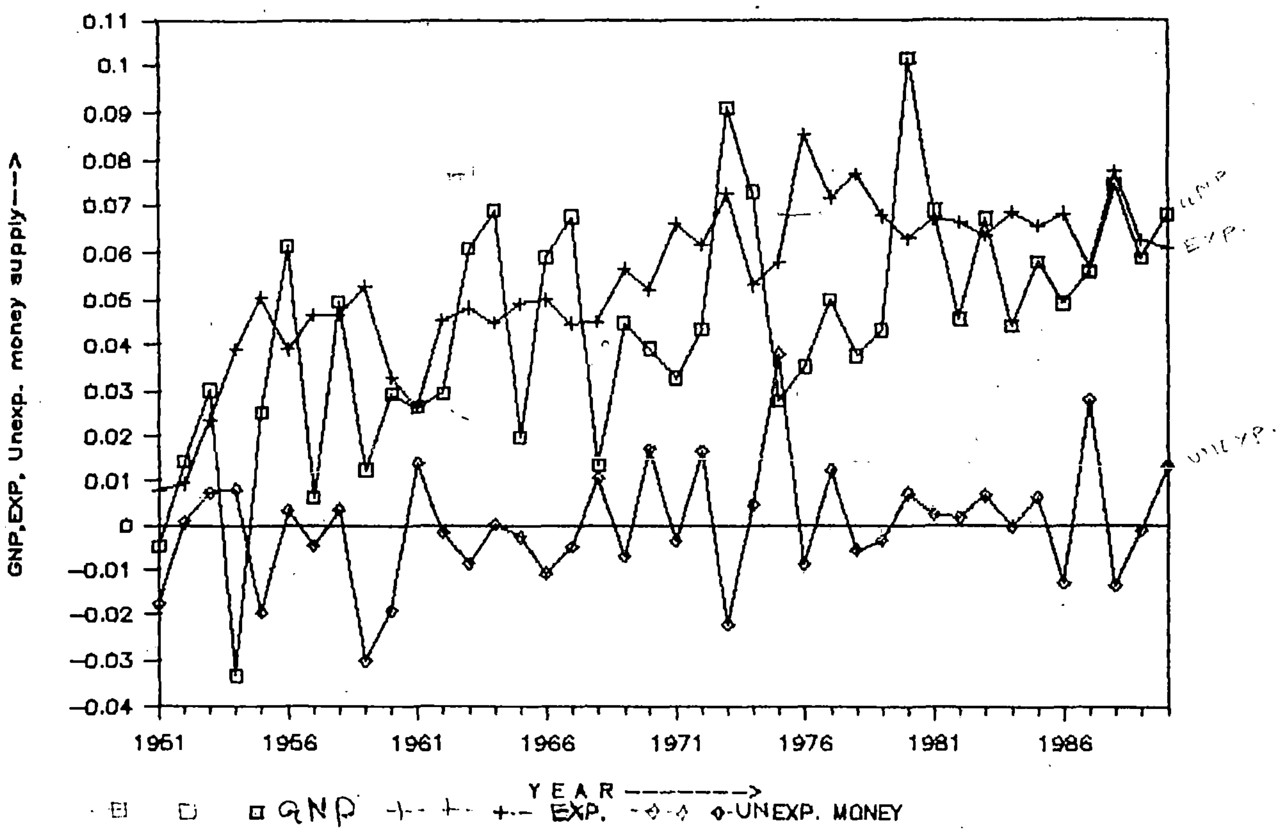

Fig . 5.9

CHAPTER - VI

ANTICIPATED AND UNANTICIPATED MONEY SUPPLY : EFFECT ON OUTPUT VARIATION

6.1 INTRODUCTION :

The introduction of rational expectatioins to a macro-economic model affects dramatically the ability of a government or a Central Bank to control economic policy. In presence of rational expectations, real variables (such as relative prices, unemployment rate and real output) are independent of changes in the Anticipated Monetary Policy. Rational expectationists like Sargent, Lucas and N. Wallace hold that change in money supply, if it is already anticipated by the agents, affects only inflation but it has no effect on real output and employment. This is the famous "Invariance Proposition" put forth by the rational expectationists. This proposition asserts that any predictable part of money supply would have no effect on output, employment or any other real variables in the economy. Only unpredictable money supply changes can affect output level, employment or any other real variables in the economy.

The idea of 'Invariance Proposition' can be clearly explained following Lucas. Let real output level (y_t)[38] be regressed on anticipated money supply (M_t^e) and unanticipated money supply (UM_t). Such that

$$Y_t = Y_p + \beta_1 M_t^e + \beta_2 UM_t + V_t \quad \text{.............................} \quad (6.1)$$

Here Yp is the capacity or existing output level.

$$\text{So } Y_t - Y_p = \beta_1 M_t^e + \beta_2 UM_t + V_t$$

$$\text{or, } y_t = \beta_1 M_t^e + \beta_2 UM_t + V_t \quad \text{............................} \quad (6.2)$$

where y_t represents the variation in output around its capacity level. The 'Invariance Proposition'holds that $\beta_1 = 0$ and $\beta_2 \neq 0$. Thus output fluctuates randomly around the existing (or capacity) level (Y_p) following unanticipated fluctuations in the money stock only. The behavioiur of output level, therefore, is independent of any predictable counter-cyclical (or even procyclical) policy by the monetary authorities. Any predictable rule for monetary policy is as good as any other rule so far as output determination is concerned. The behaviour of prices will, however, reflect the choice of the feedback rule.

38. Here $y_t = Y_t - Y_p$. However, Y_p is proxied through $\overline{Y}$. Please see chapter IV (section 4.2) for the rationale behind the use of $\overline{Y}$ for Y_p.

We seek to examine if such invariance proposition holds in Indian Economy. In Chapter-IV we have observed that output level has responded over time to money supply. It is a matter of interest to know if such positive response is varied in anticipated or unanticipated part of money supply. This chapter seeks to address this issue.

6.2 THE MODEL

The model used for estimation in this chapter is basically Lucas type model such that

$$Y_t = Y_p + \beta_1 M_t^e + \beta_2 UM_t + V_t \qquad (6.3)$$

Through transformation, we get

$$y_t = \beta_1 M_t^e + \beta_2 UM_t + V_t . \qquad [y_t = Y_t - Y_p] \qquad (6.4)$$

However, because of estimation of constraints[39] the equation (6.4) is modified accordingly as follows :

$$y_t = \alpha + \beta_1 M_t^e + \beta_2 UM_t + V_t \qquad (6.5)$$

It may again be noted that, in case of estimation of this equation, the Vectors of M_t have been used as the data set for M_t^e. Similarly, for the data set of UM_t the vectors of ε_t have been used. These vectors of M_t^e and UM_t derived through the use of the equation 5.10 in Chapter - V and shown in the table-6.1.

39. Please see chapter-IV (section 4.2) for the estimation of constraint concern and the rationale behind such transformation.

TABLE-6.1

ANTICIPATED(M^e_t) AND UNANTICIPATED (UM_t) PARTS OF MONEY SUPPLY[40]

Year	M^e_t (in billion of Rs.)	UM_t (in billion of Rs.)
1951	1.366	-0.04218
1952	1.354	-0.03987
1953	1.344	-0.01978
1954	1.354	0.001016
1955	1.386	0.01610
1956	1.435	-0.001328
1957	1.466	0.008856
1958	1.509	0.007872
1959	1.552	0.01502
1960	1.604	-0.01384
1961	1.627	-0.02343
1962	1.641	0.002412
1963	1.682	0.005070
1964	1.727	-0.0005678
1965	1.767	0.004212
1966	1.813	0.004293
1967	1.861	-0.004264
1968	1.90	-0.004577
1969	1.941	0.01009
1970	1.998	0.002651
1971	2.048	0.02067
1972	2.118	0.01258
1973	2.1820	0.02605
1974	2.261	-0.003163
1975	2.313	0.002529
1976	2.371	0.03904
1977	2.469	0.01766
1978	2.547	0.02277
1979	2.633	0.003192
1980	2.705	-0.0004592
1981	2.771	0.003457
1982	2.843	0.0009479
1983	2.914	-0.002053
1984	2.983	0.0001767
1985	3.057	-0.005698
1986	3.126	-0.003768
1987	3.20	-0.02213
1988	3.256	0.00513
1989	3.342	-0.01735
1990	3.407	-0.02151
1991	3.470	-0.01090

40. The data set on Met and UMt are presented upon log- transformation. These add up to total money supply (stationary). Stationarity in the total money supply is ensured through First Differencing. This accounts for the beginning of the data set at 1951.

6.3 ESTIMATION AND FINDINGS :

The GLS estimation of the equation [41]-

$$\hat{y}_t = 0.226598 + 0.65303M_t^e + 0.10351UM_t \text{ .... } (6.6)$$
$$(0.0141688)(0.12864) \quad (0.48192)$$
$$[15.9927] \quad [50.761] \quad [0.2536]$$

$R^2 = 0.603523$ D.F. = 37

$F^* = 8.065$ D.W. = 1.99

It is observed from the equation that

(i) the equation is good fit at 1% level since $F^* = 8.065$;

(ii) the equation is free from auto-correlation since D.W. = 1.99 ;

(iii) the regression constant ($\hat{\alpha}$) ;and the regression co-efficient ($\hat{\beta}_1$) are significant even at 5% level and

(iv) the other regression co-efficient ($\hat{\beta}_2$) is not significant even at 1% level.

6.4 IMPLICATIONS OF THE FINDINGS :

These findings have several implications. First, $\hat{\beta}_1 > 0$ is significant and $\hat{\beta}_2$ is insignificant even at 1% level. It, therefore, appears that output variation around its capacity levels is mainly due to the changes in anticipated part of money supply. Output level seems to rise above its capacity level when money supply is anticipated to rise. Similarly, output level seems to have gone down below its capacity level (Y_p) in response to an anticipated fall in money supply.

It, therefore, appears that the positive response of output level to changes in money supply as observed in section 4.4(Chapter-IV) indicates basically the positive response $\hat{\beta}_1 > 0$ of output variation around its capacity level (Y_p) to the changes in anticipated part of money supply only.

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41. The OLS estimation of this equation is shown in table-6.2 as the estimated alternative model - 5.

Second, $\hat{\beta}_2$ is not significant even at 1% level. It indicates that surprize part of money supply variation has no bearing on output variation over the period concerned (1950-91).

Third, $\hat{\beta}_1 > 0$ and insignificant $\hat{\beta}_2$[42] bear no testimony to the 'Invariance Proposition' as put forth by the rational expectationists.

Fourth, $\beta_1 > 0$ indicates that any monetary policy which is designed to affect the anticipated part of money supply can affect output level. It may be noted that monetary policy formulations, which affect money supply, can only control the anticipated part of money supply. Consequently, monetary policy seems to have a significant role in Indian Economy over the period of study.

Any counter cyclical or pro-cyclical monetary policies designed to control money supply is systematic and, therefore, known to market participants. That is why, the market participants take due note of these policy parameters while forming their anticipation for money supply. $\beta_1 > 0$ indicates that changes in these policy parameters mights have significant bearing on output variation around its capacity level over the period concerned (1950-91). Several alternative models have been estimated as shown below :

---

42. In order to confirm if $\beta_2 = 0$, the equation (6.5) is further estimated with the following modification where UM_t is the only independent variable :

$$y_t = \delta + \beta_2 UM_t + w_t$$

The GLS estimation of the equation is

$$\begin{array}{lll} \hat{y}_t = & -0.0041209 & + 0.086891 UM_t \\ & (0.0039412) & (0.2623) \\ & [-1.0456] & [0.3311] \end{array}$$

$R^2 = 0.0032132$ D.F. = 37

$F^* = 0.1096$ D.W. = 1.52

It is observed that

(i) the estimated equation is not good fit since R^2 and F^* are very small ;

(ii) the equation is free from auto-correlation at 1% level.

(iii) $\hat{\beta}_2$ is not significant even at 1% level.

This further indicates that unanticipated money supply bears no effect on the variation of output around its capacity level (Yp) over the period concerned (1950-91).

6.5 ESTIMATION OF ALTERNATIVE MODELS : COMMENTS

Alternative Model - 1

$Y_t = a + b_1 M_t^e + b_2 UM_t + u_t$

The OLS estimation of the equation is

$$\hat{Y}_t = 0.8278 + 0.8558M_t^e + 2.7491\ UM_t$$
$$(0.042227)\ (0.018338)\ (0.7681)$$
$$[19.603]\quad [46.668]\quad [3.5791]$$

D.F. = 38 $\qquad R^2 = 0.9829$
$F^* = 1094.5 \qquad$ D.W.=0.40

Here we have taken non-stationary data set of log transformation of GNP (Y_t) regressed on anticipated (M_t^e) and unanticipated (UM_t) money supply. The equation gives us that

(i) regression constant ($\hat{\alpha}$) and regression co-efficients ($\hat{\beta}_1$ and $\hat{\beta}_2$) are found significant even at 5% level ;

(ii) the equation is good fit since $R^2 = 0.982$ and $F^* = 1094.5$ and

(iii) the equation suffers from A.C. even at 1% level. Hence rejected.

Alternative Model-2 :

The GLS estimation of the equation shown in alternative model-1 is

$$\hat{Y}_t = 0.58320 + 0.62105\ M^e_t + 1.05321UM_t$$
$$(0.123541)\ (0.193521)\quad (0.985210)$$
$$[4.7207]\quad [3.2092]\quad [1.06902]$$

D.F. = 37 $\qquad R^2 = 0.60325$

$F^* = 16.72 \qquad$ D.W.=2.01

Here $\hat{\beta}_2$ fails to be significant representing s that the unanticipated money supply (UM_t) has no effect on GNP (Y_t).

Alternative Model - 3

$$Y_t = \alpha + \beta_1 Y_{t-1} + \beta_2 M_t^e + \beta_3 \overset{U}{M}_t + v_t$$

The OLS estimation of the equation is

$$\begin{aligned}\hat{y}_t = \;& 0.01704 + 0.8069\, Y_{t-1} + 0.1775 M_t^e + 0.3486 UM_t \\ & (0.096156)\ (0.1069) \quad (0.08686) \quad (0.2179) \\ & [1.7723] \quad [7.5507] \quad [2.0441] \quad [1.5997]\end{aligned}$$

D.F. = 37 $\qquad$ $R^2 = 0.9986$

F* = 93915 $\qquad$ D.W.= 0.7689

Here we have taken non-stationary data set of log-transformation of GNP (Y_t) and one period lag of GNP (Y_{t-1}). The equation tells us that -

(i) The regression constant ($\hat{\alpha}$) and and the regression co-efficients ($\hat{\beta}_1$, $\hat{\beta}_2$ and $\hat{\beta}_3$) are significant at 1% level ;

(ii) The equation is good fit since $R^2 = 0.998$ and F* = 9391.5 ; and

(iii) The equation suffers from A.C. even at 1% level. So omitted.

Alternative Model - 4 :

The GLS estimation of the equation shown in alternative model-3 is

$$\begin{aligned}\hat{Y}_t = \;& 0.00123 + 0.21054 Y_{t-1} + 0.00917 M^e_t + 0.08513 UM_t \\ & (0.000521)\ (0.08352) \quad (0.00135) \quad (0.07355) \\ & [2.3608] \quad [2.5208] \quad [6.7925] \quad [1.1574]\end{aligned}$$

D.F.= 36 $\qquad$ $R^2 = 0.61352$

F* = 12.69 $\qquad$ D.W.= 2.08.

Here $\hat{\beta}_3$ is not significant indicating that the unanticipated money supply (UM_t) has no effect on GNP (Y_t).

Alternative Model-5

$Y_t - \bar{Y} = \alpha + \beta_1 M_t^e + \beta_2 UM_t + w_t$

or, $y_t = \alpha + \beta_1 M_t^e + \beta_2 UM_t + w_t$

The OLS estimation of the equation is

$$\hat{y}_t = \underset{\substack{(0.017988)\\ [-101.95]}}{-1.8339} + \underset{\substack{(0.0078116)\\ [106.55]}}{0.8324M_t^e} + \underset{\substack{(0.3272)\\ [2.5685]}}{0.8404UM_t}$$

D.F. = 38 $\quad$ $R^2 = 0.9966$

F* = 5678.8 $\quad$ D.W.=0.5062

This is an alternative OLS estimation of non-stationary data set of the equation (6.5).

It is observed that

(i) the regression constant ($\hat{\alpha}$) and the regression co-efficients ($\hat{\beta}_1$ and $\hat{\beta}_2$) are significant even at 5% level ;

(ii) the equation is good fit since $R^2 = 0.996$ and F* = 5678 ; and

(iii) the equation suffers from A.C. at 5% level. So the equation is not considered for the analysis in our study.

All these alternative models along with the estimation have been presented in the Table-6.2.

TABLE - 6.2

Results of estimation of alternative models

Sl.No. 1	Model 2	Method 3	Estimation 4	D.F. 5	R^2 6	F* 7	D.W. 8
1	$Y_t = \alpha + \beta_1 M_t^c + \beta_2 UM_t + u_t$	OLS	$\hat{Y}_t = 0.8278 + 0.8558 M_t^c + 2.7491 UM_t$ (0.042227) (0.018338) (0.7681) [19.603] [46.668] [3.5791]	38	0.98293	1094.5	0.400
2.	$Y_t = \alpha + \beta_1 M_t^c + \beta_2 UM_t + u_t$	GLS	$\hat{Y}_t = 0.58320 + 0.62105 M_t^c + 1.05321 UM_t$ (0.123541) (0.193521) (0.985210) [4.7207] [3.2092] [1.06902]	37	0.60325	16.72	2.01
3.	$Y_t = \alpha + \beta_1 Y_{t-1} + \beta_2 M_t^c + \beta_3 UM_t + v_t$	OLS	$\hat{Y}_t = 0.01704 + 0.8069 Y_{t-1} + 0.1775 M_t^c + 0.3486 UM_t$ (0.096156) (0.1069) (0.08686) (0.2179) [1.7723] [7.5507] [2.0441] [1.5997]	37	0.99868	9391.5	0.768
4.	$Y_t = \alpha + \beta_1 Y_{t-1} + \beta_2 M_t^c + \beta_3 UM_t + v_t$	GLS	$\hat{Y}_t = .00123 + .21054 Y_{t-1} + .00917 M_t^c + .08513 UM_t$ (0.000521) (0.08352) (0.00135) (0.07355) [2.3608] [2.5208] [6.7925] [1.1574]	36	0.61352	12.69	2.08
5.	$Y_t - \bar{Y} = \alpha + \beta_1 M_t^c + \beta_2 UM_t + w_t$ i.e. $y_t = \alpha + \beta_1 M_t^c + \beta_2 UM_t + w_t$ $[y_t = Y_t - \bar{Y}]$	OLS	$\hat{y}_t = -1.8339 + 0.8324 M_t^c + 0.8404 UM_t$ (0.017988) (0.0078116) (0.3272) [-101.95] [106.55] [2.5685]	38	0.99666	5678.8	0.506

6.6. SOME RELEVANT ISSUES :

The findings are based on the estimation of the equation (6.6) with a historical data set ranging from 1950 to 1991. Over this period, India got herself transformed from a predominantly agrarian economy to an economy with sound industrial base. Several economic plans have been undertaken and executed with varying degrees of success during this period. Several banks have been nationalized and economic justice has been accorded to priority sectors of the economy. Thus, the period is marked with spectacular economic and social transformations together with varying rates of growth.

This long period, therefore, may be considered as a time span with heterogeneous process of growth. Growth of output and that of money supply have been varying overtime within this period. Consequently, the overall picture which we have obtained from the use of historical data set may have summarized the relations over different individual sub-periods concerned. This calls for the investigation into the response of output level to the changes in anticipated and unanticipated parts of money supply over shorter homogeneous sub-periods. It may then be expected to provide dynamic and better insight into the response of output levels to the changes in different parts of money supply over the period concerned. However, before such study is undertaken, it becomes pertinent to identify some homogeneous sub-periods. This constitutes the matter of over study in the following chapter.

CHAPTER - VII

' WINDOW FINDING ' OF STRUCTURAL CHANGES IN THE RELATION BETWEEN OUTPUT VARIATION AND ANTICIPATED / UNATICIPATED MONEY SUPPLY

7.1. INTRODUCTION :

The output money supply relationship may be expected to undergo changes in different sub - periods over the past few decades (1950 - 91). Monetary authorities adopted varying approaches with respect to the expansion of money supply in different plan periods. Money was let loose in early sixties when ' controlled expansion ' policy was followed in the Second and a few subsequent Five Year Plan periods. Output variations were not uniform over these periods either.

However, the choice of sub - periods is beset with some difficulties in view of the fact that the choice of sub - periods needs the identification of the periods when the structural changes have occurred. This approach, while more objective by nature, is rather difficult to formulate and work with. Alternative approach is to choose sub - periods on the basis of some subjective criteria.

The subjective criteria involve the choice of sub - periods on the basis of graphical relationship of the variables concerned. The sub - periods, where distinct changes in the association among concerned variables are discernible, may be taken for turning points in the relationship under study.

On the other hand, sub - periods may be chosen more objectively through econometric techniques. The identification of structural changes may be done with some econometric techniques which involve " WINDOW FINDING ". Such "WINDOW - FINDING " involves recursive estimation technique and the procedure, though viable, is very complex by nature.

The choice of sub - periods in this present study involves the identification of structural changes through "WINDOW FINDING ". The basic procedure and the findings are described below.

7.2 METHODOLOGY :

Researchers occasionally seek to investigate the stability of the coefficient estimates as the sample size increases. Again ssometimes researchers want to find out whether the estimates will be different in enlarged samples and whether they will remain stable over time. Working with a sample, a researcher may produce a regression which is too closely tailored to his sample by experimenting with too many formulations of his model. In this case it is not certain whether the estimated function will perform equally outside the sample of date which has been used for the estimation of coefficients. Further more, there may occur some events like changes in taxation laws, introduction of birth control measures and so on. These events may change the structure of relationships. If such structural changes occur, the coefficients may not appear stable. They may be sensitive to the changes in the sample composition.

Testing for structural stablity calls for the use of additional observations besides the sample that is used to estimate a given model. Procedures for testing structural stability are treated in a systematic way in a work by Chow [43] (1960) and in Rao [44] (1952). The procedure used in this study is discrived bellow.

Let the general model for the pooled data set be

$y = x\,\beta + u$ .... (7.1)

where

$y \longrightarrow n \times 1$

$x \longrightarrow n \times k$

$\beta \longrightarrow k \times 1$

$n \longrightarrow n_1 + n_2$

---

43. Chow, G. - " Tests for Equality Between Sets of Coefficients in Two Linear Regressions ", Econometrica, 28, 591 - 605, July, 1960.

44. Row, C.R. - "Advanced Statistical Methods in Biometric Research" New York : Willey & Sons, 1952.

Let there be two samples with n_1 and n_2 observations respectively. Let us rewrite the models for these two individual samples such as

$$y_1 = (z_1 \quad w_1) \begin{bmatrix} \gamma_1 \\ \delta_1 \end{bmatrix} + u_1 \text{ .... } (7.2)$$

and $$y_2 = (z_2 \quad w_2) \begin{bmatrix} \gamma_2 \\ \delta_2 \end{bmatrix} + u_2 \text{ .... } (7.3)$$

Where

$y_1 \longrightarrow n_1 \times 1$

$y_2 \longrightarrow n_2 \times 1$

$z_1 \longrightarrow n_1 \times l$

$z_2 \longrightarrow n_2 \times l$

$w_1 \longrightarrow n_1 \times m$

$w_2 \longrightarrow n_2 \times m$

$\gamma_1 \longrightarrow l \times 1$

$\gamma_2 \longrightarrow l \times 1$

$\delta_1 \longrightarrow m \times 1$

$\delta_2 \longrightarrow m \times 1$

By combining (7.2) and (7.3) we have

$$\begin{bmatrix} y_1 \\ \\ y_2 \end{bmatrix} = \begin{bmatrix} z_1 & o & w_1 & o \\ \\ o & z_2 & o & w_2 \end{bmatrix} \begin{bmatrix} \gamma_1 \\ \gamma_2 \\ \delta_1 \\ \delta_2 \end{bmatrix} + \begin{bmatrix} u_1 \\ \\ u_2 \end{bmatrix} \text{ .... } (7.4)$$

and the null hypothesis is

$H_O : \gamma_1 = \gamma_2$ ($= \beta$ say).

Under the null hypothesis, the model is

$$\begin{bmatrix} y_1 \\ \\ y_2 \end{bmatrix} = \begin{bmatrix} z_1 & w_1 & o \\ \\ z_2 & o & w_2 \end{bmatrix} \begin{bmatrix} \beta \\ \delta_1 \\ \delta_2 \end{bmatrix} + \begin{bmatrix} u_1 \\ \\ u_2 \end{bmatrix} \qquad \ldots\ldots\ldots\ldots (7.5)$$

The LS estimate of the coefficient vector in (7.5) is

$$\begin{bmatrix} \hat{\beta} \\ \hat{\delta}_1 \\ \hat{\delta}_2 \end{bmatrix} = \left[\begin{bmatrix} z_1 & w_1 & o \\ \\ z_2 & o & w_2 \end{bmatrix}' \begin{bmatrix} z_1 & w_1 & o \\ \\ z_2 & o & w_2 \end{bmatrix} \right]^{-1} \begin{bmatrix} z_1 & w_1 & o \\ \\ z_2 & o & w_2 \end{bmatrix}' \begin{bmatrix} y_1 \\ \\ y_2 \end{bmatrix} \qquad \ldots\ldots\ldots\ldots (7.6)$$

If we fit (7.2) and (7.3) individually, their LS estimates of the cocfficients will be

$$\begin{bmatrix} c_1 \\ \\ d_1 \end{bmatrix} = \begin{bmatrix} (z_1\, w_1)'(z_1 w_1) \end{bmatrix}^{-1} (z_1 w_1)' \quad y_1 \qquad \ldots\ldots\ldots\ldots (7.7)$$

$$\begin{bmatrix} c_2 \\ \\ d_2 \end{bmatrix} = \begin{bmatrix} (z_2\, w_2)'(z_2 w_2) \end{bmatrix}^{-1} (z_2 w_2)' \quad y_2 \qquad \ldots\ldots\ldots\ldots (7.8)$$

where C_i is the LS estimate of γ_i

The sum of squares necessary for computing test statistics can then be obtained by using the results in (7.6), (7.7) and (7.8). The sum of squares that measures the distance of individual observations from the common regression plane is

$$Q_1 = \left[\begin{bmatrix} y_1 \\ \\ y_2 \end{bmatrix} - \begin{bmatrix} z_1 & w_1 & o \\ \\ z_2 & o & w_2 \end{bmatrix} \begin{bmatrix} b \\ \hat{d}_1 \\ \hat{d}_2 \end{bmatrix} \right]' \left[\begin{bmatrix} y_1 \\ \\ y_2 \end{bmatrix} - \begin{bmatrix} z_1 & w_1 & o \\ \\ z_2 & o & w_2 \end{bmatrix} \begin{bmatrix} b \\ \hat{d}_1 \\ \hat{d}_2 \end{bmatrix} \right] \qquad \ldots\ldots (7.9)$$

Here Q_1 / σ^2 has χ^2– distribution with (n - 2m - 1) degrees of freedom where we assume that u_1 and u_2 have a common variance σ^2. Now Q_1 can be decomposed into two sums of squares Q_2 and Q_3. Q_2 will measure the distances of observations from the individual estimated regression planes, and Q_3 will measure the distances of the individual estimated planes from the common regression plane.

Thus

$$Q_2 = \left[y_1 - (z_1 w_1) \begin{bmatrix} c_1 \\ d_1 \end{bmatrix} \right]' \left[y_1 - (z_1 w_1) \begin{bmatrix} c_1 \\ d_1 \end{bmatrix} \right] + \left[y_2 - (z_2 w_2) \begin{bmatrix} c_2 \\ d_2 \end{bmatrix} \right]' \left[y_2 - (z_2 w_2) \begin{bmatrix} c_2 \\ d_2 \end{bmatrix} \right] \quad \text{.....(7.10)}$$

and $Q_3 = Q_1 - Q_2$

Here Q_2 / σ^2 has a χ^2- distribution with $[(n_1 - m) + (n_2 - m)] = (n - 2m)$ degrees of freedom [since $n_1 + n_2 = n$].

$$\begin{aligned} Q_3 &= \left[(z_1 w_1) \begin{bmatrix} c_1 \\ d_1 \end{bmatrix} - (z_1 w_1) \begin{bmatrix} b_1 \\ \bar{d}_1 \end{bmatrix} \right]' \left[(z_1 w_1) \begin{bmatrix} c_1 \\ d_1 \end{bmatrix} - (z_1 w_1) \begin{bmatrix} b \\ \bar{d}_1 \end{bmatrix} \right] \\ &+ \left[(z_2 w_2) \begin{bmatrix} c_2 \\ d_2 \end{bmatrix} - (z_2 w_2) \begin{bmatrix} b \\ \bar{d}_2 \end{bmatrix} \right]' \left[(z_2 w_2) \begin{bmatrix} c_2 \\ d_2 \end{bmatrix} - (z_2 w_2) \begin{bmatrix} b \\ \bar{d}_2 \end{bmatrix} \right] \quad \text{......(7.11)} \end{aligned}$$

It may be noted that C_1 is the estimate of γ_1 obtained from the first sample regression and $\bar{d}_2$ is the estimate of δ_2 obtained from the "POOLED" regression plane. So the ratio is

$$F = \frac{Q_3 / l}{Q_2 / (n - 2m - 2l)} \quad \text{.. (7.12)}$$

So we have an F–distribution with $[l, (n - 2m - 2l)]$ degrees of freedom. Here Q_3 is the restricted sum of squares less the unrestrected sum of squares and that Q_2 is the unrestricted sum of squares.

If, however the new observations n_2 are fewer than the number of parameters in the function we may proceed as follows.

First, from the augmented sample we obtain the regression

$$\hat{Y} = \hat{\beta}_0 + \hat{\beta}_1 X_1 + \hat{\beta}_2 X_2 + \cdots + \hat{\beta}_k X_k \quad \text{.. (7.13)}$$

from which we calculate the residual sum of squares

$$\Sigma e^2 = \Sigma y^2 - \Sigma \hat{y}^2 \quad \text{..(7.14)}$$

with $(n_1 + n_2 - k)$ degrees of freedom.

Second, from the original sample of size n_1, we have

$$\hat{Y}_1 = \hat{b}_o + \hat{b}_1 X_1 + \dots\dots\dots + \hat{b}_k X_k \quad (7.15)$$

from which the unexplained sum of squares is

$$\Sigma e_1^2 = \Sigma y_1^2 - \Sigma \hat{y}_1^2 \quad (7.16$$

) with n_1 - k degrees of freedom.

Third, substracting the two sum of residuals we find

$$\Sigma e^2 - \Sigma e_1^2 \quad (7.17)$$

with $(n_1 + n_2 - k) - (n_1 - k) = n_2$ degrees of freedom, where n_2 are the additional observations.

Fourth, we form F^* ratio where

$$F^* = \frac{(\Sigma e^2 - \Sigma e_1^2)/n_2}{\Sigma e_1^2/(n_1 - k)} \quad (7.18)$$

The null hypotheses are

$H_1 : b_i = \beta_i \ (i = 0, 1, 2, \dots\dots\dots k)$.

$H_2 : b_i \neq \beta_i$

The F^* ratio is compared with the theoretical value of F, obtained from the F - table with $v_1 = n_2$ and $v_2 (n_1 - k)$ degrees of freedom.

If $F^* > F$, we reject the null hypothesis i.e., we accept that the structural cocfficients are unstable. This indicates that their values are changing in expanded sample periods.

7.3 RECURSIVE ESTIMATION : CHOW TEST

In our study the general model of estimation[45] is

$$y_t = \alpha + \beta_1 M_t^e + \beta_2 UM_t + v_t \quad (6.5)$$

The estimation involved here is one - step recursive estimation consisting of two successive stages of estimations viz. (1) Intial Stage and (2)Recursive Stage. Different steps in the Initial Stage of estimation are described below

45. The model is taken from the chapter VI. (section 6.2)

First, We start with a sample of first five years ($n_1 = 5$) from the historical data set (period 1950 - 91) for regression.

Second, before we estimate (6.3) with limited date set, we find corresponding vectors of M_t^e and UM_t from the following equation [46]

$$M_t = \alpha + \beta M_{t-1} + v_t$$

This is the general form of the model used for one period forecast for the M_t^e and UM_t. Consequently, we get the vectors for M_t^e and UM_t for the limited period.

Third, vectors of M_t^e and UM_t, thus obtained, are used for the estimation of the equation (6.3) for the limited period concerned. Sum of squared residuals ($\Sigma\ e_1^2$) is obtained.

In the Recursive Stage, we extend the time span by one more period for regression as if the 1st sample contains $n_1 = 5$ observations and the second sample contains only one observation such that $n_2 = 1$. Now that augmented sample observations, ($n_1 + n_2 = 6$), we repeat these three different stages in the initial stage. Here we obtain the sum of squared residuals ($\Sigma\ e^2$).

Final Stage : Now given $\Sigma\ e_1^2$ and $\Sigma\ e^2$, we obtain F^* as described in equn.(7.18). If F^* indicates acceptance of Null - hypothesis[47], we proceed recursively. In each stage of recursive estimation F^* is estimated and null - hypothesis is tested. We continue 'Recursive Estimation' until null - hypothesis is rejected[48].

So long as $F^* \leq F_{0.05}^{n_2, n_1-k}$ - table, recursive estimation is continued. In each round of recursive estimation we get one estimated equatrion. Successive recursive estimations, therefore, give us successive estimated equations with progessively higher degrees of freedom.

Now $F^* \leq F_{0.05}^{n_2, n_1-k}$ - table, indicates that theestimated parameters are stable over the period concerned. Alternatively, when $F > F_{0.05}^{n_2, n_1-k}$, the

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46. The equation is taken from the chap. V , (section 5.5). The equation is estimated with the limited data set. The fitted values of $\hat{M}_t$ provides the vector of M_t^e . The residuals present the corresponding vector of UM_t. The procedure has been described in chapter-V.

47. The Null Hypothesis is accepted at 5% level if $F^* \leq F_{0.05}^{n_2, n_1-k}$

48. If $F^* > F_{0.05}^{n_2, n_1-k}$, the Null Hypothesis is rejected.

equation estimated at the last round of recurcive estimation exhibits distinct difference from other equations in this present round. In other words, parameters have under -gone changes at this period. This period, therefore, exhibits structural change. Thus one " WINDOW " of 'structural change ' is found. However, the procedure is being repeated again for finding other " WINDOWS ", if any, until the data set is exhaused.

7.4 RESULTS & FINDINGS

The results of such ' Recursive Estimations', following Chow Test, are given in the table - 7.1, 7.2 and 7.3.

It is observed from the results that

(i) $F^{*} \angle F_{0.05}$ - table (with corresponding D.F.) for the successive recursive estimations over the period 1951 -1955[49]. However, $F^{*} > F_{0.05}$ - table for the recursive estimation for the period 1951 - 1956. Consequently, one ' Window ' of structural changes is found to occur at 1956.

(ii) $F^{*} \angle F_{0.05}$ - table (with corresponding D.F.) for recurssive estimation for the period 1956 - 1962. However, $F^{*} > F_{0.05}$ - table for the recursive estimations over the period.1956 -1963. This indicates that another , ' Window ' of Structural Changes in Parameter exists at 1963.

(iii) $F^{*} \leq F_{0.05}$ - table (with corresponding D.F.) for the recursive estimation over the period 1963 - 1969. Again $F^{*} > F_{0.05}$ table (with corresponding D.F.) for the recursive estimation over the period 1963 - 1970. This indicates that another ' window ' of structural changes exists at 1970.

(iv) $F^{*} \leq F_{0.05}$ - table (with corresponding D.F.)for the recursive estimation over the period 1970 - 1979 while $F^{*} > F$ - table for the recursive estimation over the period 1970 - 1980. This shows that another ' Window ' exists at 1980.

(v) $F^{*} \leq F_{0.05}$ table for the recursive estimation over the period 1980 - 1991. No further 'Window' could be found in this period.

Results of recursive estimation have be presented in Tables - 7.1, 7.2 and 7.3.

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49. For recursive estimation of stationary data set through G L S method we get the biginning plriod at 1951.

TABLE 7.1

RESULTS OF RECURSIVE ESTIMATIONS FOR WINDOW FINDING UNDER CHOW TEST (1951 FORWORD)

Sample - 1 (Consisting)	Sample - 2 (Consisting)	Estimated F*(Chow)
1951 -55	1951 -56	19.4**
1951 -56	1951 -57	6.04
1951 -57	1951 -58	3.04
1951 -58	1951 -59	2.91
1951 -59	1951 -60	2.90
1951 -60	1951 -61	2.95
1951 -61	1951 -62	2.93
1951 -62	1951 -63	3.95**
1951 -63	1951 -64	2.07
1951 -64	1951 -65	2.11
1951 -65	1951 -66	1.99
1951 -66	1951 -67	2.01
1951 -67	1951 -68	1.99
1951 -68	1951 -69	1.79
1951 -69	1951 -70	2.81**

** Indicates that the estimated $F^{*} > F_{0.05}^{V_1, V_2}$

TABLE 7.2

RESULTS OF RECURSIVE ESTIMATIONS FOR WINDOW FINDING UNDER CHOW TEST (1991 BACKWORD)

Sample - 1 (Consisting.)	Sample - 2 (Consisting.)	Estimated F^* (Chow)
1991 -86	1991 -87	3.78
1991 -85	1991 -86	2.63
1991 -84	1991 -85	2.57
1991 -83	1991 -84	3.98
1991 -82	1991 -83	2.68
1991 -81	1991 -82	2.01
1991 -80	1991 -81	3.79**
1991 -79	1991 -80	2.01
1991 -78	1991 -79	1.95
1991 -77	1991 -78	2.11
1991 -76	1991 -77	1.99
1991 -75	1991 -76	1.79
1991 -74	1991 -75	1.46
1991 -73	1991 -74	1.91
1991 -72	1991 -73	1.84
1991 -71	1991 -72	1.75
1991 -70	1991 -71	1.92

** Indicates that the estimated $F^* > F_{0.05}^{V_1, V_2}$

The over all summarsied results correspondingto the tables 7.1 & 7.2 are given in the following table - 7.3

TABLE 7.3

FINAL RESULTS OF RECURSIVE ESTIMATIONS FOR WINDOW FINDING

Sample - 1 (Consisting of the period)	Sample - 2 (Consisting of the period .)	Estimated Chow where ($F^* > F^{V_1, V_2}_{0.05}$)	Windows of structural change (at the corresponding year)
1951 - 55	1951 - 56	19.95	1956
1956 - 62	1956 - 63	6.25	1963
1963 - 69	1963 - 70	6.35	1970
1970 - 79	1970 - 80	4.23	1980
1980-- 90	1980 - 91	2.12	—

7.5 SUBPERIODS IDENTIFICATION : IMPLICTIONS OF FINDINGS :

From the results presented in the Table 7.3, subperiods can be identi fied. These subperiods are as follow :

(i) 1950 - 1955 constitutes one subperiod. However, because of only one estimation over the period, the exact dynamic nature of output - money supply relationship cannot be ascertained. No recursive estimations were possible in the sub -period 1951 - 1955 becouse insufficient degrees of freedom. The period 1951 - 55 consists of only 5 observations on each variable concered and any estimation of the model entails loss of 3 degrees of freedom. So recursive estimations have been avoided.

(ii) Second subperiod consists of the period 1956 - 1962.

(iii)Third subperiod consists the period 1963 - 1969.

(iv)The period 1970 - 1979 constitutes the fourth subperiod.

(v) Fifth subperiod consists of the priod 1980 - 1991.

Once thre subperiods are identified, the task is to consider the relationship between output level and different parts of money supply over the identified subperiods. This is expected to provide a dynamidc and distinct nature of such relationship in different subperiods over the period concerned. We seek to address this issue in the following chapter.

CHAPTER - VIII

OUTPUT LEVEL AND DIFFERENT PARTS OF MONEY SUPPLY: RELATIONSHIPS OVER DIFFERENT SUB-PERIODS

8.1 INTRODUCTION :

From the results of the 'Recursive Estimations' following Chow Test in Chapter-VII, several sub - periods have been identified. Accross these sub-periods, relations between output level and different parts of money supply underwent changes. This Chapter is devoted to analyse these changes. However, for the reasons stated in the Chapter VII in Section 7.5, the sub-periods[50] 1950-1955 is kept out of the purview of our analysis.

8.2 RECURSIVE ESTIMATION OVER THE SUB-PERIODS 1956-1962:FINDINGS

It is observed over the sub-period 1956-1962, F* - values are not statistically significant even at 5% level i.e. $F^* < F_{0.05}^{V_1, V_2}$. So the structural parameters of the equation[51]-

$$y_t = \alpha + \beta_1 M_t^e + \beta_2 UM_t + v_t \quad \text{remained stable.}$$

The GLS estimation of the equation is

$$\begin{array}{llll} \hat{y}_t = & 0.01235 + & 0.001435M_t^e + & 0.005612UM_t \\ & (0.004822) & (0.02687) & (0.007163) \\ & [2.5610] & [0.05340] & [0.7835] \end{array}$$

$R^2 = 0.450351$ D.F. = 4

$F^* = 0.819$ D.W. = 2.01

It is observed that over this sub-period, $\hat{\beta}_1$ and $\hat{\beta}_2$ are not statistically significant even at 1% level. This indicates that $\beta_1 = 0$ and $\beta_2 = 0$.

8.3 ANALYSIS OF THE FINDINGS :

These statistical findings ($\beta_1 = 0$, $\beta_2 = 0$)[52] indicate that variation in output level over the sub-period 1956-1962 were in no way related significantly to variations in either anticipated and unanticipated parts of money supply.

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50. Because of only one estimation in the subperiod, 1950-55, the exact dynamic nature of output money supply relationship cannot be ascertained.

51.The equation is taken from chapter-VI, section-6.1.

52.$\beta_1 = 0$ and $\beta_2 = 0$ mean that M^e_t and UM_t have no influence on output over the sub-period (1956-1962).

It may be noted that this sub-period by and large covered the Second Five Year Plan period. This sub-period saw the introduction of the Industrial Policy of 1956 and the practice of "Controlled Money Expansion". The growth of output level was, therefore, mainly due to prudent fiscal management. Consequently, monetary policy failed to extend remarkable effect on output growth.

8.4 RECURSIVE ESTIMATION OVER THE SUB-PERIOD 1963-1969 : FINDINGS

It is observed over the sub-period 1963-1969, F* - values are not statistically significant even at 5% level, i.e. $F^* < F^{V_1, V_2}_{0.05}$. So, the structural parameters of the equation.

$$y_t = \alpha + \beta_1 M_t^e + \beta_2 UM_t + v_t$$ remained stable over this sub-period.

The GLS estimation of the equation is

$$\hat{y}_t = -1.4625 + 0.7523M_t^e + 0.05031UM_t$$
$$(0.45518) \quad (0.32538) \quad (0.053801)$$
$$[-3.213] \quad [2.3120] \quad [0.9351]$$

$R^2 = 0.803251$ D.F. = 4

$F^* = 4.08$ D.W.=1.95

From the estimated equation it is observed that over this sub-period $\hat{\beta}_1$ is statistically significant at 5% level and $\hat{\beta}_2$ fails to be significant (at 5% level). This indicates that $\beta_1 > 0$ and $\beta_2 = 0$.

8.5 ANALYSIS OF THE FINDINGS :

These statistical findings indicate that

(i) variation in output level over the sub-period 1963-1969 is significantly related to the variation in anticipated part of money supply since $\beta_1 > 0$ and ;

(ii) output variation is in no way significantly related to the variation in unanticipated part of money supply since $\beta_2 = 0$.

These findings have important implication regarding efficiency of monetary policy. It may be noted that anticipated part of the money supply constitutres the part of the money supply which is directly controlled through monetary policy. So, the monetary policy becomes operative through the anticipated part of money supply. Now anticipated part of money supply is found to exert significant effect on output level over the sub-period 1963-1969. It is a pointer that monetary policy was successful to affect output variation over this period.

On the other hand, unanticiapted part being a random variable, constitutes the surprise in money supply. It is, therefore, out of the calculated policy designs of the monetary authority. Consequently, $\beta_2 = 0$ indicates that surprise part of money supply has no contribution into the variation in output level over the sub-period concerned. This further testifies that well-designed calculated practices of the monetary authority exerted significant effect on output growth over this period. Random, uncalculated money supply bore no effect on output variation.

8.6 RECURSIVE ESTIMATION OVER THE SUB-PERIOD 1970-79:FINDINGS

For the recursive estimations over the sub-period 1970-1979, it is observed that F*- values are not statistically significant (even at 5% level) since $F^* < F^{V_1, V_2}_{0.05}$. These indicate that the structural parameters of the equation -

$y_t = \alpha + \beta_1 M_t^e + \beta_2 UM_t + v_t$ remained consistently stable over this sub-period.

The estimated equation[53] is

$$\hat{y}_t = 0.5327 + 0.05261 M_t^e + 0.03214 UM_t$$
$$(0.43133) \quad (0.06299) \quad (0.03562)$$
$$[1.9235] \quad [0.8351] \quad [0.9021]$$

$R^2 = 0.402138$ D.F. = 7
F* = 1.34   D.W.= 1.56

It is observed that both $\hat{\beta}_1$ and $\hat{\beta}_2$ are statistically insignificant even at 1% level. This indicates that $\beta_1 = 0$ and $\beta_2 = 0$.

8.7 ANALYSIS OF THE FINDINGS :

These statistical findings i.e. $\beta_1 = 0$ and $\beta_2 = 0$ show that variation in either anticipated or un-anticipated part of money supply had failed to explain the variation in output level over the sub-period 1970-79. Consequently, variation in output level was in no way related to variation in any part of money supply.

These findings seem to imply that monetary policy had little contribution to output gtowth. Monetary policy as such failed to play vital role in guiding the growth of output level over this sub-period concerned.

It may be noted that this sub-period (1970-1979) envisaged the period of turmoil arising out of the Indo-Pakistan War over Bangladesh issue and proclamation of Emergency in India. Again in this period the 20-point Economic Programmes was launched by the Central Government. So, the growth of output level in this period was the culmination of

53. The equation is estimated through GLS method.

many factors. The nationalization of banks paved the way for expansion of money supply but the growth of output was hindered by several socio-political events. As a result thereof, monetary expansion failed to generate any impetus for output growth.

8.8 RECURSIVE ESTIMATION OVER THE SUB-PERIOD 1980-1991 : FINDINGS

It is observed over the sub-period 1980-1991, F* - valuaes are not statistically significant (even at 5% level) since $F^* < F^{v_1, v_2}_{0.05}$. So, the structural parameters of the equation

$$y_t = \alpha + \beta_1 M_t^e + \beta_2 UM_t + v_t$$ remained stable over this sub-period.

The estimated equation[54] is

$$\hat{y}_t = \underset{\substack{(0.54127)\\[2.3160]}}{1.2536} - \underset{\substack{(0.08854)\\[-0.5963]}}{0.05280} M_t^e + \underset{\substack{(0.05842)\\[3.8256]}}{0.22351} UM_t$$

$R^2 = 0.543541$ D.F. = 9

$F^* = 3.17$ D.W.=1.97

From the above estimated equation, it is observed that $\hat{\beta}_1$ is not significant (at 5% level) but $\hat{\beta}_2$ is statistically significant (at 5% level).

It is observed from these recursive estimations that $\beta_1=0$ while $\beta_2>0$. So, the broad discernable trend in this sub-period exhibits that $\beta_1=0$ and $\beta_2>0$ while β_1 has assumed a negative value.

8.9 ANALYSIS OF THE FINDINGS :

These statistical findings show that over this sub-period (1980-91) variation in output level.

(i) was not related to the variation in anticipated part of money supply, since $\beta_1=0$ and

(ii) was positively related to that in unanticipated part of money supply since $\beta_2>0$.

$\beta_1=0$ has an important significance. It indicates that anticipated money supply which arose out of the well-designed calculated practice of monetary authority played no role for the growth of output level. As a matter of fact, this period is marked by strong inflationary pressure in the economy. Growth in money supply added more to the price rise and purchasing capacity of the economy. Consequently, anticipated part of money supply added only to price rise and not to any rise in real output level.

However, under strong inflationary pressure $\beta_2>0$ lends support to the claim of the Rational expectationists. Rational expectationists claim that in countries with volatile price level marked by strong inflationary pressure, surprise i.e. unanticipated part of money supply becomes more effective in guiding output level. The overall results of the estimated models in different sub-periods have been presented in the Table-8.1.

54. The equation is estimated through GLS method.

TABLE-8.1

RESULTS OF ESTIMATIONS IN DIFFERENT SUB-PERIODS

Sub-periods	$\hat{\alpha}$	$\hat{\beta}_1$	$\hat{\beta}_2$	D.F.	R^2	F*	D.W.
1	2	3	4	5	6	7	8
1956-62	0.01235 [2.5610]	0.001435 [0.05340]	0.005612 [0.7835]	4	0.450351	0.819	2.01
1963-69	-1.4625 [-3.213]	0.7523 [2.3120]	0.05031 [0.9351]	4	0.803251	4.08	1.95
1970-79	0.5327 [1.9235]	0.05261 [0.8351]	0.03214 [0.9021]	7	0.402138	1.34	1.56
1980-91	1.2536 [2.3160]	-0.05280 [-0.5963]	0.22351 [3.8256]	9	0.543541	3.17	1.63

8.10 OVERALL IMPLICATIONS OF THE FINDINGS : SUMMARY

It is, therefore, observed that

(i) variations in anticipated and unanticipated parts of money supply had no contribution to the variation in output level over the sub-periods 1956-62 and 1970-1979 ;

(ii) anticipated part of money supply is found to affect output level over the period 1963-1969 only while unanticipated part played no role in this respect ;

(iii) anticipated part of money supply is found to have no role in the variation of output level over the period 1980-91. However, over this period, unanticipated part of money supply is found to contribute significantly to the variation of output- level .

These findings also bear significant implications for efficacy of monetary policy. It is observed in this respect that -

(i) monetary policy was broadly ineffective in the matter of influencing output growth over the period 1956-62 and 1970-79 ;

(ii) monetary policy emerged successful in affecting output level over the sub-period 1963-1969 only ;

(iii) monetary policy, as pursued over the sub-period 1980-91, emerged ineffective in guiding the growth of output level in India ;

(iv) Surprise or unanticipated part of money supply played a significant role in affecting output level over the sub-period 1980-91 only. It lends credence to the Rational Expectationists' Proposition that output level is affected significantly by the unanticipated part of money supply when economy suffers from volatality in price level.

CHAPTER-IX

SUMMARY AND CONCLUSIONS

9.1 We have undertaken a study of the relationship between output level and different parts of money supply in India following the works of Rational Expectationists like Sargent and Lucas. It has been observed in the study that variation in output level over the period 1950-1991 is significantly associated with that in money supply (Cahpter-IV, Section 4.5).

9.2 In chapter-V we have then sought to know how output level is related to the anticipated and unanticipated parts of money supply. This requires us to estimate an equation of money supply. From several alternative models, the most appropriate one has been chosen for this purpose [eqn. (5.10) in section 5.5] . The chosen estimated equation has then been used for generating the vectors of anticipated and unanticipated parts of money supply.

9.3 In chapter-VI, output level is regressed on anticipated and unanticipated parts of money supply. It is observed that output level is related to the anticipated part of money supply only. Unanticipated part of money supply is not found to affect output level significantly (section 6.4).

9.4 In chapter-VII, historical (1950-1991) data set has been used for Recursive Estimations and Chow Test in order to identify sub-periods over which stable structural relations persisted. The sub-periods thus identified consist in 1956-1962, 1963-1969, 1970-1979, 1980-1991 respectively.

9.5 In chapter-VIII, we have sought to examine how the relation between output level and different parts of money supply underwent changes across different sub-periods. The findings are as follows :

i) Output level is found to display no relation with either anticipated and unanticipated parts of money supply over the period 1956-1962 and 1970-1979 (section 8.2 and 8.6).

ii) However, output level is found to be significantly and positively related with the anticipated part of money supply only over the period 1963-1969 (section 8.4 and 8.5).

iii) Anticipated part of money supply is found to be ineffective in explaining the variation in output level over the period 1980-1991. However, output level over this sub-period is found to be significantly favoured by the variation in the unanticipated part of money supply (section 8.8 and 8.9).

9.6 From our research it is, therefore, observed that

i) Money policy, which operates through the controlling of anticipated part of money supply is, therefore, found to be effective in influencing money supply over the sub-period 1963-1969.

It may again be noted that the price level was fairly stable over the sub-period 1963-1969. Thus, the finding supports the proposition suggested by Lucas that monetary policy is effective only under fairly stable price situation.

ii) Monetary policy [i.e. variation in anticipated part of money supply] is found to be of no help for output growth over a fairly long range of time [over the sub-periods 1956-62 and 1970-1979].

iii) Monetary policy [i.e. variation in anticipated part of money supply] is again found to be detrimental to the growth of output level in India over the period 1980-1991.

It may be noted that the period 1980-91 is marked by strong inflationary pressure in the Indian economy. Under such situation, failure of the monetary policy again is in conformity with the Rational Expectationists 'Invariance Proposition' that monetary policy becomes ineffective in countries where prices suffer from serious volatility.

iv) Positive Relationship of variation in output level with that in the unexpected part of money supply as observed over the period 1980-1991 is also in conformity with the Rational expectationist proposition that under volatile price situation only surprise part of in money supply can affect output level.

9.7 The detrimental effect of monetary policy on growth of output level over the recent past (1980-1991) needs attention. It is a pointer to the fact that unbridled expansion of money supply (i.e. anticipated part) with a view to hastening economic growth may instead deter the same. Prudent fiscal policy formulations seem to be a better alternative to such easy money policy. Such prudent fiscal policy may, therefore, be expected to play a better role for economic growth in years to come.

9.8 However, we are aware that our study over the period 1950-91 has been restricted to only four Recursive Equations. So, the picture obtained here does not enable us to draw firm conclusion about the effectiveness of monetary policy for the period to come. There is, therefore, a need for further research with the extension of data set for drawing firm conclusion over this issue.

SELECTED BIBLIOGRAPHY :

Ball, R.J. - "Inflation and Theory of Money", London, 1964, pp. 205-06.

Barro, R.J., "Unanticipated Money Growth and Unemployment in the United States, "American Economic Review, 1977, pp. 101-115.

Berg Storm, A.R. et.al., eds - "Stability and Inflation", London, Wiley, 1978.

Buiter, W. "The macro economics of Dr. Pangloss - A Critical Survey of the New Classical Macro economics", E J, (March, 90 (357), 1980, pp. 34-50.

Chatterjee, S. - "Price, Output & Money Supply in India - An Econometric Study" - An unpublished dissertation submitted to North Bengal University, 1990.

Chow, G. - "Tests for Equality between Sets of Co-efficients in Two Linear Regression", Econometrica, 28, 1960, pp. 591-605.

Devraj, I. - "Effectiveness of Monetary Policy in India", Bombay, 1993.

Dornbusch, R. - "Inflation, Growth and Unemployment : An Expository Framework" (mimeograph), 1975.

Fand, B. "A Monetarist - Model of the Monetary Process", J.S. (May) 25(2), 1970, pp.275-89.

Fischer, St. - "Long - Term Contracts, Rational Expectations, and the Optimal Money Supply rule," JPE, (Feb.) 85(1); 1977, pp. 191-205.

Friedman, B. - "Optimal Expectations and the Extreme Information Assumptions of 'Rational Expectations' Macromodels," Journal of Monetary Economics , 1979, pp. 5:23-41.

Friedman, M. - "The Role of Monetary Policy", American Economic Review, 1968, pp. 58: 1-17.

Friedman, M. ed. - "Theory of Money", Chicago, University Press, 1970, pp. 26-117.

Frisch, H. - "Theories of Inflation" Cambridge University Press, Cambridge, 1986.

Front Line : July, 20 ; August 1991, Vol. VIII, No.15; pp. 11.

Frydman, R. - "Sluggish Price Adjustments and the Effectiveness of Monetary Policy under Rational Expectations," Journal of Money, Credit and Banking , 1981, pp. 13 : 94-102.

Gordon, R.J. - "Price Inertia and Policy, Ineffectiveness in the United States, 1890-1980", North Western University and NBER, 1981.

Grossman, J. - "Nominal Demand Policy and Short-Run Fluctuations in Unemployment and prices in the United States", Journal of Political Economy, 1979, pp. 87 : 1063-85.

Guru, D. D. - "Price, Money and Output - relation of Quantity Theory of Money in India", Delhi, 1987.

"International Financial Statistics : Year Book " , 1979, 1988 ; Sept. 1993, International Monetary Fund, U.S.A.

Keynes, J.M. - "The General Theory of Employment Interest, and Money". New York, Harcourt, Brace and World, 1964.

Khusro, A.M., - "General and Sectoral Price Instability", Working paper, Institute of Econometric Growth, Delhi.

Koutsoyiannis, A. - "Theory of Econometrics : An Introductory Exposition of Econometric Methods", Foreword by C.F. Cartel, Macmillan, 1973.

Laidler, D.E.W., "An Elementary Monetary Model of simultaneous Fluctuations in Prices and Output, Berlin, spricer Verlag, 1976.

Lucas, R.E. - "Expectations and the Neutrality of Money", JET, 1976, pp. 103-24.

Lucas, R.S., "Expectations and the Neutrality of Money" in J.E.T. (April) 4(2), 1981, pp. 102-24.

McCallun, B.T. "Rational Expectations and Macroeconomic Stabilization Policy", Journal of Money, Credit and Banking, pp.12 : 716-46.

Minford, P. - "Rational Expectations Macro economics" : an Introductory Handbook, Oxford, Blackwell, 1992, pp. 30-36.

Mishkin, F.S., - "Simulation Methodology in Macroeconomics : An Innovation Technique", Journal of Political Economy, 1979, pp. 87: 816-36.

Muth, J.F. - "Rational Expectations and the Theory of Price Movements" EC (July) 29(3), 1961, pp. 315-35.

Ozga, S.A. - "Expectations in Economic Theory", London, Weidenfeld and Nicolson, 1965, pp.23.

Patinkin, D. - "Money, Interest and Prices, Harper and Row, New York, 1966.

Rao, C.R. - "Advanced Statistical Methods in Biometric Research" New York, Weliy & Sons, 1952.

Sargent, T.J.- "Rational Expectations, The real rate of interest and the Natural rate of Unemployment", BPEA 21, 1973, pp. 429-72.

Sargent, T. J. and Wallace, N. - "Rational Expectations and the Dynamics of Hyperinflation", 1973, IER (June) 4(2), pp. 328-50.

Sargent, T.J. and Wallace, N. - "Rational Expectations, the Optimal Monetary Instrument, and the Optimal Money Supply Rule, JPE, 1975, pp. 241-54.

Shah, V.C. - "Monetary Analysis in India, 1948-49, 1958-59", Indian Economic Journal, Jan, 1962, pp. 300-301.

Sheffrin, S.M., - "Rational expectations" Cambridge University Press, Cambridge, 1983.

Shenoy, B.R. - "Problems of Indian Economic Development", 1970, pp. 66-71.

Srivastaba & Saxena - "A Role on the Theory of Money, Indian Economic Journal, Oct. Sec, 1968.

Sims, C.A. - "Money, Income and Causality", The American Economic Review, 1972, vol. LXII, No. 4, pp. 540-552.

Sinha, C. - "Money Income and Price level in India Test on Causality" in Recent Economic Scenario in India, 1990.

Solow, R.M. - "Price Expectation and the Behaviour of the Price level", Manchester University Press, 1969, pp.4.

Srivastava, S.C. and Saxena P.G. - "A Note on the Quantity Theory of Money", Indian Economic Journal Oct-Dec, 1968.

Sushil Kumar - "A Price Behaviour in India During 1901-1960", an unpublished Doctoral Dissertation submitted to the Delhi University.

Swoboda, A.K. - "Monetary Approach in world wide Inflation" , edited by L.B. Krause and W.S.Salant, Washington, D.C., The Brookings Institution, 1976, pp.9-62.

Tobin, J. - "Asset Accumulation and Economic Activity" Oxford, Blackwell, 1980.

Vakil, C.N. and Prahmananda, P.R., - "Planning for an Expanding Economy, Bombay, 1956, pp. 310.