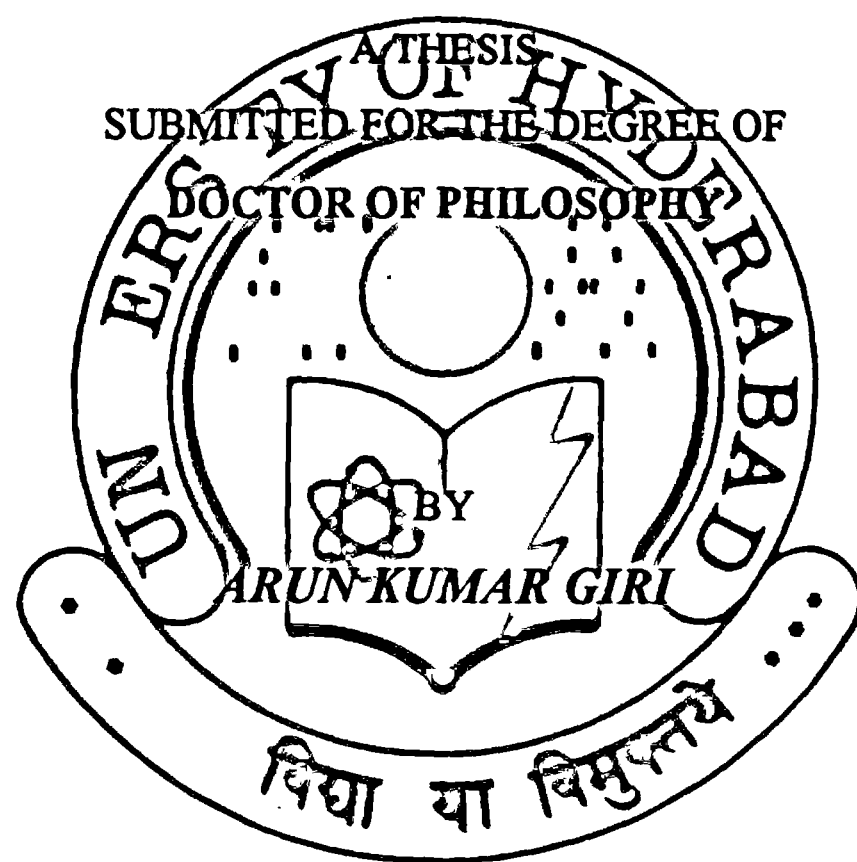


**DEMAND FOR MONEY IN INDIA:
NEW ISSUES AND EVIDENCES**



DEPARTMENT OF ECONOMICS
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HYDERABAD 500 046

INDIA

NOVEMBER 1997

TO MY PARENTS.....

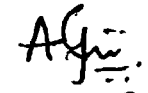
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This is to certify that I, Arun Kumar Giri, have carried out the research embodied in the present thesis entitled "Demand for Money in India: New Issues and Evidences" for the full period prescribed under Ph.D. ordinances of the University.

I declare to the best of my knowledge that no part of this thesis was earlier submitted for the award of research degree of any University.


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CHAPTER - I

INTRODUCTORY BACKGROUND, ISSUES AND OBJECTIVES OF THE STUDY

1.1 Introduction:

Money Demand elasticities have been considered of crucial importance for operation and effectiveness of monetary policy. Further, a stable demand function for money has been regarded as a necessary condition for the viability of monetary policy. Therefore, demand for money has been subjected to empirical scrutiny in many countries over the years.

Empirical research in this area centres around a few interesting issues. They include: (i) empirical definition of money, (ii) choice of appropriate scale and opportunity cost variables, (iii) role of adjustment and expected lags, (iv) estimation of functional forms and (v) temporal stability (Laidler, 1969). Starting from the pioneering work of Irving Fisher to the relatively recent buffer stock approach, the literature covering the various issues has been truly voluminous. Nevertheless, most of the issues in general and stability in particular, remains unresolved. The issues however, assume importance in the context of economies experiencing financial innovation, deregulation and technological and institutional developments. Therefore, it is felt necessary in the present context to readdress some of the issues associated with demand for money in the context of Indian economy where such changes have taken place in the recent years. It is felt that such a study would throw some light on how accurately and reliably the effects of monetary policy could be explained and predicted.

1.2 Demand for Money: Some Issues

During the past few decades, efforts have been made to study the behaviour of demand for money with a view to resolve some of the issues for the conduct of monetary policy. However, due to various reasons the efforts have not been successful. On the contrary, some additional issues have cropped up which seem to have profound implications for the operation and effectiveness of monetary policy. Some of the issues are as follows:

To begin with, for an empirical estimation of the demand for money function, the variable representing demand for money should be observable. But in reality, this variable is not directly observable. It has been the practice to use money stock (money supply) in the place of demand for money under the assumption that money supply is demand determined. In the event of any disequilibrium, it may be necessary to allow for the discrepancy between demand for and supply of money. At this juncture, the lags in adjustment between demand for and supply of money enters the demand for money function. The problem of adjustment lags is common only in studies based on quarterly and monthly observations and not on annual observation. The reason is that over a period of one year the demand for desired money is expected to get adjusted to the available stock of money. Whether instantaneous adjustment (between desired and actual money stock) is assumed or discrepancy allowed, the problem still remains for one important reason, that is the conventional partial adjustment model is not an adequate representation of the short run dynamics due to the exogeneity of money supply. Therefore, there is a need to have a fresh look at the short run dynamics of money demand under the economic environment of changes in institutional framework in which money stock could not be assumed to be demand determined.

Secondly, money can be defined in several alternative ways. It may be defined in a "narrow" sense as the sum of currency with non-bank public and demand deposits with the

banking sector, or in a "broader" sense by adding time deposits or in a still broader sense as a weighted aggregate of money and near money assets. The choice from these aggregates is an empirical question.

In India the recent financial innovations and deregulatory measures might have altered the traditional payment pattern thereby rendering the demarcating line between money and near money assets difficult. Therefore, it is also necessary to examine the impact of asset market on demand for money which may lead to a qualitatively different kind of formulation of money demand function. For example, if financial innovation takes place, an increasing proportion of narrow money begins to earn interest. As a result demand for money becomes more elastic with respect to the spread between the rates rather than the overall level of interest rate.

The Indian money market has undergone several changes over the years. More importantly, the demand side has been influenced more directly in the 1980s, with the development of capital market having pronounced impact on the money market. The growing interest of the households in investing in shares and debentures too have some bearing on the money market in the present decade. Mention may be made of the some recent institutional changes such as, setting up of Discount and Finance House of India (DFHI), Securities Trading Corporation of India (STCI), Securities and Exchange Board of India (SEBI) and National Stock Exchange (NSE) which have an important role to play in widening and deepening the money and securities market in India. Furthermore, the introduction of the primary dealers system would go a long way in the development of a well organised Government Securities market in India.

For long, the Indian financial system is characterised by an administered structure of interest rates. The weakness of the administered interest rate was well documented in the committee to review the working of the monetary system in India (Chakravarty

Committee Report). The direction of changes in monetary policy in general and interest rate in particular was set in the Narashimham Committee Report. The working group appointed by the committee recommended sweeping changes in the money market to supplement the interest rate mechanism envisaged therein (Narashimham Committee).

Although, the process of interest rate deregulation is still incomplete, it is market clearing for most of the money market instruments, such as call/notice money, participation certificates, commercial papers, certificate of deposits etc.. Deposits and lending rates of commercial banks have been considerably rationalised as a prelude to complete deregulation. In case of gilt edged securities, all dated securities including 364-day treasury bill are now sold on auction basis in the primary market. A major chunk of 91-day treasury bills, other than ad-hoc and on-tap treasury bills is also sold on auction basis. The secondary market in respect of gilt - edged securities is gradually developing which, until recently, was virtually non-existent mainly due to pre-determined returns. These developments are encouraging to make interest rate mechanism as the focal point of monetary intervention.

Not withstanding the above, there is disagreement as to whether interest rate, however defined, can be a suitable opportunity cost of holding money. The appropriateness of inflationary expectation as alternative opportunity cost of holding money was raised by many economists. The inclusion of expected inflation as an argument does not differ from the inclusion of interest rate as the increase in these variables also increases the cost of holding money. In countries with well developed financial market, the expected rate of inflation is reflected in the nominal interest rate since the latter will rise when inflation is expected to rise, compensating the lenders for the loss of purchasing power of money due to inflation. In developed economies, with well developed capital market, in which the nominal interest rates are free to move, expected inflation, becomes a relevant argument. However, in developing economies also, expected

inflation is relevant though it might not reflect the free movement of interest rates. The issue regarding the appropriate opportunity cost variable has added significance for developing countries like India for the following reasons: (i) There exists a wide divergence of rates of interest in the organised and unorganised money markets, (ii) there is a multiplicity of unorganised market interest rates and (iii) financial markets are not fully developed and there are only few organised dealings in commercial papers and bills.

All the above factors would substantiate the importance of physical assets as substitutes for money. While the substitution effect is important for both developed and developing countries, because of the lack of other financial assets, real assets substitution takes place in developing countries especially in rising prices. One of the important characteristics which make people hold money is its function as a store of value. When prices are expected to rise, its function as a store of value is undermined and money holders dispose money in favour of physical assets as a store of value. The lack of other appropriate financial assets makes this movement into physical assets a preponderant one. Therefore, the expected rate of inflation as a proxy for the rate of return on real assets needs attention and detailed investigation while modelling the money demand in India.

The external sector of the Indian economy has witnessed far reaching changes including a substantial elimination of quantitative controls on imports, reduction in tariffs, a market determined exchange rate system, convertibility on the current account, encouragement to foreign direct investment and greater access to external capital markets. These have resulted in a large volume of foreign exchange inflows to the country in the form of direct and portfolio investment. While the surge in capital inflows are welcome, in as much as the help to augment resources, it must also be recognised that they have an expansionary impact on money supply to the extent that they add to the total net foreign exchange assets of the RBI. In this regard, it is worthwhile to note that the changes in net foreign exchange assets of RBI amounting to Rs. 23, 264 crore in 1994-95, contributing

as much as 76.8% of total variation in reserve money that year. Similarly, greater access to international capital market has meant that corporates have been able to access funds at rates lower than the domestic interest rates.

Of late, real effective exchange rate has been used by many researchers as an explanatory variable to capture the effects of globalisation. The exchange rate is basically an opportunity cost of holding foreign exchange assets. In an ideal condition, the exchange rate would reflect the interest rate differentials between trading countries. Therefore, there is a need to re-examine the demand for money with exchange rate as an explicit argument in the function.

For the purpose of predicting accurately the impact of changes in income, opportunity cost of holding money and other relevant determinants of demand for money, it is essential that the function should be stable. Further, stability of the monetary aggregate representing demand for money may be sensitive to the way money is defined, its determinants, functional forms, presence of autocorrelation, misspecification in the model etc.. Stability also depends on the frequency of observation used. Therefore, the issue needs to be investigated in a wider perspective.

Given the appropriate money stock and determinants, the way these are to be related is important for the estimation of the money demand relationship. It has been recognised that the money demand models of yesteryears, mainly based on the Goldfeld (1973) equation or its variants, suffer from spurious inferences, since the least square techniques have been applied on relationships involving non-stationary variables. There is therefore, a need to re-estimate the money demand relation in India by employing Cointegration techniques. Further, the equilibrium relationship that is assumed to exist between real money balances and a given set of variables that explain the same should also be examined.

The conventional money demand function assumes that the actual money stock will ultimately equal the desired balances. The difference of opinion among economists in this respect has been regarding the equilibrating variables, time path of adjustment and choice of appropriate specifications. The underlying theory is based on the concept of short run disequilibrium and long run cointegration. As in the traditional theory, it is assumed that there exists a long run stable relationship between demand for real cash balances and its determinants. However, in the short run, there is a departure from the desired long run equilibrium path. In what is normally described as the "buffer stock" approach, the hypothesis is that exogenous shock pushes the demand off its long run path and the process of transmission takes several periods to work itself out. Since exogenous shocks keep occurring in an unanticipated or random fashion, in the short run, there can never be perfect equilibrium. Faced with uncertainty, economic agents temporarily hold a larger stock of money than they could otherwise do till they reallocate their assets portfolio. So, under the situation of uncertainty that prevails in the Indian economy in the recent past it is worthwhile to investigate into the validity of buffer stock approach or the short run dynamics of money demand relationship.

1.3 Objectives of the Study:

The present work is designed to address the above mentioned issues for Indian economy. Accordingly, the objectives of the present study are set as follows:

- (i) The first objective is to examine the role of asset markets, external sector and inflationary expectations on demand for money in the context of financial innovations, institutional changes, liberalisation and asset market changes.

- (ii) The second objective is to re-examine the issue of temporal stability and long run equilibrium relationship of money demand function by using latest time series techniques.
- (iii) The third objective is set to test the validity of the buffer stock approach to money demand and to present a model comparison with partial adjustment approach.
- (iv) The last objective is to examine the implications of the new evidences for framing monetary policy.

1.4 The Present Study: Data and Methodology:

The empirical investigations of the present study are carried out on an annual time series spanning the sample period 1960-61 to 1995-96 as well as a monthly series starting from 1981:04 to 1995:10. Monthly data are used to grasp the short run dynamics in the properties of money demand function. The choice of sample period for annual data is suggested by the availability of data and the requirement of reasonably good number of observations which is essential for empirical investigation. The study is also carried out on sub-samples to draw implications of some additional variables which seem more relevant for the later periods of the sample. The variables used in empirical experimentation, their definition, sources of time series data and the methods by which some of the time series are constructed are discussed and presented in the appendix.

A standard formulation of the demand for real money balances is formulated to be an increasing function of a "scale" variable (most often real GDP) and a decreasing function of "opportunity cost" variable (various interest rates). There have been divergent

views in literature with respect to the choice/identification of measures of these variables. Further, in the context of financial innovation, deregulatory changes and external sector reforms, selection of determinants become more complex. Since Indian economy has been subjected to such changes, money demand specifications have been reformulated in this study by taking into account those variables which represent these changes. Accordingly, a measure of stock of financial wealth (market capitalisation) is included in the model to capture portfolio decision of the agents. Stock prices (RBI share index) is also introduced to capture its effect on the level of real cash balances. Further, to incorporate the external sector's influence, exchange rate variable (real effective exchange rate) is also introduced in the model. In a situation of price rise, people tend to substitute real assets for financial assets including perishable consumer goods in their assets portfolio. Hence, inflationary expectations as a measure of rate of return on real assets have been considered meaningful and included in the model. The uncertainty about future prices may also have an effect on the precautionary money demand and assets whose value is not constant in real terms. Hence, to capture the effect of uncertain price movements, variability of rate of inflation, a measure of uncertainty has been introduced in the specifications in the present study. The formulated money demand regressions have been estimated using OLS method.

Keeping in mind the study of Bank of England and the subsequent debate it has generated, some econometric refinements in respect of estimated money demand functions have been carried out by employing some diagnostic tests in the present study. For this purpose, the non-parametric RUNs test is used to detect autocorrelation problem. The problem of heteroscedasticity is checked by using Breusch-Pagan (B-P-G) and Harvey tests. The Chi-square test is used to check normality of the residuals. Ramsey's RESET test is employed for investigating into possible misspecifications.

The stability of demand for money function has been examined by using various recursive residual tests. These are, CUSUM, CUSUM Square (BDE) due to Brown, Durbin and Evans (1975) and Harvey-Collier test due to Harvey and Collier (1977).

Cointegration tests are employed to check the long run equilibrium relationship in the demand for money function. Before going for testing equilibrium relationship, unit root tests are employed to test the presence of stochastic trend. These are Dickey-Fuller (DF), Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), Bayesian and KPSS unit root tests, both with trend and without trend. In this study we examined the cointegration evidence using both Engle-Granger two step procedure proposed by Engle and Granger (1987) and Johansen-Juselius cointegration test proposed by Johansen (1988) and Johansen and Juselius (1990).

The buffer stock approach to demand for money studies the behaviour of economic units in response to an unanticipated money stock. Unanticipated increase in money supply which is initially willingly held, provides purchasing power even if it forces the holder to go off their short run demand curves. Money being the most liquid asset performs the buffer function best. If it is absorbed by the economic agents, it can be modelled in the demand for money function. If it turns out to be positive and significant, then omission of the supply shock variable from the specification may lead to misspecification and hence instability. There are various buffer-stock models addressing this issue of which shock absorber model proposed by Carr and Darby (1981) comes closer to capture the essence of the buffer stock notion. The shock absorber model is widely used by the researchers in modelling the buffer stock money. The present study also employs the shock absorber model to investigate into the validity of buffer stock approach in India.

1.5 Organisation of the Study:

The rest of the study is organised in five chapters. Chapter II focuses on various approaches to demand for money, their theoretical underpinnings, critical appraisal and economic implications of these approaches in searching alternative specifications, and appears in six sections. Section 2.1 presents the introduction to the chapter and discusses the major issues surrounding the demand for money function. Section 2.2 provides the mainstream money demand models which include the general asset equilibrium models of Tobin and Friedman. Section 2.3 presents the standard transactions model to the demand for money function and discusses the aggregation problem and theoretical restrictions of the model. Section 2.4 discusses the historical developments which include discussions of Classical, Keynesians, Inventory Theoretic approach of Baumol and Tobin, Precautionary models, and risk aversion models. Section 2.5 outlines some of the new approaches and its evolution to modelling money demand in search for stability of demand for money. These approaches include the definitional theories, error correction models and buffer stock approach to demand for money. Section 2.6 provides an overview of the evolution to modelling money demand functions.

Chapter III highlights the importance of determinants of money demand function, provides a comprehensive review of a number of empirical works from India and outside and analyses the empirical findings of the OLS estimates. Here, the role and economic implications of the determinants are explained. The chapter also includes some diagnostic tests on the estimated money demand functions. This chapter passes through seven sections. Section 3.1 provides an introduction to the chapter and discusses the standard formulation of money demand function and identifies appropriate determinants. Section 3.2 provides a comprehensive review of the studies conducted outside India. The section reviews the empirical findings of money demand function on various issues such as: definition of money, relevant scale variable and appropriate opportunity cost and other

variables. Section 3.3 provides a detailed review of the empirical works conducted in India for finding appropriate determinants of money demand function. Section 3.4 presents the determinants of the present study. Section 3.5.1 contains the analysis of empirical findings of the OLS estimates of money demand function for both annual and monthly data and discusses the economic implications of the estimated results. Section 3.5.2 presents the diagnostic test results on the estimated money demand function of both annual and monthly specifications.

Chapter IV addresses the issue of temporal stability and the existence of long run equilibrium relationship. The evidence of stability was tested by following recursive residual tests - CUSUM, CUSUM square and Harvey Collier. The Engle-Granger and Johansen-Juselius cointegration tests are used to test the long run equilibrium relationship. This chapter also includes the test results of all the unit root tests. The issue of temporal stability and long run equilibrium relationship are discussed here in five sections. Section 4.1 discusses the importance of money demand stability in the process of monetary targeting. Section 4.2 provides a review of selected studies on the issue of money demand stability and long run equilibrium relationship. It provides a review of earlier as well as recent studies on the issue. Section 4.3 presents a few selected works on the issue relating to Indian data. Section 4.4 lays out the methodology for stability tests, various unit root and cointegration tests. The corresponding empirical evidences concerning the issue are produced in section 4.5.

Chapter V concentrates on the approaches to buffer stock demand for money, mainly the Carr and Darby shock-absorber approach. It also presents a comparison of the shock-absorber and partial adjustment approaches basing on the in-sample predictive power of the model. The chapter is divided into seven sections. Section 5.1 presents the notion of buffer stock. Section 5.2 discusses the basic idea behind the buffer stock approach and describes the role of money being appropriate to perform the role of shock

absorber in the portfolio. Section 5.3 presents a comparison of the approach with the partial adjustment approach. It also presents the basic properties of the model and major implications of the buffer stock approach. Section 5.4 lays out four different models: single equation disequilibrium, multi equation disequilibrium, forward looking buffer stock model, and shock absorber model supported by the theoretical and empirical reviews of different models. Towards the end, the section presents an empirical review of two major studies related to Indian economy. Section 5.5 presents an overview of the buffer stock models of demand for money. Section 5.6 provides the empirical estimation of the buffer stock model.

The last chapter (chapter VI) of this thesis presents a brief discussion of the implication of the findings of the study for monetary policy, followed by an overview of the thesis.

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CHAPTER - II

APPROACHES TO DEMAND FOR MONEY

2.1 Introduction

The existence of a positive demand for money is still an unresolved issue even after a century old first attempt by Walras (1954) to study as to why individual hold money at all. Mainstream economists address this issue within the framework of market economy, where the public demand is said to interact with its supply, which is assumed to be under the control of central banks.

Theorising demand for money centres around three outstanding issues. They are: (i) An appropriate definition of money, as the variable called money need to be identifiable, quantifiable, controllable and linked stably and predictably with nominal income or price level. (ii) Under what conditions a demand for money model consistent with both the principle of microeconomic theory and aggregation theory yield testable behavioural implications. The basic issue in this connection concerns the relevant constraint i.e., income or wealth variable, and the relevant opportunity cost variable i.e., one rate of interest or spectrum of rate of interests. (iii) Whether demand for money is a stable function under differing institutional arrangements and changing socio-economic environment. The different approaches to demand for money basically address the above issues.

2.2 Mainstream Money Demand Models:

The basic idea underlying the micro-theoretic approach to money demand starts with an inter temporal household utility function of the form:

$$U(C_t, L_t) + \beta U(C_{t+1}, L_{t+1}) + \beta^2 U(C_{t+2}, L_{t+2}) + \dots \quad \text{..(2.1)}$$

where C_t and L_t are consumption and leisure during time t . $\beta = 1/(1+r)$ and $r > 0$ is the household's time rate of preference. The household has a production technology as well as an initial real stock of money (m_{t-1}), bond (b_{t-1}) and capital (k_{t-1}). The household also produces goods and sells his output to purchase a number of goods. For this it spends shopping time S_t , such that $L_t \approx 1 - S_t$. The role of money is captured by shopping time function $S_t = \delta(C_t, m_t)$. As Mc Callum and Goodfriend (1987) show maximising utility results in a demand for money function which can be written in the following form:

$$m_t = f(m_{t-1}, k_{t-1}, b_{t-1}, R_t, R_{t+1}, \Pi_t, \Pi_{t+1}) \quad \dots(2.2)$$

where R_t and Π_t are the nominal interest rate and inflation rate respectively and where variables dated after 't' are anticipated values.

2.2.1 Asset Equilibrium Model of Tobin and Friedman:

The demand function as derived in equation (2.2) largely resembles the asset demand function for money derivable from Tobin's (1969) general asset equilibrium approach. Tobin's approach specifies the factors that determine the demand for and supply of various assets and how the asset prices and interest rates clear the interrelated asset market in a model as $A_i \approx f_i(i, y/w) w$, where $\sum A_i = w$ (total wealth constraint), $\sum f_i = 1$, i represents the vector of real rates of return and y is the level of income of the previous period given as exogenous.

However, the difficulties with this approach is how to separate money to be spent from money to be held due to deliberate portfolio allocation. Moreover, the approach

requires the support of such heroic assumption as spending decisions are separable from and independent of portfolio decisions.

The other striking development under this stream is the "Chicago school" approach to money demand as a part of the problem of allocating wealth among the portfolio of assets which includes money. In his approach, Friedman regards money as being held because an individual receives services from it as he would from any other durable goods each yielding a mix of explicit and implicit services like liquidity and safety etc.. The demand for money therefore, depends upon the rates of return on all assets and also on the individual's wealth. Friedman's wealth variable however, includes both human and non-human wealth. Since, an individual may borrow on the strength of his expected future earned income and hold such extra assets as money. Thus in general form, the demand for money according to general portfolio approach can be specified as

$$\frac{M_d}{P} = f(R_b, R_e, \Pi^e, W, h) \quad \dots(2.3)$$

where, R_b and R_e are the expected return on bonds and equities (including durable goods) respectively, Π^e is the expected rate of change in the price level i.e., expected rate inflation, W is Friedman's wealth variable and h is the ratio of human to non-human wealth. R_b and R_e are defined so as to include any expected capital gain or loss on bonds or equities. Π^e is included because the expected change in prices is an obvious determinant of the expected future real value of money balances and, hence, of the services likely to be yielded. Π^e is therefore to be regarded as an important determinant of the expected rate of money itself. The variable h is included to allow for the fact that, because of non-marketability of human wealth, the greater is the proportion of total wealth held in human form the greater the demand for money. The equation determines the demand for real rather than nominal balances, because it is the holdings of real

balances which determines the magnitude of the flow of services from which the asset holder derives utility.

Since, R_b and R_e tend to move together over time, they are replaced by a single interest rate, R , in the empirical version of Friedman's equation. Measurement problems have led to total wealth, W , being replaced by permanent income Y_p , to which it is directly proportional provided the rate at which future income is discounted remains constant over time. Finally, the ratio of human to non-human wealth, h , is also taken as constant over time so that empirical version of the equation takes the form:

$$\frac{M_d}{P} = f(R, Y_p, \Pi^e)$$

Furthermore, as in the Keynesian analysis of the speculative motive, Friedman posits that one aspect of the opportunity cost of holding money is the expected return on bonds. However, since there exist assets other than money and bonds that individual may hold (for example, equities or physical goods), Friedman considers the rates of return on these assets as part of the opportunity cost as well. Since, the expected rate of return on physical goods can be measured by the expected rate of inflation, this variable plays an important role in the theoretical as well as empirical analysis and hence, omission of it will lead to possible mis-specification in the function and results in instability in the demand for money function. Friedman and Schwartz (1970) preferred to advocate this portfolio approach in view of the support of empirical evidence discovered from both causal comparisons of money holdings and income and econometric analysis of money demand function using income and wealth as alternative scale variables. Early econometric studies also provided support for this asset demand approach.

2.3 Standard Transaction Model:

Equation 2.2 is hardly a conventional way of looking at money demand function, but the model does imply such representation. It is evident that the relationship does not closely resemble the transaction model. To derive such a type, after some manipulations, McCallum Goodfriend (1987) obtained an implicit function in C_t , R_t , and M_t which can be solved for

$$M_t = f(C_t, R_t) \quad \dots(2.4)$$

where, C and R are the transactions (scale) and opportunity cost (price) variables respectively. It can further be observed that for reasonable specifications of the utility and shopping time function (2.4) will be increasing in C and decreasing in R . Thus the familiar money demand function is derivable from the utility theoretic framework with money in the utility function.

(i) Aggregation Problem:

The standard formulation suffers from two major aggregation problems passing the functional relation from household model (2.4) to a macro model. The first of these concerns the usual problem of aggregating over households endowed with different tastes and income/wealth levels. The second and more formidable problem concerns aggregation over diverse economic units of household and business enterprise. Nevertheless, the relation represented in equation (2.4) with C replaced by Y can be regarded as symbolising the business demand for money. Therefore, the standard transaction model of demand for money can be written as

$$M_t = f(Y_t, R_t) \quad \dots(2.5)$$

(ii) Theoretical Restrictions:

The relation that is presented in equation (2.4) results from the fact that the structure of the model is such that the use of choice variable, C_t in (2.4) allows one to eliminate everything but R_t from (2.2) and the role of wealth is of particular interest, which appears via m_{t-1} , b_{t-1} , and k_{t-1} but which has no role in (2.4). However, four other theoretical problems crop up while deriving the relation (2.5). They are: (i) If one allows for the fact that future variable (e.g. R_{t+1} , Π_{t+1}) are not known with certainty, then it is quite likely that no closed form solution like (2.2) will exist. However, although randomness causes no solution, it can be argued that relationships such as (2.4) and (2.5) remain invariant to changes in probability distribution of the future values. (ii) The second problem concerns the dating of variables because money when held only at the start of the period can facilitate transactions to be conducted during the ensuing period. (iii) The third problem is the assumption about inelastic labour supply underlying the derivation of relation (2.2). If this assumption is relaxed, then wage rate and inflation rate will be treated as arguments of the functional relations. (iv) Finally the fourth problem associated with the relation where the validity of (2.5) is lost if the inter temporal function is not time separable.

In short, different *a priori* restrictions lead to different specifications of explanatory variables in the money demand function. Virtually all the attempts at the empirical estimation of money demand function reflects the examination of hypothesis concerning : (i) the relevant scale variable - income, wealth or permanent income, (ii) relevant opportunity cost (price) variable and (iii) any other explanatory variables that reflects the regulatory, institutional, technological and other environmental determinants of stable money demand function.

Before a review of latest developments, an overview of historical developments that led to the current mainstream approach of demand for money is initiated here.

2.4 Historical Developments:

The review of historical developments of the demand for money analysis may be analysed under macroeconomics and microeconomics approaches. The money demand literature falling under the latter category may be categorised into deterministic and stochastic models of demand for money. Finally, the theoretical literature for the stochastic models may be sub-divided into those that emphasise the precautionary demand for money and risk-aversion models.

2.4.1 Macroeconomic Approaches:

One of the most complete and early approach, needless to say influential, piece of analysis to the demand for money based on money's role as a means of exchange has been reflected in Fisher's "quantity theory of money". Though the approach did not explicitly formulate the problem in the framework of a theory of demand but the analysis is readily transformed into such terms. In this approach, it has been argued that demand for money stems from its use in the process of affecting transactions. In other words, it is the exact amount of money needed to carry out any given volume of transactions, and is determined by the nature of this very process as it exists in any particular economy.

Fisher's approach to monetary economics has much to recommend, for it postulates that the demand for money arises as a result of individuals need to trade with one another. It links the demand for money to the volume of trade going on in an economy at any time, and hence leads directly to the macro economic theory of demand for money.

Now the "Cambridge" approach to the problem of demand for money, as epitomised in the work of Marshall and Pigou, although starts in the same place and ends

with a formal statement of the demand for money function that looks very similar to that of Fisher's approach, follows totally different path to reach the end.

The Cambridge economists did not question as did Fisher, what determines the amount of money an economy needed to carry out a given volume of transactions, but rather what would determine the amount of money an individual would wish to hold, given that the desire to undertake transactions made money holding desirable at all. To this extent, the emphasis is on the want to hold rather than have to hold. This is the basic difference between the Cambridge monetary theory and Fisher framework.

Moreover, the Cambridge school also argued that the demand for money, in addition to its reliance upon the volume of transactions that an individual might be planning to undertake, will also vary with the level of his wealth and with opportunity cost of money, the income foregone by not holding other assets.

The Cambridge approach to the theory of demand for money amounts to saying that if one looks upon the problem of money holding from the point of individual choice making behaviour, one will consider the convenience an individual gets for money holding for making of transactions, his wealth, the rate of interest, the expectations he holds about the future course of events and so on, as being potentially important factors that influences the demand for money. It says little about the nature of relationships that one might expect to prevail between these variables, and it does not say much about which ones are more important. Rather, while formalising their model, Pigou chose to simplify it by assuming that for an individual the level of wealth, the volume of transactions and the level of income would at least be in stable proportion to one another in the short run.

From the above analysis, it can be concluded that Fisher as having propounded a hypothesis to the extent that the rate of interest had no significant effect on the demand for

money, considers income as the one and only one argument in demand for money function. But one can not derive a definite proposition from the work of the Cambridge school. Their contribution to monetary theory was precisely to call attention to the fact that variables like the rate of interest might be important determinants of the demand for money. They left it to their successors, however, to investigate their suggestions.

It is Keynes (1936) who developed the Cambridge school thought to the problem of demand for money. He analysed with more care than his predecessors and precisely the motive that lead people to hold money. Keynes by no means rejected the view that was emphasised by Fisher and Cambridge school that money, alone among all assets, is universally acceptable as a means of exchange, and indeed listed the "transaction motive" as the first, but by no means the only motive, that he recognised as underlying the demand for money.

Identifying three basic motives for holding money viz., transaction, precautionary and speculative, Keynes recognised that demand for real balances need to be split into two components viz., income elastic and interest elastic. The demand for transaction and precautionary balances together is assumed to be directly related to the level of income, while the speculative demand for money is assumed to be inversely related to rate of interest. Keynes' speculative demand is a novel idea to the stream of monetary economics. The speculative motive explicitly introduces uncertainty, albeit uncertainty about one particular variable i.e., the future yield on bonds. This indicates that volatile expectations might cause parameter instability.

The broad conclusions from the Keynes' theory are, firstly, individuals do not hold a diversified portfolio of assets; they hold either all bonds or all money. Second, a downward slopping demand for money function with respect to the interest rate only occurs for the aggregate demand for money. Finally, the theory predicted that in certain

circumstances, the elasticity of demand for money with respect to interest rate may become infinite and in that case the expectations are formed in such a manner so as to cause a highly elastic response of money holdings to a small change in the interest rate: that is the "liquidity trap". Clearly, Keynes' speculative demand is unrealistic at the individual level but the concept of "liquidity preference" has become enormously influential in the later days of mainstream money demand formulations.

2.4.2 Microeconomic Approaches

2.4.2.1 Deterministic Models

The work by Baumol (1952) and Tobin (1956), while extending the Keynesian analysis of transaction and speculative motives for holding money also introduced the inventory-theoretic (IT) models of demand for money that yield implications for individual behaviour that are not so readily applied to the aggregate economy. The theoretical work on the transaction demand for money, due to both Baumol and Tobin, seeks to put the analysis on a more rigorous footing, and to draw more precise implications about the variables that determine it than did Keynes' analysis. The IT model is not a portfolio model as such but can be used to solve portfolio problems. In a deterministic setting, the IT model assumes exogeneity receipts and expenditure streams and only two stores of value - money and interest bearing assets say "bond". The key elements in the model are a lumpy cost for transacting between the two stores of value, an interest differential between the earning assets and money that creates a holding cost for money and the lack of synchronisation between receipts and expenditure (Barro and Fischer, 1976).

Households attempt to minimise costs associated with transactions portfolios which are characterised by lack of synchronisation between income receipts and expenditures. Let the total cost of managing the transaction portfolio (C) consists of

foregone interest ($Rb/2$) and exchange cost (eT/b). Such that $C = Rb/2 + eT/b$, where R is the rate of interest on bond b , T is the total nominal value of transactions and e is the nominal fixed exchange cost per transaction. The IT approach leads to following money demand relation obtained by an optimisation exercise with the objective of minimising C .

$$Mdt = \frac{1}{2} \sqrt{\frac{2by}{R}} P = \alpha Y^{0.5} R^{-0.5} P$$

$$\text{where } \alpha = \frac{1}{2} \sqrt{2b} \quad \dots(2.6)$$

where b is the brokerage fee or the exchange cost. y is the real value of the transactors income and P is the price level. The above relationship is known as "square-root rule". The relationship implies that transactory demand is negatively related to the interest rate with an elasticity of 0.5 and positively related with the real income with an elasticity of 0.5.

The above suggested income elasticity to demand for money by inventory theoretic approach, is in contrast with the previous income elasticity suggested by Fisher in his quantity theory. This has important implications in monetary economics. A value of income elasticity less than unity implies economies of scale in holding money. Since a proportionate change in income require a less than proportionate change in money balances to sustain it. Equation (2.6) also suggests that "the brokerage fee" may be of relevance in the determination of transitory demand. Hence, while modelling the money demand specification, omission of any variable representing the brokerage fee provides a possible misspecification and hence leads to instability.

2.4.2.2 Stochastic Setting:

2.4.2.2.1 Precautionary Model of the Demand for Money:

The treatment of receipts and expenditure streams as exogenous in the Baumol - Tobin (IT) models is unfortunate. It can not be generalised easily to dynamic settings. While the IT model is closely related to the mainstream model, it should not be too literal. Another application of inventory theory to the demand for money is found in the work of Miller and Orr (1966), which can be interpreted as a model of precautionary motive for money holding. As in the Baumol - Tobin framework, Miller and Orr, consider two assets and transaction costs which are fixed per transaction. The theory asserts that there is minimum allowable money holding below which a penalty must be paid. Given a lower bound, below which money balances can not drop, the optimum policy consists of an upper bound, h , and a return level, Z . Whenever, money balances reach the lower bound, Z amount of bonds are converted to cash; whenever the upper bound is reached, $h-z$ amount of cash are converted to bonds. Minimising the sum of expected per-day transactions and opportunity costs yields the optimal return level:

$$Z^* = [(3b/4r) \delta^2]^{1/3},$$

where δ^2 is the daily variance of changes in cash balances ($\delta^2 = m^2 t$).

In addition, Miller-Orr showed that $h^* = 3Z^*$, and that the optimal size of the average cash balances is given by $M^* = 4Z^*/3$. Thus, like Baumol - Tobin approach, the Miller - Orr model yields a constant interest elasticity, although the value is $1/3$ rather than $1/2$. The income or transaction elasticity is a bit more ambiguous since the only scale variable is δ^2 which is a product of m^2 and t . If one thinks in terms of m , the size of each cash flow, then the scale elasticity is $2/3$. However, if one thinks in terms of t , the rate of transaction, then the scale elasticity is $1/3$. This ambiguity concerning the scale variable has resulted in the fact that the M-O model is rarely estimated directly. Nevertheless, the

M-O model is extremely useful for analysing the consequences of innovations in cash management.

2.4.2.2.2 Risk Aversion Models:

The Keynesian analysis of the speculative demand for money laid greater stress on the asset holders who have definite idea about the future movement of the interest rate and about what constitutes the "normal" rate of interest. Each individual acts "as if" he is certain about the interest rate movements and hence holds either bond or money depending upon his expectations. This on an aggregate basis provides information to the asset holders for a negative relationship between the current interest rate and demand for money and it also implies that an individual asset holder holds either all "bonds" or all "money". This is at variance with the commonly observed phenomenon of "portfolio diversification" - individuals typically hold both bonds and money.

It is common to see that one does not find individual wealth holder either "nothing but money" or "nothing but bonds" or nothing but any other single asset that one might name, rather people hold diversified portfolio, a mixture of assets, and hence such behaviour can not be explained by a theory that posit that people behave "as if" they were certain about the future. (Laidler, 1971)

Tobin (1956) reformulated the Keynesian speculative motive in terms of portfolio approach. In the two-assets version of this approach, an individual asset holder is assumed to maximise his expected utility with an optimal mix of money, treated as riskless assets and an asset with uncertainty. In the mean variance model of expected utility maximisation, the optimal portfolio mix depends on the degree of risk aversion (or expected) size of wealth and the mean variance characteristics of the risky assets return distribution.

Thus Tobin was able to explain the phenomenon of portfolio diversification. Such an analysis implied a demand for money function of the form:

$$\frac{M_d}{P} = f(R, \delta) W$$

where, W is the individual's non-human wealth and δ is a measure of the risk associated with bonds.

From the theoretical point of view, Tobin's analysis suggests that income or wealth elasticity of the demand for money should be unity. It asserts that it is real non-human wealth rather than real income that influences the demand for money. The analysis yields a negative interest elasticity of the demand for money, providing another rationalisation of Keynes liquidity preference hypothesis.

From the empirical point of view, however, the matter is less satisfactory. To be sure, given specific utility and distribution functions, one can derive estimable asset demand function. However, given the menu of assets available in most of the countries, the portfolio approach actually undermines the speculative demand for money. The reason is that, if money pays a zero return, and if there is a riskless asset paying a positive rate of return (example, saving deposits); then money is a dominated asset and will not be held. In such a setting, one has to combine the portfolio balance approach with the transaction costs.

2.5 The Search for a Stable Function and Modelling Money Demand:

A search for stable money demand relation has been the main research agenda of monetarists over two decades since the spectacular break down of money demand's missing money episode of mid 1970s. The need to repair the money demand function has been widely agreed but the means by which it should be restored has become a matter of

considerable controversy. From the debate, have emerged many new approaches to demand for money. For the purpose of discussion they may be classified into two broad categories. They are (i) definitional theories and (ii) disequilibrium theories. The disequilibrium theories again branched off into error correction and buffer stock approaches for repairing the money demand functions.

2.5.1 Definitional Theories:

In the quest for a stable money demand function it remains an open question to be answered empirically so as to which definition of money, m_1 , m_2 , m_3 or a broader definition is appropriate. The objective is to empirically identify the money stock on the basis of degree of substitutability between assets. Gordon (1984), Rose (1985), Roley (1985), among others identify that m_1 is generally stable. Whereas, Friedman and Meiselman (1963) and Mayer (1976) conclude that m_2 (m_1 + time deposit at commercial banks) is the most appropriate definition. Finally, even the microeconomic theory of monetary aggregates by Barnett (1982, 1987) for the US and Subrahmanyam and Swami (1990) for India have also proved unsuccessful. The alleged superiority of the Divisia and other superlative monetary aggregates could not be established. On the whole the appropriate definition of money proposed by these studies ranges from currency to very broad monetary aggregates.

2.5.2 Disequilibrium Theories:

2.5.2.1 Error Correction Theories:

It is recognised that the developments in the econometric theory in the 1970s that estimates the money demand relation has led to significant instabilities. Further, the specification problems in the form of error autocorrelation indeed cause parameter instabilities. These instabilities are created by the lack of adjustment between actual and

desired money balances due to fluctuations in income and volatility of inflation rate. Further, financial changes like deregulation of interest rate ceiling on demand deposits, introduction of negotiable order of withdrawals (NOW) accounts, intensive use of repurchases (RP) agreements tend to provide a cash minimising instrument to household and business sectors. The above changes render the standard money demand function unfit for regression estimates. So the function need to be repaired to tackle these problems.

Econometric theory, recommend the estimation of variables at their first differences to remove the trend and reduce the multicollinearity problem. But empirical evidence have shown that the coefficients are insignificant and sometimes give wrong sign. To rationalise the idea of partial adjustment, the use of lagged dependent variable also suggest the speed that are too low to be plausible (Gordon, 1984). Moreover, the standard determinants containing the measurement errors can cause a positive coefficient on the lagged real money balances variable even in full contemporaneous adjustment of dependent variable (Goodfriend, 1985). In such a case the lagged dependent variable is devoid of any behavioural content.

The error correction model has proved useful in modelling lags in a single equation context. Empirical Studies on the error correction model for money demand function have particularly been productive in recent years. In Britain, Hendry (1979) and Hendry (1985, 1988) have reported their results based on the error correction framework. In the United States, on the other hand, Gordon (1984), Rose (1985) have reoprtd the empirical results on a stable money demand function using the error correction framework.

2.5.2.2 Buffer Stock Approach to Money Demand:

An alternative approach to the modelling of monetary aggregates is that based on the notion of disequilibrium money. In the conventional approach to estimate money demand equations, it is implicitly assumed that the actual money supply is always equal to the aggregate short run demand. Such an assumption is uncontroversial when money stock is demand determined. But the notion was questioned after the missing money episode of mid 1970s. The exogenously determined money supply was expanding too rapidly for the money holder to adjust in the normal fashion. The idea that the exogenously determined money supply may lead to a disequilibrium in the money market forms the basis for buffer-stock models in the 1980s.

The genesis of this approach has been attributed to Johnson (1979) and Knoster (1979) although its root may be traced back to the inventory -theoretic approach by Baumol and Tobin (1952) and Tobin (1956). The principle behind this approach was developed by Knoster (1984), Laidler (1984, 1987) and Goodhart (1984).

The buffer-stock approach recognises that unanticipated or transitory event of money supply change leads to change in money holding and asset holders willingly hold a buffer in response to any unexpected or transitory changes in the money supply. Money, being the most liquid of all assets and the cost of holding money balances being much smaller than that of financial assets and definitely less than the cost of adjustments in real assets, money perform the buffer function best. Hence, in buffer stock approach, the emphasis is placed on the role of money as a medium of exchange or temporary abode of purchasing power (Laidler, 1984).

The buffer stock approach further assumes that only when changes are regarded as permanent, individuals do adjust their holdings of non-money assets rather than money. Hence, the result of an exogenous change in money supply depends crucially on whether

the change is perceived as permanent or transitory. In case of the former, the asset holder will make permanent changes in the portfolio. If however, the change is transitory or unexpected and expected to be reversed very shortly, then the money holding will take the form of buffer stock and the burden of adjustment rests upon money demand specification.

In assessing the conventional models of demand for money, Cuthbertson (1985) has outlined three important implications of the buffer stock models for money. They are; (1) transitory changes in the money supply will be willingly held at unchanged interest rate and overshooting need not necessarily occur. Second, if transitory money holdings form a substantial part of total money holding, it is expected that conventional models which ignore such transitory balances exhibit parameter instability over time. Third, long lags in response of say, prices to money supply may be, in part due to money initially being held as buffer stock and gradually flows to the expenditure on goods and services, then to changes in the interest rates, output and eventually to changes to price.

One of the popular approaches to buffer stock money is the shock absorber approach developed by Carr and Darby (1981). This approach recognises the use of unanticipated money supply component to the conventional money demand specification. The economic justification for this is that agents willingly hold a portion of monetary shocks and under rational expectation, these shocks are equivalent to the difference between actual and expected balances. Hence the name "shock-absorber approach". The impact of exogenous money supply is studied in literature by inverting the conventional money demand function within the framework of single equation disequilibrium model. A major problem with this approach is that only one argument is chosen as the dependent variable whereas on an *a priori* ground, it is quite possible that all the arguments of the demand for money adjusts simultaneously. To resolve the simultaneity problem and the best way to handle the buffer stock money is to formulate and estimate a complete disequilibrium model, where the variables included in the demand functions are determined

simultaneously. The conventional model omits the future values of the arguments. Like the past values, future expectations also influence the money holdings. So to capture the impact of expectations about the future, the forward looking buffer stock model is estimated using predictions of the determinants.

Empirical research of finding appropriate specification during 1980s was categorically based on finding the evidence of supply shock or unanticipated change in money supply as a useful determinant. Based on the theoretical ideas discussed above, if supply shock or unanticipated component of money supply turned out to be positive and significant, it can be considered as one of the important explanatory variable of the money demand function. Hence, omission of supply shock variable from the money demand function may lead to misspecification leading to instability in the money demand function.

2.6 Conclusions:

Theorising demand for money centres around few outstanding issues. They include: (i) the choice of appropriate definition of monetary aggregates, (ii) selection of proper scale and opportunity cost variables and (iii) checking whether the money demand function is stable under differing institutional arrangements and changed socio-economic environment. The current mainstream approaches and historical counterparts have proposed appropriate determinants to arrive at the stable money demand relationship. The empirical evidences reveal that these theories till the early 1970s had provided a stable relationship between money, income and suitable interest rates that helped the policy makers for effective monetary targeting in many industrial countries. However, the post 1973 empirical research has casted a serious doubt over the appropriateness of conventional function for effective monetary targeting. The unusual economic conditions such as supply shocks, high inflation, coupled with several innovations, deregulatory changes in the UK and US seem to render unsuitability to the money demand function and hence unreliable for policy formulation. Accordingly, the subsequent period calls for the

research effort to repair the conventional money demand function and the need for redefining the money stock and introduce buffer stock interpretation of the money demand function besides experimenting with several new determinants of money demand. Hence, the effort on this line from the famous Fisher's equation to the very recent buffer stock approach has addressed several issues associated with the money demand function and timely effort has been directed to resolve some of the issues. However, still there exist some new issues unsettled.

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CHAPTER - III

DETERMINANTS OF DEMAND FOR MONEY

3.1 Introduction

A standard formulation of macro money demand function relates demand for money balances as an increasing function of a "scale" variable and a decreasing function of an "opportunity" cost variable. In other words, demand for money depends on the "cost" and "return" from its holding. When money is held, the rate of return on alternative assets in which money could have been held, represents the cost aspects. The return aspects constitutes the stream of invisible services that money holding provides. The quantum of services is assumed to be proportional to the amount of balances held. Rational economic units maximise the return with respect to a budget constraint provided by wealth or income. The maximisation process thus gives rise to a demand for money function in terms of a "constraint" and an "opportunity" cost variable. The former reflects the "return" side while the later the "cost" side of the money holding. The constraint variable is also known as scale variable and is positively related to demand for money. The opportunity cost variable which reflects the rate of return on alternative assets, is negatively related to demand for money. The two sets of variables, i.e., the scale and opportunity cost variables together are called the "determinants of demand for money". Wealth, expected income/income are the proxies for the scale variable. Interest rate (short and long term), expected rate of price change etc. are the proxies for opportunity cost of holding money.

There has not been consensus about the choice / identification of the determinants of the demand for money function. While transaction theories favour real income (as a measure of transaction) as a proxy for scale variable and short term interest rate as a

measure of opportunity cost of holding money, asset theories favour expected income/wealth as proxy for scale variable and have not ignored the role of long term interest as measure of opportunity cost of holding money. Similarly, rate of inflation, inflationary expectations etc. also influence the demand for money as a measure of opportunity cost of holding money. Thus, the selection of determinants in an empirical question.

The determinants to be included in the demand for money function for developed economies has been an issue which has been extensively discussed and resolved by and large (Brunner and Meltzer, 1963; Laidler, 1966; Meltzer, 1963 and Starleaf and Reimer, 1967). The explanatory variables are usually some definition of wealth or income as the scale variable and some interest rate as the opportunity cost of holding money. There is a general agreement about the importance of the first variable, though there is considerable debate as to whether the appropriate constraint imposed on the money balances is current income, permanent income or wealth or a combination of these. However, there has been considerable disagreement regarding the interest rate however defined, as the appropriate opportunity cost variable. Friedman (1959) showed no close relationship between the demand for money and rate of interest. However, Laidler (1977) pointed out that this may have been due to an erroneous measurement of the relationship between the demand for money and permanent income.

The appropriateness of some other variables as the opportunity cost of holding money was suggested by Cagan (1956) in his study of demand for money during hyper-inflation. Following Cagan (1956) and Friedman (1959), and the associate upsurge of interest in the demand for money, the empirical studies focussed more generally upon the theoretical studies to suggest appropriate determinants. Here we look at the empirical findings on elasticities and related issues as to which variables should be included as determinants in the money demand functions. More specifically, the focus will be on

several key issues such as : (i) choice of an appropriate monetary aggregates, (ii) a proper measure of scale variable, (iii) proxies for short term interest rate, long term interest rate or other opportunity cost variables (iv) other suitable determinants viz., stock prices, exchange rate, market capitalisation etc.

3.2 A Review of Empirical Studies:

In re-evaluating the performance of the money demand specifications and finding suitable determinants of the function, it is useful to consider the measurement and specification issues on a variable-by-variable basis. We begin our review with the dependent variable money.

3.2.1 Definition of Money:

Rather obviously, an important issue in the empirical estimation of money demand is the selection of an explicit measure of money. Even if the choice is guided by theoretical considerations/framework, such choices are often less than clear cut. Moreover, what passes for money can be readily altered by changing financial institutions. In the United States at least, such changes, promoted by private financial innovation and deregulation, have had major implications for the definition of money.

The question of an appropriate definition of money to be included in the money demand function has been discussed in the literature by Artis and Lewis (1976), Brunner and Meltzer (1963), Melitz (1963), Meltzer (1963), Kavaragh and Walters (1963) and Laidler (1966, 1969). Laidler (1977) in his survey, discussed these and other studies on this issue and concluded that a narrow definition of money (currency and demand deposits) may be preferred for quarterly data and that either a broad or a narrow definition is appropriate when annual data are analysed. The issue centres on choosing an

appropriate definition so that stable demand for money function can be shown to exist under differing institutional arrangements and economic and political conditions.

In the quest for a stable money demand function it remains an open question as to which definition of money is appropriate. In this context, Meltzer(1963) argued that money should be so defined that the demand for the same should remain stable under differing institutional arrangements and under changing social, political and economic conditions. Laidler (1969) also suggested the controllability criterion. According to him, if the behaviour of an economy is to be influenced in desired direction by manipulating the quantity of money, the necessary preconditions are that the monetary authorities must be able to control the volume of the set of assets that most closely corresponds to the money stock, and at the same time, the demand function for this stock of assets must be stable enough for the consequences of changing its volume to be predictable with a high degree of reliability.

The Proponents of use of narrow money (Laidler, 1966; Melitz , 1963) argue that the supply of currency varies in response to the public's demand for it and demand deposits also responds similarly, because individuals rearrange their money holdings quickly and at low cost by varying their interest bearing deposits; and therefore substitution takes place between demand deposits and other forms of wealth (including time deposits). These movements directly affect the supply of demand deposits. A general rise in the interest rate cause substitution effect to take place between m1 and other assets and the inclusion of time deposits in the definition of money.

In the later periods, Gordon (1984), Rose (1985) and Roley (1985) employing a cross interest elasticity from a single equation money demand regression, identified narrow money (m1) to give a stable money demand function, because it avoids all complexities of the near money which are not final means of payments. Contrary to this, Friedman and

Meiselman (1963) and Mayer (1976) concluded that broad money (m_2) (m_1 + time deposits of the commercial banks) is the most closely correlated monetary aggregate with national income and hence most appropriate definition for stable demand for money.

It may be noted that different behavioural relationships may hold good for different components of the money stock. This idea was first stressed in the UK by Coghlan (1978) who argued that, "there is no general theory of the demand for money which is applicable regardless of the definition of money adopted". If this is so, we cannot expect to isolate stable demand functions for broad money aggregate involving components as different as, for example, currency and time deposit. This approach was advanced even earlier in the US particularly by Goldfeld (1973) who, having modelled the demand for narrow and broad money, argued strongly to disaggregate the broad money aggregate.

Extending the innovative line of approach introduced by Chetty (1969), Offenbacher (1979) and Subrahmanyam (1980) among others suggested how monetary assets should be selected for inclusion in an empirical definition of money. However, due to differences in the coverage of assets, the sample period and the method employed, the above studies have considered appropriate all the aggregates - m_1 to a much broader aggregate that includes S & L shares, mutual saving deposits, 91 treasury bills etc.. Finally, even the microeconomic theory of monetary aggregation by Barnett (1982, 1987) for US also proved unsuccessful. The alleged superiority of the Divisia and other superlative monetary aggregates could not be convincingly established.

In their drive to arrive at a stable demand for money function, researchers who are unhappy with the official definition of money have attempted to construct their own aggregates. Research on these lines has been in two diametrically opposite directions. They regarded the official definitions of even "narrow" money as too broad, atleast from a purely transaction point of view. This concern has led some to suggest for using a

disaggregated approach in which separate empirical demand functions are estimated for each monetary assets. This side-steps the definition issue and at the same time permits the use of econometric techniques that takes account of the interrelated nature of the demand functions. However, due to the difference in the coverage of assets, sample periods and method employed, different studies justified different monetary aggregates. On the whole the appropriate definition of money proposed by different studies ranges from currency to very broad monetary aggregates. Still the issue of an appropriate monetary aggregate has been complicated by the appearance of new financial instruments brought about by deregulation and such effort remain unresolved.

It is also difficult to reach a firm conclusion about an appropriate definition of money to be used in developing countries like India. The relative importance of the precautionary motive due to inherent instabilities in the economy and lack of other liquid assets would seem to indicate the narrower definition. While the low percapita income and the high cost of foregoing interest on cash and demand deposits would seem to favour the broader definition (m_2 or m_3). The fact that demand or current deposits in a country like India also pay interest would also seem to place the onus on the narrower definition. Hence, the suitable definition of money is an empirical question to be investigated.

3.2.2 Choice of Scale Variable:

The choice of scale variable in demand for money functions is closely linked to the definition of money employed. For narrow definitions of money, believed mainly to serve the transitory motive, it can be argued that current measured income is the appropriate scale variable. However, for broader definitions of money some measure of wealth, either non-human wealth only or total wealth (proxies by permanent income) is likely to be more appropriate.

The issue of an appropriate proxy for the scale variables has been examined in great detail in the developed economies. It has been felt that the use of permanent income, expected income or wealth has been more appropriate than the use of current income (Brunner and Meltzer, 1963; Laidler, 1966, 1970 and Starleaf and Reimer, 1967).

The likely superiority of wealth measures as scale variables was demonstrated as early as in 1963 by Meltzer (1963) who, by using the US annual data for the period 1900 to 1958, compared the stability over different decades but containing alternative scale variables: non-human wealth, permanent income and measured income. He found that the wealth variable produced a more stable demand for money function than the income variable no matter what definition was used for money. Such a conclusion was supported by Brunner and Meltzer (1963) and Laidler (1966). Chow (1966) however indicated that permanent income was more important than current income in the long run and current income more important in the short run studies.

Until recently, lack of data on private sector financial wealth for most of the countries meant that in many cases the choice of scale variable in practice lay between measured and permanent income. Choice was most frequently made on the basis that permanent income can be regarded as the distributed lag function of present and past measured income levels. However, researchers found that the estimation was not simple and hence measured income rather than permanent income could still be the appropriate scale variable.

The first serious attempt to resolve this problem was by Feige(1967) who attempted the money demand function using US data for 1915-63. Feige found that estimates of the partial adjustment parameter were not significantly different from unity, whereas the estimates of permanent income were 0.37 for narrow money and 0.30 for broad money. These results suggested that at least for annual data, the adjustment of

actual to desired balances could be treated as instantaneous. Thus, the importance of lagged income variables indeed appeared to be the result of permanent income being the appropriate scale variable.

Availability of reliable data on private sector wealth in recent times for some economies had led to more direct attempts for modelling the non-human wealth as a scale variable. Grice and Barnett (1984) in their study of the UK demand for broad money aggregate, m_3 , included the gross financial wealth of non-bank private sector in their equation along with income variable. Using quarterly data and general to specific approach, they concluded that the influence of financial wealth on money demand could not be ignored. The long-run wealth elasticities were well in excess of unity. Despite the importance of wealth, income still had a role to play. The study is therefore, unusual in that it finds a significant role for two scale variables.

In more recent years, research on scale variables has focused on the following two aspects of the transaction measures: (i) the construction of more comprehensive measure of transactions; and (ii) the disaggregated of transactions into various components, reflecting the notion that not all transactions are equally "money intensive".

The construction of more comprehensive measure of transaction is motivated by the fact that despite the appearance of gross in GNP it is much less inclusive of all sales of intermediate goods, transfers, purchases of existing goods and financial transactions, all of which may contribute to the demand for money. On the other side GNP may overstate transactions because it includes imputed items. While these shortcomings of GNP have long been recognised, thorny data problems have discouraged the construction of more general transaction measures. As a proxy for such a measure, some researchers have used data on gross debits to demand deposits accounts. While in some instances substituting

debits for GNP improved things, the effect was small and not robust (Judd and Scadding, 1982).

In recent years, however, there have been some noticeable advances in constructing general measures of transactions, precautionary by Cramer (1986) and Corrado and Spindt (1986). Since only limited data are presently available, it is too early to tell if these new data will improve the performance of money demand functions.

Whatever measure of transaction is chosen, there remains the question of whether it might usefully be disaggregated into several scale variables. Thus, for instance, if real GNP is the basic scale variable, one might separately enter various components of GNP on the ground that these components are likely to generate different payment needs. On the whole, while there is some promising indications of disaggregations (Radecki and Wenninger, 1985 and Mankiw and Summers, 1986), there is no firm evidence that disaggregation of GNP yields a dramatic improvement in the behaviour of the aggregate money demand. The case of disaggregation, however, appears a bit stronger when coupled with the disaggregation of money into types of holder (e.g. consumer, business) and types of deposits.

With regard to income as a scale variable, and the income elasticity of demand for money, there are two conflicting forces in developing economies which would determine how the income elasticities varies vis-a-vis developed countries. The preponderance of other liquid assets in developed economies would seem to indicate a lower income elasticity in developed rather than developing economies. However, as against this force, causing a higher income elasticity in developing countries, owing to lower percapita income levels, people would not be willing to forego the premium received from holding assets. This tendency would be, in turn, counteracted by the fact that due to the greater degree of uncertainty and instability in developing countries, the precautionary motive may

dominate the other motives in these countries implying a higher income elasticity. The issue can only be resolved by the empirical investigation.

3.2.3 Choice of Opportunity Cost and Other Variables:

The choice of certain measures of opportunity cost of holding money largely depends on the theoretical perspective under consideration. Neo Keynesians tend to regard short term interest rates as the most relevant one for narrow definition of money when transactory motive is dominant, and only consider long term interest rates in the context of broad money aggregates. If the holding of money is viewed as part of general portfolio decision process, then clearly rates of return on all alternative financial assets are relevant (Laidler,1969). Moneterists, however, have always maintained that rates of return on all alternative assets are relevant even for narrow money. For them, money is an effective substitute for all assets-both financial and physical.

3.2.3.1 Inflationary Expectations:

There has been some disagreement as to whether the interest rate variable, however defined, can be a suitable opportunity cost variable. The appropriateness of some other variable as the opportunity cost of holding money was raised by Cagan (1956). Expected inflation as an opportunity cost variable has been included in several money demand specifications (Cagan, (1956), Frowen and Arestis(1976) and Sapiro(1973)).

The inclusion of expected inflation as an argument does not differ from the inclusion of interest rate in that the increase in this variable also increases the cost of holding money. In countries with well developed financial markets, the expected rate of inflation is reflected in the nominal interest rate since the latter will rise when inflation is expected, compensating the lenders for the loss of purchasing power of money due to inflation. Thus, while the issue of including inflationary expectations in the money demand

function is important during the period of high inflation, in developed economies, with well developed capital markets in which the nominal interest rates are free to move to reflect expected inflation, the nominal interest rate is a relevant argument in the money demand specification. The rule of thumb proposed by Modigliani, of which variable to include, states that if the expected rate of inflation exceeds the nominal interest rate, the expected rate should be included; if not, then the nominal interest rate is the appropriate rate, Dornbusch and Fischer (1981). Adekunle (1968), Melitz (1976) and Sapiro (1973) used expected inflation in the money demand function that also contained nominal interest rate as a variable.

However, this issue regarding the appropriate opportunity cost variable has added significance for the developing countries for the following reasons: (i) The wide divergence of rates of interest in the organised and unorganised money markets, (ii) a multiplicity of unorganised market interest rates and a lack of time series data on them, (iii) underdeveloped financial markets and few organised dealings in commercial papers and bills.

All these factors would substantiate the importance of physical assets as substitutes for money. While the substitution effects of physical assets are important for both developed and developing countries, because of lack of other financial assets, the importance of real asset substitutes is enhanced in developing countries. One of the important characteristics which make people hold money is its function as a store of value. When prices are expected to rise its function as a store of value reduces and money holder shifts money into physical assets as a store of value. The lack of other appropriate financial assets makes this movement into physical assets the preponderant one.

Thus, contrary to the experience in money demand relationships for developing countries like the US, where, despite theoretical specifications, the expected rate of

change of prices is not found to play a significant role (Brunner and Meltzer, 1963), Cagan (1956) suggested that such an opportunity cost variable is particularly relevant to the demand for money during times of rapid and highly variable rates of inflation. However, the issue of appropriate opportunity cost variable(s) including inflationary expectations as a proxy should be investigated.

3.2.3.2 Rate of Inflation:

To model the effects of inflation, researchers have traditionally assumed that including nominal interest would be sufficient to take care of the opportunity cost of holding money. More recently, however, some researchers (Baba et. al., 1988; Hetzel and Mehra, 1989) have begun to directly include inflation rate in addition to nominal interest rate in their empirical models.

Theoretically, inflation may directly enter into the empirical models of money demand which concerns the issue of money substitutes and opportunity cost. Short term interest rate is included in the money demand function on the assumption that the only alternative to holding money is to hold short term bonds. Economists like Cagan (1959), Frankel (1977) and Friedman (1959) have pointed out that during the period of high inflation rate, assets other than short term bonds may serve as substitutes for money. During the period, price rise becomes taxing, individuals may accelerate their purchases of real goods and services rather than hold money or they may chose to hold in physical assets - land or gold. The idea is that these are immune to the devaluating effect of inflation. So, the implication for the empirical models of demand for money is that when certain physical goods that yield their returns in kind, serve as substitute for money holding, then the nominal return on these assets - inflation in the present case, should be included as a determinant in the money demand function separately from the nominal interest rate.

3.2.3.3 Variable Expectations and Variability of Rate of Inflation:

The use of inflationary expectations in the money demand specification is clearly established after the work of Cagan (1959) and Friedman (1969). There has been series of work, modelling the variable in the money demand function. Though there has not been any consensus about the findings of various studies, there is one thing common to most of the studies - the use of "adaptive expectation hypothesis" for deriving observation on the unobserved expected variables. The underlying assumption has been that the process of forming expectations has been static. However, the notable expectations are the works of Khan (1977) and Koot (1975). The empirical literature on the estimation and specification of the demand for money has given little attention to the possibility that the variability of the rate of inflation may affect the demand for real cash balances. Klein (1977) has presented a formal framework to deal with the problem and the research work on this issue at the empirical level are attempted by Blejer (1979), Frankel (1977) and Khan (1977).

The role of variability of expected rate of inflation in the money demand function has been explained by Blejer (1979). According to her, the variability of expected rate of inflation can have a dual effect on the demand for money. This variable which represents uncertainty on the price front is positively related to demand for money if people want to hold more money as a precautionary measure. On the contrary, it will give rise to the fear of loss of value of the assets whose value is not constant in real terms and hence, induce people to diversify the portfolio composition by reducing demand for money. Hence, it is of interest to capture the net effect of variability of expected rate of inflation on demand for money which is considered an important determinant in the context of economies where price stability has been elusive.

Klein (1977) measured variability by 5 term moving standard deviation from the 10 term moving mean of the annual rate of inflation. He obtained a positive and significant

effect of this variable on the United States demand for money. Frankel (1977), studying German hyperinflation, does not obtain significant results using the variance of the prediction error. Khan (1977) estimated the Cagan's model of demand for money for six hyper-inflation countries (Austria, Germany, Greece, Hungary, Poland and Russia) allowing the coefficient of expectation to vary with the level and change in the rate of inflation. The results indicated a considerable support for the hypothesis that the level and variability of rate of inflation have an effect on the change in expectation of inflation and hence the usefulness of incorporating variability of rate of inflation in the model. The effect on the demand for real cash balances of changes in the variability of rate of inflation was tested by estimating the money demand function of three Latin American countries - Argentina, Brazil and Chile by Blejer (1979) for the annual data period: 1951-1975. The results indicated that all the coefficients of variability of rate of inflation were negative and statistically significant. The results suggested that in highly inflationary situations, the greater financial risk implied by the increased instability of the inflation rate has a negative effect on the demand for money, which is not fully offset by the positive effect of greater variability may have on the precautionary demand.

The above discussion clearly suggests that the time varying character of inflationary expectations and variability of rate of inflation have to be modelled in the conventional money demand analysis especially in developing countries to capture the dynamic behaviour of the prices.

3.2.3.4 Stock Market Prices:

In the existing literature, it has been shown (Hamburger, 1977; Laidler, 1980), that dividend/price ratio variable has a place in the money demand specifications. Such an idea is based upon Friedman's belief that money is a substitute for all assets, both real and financial, so that rates of return on the whole range of assets are relevant. Hamburger (1977) used a dividend/price ratio variable as a measure or "real rate" on all equities

including durable goods for the US economy. The study found the rates of return on equities as an important determinants of demand for money even when narrow monetary aggregate was adopted.

Since then there has been considerable investigation on the relation between money and stock prices. In the literature, the relation has been treated in more than one way: first by treating volume of financial transaction as an argument in the demand for money function on the ground that such transaction would absorb money and hence reduce the income velocity. (Cramer, 1986 and Wenninger and Radecki, 1986). On the other hand, by treating the earning or dividend yield on securities as one of the returns alternative to money in a portfolio (Hamburger, 1977). The empirical results have supported the direction of effect suggested by the theory but the magnitude of the effect is small. There has not been a serious attempt to relate the levels of stock prices to demand for money except Friedman (1988). The role of stock market in influencing money demand is analysed by Friedman by using quarterly US data for the period: 1961-1986. The study found that the real quantity of money relative to income is found to be negatively related to the real stock prices and positively related to the real stock prices lagged three periods. It has been suggested that the former represents the substitution effect and the latter as wealth effect.

3.2.3.5 Market Capitalisation:

Since the mid 1970s, attempts have been made to find out whether innovation and institutional changes in financial markets have caused shift in demand for money functions. However, it has been difficult to model financial innovation due to the limitation of data availability for appropriate variables. It has been proposed that in the empirical estimation of money demand function, the financial savings of the community in the form of financial assets other than money could be captured under capitalisation of stocks. Hence, market capitalisation could be an useful surrogate for financial innovations in money demand

function to capture the portfolio decision of the agents in a situation of financial innovation.

Croker (1990) estimated money demand function by incorporating a measure of financial assets of private non-financial sectors in Japan as a proxy for wealth variable. This variable was hypothesised to capture private portfolio decisions among financial assets. The study concluded that the demand for money function for broad money explained both secular trend in the income velocity during 1970s and 1980s and the acceleration in the decline in velocity during 1986-88. The acceleration in the broad money velocity was attributed to the wealth effect that caused a rapid expansion in the demand for all assets. This effect was strongly guided by the rapid pace of financial liberalisation in Japan. However, a priori, market capitalisation may have both wealth as well as substitution effects. The relative strength of these two is however an empirical question.

3.2.3.6 Exchange Rate:

Like the rates of return on equities or dividend yield on the domestic capital market which are treated as useful determinants, there is also evidence that in more open economies, interest rate relating in the international capital markets should be regarded as a relevant opportunity cost variable. Hamburger (1977) found that three month rate on Euro dollar deposits to be a significant variable in the UK demand for money function, thus confirming the openness of UK economy and the close substitutability between UK domestic money and Euro dollar deposits. Hamburger also provided evidence that the Euro dollar rate might be important in the west Germany's demand for money function.

Recently, exchange rate has been used (Branson and Buiter, 1983; Bahmani and Pourheydarian, 1990) as an appropriate determinant in the money demand specifications. This has been found to be relevant on the ground that most of the economies have

gradually opened up and integrated globally to reflect the interest rate differentials between the trading countries. Theoretically, the role of exchange rate in effecting real money holding may be rationalised in either of two diametrically opposite ways: (a) a depreciation of domestic currency may lead to a decline in demand for real money balances through a decline in real wealth; (b) a depreciation may result in an increase in wealth on account of net debtor's position in terms of ownership claims on the rest of the world and hence increase the demand for real cash. The evidence is in line with the results obtained by Bahamani - Oskooee (1991) for the UK and Bahmani - Oskooee and Pourheydarian (1990). The above discussion suggested that the economies which have gradually opened up and integrated globally, the exchange rate variable may be treated as a suitable determinant in the money demand function.

3.3 Review of Studies Conducted in India:

In India there have been several attempts over the years to estimate the demand for money considering either the narrow definition (m1) or broad definition (m2 or m3) of money. Furthermore, in some studies, the demand for money has been analysed by its major components viz., currency, demand deposits and time deposits. Again, the demand for money covers two approaches - the macro (aggregate) approach to demand for money and its components and the sectoral approach. Further, the major determinants included in the money demand specifications were real income, relative share of agriculture to non-agricultural income, permanent or expected income, several interest rates, inflationary expectations, stock prices, variability of rate of inflation and exchange rate. Excellent surveys of literature covering the empirical studies on demand for money for India are presented in Vasudevan (1977) and Jadhav (1994). Here we review some of the major studies carried out on Indian data on various issues associated with the money demand specification and finding appropriate determinants for the money demand function for India.

One of the earliest study on Indian data was by Shah (1961) for the period 1948-1959. He examined the income velocity of money for India during the period. By computing the correlation coefficient between real income per capita, interest rate and velocity of money, he found that the income was not a significant variable. This finding was attributed to the low monetization of the economy. The cost of money holding (rate of interest) went a long way to explain the behaviour of money velocity. But Shah's method was crude and suffered from number of estimation problems. In another paper, Shah (1961), fitted the Indian data to the reduced form equations of quantity theory and Keynesian income - expenditure theory for the same period. He found that the correlation coefficient is higher in the quantity theory equation compared to the Keynesian theory. Further it was found that the quantity theory estimates were superior to the keynesian income expenditure theory for India. However, this study also suffers from limitations similar to the first study.

Biswas (1962) carried out a study on Indian data for the period 1935-55. Among the different variables like growth of population, degree of monetization, wealth and share prices and interest rates (both short term and long term), he highlighted the significant influence of changes in the non-farm income rather than national income. The major findings of the study were: (a) the broader definition produced better results, (b) the short term interest rate was statistically insignificant in all specifications but the long term interest rate was found to have a significant relationship with total bank deposits, (c) both the rate of change of share price and the rate of change of interest rate were found to be insignificant and (d) non-firm income was found to have the greatest explanatory power among the income measures used. In the same year, Sastry (1962) used a narrow definition of money in his estimates of velocity of money function for the period 1935-36 to 1960-61. His result showed that the reciprocal of velocity of money (M/Y) was inversely related to both the short term rate (yield on three month treasury bill) and the

long term interest rate (yield on undated rupee paper). However, the coefficient of determination he obtained was around 0.5.

Though the study by Sastry was on line with the previous studies, the later found contradictory evidence on the interest rate and money demand relationship. Rangarajan (1965) showed that the demand for nominal as well as real balances was related only to non-agricultural income and not to agricultural income. In his model, non-agricultural and agricultural income were regarded as proxies for monetised and non-monetised income respectively. However, the interest rate was insignificant in the real money demand equation, but significant in the nominal demand equation.

Another study by Gujarati (1968) by using the data from 1948 to 1964 highlighted that the real demand for money was conditioned by the real national income and yield on Government securities having maturity of 20 years. In the long run, demand for money function was found to be income elastic and interest rate inelastic. Gupta (1970) studied the demand for money behaviour for the period 1949-50 to 1965-66. Using the same model as Gujarati, but disaggregating component-wise, he found the short term treasury bill rate to be satisfactorily significant in both currency as well as in the aggregate demand equations. He found that the rate on commercial bank time deposits was a significant variable in the demand deposit equation, while the yield on private securities was only marginally significant in the equation for demand deposit and currency. Further, he found real income to be the most significant variable in all equations. His results confirmed that wealth was not a significant variable and that physical assets did not turn out to be substitute either for total money balances or for currency and demand deposits separately.

Singh (1969) carried out a study for the period 1949-50 to 1965-66 taking the treasury bill rate, the bazaar bill rate, national income, tangible wealth and the yield on government securities as the explanatory variables, and arrived at a more or less same

conclusions as obtained by Gujarati (1968). The study also found that the introduction of wealth made the regression coefficient of income either negative or insignificant. Therefore, income and wealth could not be taken together as the explanatory variables of demand for money.

Mammen (1970) while testing a complete econometric model for India for the sample period 1914-15 to 1963-64, found permanent income to be the significant variable. Whereas, the rate of interest was found to be insensitive to the holding of real balances.

On the basis of a sectoral study for the period 1950-51 to 1962-93, Saravane (1971) concluded that demand for money by business sector was affected not only by the rate of interest, but also by debt-equity ratio, credit availability by financial institutions. The demand for money by the household sector was found to be influenced by the variables in the form of shift from money balances to near money assets such as time and saving deposits with the banks, and the earning capacity of these assets. Since, rural saving -income ratio was rising, he concluded that a redistribution of income in favour of urban households would have an adverse effect on the velocity of money.

Gupta (1973) estimated a monetary policy model of India which contained the demand for money equation. The study found that the influence of income on the demand for money is more certain than that of interest rates, whether it is short term or long term. The study suggested that as the economy develops, the demand for money is also likely to be influenced by a number of factors and not just one.

Bhattacharya (1974) carried out a detailed study of the demand for and supply of money in India. His study was particularly interesting because he specifically dealt with the problem of simultaneous equation bias, and estimated the money demand with magnetised income data and showed how it differed from that estimated with national

income data. His conclusions were: (i) only demand for "money proper" (currency and demand deposits) was inversely related to the interest rate. Interestingly, this was not revealed in the OLS estimate but only in the 2SLS estimate, probably due to the simultaneous equation bias present in the former. The inclusion of time deposits in the definition of money washed off the inverse interest rate money relationship even in the 2SLS estimation. (ii) Keynesian liquidity preference theory held good for the organised money market, but not for the unorganised money market. (iii) Money demand depended on the monetised component of national income rather than total income, thus indicating that the use of national income data led to an under-estimation of the income elasticity of money demand.

Shahi (1977) in his study of demand for money function for the period 1960 to 1974 found income to be an insignificant but the interest rate to be statistically significant. In a partial adjustment formulation, the results showed that both income and interest rate were insignificant with only lagged money stock as the significant variable. Another formulation in which expected income was included showed income to be insignificant with interest rate, lagged interest rate and the lagged money stock highly being significant.

Sharma (1978) conducted an empirical study of the demand for money function for Indian economy on the basis of data from 1951-52 to 1971-72. The study suggested that both the level of income and the rate of interest were significant in determining the demand for money. The interest rate elasticity was found to vary between -0.61 and -0.69.

Vasudevan (1979) conducted study on demand for money in India taking annual observation for the period 1961-62 to 1976-77. The method followed is the well known single-equation approach, with more than one argument in the function. In his study, money was defined in the narrow sense, the concept of income employed was the net national product at factor cost at current price, the rate of interest was a composite rate of

return on a cluster of assets that economic unit generally prefer to hold - composite asset inflation rate. The study concluded that the composite asset inflation rate and the net national product at factor cost as the most significant variables in explaining the demand for money in India.

Kamaiah and Paul (1979), in a study on the velocity of money behaviour in India for annual data for the period 1951-52 to 1974-75 found only inflationary expectation and percapita availability of banking facilities to be affecting velocity of both m1 and m3 money. The study found that the percapita availability of banking facilities increased the demand for money. This suggests that increasing banking facilities and monetisation of the economy might have increased the transaction and other types of demand for money as an "abode of purchasing power". The study did not find any significant difference between m1 and m3 pattern of velocity results.

Trivedi (1980) tested the role of inflationary expectations on the demand for money in India in a study based on annual data, covering the period between 1950-51 to 1974-75. Following a standard model of demand for money in which inflationary expectations is specified as opportunity cost variable, this study tested their empirical performance in India. The study made use of adaptive expectation hypothesis to generate the inflationary expectation series for the sample period. The results suggest that a model of demand for money which specifies it as a function of permanent income and anticipated rate of inflation fitted the data remarkably well. The results suggested that though Indian economy had not experienced as high rates of inflation as some Latin American countries, even then, the anticipated rate of inflation came out unambiguously significant.

Paul (1981) tested the Indian money demand function by taking the variability of inflation as a proxy for the unanticipated inflation for the period 1951-52 to 1977-78. The study pointed out that the variability of rate of price rise comes out as an important

explanatory variable for the sample period. Again, the study found a very significant empirical relation in the demand for money in India, employing permanent income, inflationary expectations and variability of inflation as the independent variables. The study found a positive coefficient of variability of inflation against a negative one for the inflationary expectations. The study concluded with a quote of Klein (1975), "because of the quantity of change in the real money balances, one can reasonably conclude that the task of stabilisation policy will be made difficult as a result of the uncertainty of the rate of change of the prices and its impact on the demand for money".

Sampath and Hussain (1981) carried out a study on demand for money using annual data for the period from 1960 to 1975. The study used log-linear functional form and single equation estimation method for estimating conventional models using income, interest rate (short term and long term) and prices in various combinations affecting the demand for money. The study used two definitions of money - m1 (the narrow definition) and m2 (the broad definition). The study found that the conventional equations did not perform satisfactorily in explaining the demand for money in India. So, the study used McKinnon's (1973) alternative model to explain the money demand behaviour. The conclusion arrived from the study confirmed that the complementary hypothesis suggested by McKinnon performed better than the conventional money demand models in the context of India. The above findings imply that money and physical assets are more complementary in the context of India than substitutes.

Kamaiah and Subrahmanyam (1982) examined the role of variability of expectations about income and rate of inflation in the context of demand for money in India during the period 1951-78. They proposed a non-constant (time varying) expectational scheme and estimated using non-linear least squares. The study found that while income expectations remained constant, expectations about rate of inflation varied over time during the study period. The study suggested that the time varying character of

inflationary expectations had to be appropriately modelled while modelling demand for money in India.

Singh et. al (1982) for the first time presented a quarterly demand function for the components of broad money. The study covered 10 year period from 1970-71 to 1980-81 and employed partial adjustment mechanism. The study found that income elasticity of currency was below unity (0.86) while that of demand and time deposits exceeded unity (1.41 and 1.80 respectively). The interest elasticity was found to be highest for time deposits (-0.70) and lowest for demand deposits (-0.33) with that of currency (-0.25). Expected inflation was found to be significant for currency and time deposits but not for demand deposits, implying that the deposits were primarily held for transaction purpose.

Singh (1984) estimated the equations for narrow definition money, m_1 , with NNP at factor cost, rate of inflation, yield on government securities, treasury bill rate for the period of 1952-53 to 1979-80. The OLS elasticity of elasticity was found to be 0.78 with regard to income, -0.035 with regard to treasury bill rate, -0.26 with regard to yield on government securities and -0.011 with respect to rate of inflation. Thus the demand for money was relatively income elastic and interest inelastic. The study suggested that the less developed money and capital markets and lack of any representative interest rate might be the causes for the insignificance of interest rate variable in the money demand function in India.

Kamath (1984) examines the specification of demand for money function for India and the issue of appropriate opportunity cost variables to be modelled in the money demand function. The study used time series data on money stock (both m_1 and m_3), scale variable-gross domestic product, call money rate, government bond-yield rate and consumer price index for the period 1951 to 1976. For this study annual data were used. The study examined partial adjustment and adaptive expectations mechanisms to test the

existence of adjustment lags and the importance of permanent values vis a vis current values of the variables. Use is also made of flexible distributed (Almon) lags. Demand adjustment and expectation lags are both found to be important. From the study, it was found that the interest rate variable was not an appropriate argument in the money demand function.

Bhole (1985), estimated money demand function separately for m1 and m3 using annual data for 1951-52 to 1979-80 with income, interest rate (proxied by one year term deposit rate), expected inflations (measured by three year moving average of actual inflation rate) and lagged money stock as independent variables. Using the linear money demand model with nominal and real money stock as dependent variables separately, the experiment found satisfactory results.

Gupta (1987), examined the relevance of Friedman's permanent income hypothesis for both narrow and broader definition of money covering the period 1954 - 83. The study found that permanent income outperformed the measured income, thus confirming the Friedman's hypothesis for both narrow as well as broad money. On the other hand, the ratio of non-agriculture to agriculture income and short term interest rate (proxied by 91 day treasury bill rate) were found to be statistically insignificant.

Paul (1992) examined the role of real stock prices as a variable in money demand function in a study carried out on quaterly data for the period 1973 to 1989 as well as annual data for the period 1974 to 1988. The study found a positive coefficient on real stock prices, four quarter earlier and also contemporaneously for the quarterly data implying the presence of wealth or transaction effect on money holding. However, the wealth effect was absent for both m1 and m3 functions for the earlier sub-period: 1973:1 to 1979:04 in contrast to that of later sub-period: 1980:1 to 1989:1. Again, significant substitution effect is found for annual data for the period 1974 -88. The other interest of

this paper was to examine the role of inflationary expectations on the demand for money. The results suggested that inflationary expectations was significantly and negatively affecting the demand for m1 and m3 money for both quarterly as well as annual data. However, quite interestingly, for the sub-period 1980:1 to 1989:1 it had not been statistically significant though negatively affected the demand for m3 money.

Prasad (1994) analysed the determinants of money demand function for the Indian data from 1970-71 to 1987-88. In analysing the role of determinants, the study made use of log-linear regression equation for both narrow definition of money - m1 as well as broad definition -m3. The alternative money demand specifications were formulated in terms of income variable proxied by NNP at factor cost, both long term interest rate (IDBI primary lending rate) and short term interest rate (SBI primary lending rate), price (wholesale price), commercial call money rate, inflation based on WPI and inflation based on CPI. The results of the study suggested that nominal and real income, long term interest rate, current inflation rate with one year lag were the major determinants of demand for money in the Indian context.

From the foregoing overview of the studies, it is evident that in most of the studies, the influence of real income on demand for money, whether macro level (Bhattacharya, 1974; Gupta, 1973; Mammen, 1970) or sectoral level studies (Rangarajan, 1965; Saravane, 1971) was significant. This is compatible with the view that in a developing economy like India, money demand would respond more to changes in scale factors i.e., income (Gujarati, 1968; Gupta, 1973; Vasudevan, 1979) , permanent income (Gupta, 1987; Mammen, 1970) than to those relating to the opportunity cost of holding money i.e., interest rates - short term or long term (Gujarati, 1968; Mammen, 1970). However, price is also a significant variable in some studies (Vasudevan, 1979). The studies (Gujarati, 1968; Kamath, 1984; Mammen, 1970 and Singh, 1984) confirmed the interest inelasticity of demand for money suggested that the interest inelasticity of the

demand for money is due to the administered interest rate that prevailed during the major period of these studies. However, some studies do find contradictory evidence on the interest rate money demand relationship (Gupta, 1970, Shahi, 1977). In the household sector, shifts have occurred from the pure cash holding to quasi-money assets when interest rates are relatively high. In respect of the business sector, firms hold liquid assets in alternative forms and economise on cash balances.

Upto mid 1970s, the studies on demand for money included mainly measured income, permanent income as proxies for the scale variable and yield on debentures, yield on government securities, treasury bill rate, deposit rate and call money rate as measures of interest rates. However, studies since mid 1970s started modelling the money demand function with new set of determinants to study the effect of financial innovation, structural deregulation and globalisation. Studies (Bhole, 1985; Kamaiah and Paul, 1979; Paul, 1992; Singh et al 1982; Trivedi, 1980) have included inflationary expectation as a suitable proxy for opportunity cost of holding money in Indian context. Stock prices was included as an extra explanatory variable in the money demand specification and found to be significant (Joshi and Sagar, 1995 ; Paul, 1992). Few recent studies also found exchange rate variable to be significant determinant in the money demand specification (Joshi and Sagar, 1995 and Nag and Upadhyay, 1993). Studies (Kamaiah and Subrahmanyam, 1982; Paul, 1981) also incorporated the variability of rate of inflation to capture the effect of volatility of inflation on the demand for real cash holding. Further, the roles of stock market and exchange rate have been recognised as instruments in a new channel of monetary transmission mechanism through which monetary policy operation could be guided. Based on the foregoing discussion and the survey of evidence, it is highly motivating to pursue a study to detect the new transmission mechanism under the situation of financial innovation, structural deregulation and globalisation of Indian economy.

3.4 Choice of Determinants for the Present Study:

Based on the above discussion, the present study has selected the following determinants of demand for money function to capture the effects of the developments in the money / securities and external market in the recent past.

3.4.1 Rate of Interest:

While modelling demand for money, researchers are confronted with the problem of multiplicity of interest rates. In fact, there are instances of use of more than one interest rates in the typical money demand function (Mahajan, 1979). However, most of the Indian studies have included a single interest rate in the function. They are treasury bill rate (Sastry, 1962; Gujurati, 1968), yield on Government securities (Gujurati, 1968), deposit rate (Singh, 1969), 91-treasury bill rate (Gupta, 1987), Call money rate (Jadhav, 1994). Ideally, interest rate should be market clearing one, which can be considered as the opportunity cost of holding money. However, when interest rate is administered, it loses its explanatory power.

With a move towards deregulation, a particular interest rate may be administered and market determined, partly for a particular time period. However, in India, money market instruments like call money, commercial papers, certificate of deposits are market determined. Deposit and lending rates have been rationalised as a prelude to complete deregulation. Major chunk of treasury bills are sold on auction basis. Again, the recent institutional arrangements have important role to play in widening and deepening the money/securities market in India. All these arrangements are primarily aimed at providing basic infrastructure for the emergence of interest rate mechanism as the focal point of intervention. So, in the context of recent changes in the money market in India, interest rate have become a relevant proxy for opportunity cost variable in the money demand function.

For the present purpose, however, we could not get any interest rate which is market determined throughout the sample period. Among all the available interest rates, the call money rate seem to have been somewhat market related for maximum number of period of our sample. The average call money rate at Bombay is therefore chosen as a useful surrogate for the opportunity cost in our study. We have also tried out one year deposit rate as an alternative opportunity cost variable in our study under the presumption that the authorities might have taken into consideration the prevailing market condition in fixing the one year deposit rate. That other alternative interest rates included in this study are treasury bill rate and yield on debentures.

3.4.2 Rate of Inflation and Inflationary Expectations:

Most of the studies related to countries like US, UK and Canada which has been relatively free from the high rates of inflation in the past, have generally concentrated on investigating the demand for money function with either of the interest rates (short term or long term) as the relevant opportunity cost variable. However, in India, studies on demand for money published during last two decades, have included inflationary expectations as a useful proxy for opportunity cost variable in the money demand function (Kamaiah and Paul, 1979; 1979; Trivedi, 1980; Paul, 1992; Singh *et. al.* 1982; Bhole, 1985). Due to the presence of special characteristics of Indian economy, where capital market was not organised (at least in the early period of the sample), the existence of unorganised securities market, the presence of wide divergence of rates of interest rate in the organised and unorganised money market, and absence of appropriate financial assets, there is a strong case for considering the substitute relationship between money and real assets including non-perishable consumer goods as operationally more meaningful. Hence, the net adjustment in the above particular category of assets is more representative as compared to the yield on paper securities traded in the organised market.

Moreover, in terms of the inflation performance, the decades of sixties, seventies, eighties and the present, the rate has been predominantly high. During the sixties, the increase in price was particularly sharp at 6.3 per cent and in seventies, money supply accelerated to 17.7 per cent per annum with a preponderant effect on prices as inflation rose on an average to 9.0 per cent. In the subsequent decade, though there was marginal decline in the rate compared to the previous decade, still it remained at 8.0 per cent. In 1990s, (upto 1996-97) again there was significant pick up in the rate to 9.6 per cent.

The evidence of high inflation rate and the existence of unorganised money/ securities market and the absence of suitable financial assets, there is a strong case for including inflation rate and inflationary expectations as the relevant proxy for opportunity cost and an extra determinant in the money demand function. In the present study, we have considered both the variables in formulating alternative money demand specifications.

3.4.3 Variability of Rate of Inflation:

The use of inflation and inflationary expectations in the money demand function has been clearly established after the work of Friedman (1968) and Cagan (1969). Further, after the work of Blejer (1979), Khan (1977), the empirical literature has emphasised on using variability of rate of inflation as an extra determinant in the money demand function. In India, there are few attempts to substantiate the use of variability of rate of inflation in the money demand function (Kamaiah and Subrahmanyam, 1982; Paul, 1981). Again it is necessary to note that the average inflation rate was consistently high, the volatility of it was prominent. During the past four decades, the inflation fluctuated from as high as 25.15 % to as low as -12.7%. And also the year to year fluctuation in the rate were prominent. These trends confirm that price stability is an elusive phenomenon in India. To capture the effect of volatile nature of the inflationary movement on demand for real cash, the present study has included the variable in the alternative money demand specifications.

3.4.4. Exchange Rate:

Of late, the exchange rate has been used by researchers (Joshi and Sagar, 1995, Nag and Upadhyay, 1993) as an relevant determinant in the money demand function. This is used in the view of the fact that when countries are opened up globally, the exchange rate would reflect the interest rate differential between the trading countries and hence the portfolio decision will be affected. In a developing country like India, where external sector has witnessed far reaching changes including substantial elimination of qualitative controls on imports, reduction in tariffs, a market determined exchange rate system, convertibility on the current account, encouragement to foreign direct investment and greater access to the external capital markets, would certainly have a bearing on the portfolio decision. The above deregulatory measures have a expansionary impact on the money supply and at the same time greater access to international capital market. It may mean that the corporate bodies have greater access to funds at rates lower than the domestic interest rates. The innovations have exposed the policy makers to the vulnerability of exchange rate movements. Large scale cross-border movements of capital and increasing tempo of globalisation, in fact, have thrown new challenges for the policy makers to manage liquidity on day-to-day basis. In the present study we have chosen the real effective exchange rate as an explanatory variable under the identical presumption as preferred to earlier, in respect of interest rate.

3.4.5 Stock Market Price and Market Capitalisation

After the serious attempt of Friedman (1988) to relate the level of stock prices to the demand for money, studies conducted in India have reformulated their money demand function by including stock market prices as one of the determinants (Paul, 1992 and Joshi and Sagar, 1995). The capital market in India which was laying as a dormant segment of the financial system has undergone metaphoric transformation since the mid eighties involving multi-dimensional growth. The magnitude of growth have been rapid in terms

of funds mobilised, the turnover on the stock exchange, the amount of market capitalisation and expansion of investor population. The development of capital market during the 1980s, signifies the widening and deepening of the market. Since the mid eighties, debentures emerged as a powerful instrument of resource mobilisation in the primary markets. Introduction of public sector bonds since 1985-86, imparted an additional dimension to the market. The growth in the secondary market was also impressive since 1984-85 in terms of increase in the number of institutions, listed companies, their paid-up capitals and market capitalisation. The capital market also witnessed the emergence of several specialised institutions such as SEBI, CRISIL, CARE, ICRA and OCTEI.

The above development in the Indian stock market thus have brought about a new element in which the demand for money should include the stock prices and market capitalisation to capture the effect on the variation of cash holdings. The present study has used both RBI share index and BSE index and market capitalisation in the money demand specifications.

3.4.6 Scale Variable:

The issue concerning the selection of appropriate scale variable is closely linked to the definition of money used and the nature of study-whether long run or short run. In India, most of the studies have used income (Gujarati, 1968; Gupta, 1973, Joshi and Sagar,1995; Prasad, 1994; Vasudevan, 1979) or permanent income (Gupta, 1987; Mammen, 1970; Paul, 1981) as the relevant proxy for scale variable. However, the present study takes only the measured income (Gross Domestic Product) as the scale variable for annual data and Index of Industrial Production for monthly data money demand function.

3.4.7 Monetary Aggregates:

The question for appropriate definition of money to be included in the money demand function has been discussed in the literature and concluded that choice depends on the frequency of data used (monthly, quarterly or annual), the appropriate scale variable used, coverage of assets, sample period, and method used. The choice ranges from $m1$ to broader definition, or construction of new aggregates (divisia) or individual components - currency, demand deposits and time deposits. In India, there have been several attempts over the years to estimate the demand for money considering either narrow definition or broad definition of money. Further, in some studies, the demand for money has been analysed by its major components viz., currency, demand deposits and time deposits. However, the present study has included both narrow monetary aggregates, $m1$ (currency + demand deposits + other deposits) and broad monetary aggregates, $m3$ ($m1$ + time deposits).

3.5 Empirical Results:

The present study is an empirical study of macro (aggregate) demand for money in India for the period: 1960-61 to 1995-96 and as such does not derive motivation from any of the approaches in isolation as outlined in the chapter II. Hence, a standard formulation of the function is adopted in which the salient features of various conventional approaches have been adopted. Accordingly, demand for money specifications have been formulated with suitable determinants.

In the present study, money has been defined in two ways viz., "narrow" money ($m1$) and "broad" money ($m3$) both in real terms. The present study has been carried out both on annual as well as monthly data. For the annual data specifications, the real domestic product (RGDP) is chosen to represent the "scale" variable. The opportunity cost is measured by call money rate (CALLRATE), 1-3 year deposit rate (DPRATE),

treasury bill rate (TBRATE), yield on debentures (DYRATE), rate of inflation based on WPI (WINFL) and inflationary expectations (IE), market capitalisation (RMCAP) and RBI share index (RSHIDX) as measure of stock market, real effective exchange rate (REER) are also included in the study. The variability of rate of inflation (VRI) as measure of uncertainty on the price front has also been considered while searching for the determinants of the demand for money. The variables are described in table 3.1.

3.5.1 Empirical Results: OLS Estimates

In the present study we have also estimated the monthly regression equations for the data from 1981:04 to 1995:10. In the monthly equations the index of industrial production (IP) as a proxy for scale variable and CALLRATE as a proxy for the opportunity cost of holding money are used. The other variables used in the analysis include: RBI ordinary share price index, BSE index and 36 country trade weighted real effective exchange rate (REER). Here also, we have formulated alternative money demand specifications for both m1 and m3 money. The variables are described in table 3.10 (a).

A number of alternative formulations (specifications with various combinations of determinants) both for m1 and m3 have been estimated. After extensive regression (experiments), a set of alternative specifications have been identified. These are reported in tables 3.2(a) and 3.2(b) for annual data and in table 3.10(b) for monthly data.

3.5.1.1 Empirical Results of OLS Estimates: Annual Data:

For the annual data for the period of 1960-61 to 1995-96, six alternative specifications each for m1 and m3 have been estimated and presented in table 3.4. The estimated specifications are in semi-log form and estimated using OLS procedure. The correlation matrix of the scale and opportunity cost measures for the period 1960-61 to

1995-96 and its sub-period 1970-71 to 1995-96, have been presented in tables 3.3(a) and 3.3(b) respectively. The correlation co-efficients have been helpful in choosing the alternative measures of the opportunity cost and other variables in the specifications. It is to be noted that due to the presence of high correlation of LREER with both DPRATE and CALLRATE the combination is avoided. Again, the combination of LRMCAP and LREER in one specification is also avoided to eliminate the problem of multicollinearity. For its sub-period and extra variable regression, we have excluded the combination of LRSHIDX and LRMCAP due to the presence of high correlation between them.

3.5.1.1.1 Results for the Total Period : 1960-61 to 1995-96

Table 3.4 contains the OLS estimates of alternative money demand specifications presented in table 3.2(a). In the table, the first six equations have real narrow money ($m1$) and the next six real broad money ($m3$) as the dependent variable. Both are measured in logs. The estimated t-ratios are presented in the parentheses below respective coefficients. In the first specification, it is shown that the real income variable (LRGDP) is highly significant with appropriate sign. The interest rate variable (DPRATE) comes out with expected negative sign though not significant. The market capitalisation (LRMCAP) is highly significant with positive sign. The income coefficients are significant at 1% level. The estimated $\bar{R}^2$ is 0.98. In the second specification, deposit rate is replaced by call money rate (CALLRATE). A measure of variability of expected rate of inflation (VRI) is included as an additional determinant in the specification. Both income and market capitalisation are found to be significant at 1% level. Here also LRMCAP comes out with a positive sign. Call money rate comes out with a negative coefficient without being significant. Further, VRI is not significant even at 5% level, though it possesses a positive sign. The goodness of fit is statistically sound. The third specification introduces inflation rate (WINFL) based on whole sale price index as a proxy for opportunity cost variable. Though the variable comes out with the expected sign, it lacks statistical significance. The real effective exchange rate (REER) shows positive influence on holding real cash

The results in table 3.4 shows that the income elasticity of demand for real cash balances ranges from 0.88 to 1.49 for the m1 specifications while it ranges from 1.67 to 1.93 for m3 specifications. In all the cases, save two cases where it is less than one, it is greater than unity indicating diseconomies of holding real cash. It is worth noting here that for m1 definition of money in all cases, including interest rate variable leads to reduction in income elasticity parameter below unity. Whereas, the inclusion of price variable (inflation or inflationary expectations) leads to changing the income elasticity magnitude from below unity to above unity for all the specifications. The m3 functions have higher income elasticity with magnitude greater than unity. Here also the specifications containing interest rate variable as one of the determinants reflects lower income elasticity compared to the specifications without it. It is also evident that the interest rate coefficients are low and statistically not significant though having the proper algebraic sign. The numeric values being very small supports Friedman's idea that interest rate is an unimportant variable.

From the above findings for the sample period: 1960-61 to 1995-96, a few implications may be drawn. First, the long run income elasticity is greater than unity in most of the equations implying that a proportionate change in income requires a more than proportionate change in money balances to sustain it. Secondly, the lack of significant evidence in respect of influence of rate of interest on demand for money in India may be attributed to the less developed money market and lack of representative rate of interest due to thorny data problem. Further, the absence of an active speculative market especially in the early part of the sample period seems to be responsible for the inconsistent and insignificant evidence of rate of interest in the demand for money in India. This is somewhat convincing, as the finding refers to the total period starting from 1960-61. Thirdly, the evidence on inflationary expectations shows that people do adjust their portfolio with non-money assets as inflation rises. With an underdeveloped financial market, lack of appropriate financial assets, a few commercial papers and bills in a

developing country like India, especially during the early periods, would substantiate the importance of physical assets as substitute for money. A positive elasticity for real effective exchange rate implies that the exchange rate depreciation reduces the real wealth and hence the demand for real cash balances. A positive and significant elasticity on market capitalisation reveals that people do demand more cash balances in the face of increasing financial wealth.

3.5.1.1.2 Results for the Sub-Period : 1970-71 to 1995-96:

The regression estimates for the sub-period: 1970-71 to 1995-96 are presented in tables 3.5 and 3.6. Table 3.5 presents the estimates of alternative money demand specifications that are presented in table 3.2(a) for the sub-period 1970-71 to 1995-96. In the first specification, DPRATE comes out with insignificant coefficient though holds proper sign. The LRMCAP though loses significance, still remained significant at 5% level in explaining the variation in demand for real cash. In the second specification, CALLRATE remained statistically insignificant and the coefficients of VRI and LRMCAP bear positive sign though not significant. Surprisingly, in the third specification, WINFL (inflation rate) bears a positive sign for the sub-period. In the remaining three specifications for m1 money (specifications (4), (5) and (6)), the IE variable loses its significance though possesses appropriate sign. This variable is significant at 5% level for specification (4) and (5). However, the VRI variable comes out with the appropriate negative sign without being significant statistically.

The second half of the table 3.5 contains estimates of equations for m3 aggregates. They shows that again the interest rate variables are statistically insignificant in explaining the money demand variation. However, the inflation rate variable turned out with a negative coefficient for m3 function. Here, the LRMCAP bears negative sign though not statistically significant. In specifications (10), (11) and (12), IE though bears a negative sign, is statistically less significant compared to the m1 specifications as well as to the total

sample results. For m3 specifications, VRI carries a positive coefficient, confirming the evidence in favour of precautionary motive of holding money.

From the sub-sample results it is evident that income elasticity is large compared to the overall period elasticity and statistically highly significant. The coefficients are greater than unity for all m1 and m3 specifications. It ranges from 1.20 to 1.38 for m1, and from 1.77 to 2.01 for m3 functions. When compared to the overall period, the interest rate variable remained to be statistically insignificant, IE less significant. Evidence on the financial wealth (LRMCAP) has not been consistent particularly for the m3 functions. The estimated elasticities of exchange rate (LREER) do not exhibit significant differences between the whole period and the sub-period.

Table 3.6 presents OLS estimates of the models involving some additional variables which seem more relevant for this sub-period. The estimates are for the specifications as listed in table 3.2(b). The additional variables include, treasury bill rate (TBRATE), deposit yield rate (DYRATE) and RBI ordinary share price index (LRSHIDX). The results shows that the new proxies for interest rate i.e., TBRATE, DYRATE are even not significant statistically. However, they show negative influence on the narrow money holding. It is to be noted that the share price index LRSHIDX and LMRCAP positively explain the m1 demand for money whereas, it has a negative impact on the m3 money demand. The income elasticity for m1 is found to be around unity while for m3 it is above the Freidman's limit of 1.8.

3.5.1.1.3 Implications of OLS Estimation Results: Annual Data:

Following are the implications drawn from the regression estimates based on the annual data:

- (1) The income elasticity is large and statistically significant. This result is in conformity with the monetary experience of developing economies. Large value of income

elasticity indicates that the transaction demand for money is more important. The elasticity is more than unity in most of the cases (more than unity in all cases for the sample period 1970-71 to 1995-96) implying that there are no economies of scale in holding money and a proportionate change in income requires more than proportionate change in money to sustain it. Income elasticities of demand for money are found to be significantly greater than one and neighbourhood of two supports the monetarists hypothesis that money holding is a luxury in India.

- (2) The statistical insignificance of the interest rate variables as a proxy for the opportunity cost of holding money does not seem to be a suitable variable for monetary management in India. This may be attributed to the presence of less developed money market, lack of representative interest rate and/or data problem for a useful interest rate. As Kamath (1984) in his study of demand for money in India has put forward the following hypothesis, "Physical assets served as substitute for money in developing countries rather than financial assets since there are few alternative financial assets available for wealth holders due to the underdeveloped financial markets".
- (3) On the basis of the above hypothesis, the study introduced inflationary expectations under the economic logic that this variable which represents the return on one of the ways in which wealth could be held, will work as a useful surrogate to the opportunity cost variable in a developing country like India. The significance of inflationary expectation reflects the tendency of reallocating non-money assets into the portfolio in the situation of continuous price rise. This also substantiates the important characteristics of money as a store of value. When prices are expected to rise, its function as a store of value reduces and money holders shift out of money into physical assets as a store of value.

- (4) The positive effect of the financial wealth variable reflects the wealth effect dominating the substitution effect in Indian money / securities market. Again, the real stock prices are positively related to the money demand supporting the presence of wealth effect of stock prices in holding real money balances.
- (5) A positive sign on the real effective exchange rate implies that a depreciation of the domestic currency decreases the demand for real balances. This could mean that by raising the price level, exchange rate depreciation reduces real wealth and hence demand for real money balances. The effect more than offsets the absorption reducing effects of exchange rate depreciation through a rise in wealth on account of the net debtor's positions in terms of ownership claims on rest of the world.

3.5.1.2 Findings From Monthly Data:

In the present study, we have also estimated the monthly regressions for the period from 1981:04 to 1995:10 and two sub-sample periods: 1985:05 to 1991:06 and 1991:07 to 1995:10. Taking the relevant proxies for scale and opportunity cost variables and other suitable variables, five alternative specifications each for m1 and m3 money aggregates are estimated. These specifications are listed in table 3.10(b). The data are deseasonalised before being used in the analysis. The estimations are carried out using the OLS and in logs of the variables. The correlation matrix of the scale and opportunity cost measures for the monthly data for the period: 1981:04 to 1995:10 and its sub-periods: 1985:04 to 1991:06 and 1991:07 to 1995:10 are presented in tables 3.11(a), 3.11(b) and 3.11(c) respectively.

3.6.2.1 Monthly Regression Results for the Total Period: 1981:04 to 1995:10

For the monthly data (1981:04 to 1995:10) five alternative specifications each for m1 and m3 have been estimated and presented in table 3.12. In the table, the first five

equations have real narrow money (m1) and next five have real broad money (m3) as the dependent variable. The estimated t-ratios are presented in the parentheses below the respective coefficients. The results shows that by using industrial production index as a proxy for income variable, the income elasticities are found to be less than unity for almost all the specifications (both narrow as well as broad money functions) save one, specification (9) for m3, where it is slightly more than one, i.e., 1.03. The call money rate as a proxy for opportunity cost of holding money is found to have a positive elasticity in the m1 equations but revealed the expected (-ve) sign without being statistically significant for the m3 functions. The real effective exchange rate variable bears negative sign in both m1 and m3 functions. The coefficients are significant either at 1% or 5% level for all the specifications save one (specification (3) for m1). Again, it is evident from the regression estimates that the real stock prices, both RBI ordinary share index and BSE index are highly significant in seven out of total eight equations in which these variables are included as determinants. These variables are significant at 1% level with a positive elasticities in all these money demand specifications. All the estimated equations have high $\bar{R}^2$ and low D-W statistics.

3.5.1.2.2 Findings from Monthly Data for Sub-Periods: 1985:04 to 1991:06 and 1991:07 to 1995:10:

The OLS estimates of two sub-sample periods: 1985:04 to 1991:06 and 1991:07 to 1995:10 are presented in tables 3.13 and 3.14 respectively. From the results of table 3.13, it is evident that the income elasticities of demand have reduced drastically and in some cases for m3 specifications it comes out without being significant and elasticity as low as 0.30. The call money rate retained positive elasticity in the m1 equations and negative elasticity in the m3 equations. The exchange rate (LREER) variable bears the same negative sign in both m1 and m3 functions and the coefficients are highly significant (at 1% level) in explaining the variation in real cash holding. However, the LASBSE variable loses its significance for both m1 and m3 specifications while LASRBI loses

significance only for m3 specifications. However, the two share price indices have positive elasticities for the present sample period as well.

Table 3.14 presents the results for the second sub-sample period: 1991:07 to 1995:10. The estimates shows that the income elasticities are found to be around unity for both m1 and m3 money demand functions with expected sign. All the coefficients are found to be significant at 1% level. The call money rate comes out with negative elasticity for two m1 specifications and for all m3 specifications. It is worth noting that the interest elasticities are highly significant in the m3 specifications. For the remaining variables: LASBSE, LASREER, LASRBI the results are similar to those of the total sample i.e., the real effective exchange rate variable bears negative sign in all the specifications and the real stock prices, both RBI and BSE indices are highly significant with positive elasticities.

3.5.1.2.3 Implications of Results : Monthly Data:

From the monthly estimations, which covers relatively more recent periods which is characterised by a full fledged development in the capital market, a fledging market for government debt, a buoyant market for primary issues in stock market, and an introduction of new instruments in both these markets, the following implications may be drawn.

First, The demand for real cash balances is positively and significantly related to the real stock prices (both RBI and BSE share index) reflecting the presence of wealth or transaction effect. This findings are in confirmity with the result obtained from the annual data. This shows that the demand side has been influenced more directly in the eighties and nineties with the development in the capital markets having a pronounced bearing on the money markets.

Secondly, the significance of real effective exchange rate indicates the presence of absorption reducing effect of exchange rate depreciation through a rise in wealth on account of the net debtors position in terms of ownership claims on the rest of the world. This result is in contrast to the results obtained from the annual observations. This implies that the effect is only a temporary one, short run phenomenon, which may peter out in the long run.

3.5.2 Diagnostic Tests:

In most of the previous studies in India, money demand functions are estimated using the OLS method without paying due attention to the possible econometric problem that arises out of violation of the standard OLS assumptions. Hence, to have a more accurate conclusions, It is felt necessary to carry out some diagnostic tests on the estimated models. For this purpose, we have performed the non-parametric Run's test to detect the auto-correlation problem. The problem of heteroscedasticity is checked by using both Breusch-Pagan (B-P-G) and Harvey test. The χ^2 test is used to check normality of the residuals and the study made use of Ramsey's RESET test for investigating into possible misspecification in the function. The description of these tests are given in the methodology section of this chapter. The results of these tests are presented in table 3.7, 3.8 and 3.9 for annual data and table 3.15, 3.16 and 3.17 for monthly data.

3.5.2.1 The Diagnostic Testing: Annual Data

Table 3.7 presents diagnostic test results for 12 alternative specifications for the period:1960-61 to 1995-96. From the test statistics of B-P-G and Harvey test for heteroscedasticity, it is revealed that all the test statistics, except for specifications (10) and (11), fall within the 5% acceptance region. Hence, it may be safely concluded that most of the specifications are free from the heteroscedasticity problem. From χ^2 test of

normality of residuals, it is found that all the specifications have normal residuals. The presence of homoscedasticity in the estimated equations does not rule out the possibility of autocorrelated errors in time series data. Hence testing for autocorrelation is also carried out in this study using non-parametric Run's test. The calculated Runs for all the specifications are equal to or less than the critical values of Runs at 0.05 level of significance. Hence, the null hypothesis of random sequence of error is rejected for all the specifications. Thus, the formulated models for m1 or m3 seem to suffer from autocorrelated error.

To check the possible misspecification in the money demand function, we have applied Ramsey's RESET test. The estimated F-values for the RESET test shows that for specifications (3), (4), (5) and (6), the calculated values are more than the 5% critical values. However, for all m3 specifications (specifications (7) to (12)), the calculated values are well within the critical limit. From the above, it is clear that most of the m1 specifications suffer from misspecification error in contrast to the m3 specifications. The misspecification in the m1 money demand functions may be due to omission of some relevant interest rate variable or the way inflationary expectation is modelled.

Table 3.8 and 3.9 presents the estimated statistics of various diagnostic tests for the specifications listed in table 3.2(a) and 3.2(b) for the sub-period: 1970-71 to 1995-96. First, we will analyse the results presented in table 3.8 (specifications (1) to (12)). From the Run's test it is known that except specifications (10) and (11), all other are free from autocorrelation problem. In all these cases, the estimated Run's fall within the critical range of runs at the 0.05 level of significance. From the B-P-G and Harvey test, it is known that all, save one (specification (3)) are free from heteroscedasticity problem. In other words, for all most all the specifications, the residuals have equal variance or spread. From the χ^2 test of normality, it is seen that none of the equations confirm non-normal errors. Further, through Ramsey's RESET test it is confirmed that all the m1 money

demand specifications, except specification (3), are free from misspecification. However, in contrast to the evidence for m1 specifications, all the m3 specifications are found to be misspecified. Table 3.9 presents the diagnostic results for the remaining specifications (specifications (13) to (24)) for the period: 1970-71 to 1995-96. The result from Run's test show that all but specification (17), are free from autocorrelation error. From the B-P-G test, it is found that all the specifications are free from heteroscedasticity problem. Further, from Harvey test it is confirmed that only specification (14) and (24) suffer from the problem of heteroscedasticity. χ^2 test confirms normality of residuals for all specifications. From the F-values of RESET test we could reject the hypothesis of no-misspecification for all the m1 money demand functions. However, the test statistics revealed that all the m3 functions are misspecified.

The main findings of the diagnostic tests for the total as well as sub-periods together for the annual data as follows:

- (i) The χ^2 test of normality of residuals shows that the money demand functions have normal residuals.
- (ii) The B-P-G and Harvey tests show that the problem of heteroscedasticity is not present in most of the money demand specifications.
- (iii) The non-parametric Run's test reveals that for the total period, most of the specifications considered are having autocorrelated errors. Whereas, for the sub-period data, very few suffer from the problem of randomness of errors.
- (iv) The Ramsey's RESET test for total sample shows that most of the m1 specifications suffer from misspecification. In contrast, the result for sub-period show that all the m3 specifications are misspecified.

3.5.2.2 The Diagnostic Testing : Monthly Data:

Table 3.15 presents the diagnostic test statistics for 10 alternative specifications for the monthly data from 1981:04 to 1995:10. From the computed Run's statistics, it is confirmed that most of the specifications suffer from autocorrelation problem. The B-P-G test for heteroscedasticity shows that only three specifications for m1 (specification (2), (4) and (5)) are heteroscedastic. Further, the Harvey test confirms that specifications (2), (3), (4), (6), (7) and (8) do not have same variance. The χ^2 test for normality reveals that all the specifications tested have non-normal errors. However, the RESET statistics reveal the problem of misspecification for all m3 functions in contrast to that of m1.

Table 3.16 contains various diagnostic test results for monthly data for the sub-period: 1985:04 to 1991:06. The Runs test results rejects the hypothesis that the observed sequence is random for most of the specifications. The results for χ^2 test for normality says that all the specifications tested do not have normal errors. The B-P-G test for heteroscedasticity confirms that only two specifications ((1) and (3)) suffer from the problem. In contrast to that, the Harvey test shows that most of the specifications are heteroscedastic. The test result for RESET test shows that except specifications (1) and (6), all other suffer from the misspecification problem.

Table 3.17 gives the results for the sub-period: 1991:07 to 1995:10. The Run's test evidence confirms that most of the specifications are having autocorrelation problem. The χ^2 test shows that all the m3 specifications have non-normal residuals. The B-P-G test finds that all the specification have same variance. The Harvey test shows that except specification (6) and (10) all other are homoscedastic. However, the RESET statistics reveal that all the m1 specifications are misspecified in contrast to that of m3.

Diagnostic testing of estimated money demand functions for monthly data revealed the following conclusions:

- (i) The non-parametric Run's test reveals that most of the specifications are found to be having autocorrelated errors.
- (ii) The Breush-Pagan and Harvey tests show that the problem of heteroscedasticity is not severe in the OLS estimates of money demand specifications for monthly data.
- (iii) The χ^2 test of normality of residuals shows that most of the OLS money demand specifications have non-normal residuals. This is in contrast to the findings of annual data where the problem of non-normality of residuals was absent.
- (iv) The RESET test has shown that most of the specifications are misspecified in the OLS function of money demand for monthly data. This result is also in contrast to the evidence from annual data where the problem of misspecification was confined to a few specifications.

3.6 Concluding Remarks:

The main focus of this chapter is to re-evaluate the performance of the money demand specifications in the context of identifying suitable determinants. The major concern of this effort is to find out appropriate channel of monetary transmission mechanism or the routes of the effects of monetary policy operations. The major conclusions that emerge from this analytical and empirical study are as follows.

The income elasticity of the demand for money is positive, statistically significant and in most of the cases greater than unity. This result clearly suggests that there is no economies of scale in holding money and a proportionate change in the income requires more than proportionate change in money to sustain it. Again, the result suggests that money is considered to be a luxury asset in India. This result may be ascribed to the fact that people are willing to forego the premium received from holding assets in illiquid form.

Moreover, the large value of income elasticity indicates that transaction demand for money is important. The statistical insignificance of the interest rate variable implies that interest rate can not be a suitable variable for monetary management variable in India. This implies that interest rate fail to become an appropriate proxy for opportunity cost variable in the context of India. The results obtained from fitting inflationary expectations as an opportunity cost variable suggest an expected sign and statistically significant. This suggests the importance of physical assets in people's portfolio in the country like India.

The insignificant influence of the rate of interest on the demand for money in India may be attributed to the less developed money and capital markets and lack of a representative interest rate. This may be true as our study period starts from 1960s onwards. Moreover, the lack of speculative demand for money (which is mainly a function of rate of interest) also seems to be responsible for the insignificant effect of rate of interest on the demand for money in India.

The demand for real cash balances is positively and significantly related to the movement of real stock prices. The positive relation appears to reflect a wealth and / or transaction effect. Further, in Indian context, the transaction effect cannot be ruled out and difficult to be separated from the wealth effect. The result also suggest that the demand side has been influenced more directly with the development in the capital market having pronounced bearing on the money market.

The effects of exchange rate on the level of real money balances show different results for annual and monthly money demand specifications. For annual data it confirms the positive effect whereas for the monthly demand specifications it confirms negative effects (absorption reducing effect). This suggests either of the following reasons: (i) the absorption effect is only a temporary short run phenomenon, which peters out in the long

run and even on an annual basis, or (ii) the absorption reducing effect is only a recent phenomenon of the 1980s and 1990s, which may even continue in future.

From the above conclusions, the following implications may be drawn for the effective operation of monetary policy in India. The ineffectiveness of the interest rate shows the lack of response mechanism through the changes in the interest rate. Under such a situation, monetary authorities should go for a complete deregulation of interest rate. Further, the results indicate that the expectations about future price level play a crucial role in determining the demand for money. The results also show that, exchange rate is gradually emerging as an alternative route through which monetary impulses could be transmitted to the economy. The asset prices of the capital market provide sufficient clues for becoming the channels of transmitting the monetary policy operations. The market capitalisation used as an explanatory variable turned out to be positive and significant. This suggests that long term assets market has emerged as a possible channel of monetary transmission which supports the hypothesis that money is required for investment purposes.

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TABLE - 3.1
Description of Variables
(Annual Data: 1960-61 to 1995-96)

Variables	Definition
RM1 (m1)	: Real narrow money which comprises of currency with the public, demand deposit with banks and other deposits with RBI
RM3 (m3)	: Real broad money which includes m1 and time deposits with banks.
RGDP	: Real gross domestic product at factor cost at 1980-81 prices
CALLRATE	: Weighted average of call money rate at Bombay, average of weeks
DPRATE	: 1-3 year deposit rate.
IE	: Inflationary Expectations.
VRI	: Variability of rate of inflation.
TBRATE	: Treasury Bill rate.
DYRATE	: Yield on debentures.
WINFL	: Inflation rate based on whole sale price index (WPI) with base 1980-81 = 100.
RMCAP	: Real market capitalisation (Stock Markets).
REER	: Real effective exchange rate (36 country trade weighted).
RSHIDX	: RBI share price index.

■Note: The Variables IE and VRI are not directly observable. The procedure for generating observations on these variables is discussed in Appendix - A.

TABLE - 3.2 (a)

**Money Demand Specifications: 1960-61 to 1995-96 and 1970-71 to 1995-96.
(Annual Data)**

Sr. No.	Dependent variable	Independent Variabels
(1)	LRM1	LRGDP, DPRATE, LRMCAP
(2)	LRM1	LRGDP, CALLRTAE, VRI, LRMCAP
(3)	LRM1	LRGDP, WINFL, LREER
(4)	LRM1	LRGDP, IE
(5)	LRM1	LRGDP, IE, VRI
(6)	LRM1	LRGDP, IE, LREER
(7)	LRM3	LRGDP, DPRATE, LRMCAP
(8)	LRM3	LRGDP, CALLRTAE, VRI, LRMCAP
(9)	LRM3	LRGDP, WINFL, LREER
(10)	LRM3	LRGDP, IE
(11)	LRM3	LRGDP, IE, VRI
(12)	LRM3	LRGDP, IE, LREER

TABLE - 3.2 (b)

**Money Demand Specifications: 1970-71 to 1995-96.
(Annual Data)**

Sr. No.	Dependent variable	Independent Variabels
(13)	LRM1	LRGDP, DYRATE, LRSHIDX
(14)	LRM1	LRGDP, DYRATE, VRI, LRMCAP
(15)	LRM1	LRGDP, DPRATE, LRSHIDX
(16)	LRM1	LRGDP, DPRATE, VRI, LRMCAP
(17)	LRM1	LRGDP, TBRATE, LRSHIDX
(18)	LRM1	LRGDP, TBRATE, VRI, LRMCAP
(19)	LRM3	LRGDP, DYRATE, LRSHIDX
(20)	LRM3	LRGDP, DYRATE, VRI, LRMCAP
(21)	LRM3	LRGDP, DPRATE, LRSHIDX
(22)	LRM3	LRGDP, DPRATE, VRI, LRMCAP
(23)	LRM3	LRGDP, TBRATE, LRSHIDX
(24)	LRM3	LRGDP, TBRATE, VRI, LRMCAP

TABLE - 3.3 (a)**Correlation Matrix of Variables for Annual Data: 1960-61 to 1995-96**

Variables	LRGDP	DPRATE	CALLRATE	WINFL	IE	VRI	LRMCA P	LREER
LRGDP	1.0000							
DPRATE	0.9523	1.0000						
CALLRATE	0.7755	0.8207	1.0000					
WINFL	0.1099	0.1417	0.2424	1.0000				
IE	0.2869	0.3845	0.4425	0.7774	1.0000			
VRI	-0.3328	-0.3622	-0.2959	-0.2207	-0.1448	1.0000		
LRMCAP	0.8612	0.8271	0.6733	0.1014	0.1794	-0.6191	1.0000	
LREER	-0.9636	-0.9389	-0.8219	-0.1049	-0.3248	0.2645	-0.8165	1.0000

TABLE - 3.3 (a)

Correlation Matrix of Variables for Annual Data: 1960-61 to 1995-96

Variables	LRGDP	DPRATE	CALLRATE	WINFL	IE	VRI	LRMCA P	LREER
LRGDP	1.0000							
DPRATE	0.9523	1.0000						
CALLRATE	0.7755	0.8207	1.0000					
WINFL	0.1099	0.1417	0.2424	1.0000				
IE	0.2869	0.3845	0.4425	0.7774	1.0000			
VRI	-0.3328	-0.3622	-0.2959	-0.2207	-0.1448	1.0000		
LRMCAP	0.8612	0.8271	0.6733	0.1014	0.1794	-0.6191	1.0000	
LREER	-0.9636	-0.9389	-0.8219	-0.1049	-0.3248	0.2645	-0.8165	1.0000

TABLE - 3.3 (b)

Correlation Matrix of Variables for Annual Data : 1970-71 to 1995-96

Variables	LRGDP	DPRATE	CALLRATE	WINFL	IE	VRI	LRMCAP	LREER	DYRATE	LRSHDX	TBRATE
LRGDP	1.0000										
DPRATE	0.9217	1.0000									
CALLRATE	0.6045	0.6969	1.0000								
WINFL	-0.0676	-0.0484	0.1386	1.0000							
IE	0.0217	0.1504	0.3026	0.7638	1.0000						
VRI	-0.6389	-0.6386	-0.4998	-0.2645	-0.2151	1.0000					
LRMCAP	0.9235	0.8748	0.6024	0.0445	0.0719	-0.7496	1.0000				
LREER	-0.9429	-0.8995	-0.6998	0.0940	-0.0284	0.6157	-0.9268	1.0000			
DYRATE	0.5521	0.5899	0.4452	-0.0666	0.1262	-0.0915	0.2633	-0.4279	1.0000		
LRSHDX	0.7231	0.7995	0.7191	0.1069	0.2660	-0.4777	0.8069	-0.7857	0.2384	1.0000	
TBRATE	0.9643	0.9071	0.5907	0.0454	0.1102	-0.7124	0.9800	-0.9334	0.3885	0.7894	1.0000

TABLE 3.4

OLS Estimates of Demand for Money Functions: Annual Data 1960-61 to 1995-96.

Independent Variables											
Dependent Variable	Constant	LRGDP	DPRATE	CALLRATE	WINFL	IE	VRI	LREER	LRMCAP	R ²	D.W.
LRM1	-2.3749	0.9782* (9.9674)	-0.0249 (-1.5349)						0.1294* (6.5911)	0.98	1.05
LRM1	-1.4899	0.8865* (12.2656)		-0.0063 (-1.3246)			0.0022 (0.2924)		0.1342* (4.4178)	0.98	0.98
LRM1	-9.4875	1.4952* (10.4553)			-0.0022 (-0.7429)			0.4537** (2.4751)		0.96	0.62
LRM1	-3.5998	1.1843* (31.0156)				-0.0195* (-3.0235)				0.97	0.41
LRM1	-2.9969	1.1435* (34.3312)				-0.0207* (-3.8547)	-0.0241* (-3.8868)			0.98	0.55
LRM1	-8.4904	1.4550* (11.1412)				-0.0169* (-2.7221)		0.3660 (2.1584)		0.97	0.61
LRM3	-9.9099	1.6721* (13.9054)	-0.0263 (-1.2502)						0.0268 (1.0492)	0.98	0.76
LRM3	-8.8082	1.6444* (17.7222)		-0.0060 (-0.9855)			0.0087 (0.8862)		0.0478 (1.3359)	0.97	0.68
LRM3	-13.2121	1.9361* (15.0891)			-0.0023 (-0.8614)			0.3131 (1.9039)		0.98	0.88
LRM3	-9.1875	1.7269* (52.2891)				-0.0173* (-3.1039)				0.99	0.71
LRM3	-9.1623	1.7252* (48.9694)				-0.0173* (-3.0617)	-0.0010 (-0.1576)			0.99	0.71
LRM3	-12.2856	1.8984* (16.2667)				-0.0153* (-2.8207)		0.2319 (1.5295)		0.99	0.89

Note: t - values are presented in the parentheses.

* indicates significance at 1% level.

** indicates significance at 5% level.

TABLE 3.5

OLS Estimates of Demand for Money Functions: Annual Data: 1970-71 to 1995-96.

Independent Variables											
Dependent Variable	Constant	LRGDP	DPRATE	CALLRATE	WINFL	IE	VRI	LREER	LRMCAP	R ²	D.W.
LRM1	-4.4898	1.2023* (10.4411)	-0.0177 (-1.0948)						0.0659* (2.6177)	0.98	1.26
LRM1	-3.9190	1.1461* (12.0886)		-0.0063 (-1.4452)			-0.0001 (-0.0112)		0.0669* (2.2612)	0.98	1.32
LRM1	-6.4312	1.3796* (11.4930)			-0.0012 (-0.4902)			0.0689 (0.3979)		0.96	0.89
LRM1	-5.4903	1.3349* (36.8443)				-0.0102* (-2.6585)				0.98	0.93
LRM1	-4.7801	1.2814* (28.1878)				-0.0125* (-2.6576)	-0.0109 (-1.8109)			0.98	0.97
LRM1	-6.3380	1.3800* (12.3637)				-0.0101** (-2.0109)		0.0690 (0.4326)		0.98	0.92
LRM3	-12.1644	2.0157* (14.1776)	-0.0119 (-0.6003)						-0.0525 (-1.6899)	0.98	1.15
LRM3	-11.8453	1.9745* (17.1358)		-0.0066 (-1.2618)			0.0041 (0.4741)		-0.0405 (-1.1259)	0.98	1.22
LRM3	-13.3894	1.9608* (14.6946)			-0.0007 (-0.2794)			0.2838 (1.4733)		0.98	0.92
LRM3	-9.8343	1.7779* (43.4672)				-0.0131** (-2.3379)				0.99	0.88
LRM3	-10.3053	1.8719* (36.3374)				-0.0115 (-1.9922)	0.0073 (1.0155)			0.99	0.99
LRM3	-13.1401	1.9541* (16.4139)				-0.0128** (-2.3728)		0.2692 (1.5693)		0.99	1.01

Note: t - values are presented in the parentheses.

* indicates significance at 1% level.

** indicates significance at 5% level.

TABLE 3.6

OLS Estimates of Demand for Money Functions: Annual Data: 1970-71 to 1995-96.

Independent Variables											
Dependent Variable	Constant	LRGDP	DYRATE	DPRATE	TBRATE	VRI	LRSHDX	LRMCAP	$\bar{R}^2$	D.W.	
LRM1	-4.7338	1.2607* (6.4787)	-0.0145 (-1.4263)				0.0395 (0.6864)		0.98	0.99	
LRM1	-4.7888	1.2499* (7.2708)	-0.0112 (-0.9022)			0.0013 (0.1772)		0.0365 (0.8349)	0.98	1.03	
LRM1	-3.4684	1.1257* (7.4955)		-0.0176 (-1.0555)			0.1013 (2.8441)		0.96	1.19	
LRM1	-4.4791	1.1998* (9.9219)		-0.0176 (-1.0559)		0.0006 (0.0912)		0.0673* (2.8200)	0.98	1.26	
LRM1	-2.7517	1.0559* (7.3562)			-0.0009 (-0.0861)		0.0951 (2.3051)		0.98	1.01	
LRM1	-3.6570	1.1137* (11.2541)			-0.0050 (-0.4235)	0.0026 (0.3286)		0.0746** (2.3231)	0.98	1.12	
LRM3	-11.5201	1.9280* (8.1447)	-0.0092 (-0.9777)				-0.0608 (-0.8709)		0.98	1.09	
LRM3	-10.8019	1.8591* (8.8808)	-0.0777 (-0.5125)			0.0055 (0.6317)		-0.0234 (-0.4410)	0.98	1.08	
LRM3	-13.1961	2.0983* (11.6543)		-0.0114 (-0.5698)			-0.0809 (-1.6422)		0.98	1.13	
LRM3	-12.0819	1.9968* (13.4736)		-0.0108 (-0.5330)		0.0051 (0.5682)		-0.0413 (-1.1123)	0.98	1.14	
LRM3	-12.4882	2.0276* (12.1201)			-0.0090 (-0.7009)		-0.0728 (-1.1854)		0.98	1.12	
LRM3	-11.5457	1.9285* (16.4717)			-0.0131 (-0.9323)	0.0085 (0.9217)		-0.0171 (-0.3713)	0.98	1.12	

Note: t - values are presented in the parentheses.

* indicates significance at 1% level.

** indicates significance at 5% level.

TABLE - 3.7

Diagnostic Tests: Annual Data: 1960-61 to 1995-96

Specific ations*	Runs Test of Autocorrelation (RUNS)	CHI-Sq Test Normality (χ^2 Values)	BPG Test Heteroscedasticity (χ^2 Values)	Harvey Heteroscedasticity (χ^2 Values)	RESET Misspecification (F Values)
1	11 runs (21p, 15n)	1.4959 (2)	0.1244 (3)	1.8203 (3)	0.0051 (1, 31)
2	11 runs (16p, 20n)	1.0959 (2)	1.3712 (4)	4.7621 (4)	0.2214 (1, 30)
3	11 runs (17p, 19n)	1.4804 (2)	1.1760 (3)	1.3890 (3)	36.3330 (1, 32)
4	9 runs (20p, 16n)	0.6826 (2)	4.4312 (2)	0.6511 (2)	52.6361 (1, 32)
5	7 runs (19p, 17n)	0.4978 (2)	6.8250 (3)	0.2500 (3)	46.258 (1, 31)
6	13 runs (20p, 16n)	1.4137 (2)	2.1270 (3)	1.9730 (3)	40.056 (1, 31)
7	10 runs (21p, 15n)	0.8608 (2)	3.8830 (3)	3.8112 (3)	1.2676 (1, 31)
8	8 runs (19p, 17n)	0.6365 (2)	5.5500 (4)	9.0666 (4)	0.2219 (1, 30)
9	12 runs (17p, 19n)	0.1972 (2)	6.2900 (3)	7.4300 (3)	0.6784 (1, 31)
10	14 runs (18p, 18n)	0.2489 (1)	8.5420 (2)	9.4771 (2)	1.6276 (1, 32)
11	14 runs (18p, 18n)	0.2444 (2)	8.6691 (3)	11.5821 (3)	1.8498 (1, 31)
12	12 runs (19p, 17n)	0.5152 (2)	7.6332 (3)	5.6241 (3)	0.7447 (1, 31)

Note: p and n inside parentheses of column (2) refer to positive and negative runs respectively.

Degrees of freedom are presented inside parentheses.

* Specifications (1) to (12) are the same as listed in table 3.2(a)

TABLE - 3.8

Diagnostic Tests: Annual Data: 1970-71 to 1995-96

Specific ations*	Runs Test of Autocorrelation (RUNS)	CHI-Sq Test Normality (χ^2 Values)	BPG Test Heteroscedasticity (χ^2 Values)	Harvey Heteroscedasticity (χ^2 Values)	RESET Misspecification (F Values)
1	11 runs (14p, 12n)	0.0939 (2)	2.1303 (3)	2.6941 (3)	0.1884 (1, 21)
2	11 runs (14p, 12n)	0.0438 (2)	0.4832 (4)	2.7921 (4)	1.6731 (1, 20)
3	9 runs (13p, 13n)	0.3579 (2)	8.0830 (3)	9.1221 (3)	4.7842 (1, 21)
4	11 runs (11p, 15n)	1.5071 (2)	1.3971 (2)	0.9952 (2)	0.9818 (1, 22)
5	11 runs (11p, 15n)	1.5046 (2)	2.0991 (3)	1.7781 (3)	1.0155 (1, 21)
6	11 runs (11p, 15n)	1.5045 (2)	1.4400 (3)	1.1370 (3)	1.1695 (1, 21)
7	11 runs (11p, 15n)	0.5350 (2)	2.8242 (3)	0.3992 (3)	5.2323 (1, 21)
8	11 runs (12p, 14n)	0.5900 (2)	1.5630 (4)	2.3861 (4)	8.0946 (1, 20)
9	11 runs (12p, 14n)	0.7202 (2)	3.5270 (3)	1.8901 (3)	7.2491 (1, 21)
10	7 runs (12p, 14n)	0.4843 (1)	5.5362 (2)	1.7612 (2)	14.8321 (1, 22)
11	7 runs (11p, 15n)	0.4786 (2)	4.7761 (3)	3.7453 (3)	13.2381 (1, 21)
12	11 runs (13p, 13n)	0.7278 (2)	3.7573 (3)	1.5721 (3)	11.5691 (1, 21)

Note: p and n inside parentheses of column (2) refer to positive and negative runs respectively.

Degrees of freedom are presented inside parentheses.

* Specifications (1) to (12) are the same as listed in table 3.2(a)

TABLE - 3.9**Diagnostic Tests: Annual Data: 1970-71 to 1995-96**

Specific ations*	Runs Test of Autocorrelation (RUNS)	CHI-Sq Test Normality (χ^2 Values)	BPG Test Heteroscedasticity (χ^2 Values)	Harvey Heteroscedasticity (χ^2 Values)	RESET Misspecification (F Values)
13	11 runs (15p, 11n)	0.7584 (2)	3.7022 (3)	5.2881 (3)	0.9261 (1, 21)
14	11 runs (13p, 13n)	0.3455 (2)	4.4291 (4)	8.6392 (4)	1.6562 (1, 20)
15	9 runs (15p, 11n)	0.1768 (2)	3.7602 (3)	1.9850 (3)	0.0073 (1, 21)
16	11 runs (12p, 14n)	0.1688 (2)	2.2253 (4)	3.0165 (4)	0.3945 (1, 22)
17	7 runs (13p, 13n)	0.1522 (2)	6.1330 (3)	3.3280 (3)	0.2120 (1, 21)
18	11 runs (12p, 14n)	0.2947 (2)	3.8562 (4)	3.5480 (4)	0.1767 (1, 21)
19	11 runs (12p, 14n)	3.0329 (2)	3.1350 (3)	5.0352 (3)	4.2099 (1, 21)
20	11 runs (12p, 14n)	0.8979 (2)	3.8820 (4)	2.3231 (4)	6.0308 (1, 20)
21	9 runs (12p, 14n)	1.0587 (2)	2.6301 (3)	0.4380 (3)	5.2775 (1, 21)
22	11 runs (11p, 15n)	0.2399 (1)	3.0150 (4)	1.6921 (4)	6.0336 (1, 20)
23	9 runs (13p, 13n)	1.8626 (2)	2.4421 (3)	1.0211 (3)	4.2139 (1, 21)
24	11 runs (10p, 16n)	0.6389 (2)	2.8572 (4)	12.3912 (4)	5.8466 (1, 20)

Note: p and n inside parentheses of column (2) refer to positive and negative runs respectively.

Degrees of freedom are presented inside parentheses.

* Specifications (13) to (24) are the same as listed in table 3.2(a)

TABLE - 3.10(a)
Description of Variables
(Monthly Data: 1981:04 to 1995:10)

Variables	Definitions
ASRM1	: Real narrow money.
ASRM3	: Real broad money.
ASIP	: Index of Industrial Production.
ASCALL	: Call money rate at Bombay, average of week.
ASREER	: Real effective exchange rate.
ASBSE	: BSE index.
ASRBI	: RBI share index.

Note: All the variables are seasonally adjusted using an additive deseasonalization procedure.

TABLE - 3.10 (b)
Money Demand Specifications for Monthly Data: 1981:04 to 1995:10.

Sr. No.	Dependent variable	Independent variables
(1)	LASRM1	LASIP, LASCALL, LASREER
(2)	LASRM1	LASIP, LASCALL, LASREER, LASRBI
(3)	LASRM1	LASIP, LASCALL, LASREER, LASBSE
(4)	LASRM1	LASIP, LASCALL, LASRBI
(5)	LASRM1	LASIP, LASCALL, LASBSE
(6)	LASRM3	LASIP, LASCALL, LASREER
(7)	LASRM3	LASIP, LASCALL, LASREER, LASRBI
(8)	LASRM3	LASIP, LASCALL, LASREER, LASBSE
(9)	LASRM3	LASIP, LASCALL, LASRBI
(10)	LASRM3	LASIP, LASCALL, LASBSE

TABLE - 3.11(a)

Correlation Matrix of Variables for Monthly Data (deseasonalised): 1981:04 to 1995:10

Variables	ASBSE	ASRBI	ASIP	ASREER	ASWPI	ASCALL
ASBSE	1.0000					
ASRBI	0.9926	1.0000				
ASIP	0.9309	0.9341	1.0000			
ASREER	-0.9435	-0.9417	-0.9339	1.0000		
ASWPI	0.9704	0.9752	0.9648	-0.9572	1.0000	
ASCALL	0.2947	0.3055	0.3663	-0.3411	0.2841	1.0000

TABLE - 3.11(b)

Correlation Matrix of Variables for Monthly Data (deseasonalised): 1985:04 to 1991:06

Variables	ASBSE	ASRBI	ASIP	ASREER	ASWPI	ASCALL
ASBSE	1.0000					
ASRBI	0.9622	1.0000				
ASIP	0.7453	0.7990	1.0000			
ASREER	-0.7668	-0.6786	-0.9161	1.0000		
ASWPI	0.8132	0.8579	0.9599	-0.9405	1.0000	
ASCALL	0.7555	0.7901	0.6419	-0.5958	0.7083	1.0000

TABLE - 3.11(c)

Correlation Matrix of Variables for Monthly Data (deseasonalised): 1991:07 to 1995:10

Variables	ASBSE	ASRBI	ASIP	ASREER	ASWPI	ASCALL
ASBSE	1.0000					
ASRBI	0.9534	1.0000				
ASIP	0.6400	0.6245	1.0000			
ASREER	0.4437	0.5776	0.2510	1.0000		
ASWPI	0.7034	0.6841	0.9281	0.2717	1.0000	
ASCALL	-0.3096	-0.2009	-0.1544	-0.0729	-0.3285	1.0000

TABLE 3.12

OLS Estimates of Demand for Money Functions on Deseasonalised Monthly Series: 1981:04 to 1995:10.

Dependent Variable	Independent Variables						R ²	D.W.
	Constant	LASIP	LASCALL	LASREER	LASRBI	LASBSE		
LASRM1	7.4376	0.8708* (25.236)	0.0099 (1.0698)	-0.3088 (-6.2757)			0.98	1.11
LASRM1	6.7927	0.7774* (21.604)	0.0162 (1.8694)	-0.1439 (-2.6554)	0.0661* (5.5647)		0.98	1.12
LASRM1	6.6043	0.7728* (22.387)	0.0188 (2.2313)	-0.1094 (-2.0281)		0.0662* (6.4601)	0.98	1.20
LASRM1	5.8436	0.8185* (24.761)	0.0177 (2.0202)		0.0833* (8.2342)		0.98	1.12
LASRM1	5.8856	0.8028* (25.525)	0.0205 (2.4049)			0.0781* (9.2109)	0.98	1.23
LASRM3	8.0801	0.9867* (20.187)	-0.0101 (-0.7683)	-0.3489 (-5.0048)			0.96	1.33
LASRM3	7.8658	0.9557* (17.318)	-0.0081 (-0.707)	-0.2942 (-3.5378)	0.0219 (1.2052)		0.96	1.30
LASRM3	7.4981	0.9183* (17.245)	-0.0038 (-0.2967)	-0.2096 (-2.5193)		0.2046* (2.9246)	0.97	1.32
LASRM3	5.9267	1.0397* (20.199)	-0.0048 (-0.355)		0.0572* (3.6283)		0.96	1.28
LASRM3	6.1210	0.9759* (19.986)	-0.0009 (-0.065)			0.0691* (5.2442)	0.96	1.34

Note: t - values are presented in the parentheses.

* indicates significance at 1% level.

** indicates significance at 5% level.

TABLE 3.13

OLS Estimates of Demand for Money Functions on Deseasonalised Monthly Series: 1985:04 to 1991:06.

Dependent Variable	Independent Variables							
	Constant	LASIP	LASCALL	LASREER	LASRBI	LASBSE	R ²	D.W.
LASRM1	10.1019	0.5154* (9.0354)	0.0739 (5.2029)	-0.5319* (-6.5648)			0.96	1.53
LASRM1	9.8829	0.4682* (8.6283)	0.0377 (2.2867)	-0.4847* (-6.3827)	0.0605* (3.6369)		0.97	1.45
LASRM1	9.8655	0.5159* (9.0482)	0.0639 (3.7181)	-0.4997* (-5.7622)		0.0179 (1.0398)	0.96	1.51
LASRM1	6.2445	0.7413* (17.776)	0.0289 (1.4091)		0.0786* (3.8406)		0.95	1.64
LASRM1	6.0890	0.7828* (19.533)	0.0459 (2.2520)			0.0533 (2.7539)	0.95	1.75
LASRM3	14.5282	0.3391* (2.701)	0.0066 (0.211)	-1.0551* (-5.9157)			0.86	2.26
LASRM3	14.3481	0.3003 (2.332)	-0.0230 (-0.593)	-1.0163* (-5.6380)	0.0498 (1.2596)		0.86	2.26
LASRM3	14.1414	0.3399* (2.699)	-0.0098 (-0.259)	-1.0024* (-5.2332)		0.0293 (0.7698)	0.86	2.26
LASRM3	6.7197	0.8728* (9.1978)	-0.0416 (-0.892)		0.0879 (1.8823)		0.80	1.77
LASRM3	6.5652	0.8753* (10.173)	-0.0460 (-1.052)			0.1004 (2.4152)	0.81	1.86

Note: t - values are presented in the parentheses.

* indicates significance at 1% level.

** indicates significance at 5% level.

TABLE 3.14

OLS Estimates of Demand for Money Functions on Deseasonalised Monthly Series: 1991:07 to 1995:10.

	Independent Variables							
Dependent Variable	Constant	LASIP	LASCALL	LASREER	LASRBI	LASBSE	$\bar{R}^2$	D.W.
LASRM1	5.5789	0.9928* (15.761)	-0.0048 (-0.439)	-0.0114 (-0.0858)			0.83	1.09
LASRM1	7.0135	0.8133* (11.519)	0.0008 (0.0855)	-0.3371 (-2.4582)	0.1253* (4.2616)		0.87	1.29
LASRM1	6.4165	0.8345* (11.259)	0.0056 (0.5433)	-0.1881 (-1.4568)		0.0917* (3.5445)	0.86	1.35
LASRM1	5.7409	0.8428* (11.525)	-0.0003 (-0.0312)		0.0850* (3.3129)		0.86	1.14
LASRM1	5.7248	0.8405* (11.222)	0.0044 (0.4249)			0.0772* (3.1955)	0.86	1.22
LASRM3	7.1988	0.9139* (14.641)	-0.0378* (-3.6000)	-0.0263 (-0.2096)			0.84	0.95
LASRM3	8.2133	0.7869* (10.896)	-0.0338* (-3.429)	-0.2566 (-1.8294)	0.8886* (2.9459)		0.86	0.98
LASRM3	7.7648	0.8071* (10.825)	-0.0307* (-2.933)	-0.1457 (-1.1225)		0.0620 (2.3823)	0.85	1.01
LASRM3	7.2444	0.8095* (11.106)	-0.0347* (-3.438)		0.0579** (2.2653)		0.85	0.92
LASRM3	7.2289	0.8116* (10.870)	-0.0316* (-3.023)			0.0507 (2.1069)	0.85	0.94

Note: t - values are presented in the parentheses.

* indicates significance at 1% level.

** indicates significance at 5% level.

TABLE - 3.15

Diagnostic Tests for Deseasonalised Monthly Series :1981:04 to 1995:10

Specific ations*	Runs Test of Autocorrelation (RUNS)	CHI-Sq Test Normality (χ^2 Values)	BPG Test Heteroscedasticity (χ^2 Values)	Harvey Heteroscedasticity (χ^2 Values)	RESET Misspecification (F Values)
1	52 runs (93p, 82n)	5.9037 (2)	5.8924 (3)	6.4073 (3)	1.4435 (1, 170)
2	48 runs (99p, 76n)	23.3889 (2)	11.6791 (4)	20.034 (4)	1.4372 (1, 169)
3	56 runs (96p, 79n)	15.6248 (2)	8.0832 (3)	15.393 (4)	0.5029 (1, 169)
4	46 runs (92p, 83n)	33.5322 (2)	12.0071 (3)	7.0685 (3)	1.1467 (1, 170)
5	54 runs (93p, 82n)	20.1540 (2)	7.3680 (3)	5.5380 (3)	0.2502 (1, 170)
6	47 runs (106p, 69n)	2639.583 (2)	1.8972 (3)	23.166 (3)	12.863 (1, 170)
7	43 runs (107p, 68n)	2626.248 (2)	1.9660 (4)	23.398 (4)	23.389 (1, 169)
8	51 runs (100p, 75n)	2577.666 (2)	3.246 (4)	28.177 (4)	26.880 (1, 169)
9	51 runs (97p, 78n)	2586.063 (2)	1.4821 (3)	6.2170 (3)	19.3341 (1, 170)
10	53 runs (98p, 77n)	2520.826 (2)	3.1430 (3)	6.7021 (4)	22.4632 (1, 170)

Note: p and n inside parentheses of column (2) refer to positive and negative runs respectively.

Degrees of freedom are presented inside parentheses.

* Specifications (1) to (10) are the same as listed in table 3.10(b)

TABLE - 3.16**Diagnostic Tests for Deseasonalised Monthly Series :1985:04 to 1991:06**

Specific ations*	Runs Test of Autocorrelation (RUNS)	CHI-Sq Test Normality (χ^2 Values)	BPG Test Heteroscedasticity (χ^2 Values)	Harvey Heteroscedasticity (χ^2 Values)	RESET Misspecification (F Values)
1	83 runs (40p, 36n)	10.4601 (2)	10.181 (3)	11.344 (3)	3.1282 (1, 71)
2	33 runs (38p, 38n)	14.4691 (2)	8.6641 (4)	12.387 (4)	19.198 (1, 70)
3	39 runs (39p, 37n)	11.4836 (2)	9.9052 (4)	11.378 (4)	6.1187 (1, 70)
4	27 runs (40p, 36n)	24.4838 (2)	4.5021 (3)	3.0322 (3)	26.565 (1, 71)
5	25 runs (42p, 34n)	26.4171 (2)	6.0340 (3)	5.5330 (3)	12.309 (1, 71)
6	31 runs (50p, 26n)	4229.052 (2)	3.8372 (3)	18.392 (3)	2.4218 (1, 71)
7	31 runs (46p, 30n)	4554.061 (2)	3.9110 (4)	14.380 (4)	6.4207 (1, 70)
8	27 runs (47p, 29n)	4211.543 (2)	4.245 (4)	20.289 (4)	4.0268 (1, 70)
9	23 runs (42p, 34n)	3355.272 (2)	2.3731 (3)	4.6810 (3)	16.4411 (1, 71)
10	23 runs (40p, 36n)	3079.725 (2)	3.2810 (3)	2.8741 (3)	10.6022 (1, 71)

Note: p and n inside parentheses of column (2) refer to positive and negative runs respectively.

Degrees of freedom are presented inside parentheses.

* Specifications (1) to (10) are the same as listed in table 3.10(b)

TABLE - 3.17**Diagnostic Tests for Deseasonalised Monthly Series :1991:07 to 1995:10**

Specific ations*	Runs Test of Autocorrelation (RUNS)	CHI-Sq Test Normality (χ^2 Values)	BPG Test Heteroscedasticity (χ^2 Values)	Harvey Heteroscedasticity (χ^2 Values)	RESET Misspecification (F Values)
1	14 runs (28p, 23n)	2.0642 (2)	2.7444 (3)	2.6751 (3)	5.3761 (1, 46)
2	16 runs (30p, 21n)	5.6784 (2)	0.6151 (4)	7.444 (4)	12.409 (1, 45)
3	16 runs (29p, 22n)	5.3671 (2)	0.5072 (4)	4.6382 (4)	16.281 (1, 45)
4	12 runs (27p, 24n)	2.8616 (2)	0.8331 (3)	4.5533 (3)	18.252 (1, 46)
5	14 runs (30p, 21n)	4.1968 (2)	0.5641 (3)	5.0360 (3)	20.031 (1, 46)
6	22 runs (29p, 22n)	8.7346 (2)	3.6192 (3)	13.331 (3)	1.8945 (1, 46)
7	16 runs (28p, 23n)	14.4842 (2)	1.8242 (4)	4.862 (4)	3.1065 (1, 45)
8	16 runs (29p, 22n)	13.0036 (2)	2.2442 (4)	4.0141 (4)	3.5476 (1, 45)
9	16 runs (29p, 22n)	14.0891 (2)	1.8071 (3)	5.0400 (3)	2.8198 (1, 46)
10	18 runs (29p, 22n)	13.4476 (2)	1.7200 (3)	8.6731 (4)	3.0911 (1, 46)

Note: p and n inside parentheses of column (2) refer to positive and negative runs respectively.

Degrees of freedom are presented inside parentheses.

* Specifications (1) to (10) are the same as listed in table 3.10(b)

CHAPTER - IV

STABILITY OF DEMAND FOR MONEY

4.1 Introduction

A stable demand function for money has long been perceived as a pre-requisite for the use of monetary aggregates in the conduct of monetary policy. Proper management of monetary policy and its effectiveness to influence the real economy call for a stable relationship between money demand and its determinants such as real GNP, prices and interest rate. The importance of a stable money demand function for the conduct of monetary policy can be illustrated with the standard IS-LM framework where interest rate and GNP are treated as endogenous variables. A stable demand for money in this context, allows the slope and position of LM curve to be determined given the knowledge of quantity of money. This follows that given the knowledge of IS curve, changes in money will exert a predictable influence on GNP. Further, the monetarists claim that the money multiplier is more stable than fiscal multiplier. A necessary condition for stable money multiplier is a stable money demand function. An unstable demand for money would make impossible or difficult to predict the effect on interest rate and hence, on aggregate expenditure of a given change in the money supply. Hence, the efficacy of targeting money supply essentially rests on the stability of money demand function. It is in this context, Rangarajan (1989) argued that, "if one were to deny the existence of a reasonable stable demand function for money, there will be little scope for monetary policy to play the role in inflationary management".

One of the major concern of the monetary authorities is to have a fairly accurate idea about the monetary transmission mechanism to have a predictable influence of monetary targeting. The classicals and monetarists maintain that there exist a stable and

predictable link between money and the ultimate goal variables - income and price level. This assertion has major implications. First, changes in money supply would produce predictable changes in real income and price level. Second, the monetary authority can bring about changes in prices and income by controlling money supply. Therefore, monetarists consider monetary aggregates (bank reserves, monetary base, money supply etc.) as the most important target of monetary policy. By controlling monetary aggregates, the central bank can achieve its policy objectives, namely, price stability, economic growth and full employment. Friedman and Schwartz (1963) has asserted that, "applicable changes in the rates of growth of money stock is a necessary and sufficient condition for applicable changes in the rates of growth of money income". The theoretical and policy conclusions stated above are based on a stable money demand function.

The transmission mechanisms of how money affects the economy is neither static nor uniform across countries and over the years. Since mid 1970s, sweeping changes have been taking place in the financial systems all over the world. It is but natural for the transmission mechanism to undergo changes possibly making the earlier channels less effective compared to the new ones. Moreover, the stability property of demand for money has been seriously questioned after the missing money episode of 1973.

There is a conceptual problem also with respect to measurement of liquidity after the changes have occurred in the financial system. Firms and households have diversified their portfolios and hold a variety of assets to optimise their return. It has become increasingly difficult as to which assets should be included in the measure of liquidity. In the whole spectrum of financial assets, instruments with investment characteristics are generally excluded from the measure of liquidity although they can be converted into liquid assets without much difficulty. The conversion cost, in fact, declined dramatically over time. It is this characteristic of assets which generates instability in the system in a number of ways. One such instability discussed in the literature relates to the demand

function. One is therefore, naturally encouraged to explore to what extent the financial innovations and deregulatory changes have been responsible for money demand instability. Such an attempt is made in the present chapter by considering the Indian case.

It has been recognised that money demand models based on Goldfeld (1976) or one of its variants, suffer from spurious inference, since the least square techniques have been applied on relationships involving non-stationary variables. There is therefore, a need to re-estimate the money demand relation in India by employing cointegration techniques. Further, the long run equilibrium relationship that assumed to exist between real money balances and a given set of variables will be examined in the present chapter.

Thus, the present chapter focuses on the issue of stability of demand for money and the long run relationship underlying the money demand function, so that the transmission mechanism can be better understood in the light of phenomenal changes in the Indian financial sector.

4.2 Survey of Empirical Studies on Stability of Money Demand Function

Evidence on demand for money at least prior to mid 1970s, suggested a stable relationship between money, output and prices in a large number of countries. Laidler (1977) asserted that the large body of research carried out over the post-War period showed a stable demand for money function. The situation thereafter has changed. Studies (Artis and Lewis, 1976; Goldfeld, 1976; Hacche, 1974) undertaken thereafter questioned the stability of demand for money relation.

Most of the studies undertaken during 1960s and early 1970s (for instance Meltzer (1963), Brunner and Meltzer (1963), Laidler (1966) and Goldfeld (1973) for the US and Laidler and Parkin (1970) for the UK) have found stable and well determined money demand functions. The precise form of equation and the type and period of data used

varied across the studies; static long run equations were common for annual data, while studies using quarterly data generally estimated short-run equations which allowed for adjustment and expectational lags. The results, for the US in particular, were broadly invariant to the precise data period involved and the particular definition of money, interest rate and scale variables used. Consequently, nobody seriously questioned that the demand for money was stable. At this juncture, it is pertinent to quote Laidler (1971) who claimed that, "the evidence for Britain certainly points to the existence of a stable demand for money function in that economy. For the United States the evidence is overwhelming, and for Britain it is at the very least highly suggestive".

In contrast, studies undertaken since the mid-1970s, using quarterly data for both the UK and US, have often had difficulty in modelling the money market and have consequently questioned the existence of a stable demand for money relation. Indeed, this problem was not solely confined to the UK and US. The period since the mid-1970s has been marked by unusual economic conditions such as supply shocks, high and variable inflation, recession etc., in many countries. The period also coincided with substantial institutional changes brought by financial innovation and deregulation. As a result, what has been really thought of as "money" ceased to remain the same. The role of demand deposits as a close substitute to cash holding through prohibition of interest payment has since changed. Commercial banks in fact have been offering compensation to demand deposits by way of repurchases of securities at higher prices, cash management services at rates tied to market interest rate etc.. The concentration account, zero balance account allow firms to manage their deposit balances more carefully (Simpson and Porter, 1980). Among the regulatory changes, authorisation to commercial banks to open interest bearing checkable deposits and growth of negotiable order of withdrawals (NOW) in the US have blurred the distinction between interest bearing and non-interest bearing deposits. Non-inclusion of these innovations might have contributed to instability of the money demand functions.

Thus, with the deepening and widening of the financial systems across the countries tended to provide a very severe test to the stability of demand for money relationships. During this period, a number of shortcomings in the conventional money demand functions have been exposed. Repeated break down of the existing models in the face of newly emerged data has compelled the researchers to improve the demand for money function, in terms of more sophisticated examination of dynamics, functional forms and expectations.

In the UK, Hache (1974) found that equations estimated from quarterly data for 1964 to 1971 severely underestimated the broad money aggregate-M3, during 1972-74. He pointed out that this was specially for that portion of M3 held by the company sector. He argued that the major reforms of the UK monetary system in 1971 had led to competition by the clearing banks for large wholesale deposits. The clearing banks also began issuing their own certificates of deposits. These developments increased the attractiveness of M3 to the asset holders and hence led to an upward shift in the demand for M3 function.

Artis and Lewis (1976) showed that the Bank of England's demand for money functions seriously under-predicted monetary growth during the period 1971-73. Their study was based on quarterly data from 1963 to 1973. They suggested a very different reason from that of Hache for the break in the money demand relationship. They argued that it was no longer reasonable, during the post 1971 period to treat the supply of money as endogenous or "demand determined" after the competition and credit control reforms in the UK which created a new spirit of competition in the banking system and abolished the direct control of bank advances. These factors with several other changes led to large independent changes in the money supply in the UK during 1970s and had led to disequilibrium in the money market. Their model was estimated using both M1 and M3

money aggregates, GDP as income variable, domestic borrowing requirement and high powered money stock as other determinants. The first two of these measures proved exerting to be important influences on the M1 and the third one on the M3 functions.

Hamburger (1977), in a study on the US money demand function for the period 1955:2 to 1972:4 focused upon the importance of including a broad spectrum of asset yields in the money demand function. Such an approach confirms to Friedman's demand for money function being based upon the monetarist view that money is a substitute for a wide range of assets - both financial and real. Hamburger specified a function for M1, in which the real demand for money depended upon real income, the lagged money stock and three rates of return representing the return on time deposit, the long term bond rate and dividend-price ratio ruling the stock market.

The belief that there had been a general break down in all the UK demand for money function was first seriously questioned by Coghlan (1978). Coghlan started from a reasonable proposition that no general theory of the demand for money could be applicable regardless of the definition of money applied. Since, M1 could be regarded as demand-determined throughout 1960s and 1970s, Coghlan retained it as the dependent variable for his analysis. Equations incorporating both adjustment and expectational lags were estimated for quarterly data 1964-1976. The lag structure taken are complex and different for each explanatory variables. Coghlan concluded that there is no evidence of a break down in the demand function for narrow money in the 1970s.

Hafer and Hein (1979) criticised Hamburger's equation. They showed that exclusion of money market and the constraining of the long -run real income elasticity to unity, were not supported by the data used to estimate the equation. First, the coefficient on real GNP is significantly different from unity when the restriction is removed. Second, when the commercial paper rate was added to the equation, it is statistically significant.

Finally, when both of these changes are made simultaneously, the root mean squared error for dynamic forecasts exceeds that of the Goldfeld equation. Thus, the ability of Hamburger's equation to forecast well out of sample appears to rest on estimation results which depend on restrictions not supported by the estimation sample data.

Heller and Khan (1979), expanded the range of opportunity cost of money in their equation to include the entire term structure of interest rates. This is done by approximating the yield curve at any point of time by a quadratic function that characterises the term structure by three parameter - its level, slope and curvature. These parameter estimates are then entered as proxies for the entire term structure in Heller and Khan's money demand regression which are estimated over 1960:3 to 1976:4.

Hendry (1979) also found that the demand for M1 functions exhibited greater parameter stability when a more flexible lag response was allowed in a model in which the long run real demand for money depended upon real income, rate of interest and expected rate of inflation.

Kimball (1980) provided evidence that it was cash management, rather than repurchases (RPs) themselves, that explained the money demand shifts. He noted that the adoption of modern cash management techniques is likely to result in a rise in the volume of wire transfers. Thus, the number of wire transfers can be used as a proxy for the utilisation of cash management practices.

Whereas in the UK it has been the broader money equations which have proved to be particularly difficult to model, in the US it is the narrow money demand function which has been more problematic. Goldfeld (1976), Enzler et al.(1976) and Laidler (1980) all observed that the conventional restricted distributed lag models were prone to over

predict the stock of narrow money in the early 1970s giving rise to the concept of "missing money".

Judd and Scadding (1982) felt that the most likely cause of this apparent instability in the demand for money function was institutional changes and in particular innovation in financial arrangements, which allowed the private sector to economise on its holdings of transaction balances. These changes appear to have been induced by high interest and inflation rates, and the existence of legal impediments to the payment of a market rate of return to transaction balances.

Several researchers investigated whether financial innovation and deregulation had led to instability in the money demand function during 1970s. Garcia and Park (1979) like Judd and Scadding, observed that instability in demand for money was due to financial innovation. In their study on the US data from 1955:2 to 1976:4, they showed that the demand function was considerably stable over the period 1974-1976 when the dependent variable included repurchases (RPs) than when it did not. With this redefinition, the estimated coefficients on income and the lagged dependent variable were not substantially different from those of Goldfeld's (1976) pre-1974 results.

Regression evidences also lend support to the view that ratchet variables, hypothesised to reflect reduction in the transaction costs or in the variance of firms cash flow, can help to account for the money demand shifts. Ratchet on interest rate and income have been tried by Enzler et.al. (1976), Goldfeld (1976) and Simpson and Porter (1980).

Spindt (1987) characterised the unsettled flavour of literature by noting that, "researchers either seem to conclude that no explanation is adequate to explain the recent money demand puzzle or that the authors own specification still works just fine so that

there is not any puzzle at all". Spindt seems to be suggesting an alternative paradigm, which is echoed in recent reviews of empirical findings of money demand functions (Judd and Scadding (1982) and Gordon (1984)).

The studies reviewed above seem to have heavily relied upon the parametric regression technique which is based on ordinary least square (OLS) for establishing stability of the money demand relationship. The drawback of this approach however, has been well documented in time series literature. Since most of the variables constituting the money demand functions are now known to be non-stationary at their levels, OLS regression techniques may give misleading results. Granger and Newbold (1974) argue that the levels of many economic time series are non-stationary; their sample paths are well presented by integrated processes of the ARIMA type; and often they appear to be near random walk. It is further argued that regression equations which relate such time series frequently, have high $\bar{R}^2$ yet also typically display highly autocorrelated residuals, indicated by very low Durbin Watson statistics. In such a situation, it is rightly contended that the usual significance tests about the regression coefficients are very misleading. The sampling experiments of Granger and Newbold conducted provided with strong evidence that the conventional significance tests are seriously biased towards rejection of null hypothesis of no relationship and hence acceptance of a spurious relationship, even when the series are generated as statistically independent random walk.

Since the publication of Granger and Newbold paper (Granger and Newbold (1974)), there has been enormous growth in literature to deal with such type of problems. The concept of cointegration proposed by Engle and Granger (1987) is an attempt to salvage the regression techniques from the problem of non-stationarity and has emerged as a potent method in the area of applied econometrics.

Recently, the cointegration and error correction framework has become a standard tool to determine money demand stability. Applying cointegration techniques to quarterly data for narrow money demand function for the period 1967-86, Hall et al.(1990) found that a long run cointegration vector can not be established unless a measure of financial innovation is included among the set of explanatory variables.

Hall et al.(1990) as well obtained cointegrating vectors for both M3 and M4, using quarterly data for the period 1968 - 1987. The ratio of M4 to nominal income is linked to wealth to income ratio, rate of inflation and variable based upon past falls in the stock market index. They felt that different rates might be appropriate for different sectors of the economy. General to specific modelling techniques were used to estimate short equation, with preferred relation linking the appropriate change in M4 holding to the lagged change and an error correction mechanism. A similar cointegrating vector and short run dynamic equation was obtained for M3.

Another study by Glenn Otto (1990) for Canada found a unique cointegrating vector for M1, the price level, real output and the nominal interest rate for quarterly data over the period from 1956 to 1988. Although Otto found the unique cointegrating vector using the Johansen methodology. He found evidence of a permanent downward shift in the steady-state demand for M1 at the end of 1981.

Cointegration techniques were also applied to the analysis of the US demand for money by Miller (1990, 1991) and Hafer and Jansen (1991). All these studies found that a long run cointegrating relationship existed between the broad M2 aggregates, real income, prices and interest rate variable, but that the existence of a long run equilibrium relationship for narrow money demand function was doubted. Miller (1991) results were based upon the quarterly data for the period 1959-87, confirmed by using Engle-Granger cointegration techniques, whereas, Hafer and Jansen(1991) employed the Johansen's

cointegration techniques on the quarterly data for a longer period encompassing the years from 1915 to 1988.

Dickey et al.(1991) estimated quarterly (1953 -1988) money demand function for the US economy following methodologies suggested by Johansen, Stock Watson and Engle Granger for both narrow and broader money demand functions. It was found that broad money functions were found to be more stable compared to the narrow aggregates.

A number of recent studies have searched for a stable long run money demand function in many countries. The goal of these papers has been primarily to explain the instability that has been found in money demand relationships since the early 1980s. The cause of this instability has generally been attributed to the many financial innovations that occurred during that period.

In two recent papers Hendry and Ericsson (1991) and Baba, Hendry and Starr (1992) estimated money demand relationship for M1 in the US and UK respectively. The authors believe that instability in money demand functions is more likely the result of model misspecifications than any fundamental behavioural shifts in demand. The latter paper lists four possible types of misspecification that could arise: (a) incomplete dynamic structure, (b) inadequate treatment of M1's own yields and those of alternative monetary instruments in the presence of financial innovations, (c) inappropriate exclusion of inflation from the model , and (d) the omission of the yield and risk level of other assets such as long term government bonds. These studies found that once the short-run dynamics were properly modelled, it was possible to find stable long run money demand relationship for M1, even when the 1980s were included. The primary variables used to achieve this goal were interest rates on new financial innovations. Other important variables were the inflation rate, the yield curve and the volatility of the long term bond rates.

Haug and Lucas (1994) found a stable cointegrating relationship for real M1 in Canada from 1968 - 1990 but the stability test failed when a longer sample from 1953 to 1990 was used. Also, they obtained an implausibly low income elasticity and an insignificant interest rate elasticity. These results may have been due to not properly accounting for the financial innovations, even though the test implied stability.

In a study, however, Hess, Jones and Porter (1994) criticised the Baba, Hendry and Starr paper on the ground that, once the data for the 1988-1993 period were added to the sample, most of the "good" results disappeared. Many of the parameters become unstable or insignificant and the predictive power of the model was substantially reduced. The quality of the results of the Baba, Hendry and Starr model was found to be overly sensitive to the specification of the lag lengths and to minor changes in the learning functions.

In a study Hendry (1995) estimated the long run money demand relationship over the period from 1956-1993 for Canada. This paper examined the relationship among M1, output, prices and interest rates at monthly and quarterly frequencies and over different sample periods. The Johansen-Juselius multivariate approach was used to ensure the stability of the system while enhancing the estimates of the cointegrating relationships themselves. By comparing the parameter estimates and dynamic behaviour of the estimated systems with theoretical prior, the study identified unique, well-specified and stable cointegrating relationships among M1, output, prices and an interest rate.

Empirical studies of money demand function generally adopted a partial adjustment model which typically treats the real money demand as a dependent variable, with real GNP and interest rate as well as lagged dependent variable, as an explanatory variable. The representative of these studies is the study by Goldfeld (1973). At least prior to the mid 1970s, the relationship suggested a stable relationship underlying the money demand

function. In the mid 1970s, however, this model began to lose its adequacy in explaining developments in money demand as major divergence emerged between the forecasted and the actual values (Goldfeld, 1976). This phenomenon persisted despite effort to rectify the situation such as adding new explanatory variables to the conventional functions. This situation led many monetarists to suggest that financial innovation and deregulation resulted in the shift in money demand function (the "missing money" phenomenon).

The episode of missing money phenomenon led to two strands of research on money demand studies. First, a number of researchers have modified the existing specifications to capture the effects of innovation and financial deregulation since 1970s. Research on this line had been carried out by including extra variables such as interest rate changes (Goldfeld, 1976), yield on certificate of deposits (Hacche, 1974), Bank debits (Goldfeld, 1976, Hamburger, 1977), time trend (Lieberman, 1977), Brokerage fees proxies (Porter and Offenbacher, 1982) in the money demand functions. Second, the experience during the mid 1970s led others to reevaluate the conventional money demand specifications. Artis and Lewis (1976), Carr and Darby (1981) presented empirical models emphasising the problem of endogeneity of money supply. And the research on this line led to modelling "buffer stock" approach to demand for money. In addition, Gordon (1984), Granger and Newbold (1974) and Laidler (1980), raised some important issues concerning the econometric properties of estimated money demand equations. Granger and Newbold asserted that non-stationarity in the log-level or log-difference of the economic variables produced spurious regression results, throwing most of the research result into serious doubt and prompting the researchers to revisit the money demand function. The concept of cointegration, proposed by Engle-Granger (1987) is an attempt to salvage the regression techniques from the problem of non-stationarity. Since then, cointegration and error correction framework has become a standard tool to determine long run equilibrium relationship underlying money demand function. Since then studies (Dickey, et al. (1991), Hall et al. (1990), Miller (1990;1991), Hendry, (1995), Hendry et

al. (1992)), have investigated the presence of long run equilibrium and stability of money demand function using this technique.

Searching for the stability property of money demand relation has undergone an evolution since the "missing money" episode. The researchers across countries have revisited the money demand function to incorporate the instruments of innovation and deregulation to arrive at a stable money demand relation for the purpose of effective monetary targeting. The financial innovation and deregulation is not limited to a particular country. Economies have experienced this changes over different period of time. In India too, the above changes have taken place in the recent past, which brought about a new element in the money and securities markets. In the light of this, money demand would have to be studied afresh with an eye on the possible shift in the function. Further, the framework for empirical testing has also undergone a radical change, as most of the recent studies in the literature have used cointegration framework to test the stability property of money demand. Hence, it is essential to use the cointegration framework in the present context to test the stability property of the function.

4.3 Empirical Evidence on Stability of Demand for Money in India:

A vast amount of literature exists on the stability of the demand for money function in India. Controversy regarding the estimation of the money demand function centred around the appropriate measure of money (i.e., M1 or M2 or M3), the choice of appropriate scale and opportunity cost variables, for monetary targeting. Much of the existing research has been done to ascertain the stability property of money demand function since 1970s..

In the existing literature, the empirical evidences on stability of demand for money in India since the mid-1970s have been somewhat mixed. Mahajan (1979) by using varying parameter model for the period 1950-1975 found that both narrow money (M1)

and broad money (M2) were equally unstable, though there was evidence of increased stability with use of the broader M2 aggregate. His results showed that narrow money definition M1 and broad money definition M2 were equally unstable and had gone through a permanent change. To achieve stability Mahajan modified his functions to include both long and short run interest rates, despite the potential problems of multicollinearity. When the specifications of both M1 and M2 included more than one interest rate, the functions turned out to be stable. Laumas (1978) tested stability of demand for money in India during 1950-1965 using varying parameter model developed by Cooley-Prescott (1976). The study concluded that the demand for money in India are essentially stable.

Gupta (1979) investigated Indian money demand for the period 1950-75. He showed that the standard money demand function in India had probably not been stable in the Cooley-Prescott sense, either over 1950-65 or 1950-75. According to Gupta, a contrary conclusion was reached by Lumas (1978) for the period 1950-65 which could be due to the application of a method that might have been inappropriate for the small sample he had. In Gupta's view Mahajan's conclusion that the functions were unstable over the period 1950-75 might be correct, but his method was also possibly not entirely appropriate, and the conclusion seemed to rest on somewhat unusual specification adopted. The inference that money demand with several interest rates showed stability was somewhat doubtful, but introduction of lagged money stock variable could tend to stabilise the function.

Deadman and Ghatak (1981) found that for a standard demand for money function for India, there is a strong indication of structural instability for any narrowly defined monetary aggregate over the period 1948-76. The use of M3, the most broadly defined aggregate used in the study, indicates much greater stability over this period when compared to the narrowly defined money. In all cases, the usual findings of greater

importance of income over interest rates as explanatory variables in the demand for money function was confirmed.

The main purpose of the study by Ram and Biswas (1983) was to investigate stability of demand for money in India for the period 1950-1975. The results indicated that both M1 and M2 seem to have been unstable over the sample period, and an increase in the number of interest variables did not help. However, the introduction of a lagged money stock regressor reduced instability. It seems useful to look at closer to determine the source of divergence between the results of the present study and those of others and to examine whether any specification and/or procedural modifications would yield more consistent results. This paper makes two methodological points: (i) within the Colley-Prescott varying parameter framework, the hazards of using the maximum likelihood method when one is working with small sample; (ii) the study shows the potential usefulness of the first principal component as a composite interest rate variable in place of several interest rate variables.

Kamath (1984) examined the specification and stability of demand for money function for India and the issue of appropriate opportunity cost variables to be modelled in the money demand function. The study used time series data on money stock (both M1 and M3), scale variable - gross domestic product, call money rate, government bond yield rate and consumer price index for the period 1951-1976. The study examined partial adjustment and adaptive expectations mechanism to test the existence of adjustment lags and importance of permanent values vis-a-vis current values of the variables. From the study, it is found that the interest rate variable is not an appropriate argument in the money demand function. The results show that there exists a stable money demand function for India with income as a scale variable and rate of interest as a relevant variable.

Kamaiah (1985) showed that the stability of demand for money in India during 1950-1978 depends upon : (i) the definition of money, (ii) the combination of determinants, (iii) the types of functional forms. He concluded that the exhibited instabilities in money demand function were due to the functional misspecification. He further concluded that demand for money turned out to be stable when the functional misspecification was corrected.

Bhoi (1992) examined the instability of money demand relation with the use of step-wise regression exercise for Indian data for the period 1960-91. He observed that: (i) the structural break in the conventional money demand function appears to have set in since 1980s, (ii) the poor predictability power of the conventional money demand function was due to misspecification (inadequate to capture the recent changes in the financial innovation), and (iii) the missing variables has to be modelled appropriately to have a stable money demand function.

The studies carried out the search for stability of money demand function have shown a mix of evidence on the relative stability from different specifications and different money stock measures. Most of them have continued to employ single equation OLS models or a traditional simultaneous equation system in which money demand continues to be estimated through least squares. As late as 1990s, studies continued to rely on traditional econometric techniques that do not provide for unit root testing for stationarity of the variables.

Moosa (1991) highlighted the limitations in the earlier studies in respect of testing for stationarity. Based on this criticisms, an alternative approach was proposed to estimate the demand for money function using three monetary aggregates: currency in circulation, narrow money and narrow money. A sample of 76 quarterly observations was used covering the period 1972:1 to 1990:4. By using the cointegration techniques

developed by Engle-Granger and Johansen-Juselius he confirmed the narrow money stock was more stable than broad money. The results from error-correction model were much better in the case of currency and narrow money than in case of broad money.

Nag and Upadhyay (1993) estimated money demand functions for India using Johansen (1988) cointegration techniques. The sample period used in the study was from April 1982 to March 1991. The results showed the existence of a reasonably stable money demand function for India with yield on ordinary shares emerging as good proxy for opportunity cost of narrow money. An error correction model for money demand was identified and it was observed that movements in gold prices did have an impact on the level of money demand in the short run.

Bhattacharya (1995) also applied cointegration and error correction mechanisms on Indian annual data for the time period 1950-1990. The study concluded that narrow money (M1) had long run equilibrium relationship with GNP and a few measures of opportunity cost of holding money. In contrast, broad money (M2 or M3) did not have long run stable relationship with real GNP and either of the rate of interest (long or short term).

Joshi and Sagar (1995) also re-examined the stability of demand for money in India for the period: 1960-61 to 1992-93 with the help of recent techniques and some new determinants viz., exchange rate and market capitalisation (a proxy for financial wealth). The results based on Johansen's multivariate cointegration techniques and CUSUM square stability test found no evidence of in-sample instability both for narrow and broad money demand function.

In India, there have been several attempts over the years to estimate the stability of money demand function considering either narrow or broad definition of money. The

search for stability centres around the choice of appropriate measure of money and the suitable determinants of the money demand function. Most of the studies support the hypothesis of stable demand function for money with a few exception (Bhoi, 1992, Gupta, 1979, Ram and Biswas, 1983). The studies that found the evidence of instability have suggested that structural breaks or instability of the money demand has occurred due to (i) inappropriate methodology used and (ii) misspecification (inadequate to capture the changes in financial innovation and deregulation). Dissatisfied with the conventional methods, the studies during 1990s, started using Engle-Granger (Moosa, 1991, Bhattacharya, 1995) and Johansen-Juselius (Joshi and Sagar, 1995, Nag and Upadhyay, 1993) methods and confirmed that long run equilibrium relation existed either for both the aggregates (Joshi and Sagar, 1995, Nag and Upadhyaya 1993) or that narrow money aggregate was more stable compared to that of broad definition of money (Bhattacharya, 1995 and Moosa 1991).

Though there have been regular attempts to resolve various issues associated with the money demand relation, still the issue of stability of money demand function is far from settled in the Indian case. The issue needs further empirical attention in an environment of phenomenal change of financial innovation, deregulation and institutional changes during recent past. Further, the framework for empirical testing for stability of money demand function has undergone radical changes. Hence, it is essential to use cointegration approach to test the money demand function in the present context of the phenomenal changes. Specifically, the focus of the present chapter is to find out an appropriate monetary aggregate for effective monetary targeting for India.

4.4 Methodology: An Overview

4.4.1 Alternative Tests of Model Stability:

A structural relationship among variables is not time invariant, changes in these relationships are reflected in shifts of parameters involved. The shifts in parameter of a model can be studied by making use of residuals. The plot of residuals against time, most often may not fully reflect the sensitive departure in the model specifications or shift in the parameters. A common technique for capturing structural shifts is the well known Chow test. A particular limitation of this test is that it requires rather definite piece of information, viz., *a priori* knowledge of the exact point of time when structural change is taking place. Brown et. al. (1975) made use of recursive residuals to examine departures in the model specifications.

The technical details of the tests are presented in the Appendix -A which is placed towards the end of the thesis. Here we present only an overview of the various tests. We start with the Cusum Square test (BDE). Operationally, the test statistic (S_t) is plotted against time and the plot is examined in terms of the 99 % or 95 % confidence bounds around its mean path $E(S_t)$. For a two sided test of hypothesis, a linear confidence interval for S_t is constructed. If the plot of S_t stays outside the confidence bounds, the null hypothesis of no parameter instability is rejected, i.e., a structural break or shift in the model is said to have occurred at the corresponding point(s).

Brown et. al. suggested another test to detect the model stability over time with the use of recursive residuals. The test (CUSUM test) proposes a cumulative sum test statistics (W_t) and is plotted against time. In the present case also, the instability of the parameters will be indicated, if the plots of W_t crosses the significance lines.

An alternative test procedure to test the model stability is Harvey -Collier test proposed by Harvey and Collier (1977). The test is the related to the Cusum test discussed above. Under the null hypothesis of model stability, the test provides a t-statistics which is to be compared to the t -distribution with (T-K-1) degrees of freedom to derive at the conclusion about the stability of the model.

4.4.2 Testing Unit Root and Cointegration:

Before estimating the cointegration models, it is essential to examine the time series properties of the variables in level or in first differences. If the equation is estimated with data that are nonstationary, the application of OLS method would not yield a consistent parameter estimator. That is, the t-statistics of the estimated coefficients are unreliable since the underlying time series would have theoretically infinite variance (Hendry, 1986, Granger, 1986). Moreover, in estimating the cointegration, it is necessary that the variables should be non-stationary. Hence, the following, Dickey-Fuller (DF), Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), Bayesian and KPSS unit root tests are performed to know whether the process governing the concerned variables is stationary or not.

4.4.2.1 Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF):

It is necessary to start with a unit root test to check whether a given series say X_t is stationary or not. The Dickey-Fuller and Augmented Dickey-Fuller unit root tests are popular in the literature. The tests require estimation of the following equation

$$\Delta X_t = \mu + \alpha X_{t-1} + \sum_{i=1}^k \gamma_i \Delta X_{t-i} + \varepsilon_t \quad \dots(4.1)$$

where k is the value which ensure ε_t be a white noise series, Δ is the difference operator, α and γ_i are parameters. The above procedure is known as the ADF test. The DF test follows a special case of ADF test when summation part of the equation (4.1) is zero, that is when $k = 0$. The test statistics of DF and ADF are tested under the null hypothesis of non-stationarity against the alternative of stationarity.

4.4.2.2 Phillips-Perron:

Phillips and Perron (1988) have suggested an alternative unit root test. The advantage of this test is that it is neutral to the selection of lag-length in the ADF equation. Further, the error term over there could be serially correlated and heteroscedastic. This test also tested with the null hypothesis of non-stationarity and alternative of stationarity for which the procedure requires that the test statistics are to be negative and statistically significant in comparison to the tabulated value.

4.4.2.3 KPSS Unit Root Test:

It is well established that the standard unit root tests that are discussed above have unit root as its null hypothesis. And it is established that these standard unit root tests failed to reject the null hypothesis of unit root for many economic time series (Nelson and Plosser, 1982). It is because, these tests are biased in favour of the null hypothesis. They tend to accept the null hypothesis, except when there is strong evidence against it. Therefore, an alternative explanation for the common failure to reject a unit root is simply that the standard unit root due to Kwiatkowski, D, Phillips, P C B, Schmidt, P and Shin, Y (1992) tests are not very powerful against the relevant alternatives. Hence it has been suggested (Dejong and whiteman (1991), Diebold and Rudebusch (1991)) that it would be useful to perform test of null hypothesis of stationary as well as of unit root. KPSS unit root test provides a test of null hypothesis of stationarity against an alternative of unit root, to test whether the series is differenced stationary.

4.4.3 Cointegration:

Cointegration theory was developed by Granger and his associates to examine whether long run equilibrium exist between the variables (Granger , 1986, Engle and Granger, 1987).

Consider initially a pair of series X_t and Y_t , each of which is said to be integrated of order one, denoted by $I(1)$ and having no drift or trend in mean. It is generally true that any linear combination of these variables will also be integrated of order one. However, it is possible that there exist a linear combination say Z_t , such that it is $I(0)$ or stationary, it is said that X_t and Y_t are cointegrated.

However, when X_t is the vector of N components time series, each without trend in mean and each $I(d)$, $d > 0$. Then X_t will be said to be cointegrated $CI(d,b)$ if there exist a vector such that $Z_t = \alpha' X_t$ is $I(d-b)$, $b > 0$.

The case considered earlier has $N = 2$ and $d = b = 1$. Moving to a general values for N , d , b , adds a large number of possible interrelationships and models. In particular, α will not be unique, as there will be several equilibrium relationship linking $N > 2$ variables. If there are r vectors α , each of which produces Z 's integrated of order less than d , then r is called the "order of integration" and is easily seen that $r \leq N-1$.

4.4.3.1 Tests of Cointegration:

(i) Engle Granger Two Step Procedure:

Suppose that by using the unit root tests described above, we have detected that variables are non-stationary at levels or having random walk, but at first differences they

are stationary. It is then quite easy to test whether the combination of the variables are cointegrated. To ascertain this, Engle Granger (1987) propose a two step procedure, where the first step is running the OLS regression of the combination of variables and extracting the residuals from the regression. And the second step is testing or ascertaining the stationarity of these residuals. To test the stationarity of the residuals, the usual unit root tests are followed.

(ii) Johansen -Juselius (JJ) Procedure:

Tests of Cointegration such as Engle Granger two step procedure allows for the estimation and testing of unique cointegrating vector, even though there could be as many as the number of variables involved less one. As well since this single equation method estimates the cointegrating vector with the data on the levels only, it has been criticised for ignoring potentially valuable information contained in the short run fluctuation of the variables. Moreover, the Engle-Granger test procedure relies on the OLS residuals for the estimation of the test statistics. Johansen (1988) outlined a method which was later expanded by Johansen and Juselius (1990), which allowed for the testing of more than one cointegrating vector in the data and for the calculation of maximum likelihood of these vectors. This procedure yields two test statistics of the number of statistically significant cointegrating vectors. One is λ - max, which compares the null hypothesis $H_0(r)$ with an alternative $H_1(r+1)$ where r is the cointegrating vector. The second test is the trace test which examines the same null of $H_0(r)$ versus a general alternative, $H_1(p)$ where p is the number of variables. In this framework, it is desirable to obtain at least one cointegrating vector, $r = 1$ to establish the model. If one gets $r = 2$, then one could in principle assume that the system is stable in more than one dimension.

4.5.1 Test Result of Model Stability:

Stability of demand for money has been examined in this study with the help of the tests based on recursive residuals. The tests employed here have already been discussed in the methodology section of this chapter. These tests are carried out on both annual as well as monthly data. The specifications considered are the same as those listed in the tables 3.2 (a) and 3.10(b) of chapter III.

4.5.1.1 Results form Annual Data:

Table 4.1 gives the summary of results of the forward recursive residual tests on structural breaks for each of the specifications given in table 3.2 (a) for annual data for the period 1960-61 to 1995-96. The possible structural breaks for the sample period of money demand functions was tested both at 1% and 5% level of significance.

The results suggest that specifications (4), (5) and (6) show signs of structural breaks only at 5% significance level. However, there are no signs of break at 1% level of significance. From the results it is clear that all the specifications showing sign of structural breaks are related to m1 demand functions. The possible period of break starts at 1976-77 and continues till 1986-87. The results confirm that Indian economy experienced structural breaks during the early 1980s. In contrast to the structural breaks for m1 specifications, the results for m3 specifications show no sign of structural breaks for all specifications at 1% or at 5% significance level during the sample period.

It has been believed that these breaks during the early 1980s may have been due to the financial innovation in the money market and widening the institutional base by establishing an impressive network of banks and financial institutions, i.e. due to widening and deepening the financial system in India since early 1980s.

4.5 Empirical Results:

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stable. It is to be noted that the inference on the structural breaks varies across the tests for the m3 functions. Graph (7) shows that while the function is stable at 1% level of significance for both the tests, the plottings crosses the 5% bounds exhibiting structural breaks for the sample period. Graph (8) depicts that the inference of structural break varies across tests. While structural breaks are detected with the help of BDE test statistics, the CUSUM plots are well inside the significance bounds. So the results suggest that in case of Cusum plots, specifications (7) and (8) which include either of the interest rates and market capitalisation as the explanatory variables, are stable. Further, the test (CUSUM) rejects the null hypothesis of stability in the case of rest of specifications for m3 money (eg. (9), (10), (11) and (12)). The BDE plottings show that all the specifications with m3 as dependent variable (graph (7) to (12)) are stable over the sample period. The graphs for the BDE test show that in all cases, the test statistics (s-value) are within the 1% and 5% significance bounds except graph (8) where the s-value has crossed the significance lines for a short period. Hence, there is no major kink visualised during the sample period for the m3 money demand functions.

The main feature of the findings from these two tests (Cusum and Cusum Square) is that the inference on structural breaks varies across the tests and specifications. Moreover, the tests found that a structural break has been visualised for m1 money demand specifications in contrast to the m3 money demand specifications which have been more or less stable.

The present study has also used the Harvey-Collier t-test to test the stability of the money demand functions under the null hypothesis of model stability. The Harvey-Collier statistics with significance level for alternative money demand specifications on annual data are presented in table 4.3.

The result shows that the null hypothesis of stability could not be rejected for specification (1) and (2). Whereas, in case of specifications (3), (4), (5) and (6) with LREER, WINFL, IE and VRI as explanatory variables, the null hypothesis is rejected even at 1% level of significance. Hence, it is clear that null hypothesis of model stability is rejected for all those specifications that are detected to be unstable by the Cusum plottings. The test statistics for m3 money demand specifications show that all the specifications save specification (10) and (11) are stable. For these two specifications where demand function is modelled with either IE or VRI as one of the explanatory variables, the statistics is significant only at 5% significance level. For all other specifications, the null hypothesis could not be rejected even at 5% level. So, we conclude that m3 money demand functions are more stable in comparison to the m1 money demand function for the sample period.

4.5.1.2 Results from Monthly Data:

The same set of stability tests that are employed on the annual data are repeated on the monthly data from 1981:04 to 1995:10. The same 10 alternative specifications with index of industrial production as a proxy for "scale" variable, call money rate as a proxy for "opportunity cost" variable, two share price indices - RBI ordinary index and BSE index and Real Effective Exchange Rate (REER), which are listed in table 3.10(b) of chapter III, are considered here for the test of stability.

The results from forward recursive residuals for all ten specifications at both 1% and 5% level of significance are presented in table 4.2. From the results it is clear that all the specifications with m3 money as dependent variable, show structural break both at 5% as well as 1% level of significance. Whereas, the result for m1 money demand specification suggest that all the specifications are stable. For all the m3 money demand functions that are detected to be unstable, the structural breaks are visualised during the

period: late 1987 till mid Of 1990. The results thus confirm that structural shifts have occurred in the m3 money demand specifications in contrast to that of m1 functions.

The BDE test is also performed on the monthly data. The plots of BDE test statistics for all ten specifications(see table 3.10(b) of chapter III) are shown in graphs (13) to (22). Each graph may be identified by the dependent variable (i.e. m1 or m3) and the relevant alternative explanatory variables. In each graphs, the s-values are plotted with either 1% or 5% confidence bounds. Graphs (13) to (17) are for the m1 functions and graphs (18) to (22) are for the m3 money demand functions.

Graphs (13), (15) and (17) provide support for stability at both 1% as well as 5% significance levels, as the s-value lies within the confidence bounds over the sample period. whereas, graphs (14) and (16) indicate the sign of over flowing s-values off the confidence bounds for a shorter period. The evidence of kink is exhibited during the late 1980s and early 1990s. In contrast to the stability of most of the m1 money demand specifications, graphs (18) to (22) indicate the sign of structural break fort all the m3 money demand functions over the sample period. The plots of s-values of all m3 functions have crossed both the 1% and 5% confidence lines.

The Harvey-Collier test statistics for all the ten money demand specifications are presented in table 4.4. The test statistics (t-statistics) shows that the null hypothesis of model stability is rejected for the specifications (4) and (5). Except these two specifications, all other specifications are found to be stable under this test.

To conclude, the Cusum square test (BDE test) or the plottings of s-values for deseasonalised monthly series show that the m1 demand function is stable during the sample period with the exception of specifications in which RBI share price index appears

as one of the explanatory variables. In contrast to that, the s-values cross both 5% and 1% significance bounds for all the m3 specifications.

The main findings from the monthly data is that structural shifts have occurred in the m3 money demand functions in contrast to those of m1. The structural breaks have taken place during the period between late 1980s and early 1990s. These breaks may be attributed to the financial deregulation, stock market boom and globalisation of the Indian economy during the sample period.

4.5.2 Unit Root Evidence

The unit root tests are employed to test the presence of stochastic trend of deseasonalised monthly macroeconomic variables that are used in formulating the alternative money demand specifications over the total sample from 1981:04 to 1995:10 and two sub-samples : 1985:04 to 1991:06 and 1991:07 to 1995:10. The variables considered are m1, m3, call money rate, index of industrial production, RBI and BSE share index and real effective exchange rate. The data are monthly deseasonalised and in logs. For the test of unit root, the present study used Dickey-Fuller(DF), Augmented Dickey Fuller (ADF), Phillips-Perron (PP), Bayesian and KPSS unit root tests both with trend and without trend for three sample periods. The results are presented in tables from 4.5 to 4.10.

Table 4.5 presents the unit root tests statistics for DF, ADF, PP and Bayesian tests for the sample period 1981:04 to 1995:10. Looking at the results in the upper tier of the table 4.5 for DF test without trend, the hypothesis of unit root in the level data is not rejected at the 1% critical level across all the series, save one (LASCALL - call money rate). But DF test with trend indicates that some variables (call money rate, index of industrial production, m3 and BSE share index) are trend stationary. Here, in the present study the order of ADF test (value of lag-length, (k)) is selected by following FPE

criterion. The test results confirm that for all the series both with and without trend, the statistics are not statistically significant to reject the null hypothesis of non-stationarity. Therefore, according to the ADF test, all the series (with and without trend) are non-stationary in levels. The test statistics for PP and Bayesian tests shows that all the series are non-stationary at levels barring call money rate. Further, the same test confirm that call money rate, m1, m3, index of industrial production and BSE share index are trend stationary.

The lower tier of the table presents the unit root test statistics for all the variables at their first differences. From the results it is found that the DF, ADF, PP, Bayesian test statistics are statistically significant for almost all the series. Hence, the evidence across the tests indicates that the given macro economic variables are difference stationary (i.e., $I(1)$).

4.5.2.1 KPSS Unit Root Test Evidence:

It is important to note that the unit root tests employed above have the presence of unit root as the null hypothesis and the way in which these tests are carried out ensure that the null hypothesis is accepted unless there is strong evidence against it. Hence, the standard unit root tests discussed above, are not powerful against the relevant alternatives. So, Dejong et. al. and Whiteman (1991) and Diebold and Rudebusch (1991) after finding that these tests are weak, suggested that in trying to decide by classical methods whether a given economic data are stationary or integrated, it should be useful to perform test of the null hypothesis of stationarity as well as test of the null hypothesis of unit root.

The present test known as KPSS unit root test provides the test statistics under the null hypothesis of stationarity against the alternative of a unit root, to test that the series is differenced stationary. Following the methodology provided by Kwiatkowski, D, Phillips, P C B, Schmied, P and Shin, Y (1992), the test statistics are calculated for all the

macroeconomic variables at levels and at first differences with trend and without trend. Table 4.8 presents the test statistics calculated by following KPSS methodology for the sample period 1981:04 to 1995:10. It is to be noted that the 5% critical values of the test with trend and without trend are 0.146 and 0.463 respectively. A rejection of null hypothesis (at 5% level) requires statistically significant test statistics more than 0.146 for with trend and 0.463 for with out trend. The upper tier of the table presents the test statistics with and without trend for $k = 1$ to $k = 4$. The results shows that all the test statistics are significant enough to reject the null hypothesis of stationary both with and without trend. Hence, all the variables are non-stationary at levels. The lower tier of the table shows the test statistics for all the series at their first differences. It is checked that all the calculated values are below the critical tabulated values for both with and without trend. In otherwords, none of the statistics are significant enough to reject the null hypothesis of stationary. Hence, it is concluded that the series are differenced stationary i.e., integrated of order one ($I(1)$).

Hence, the overall evidence from the unit root tests suggests that all the variables examined here for total sample period: 1981:04 to 1995:10, are first differenced stationary i.e., integrated of order one ($I(1)$). Hence, the search for cointegration among the variables is initiated, as the necessary condition (all the variables are being integrated of the same order, $I(1)$ in this case) is satisfied.

4.5.2.2 Unit Root Results form Sub-Sample Data:

The tests of unit roots have also been carried out for two sub-samples: 1985:04 to 1991:06 and from 1991:07 to 1995:10. Table 4.6 contains the unit root test statistics for DF, ADF, PP and Bayesian test for the sub-sample 1985:04 to 1991:06. The upper tier of the table presents the test statistics for all the variables with and without trend at their levels and the lower tier presents the statistics for the variables at their first differences. Looking at the upper tier results it is confirmed that the null hypothesis of unit root is not

rejected at 5% significance level and without trend for all the variables except call money rate. Whereas, DF, PP and Bayesian test with trend indicate that variables call money rate, m1, m3, index of industrial production and BSE index are level stationary. However, the ADF test results indicate that for all the series, with and without trend, the statistics are not significant enough to reject the null hypothesis of non-stationary. Therefore, according to ADF test, all the series are non-stationary at their levels. The test results in the lower of the table show that for all the unit root tests-DF, ADF, PP and Bayesian, the test statistics rejects the null hypothesis of non-stationary. And hence, the evidence across tests for all the macro economic variables confirm the presence of unit root - the variables are differenced stationary(i.e., $I(1)$).

Table 4.9 presents the test statistics for KPSS unit root test of all the variables both with and without trend for the sub-sample period 1985:04 to 1991:06. The calculated statistics at levels shows that with $k = 1$, all the variables with trend are statistically significant to reject the hypothesis of stationarity. However, at $k = 2$ and with trend, the variables BSE index and m1 and at $k = 3$, the variable index of industrial production, failed to reject the null hypothesis. However, the results confirmed that for all the series without trend, the statistics are significant enough to reject the null hypothesis of stationarity. Again, the test statistics for the variables at their first differences confirm that all the series, with and without trend and for all levels of k , are stationary. Hence, the test confirms that the given variables are differenced stationary for the given sample period.

Table 4.7 presents the unit root test statistics for the second sub-sample period, 1991:07 to 1995:10. Here also, the upper tier of the table contains the test statistics of all the unit root tests (DF, ADF, PP and Bayesian) for the macroeconomic variables at their levels and the lower tier contains the test statistics for the variables at their first differences. Here also, DF, PP and Bayesian tests suggest that all the variables are non-stationary without trend save, the call money rate. Whereas, variables like call money

rate, m1, m3, index of industrial production are found to be trend stationary. However, the ADF test results confirm that all the variables are non-stationary at levels both with and without trend. The result from the lower tier of the table confirm that all the variables both with and without trend are stationary. The null hypothesis is rejected across tests to confirm that the given variables are differenced stationary (i.e. $I(1)$).

The KPSS unit root test results for the sub-sample from 1991:07 to 1995:10 are presented in table 4.10. Looking at the results in the upper tier of the table for without trend, the hypothesis of unit root for the level data is accepted at 5% critical level across all the series, save one (real effective exchange rate). But the test statistics indicate that with $k = 2$, variables like BSE and RBI share index and at $k = 1$, the real effective exchange rate and m3, fails to reject the null hypothesis. However, it is observed that the test statistics for all the variables in their first differences and with and without trend are below the critical levels. Hence, the null hypothesis of stationarity is accepted for all the variables at their first differences. So, the evidences suggest that the given variables are difference stationary (i.e., $I(1)$).

Hence, the overall evidences from all the unit root tests for all three samples indicate that all the variables examined are first difference stationary i.e., integrated of order one ($I(1)$). Hence, the search for cointegration among the variables is initiated here.

4.5.3 Cointegration Tests:

Cointegration tests are employed to check the long run equilibrium relationship among the observed time series variables. The essence of the cointegration analysis is that if the variables are individually integrated of the same order, say $I(1)$, but a linear combination of the variables exists such that it is $I(0)$, then it may be stated that there exists stable long run equilibrium relation among them, though each tends to drift away from the others over time.

In this study we examine the evidence of cointegration on the demand for money functions using both Engle-Granger two step procedure proposed by Engle and Granger (1987) and Johansen-Juselius technique proposed by Johansen (1988) and Johansen and Juselius (1990).

4.5.3.1 Testing for Cointegration: The Engle-Granger Two-Step Procedure:

In this section we present the result of cointegration test using the Engle-Granger two step method. In computing these results, the first step is to estimate a cointegration regression (in the present case, money demand specifications which are listed in table 3.10(b) of chapter III) and extract residuals from the regressions. In the second step, the stationarity of the residuals derived from the regressions are examined. The DF, ADF, PP and Bayesian tests are carried out to test the null hypothesis of non-stationarity of the residuals obtained from the cointegration regressions. The tests for cointegration have been carried out for three samples: 1981:04 to 1995:10, 1985:04 to 1991:06 and 1991:07 to 1995:10.

Table 4.11 presents the cointegration test results computed using the residuals derived from the alternative money demand specifications for the total sample period, viz., 1981:04 1995:10. The statistics are computed by using the methodology of DF, ADF, PP and Bayesian tests. It is clear from the results that the DF, PP and Bayesian tests are able to reject the non-stationarity of residuals both with and without trend. However, the ADF test fails to reject non-stationarity of error at 5% level of significance for both m1 and m3 regression using index of industrial production, call money rate and BSE index (specifications 5 and 10) as explanatory variables. Again, the test fails to reject the non-stationarity of error at 1% level of significance for m1 specification using index of industrial production, call money rate, real effective exchange rate and BSE index

(specification 3) and m3 specification using industrial production, call money rate, real effective exchange rate and either RBI or BSE share index (specification 7 and 8) as the explanatory variable for both with and without trend.

So, the cointegration test (Engle-Granger two step procedure) for the total sample data suggests that each of the monetary aggregates (both m1 and m3) has a long run trend relationship with the appropriate determinants examined.

Table 4.12 contains the cointegration test statistics obtained from the OLS regression of ten alternative money demand specifications for the first sub-sample, viz., 1985:04 to 1991:06. The test statistics computed for DF, PP and Bayesian tests with and without trend suggest that the errors of all the specifications are stationary at levels confirming the presence of long run equilibrium relationship. However, the ADF test fails to reject the null hypothesis of non-stationarity of errors at 5% level of significance for m1 regression using index of industrial production, call money rate and real effective exchange rate (specification (1)) and the same set of variable with either RBI or BSE share price index (specification 2 and 3) as explanatory variables. The test again fails to reject the hypothesis of no cointegration for m3 specification using index of industrial production, call money rate and BSE index (specification (10)) as the explanatory variable for both with and without trend.

The cointegration test results for the second sub-sample period , i.e., 1991:07 to 1995:10 are presented in the table 4.13. The test statistics computed for DF, ADF, PP, and Bayesian tests on the residuals derived from the alternative specifications presents an interesting inference on the long run equilibrium relationships. By looking at the results it is confirmed that the statistics for DF, PP and Bayesian tests for all the specifications are significant enough to reject the null hypothesis of non-stationarity of errors for both with and without trend. However, the ADF test statistics fail to reject the null for all the above

specifications, save one (specification (1)). In contrast to the above results, the results for all the m3 money specifications shows that the DF, ADF, PP test statistics fails to reject the null hypothesis of non-stationarity (no-cointegration) even at 5% level of significance for with and without trend. Hence, it is confirmed that m3 money demand functions do not have long run cointegration relationship for the sample period.

The cointegration test (Engle-Granger two step procedure) suggests that each of the monetary aggregates (m1 and m3 in our case) has a long run cointegration relationship with the appropriate determinants for the total sample period from early 1981 to end of 1995. This result suggest that there exist an equilibrium long run relationship for both m1 and m3 money demand functions. However, the results for the sub-sample period of 1990s show that the long run trend relationship does exist for m1 money demand functions in contrast to the m3 counterparts. So, the findings suggest that whereas either of the monetary aggregates can be used as the guide for monetary targetting in 1980s, only m1 suits well to be the appropriate aggregate for monetary targetting during the 1990s.

4.5.3.2 Testing for Cointegration: The Johansen and Juselius (JJ) Procedure

Tests of cointegration such as Engle-Granger two step procedure (Engle and Granger, 1987) allowed for the estimation and testing of unique cointegrating vector, even though there could be as many cointegrating vectors as the number of variables involved less one. As well, since this single equation method estimates the cointegrating vector with the data in levels only, it has been criticised for ignoring potentially valuable information contained in the short-run fluctuations of the variables. Moreover, the Engle-Granger test procedures relies on the OLS residuals for the estimation of test statistics. In the past few years, there has been a movement towards estimating cointegrating relationships in a system of equation framework to make better use of all the information available in the long run and short run fluctuation of each variable. Johansen (1988)

outlined a method, which was later expanded by Johansen and Juselius (1990), that allowed for the testing of more than one cointegrating vector in the data and for the calculation of maximum-likelihood estimates of these vectors. Again, the procedure also allows direct hypothesis tests on the coefficients in the cointegrating vectors.

The present study makes use of the Johansen and Juselius (1990) technique on deseasonalised monthly data for the total sample - 1981:04 to 1995:10 and of its two sub-samples - 1985:04 to 1991:06 and 1991:07 to 1995:10. The lag-lengths for the VARs were selected according to the Akaike Information Criterion for each specification.

Table 4.14 reports the results of cointegration tests using the Johansen and Juselius technique for the total sample period (1981:04 to 1995:10) on selected alternative specifications. This study relies upon only the trace statistics to determine the number of cointegrating vectors. The results of the trace statistic rejects the null hypothesis of $r = 0$ for all specifications, both of m1 and m3. Hence, it may be concluded that a long run equilibrium relationship exist among money (both narrow and broad), output, interest rate, real effective exchange rate and share price index for Indian economy. However, it is found that the first three specifications for m1 (specification (1), (2) and (3)) the statistics imply the existence of three cointegrating vector and specifications (4) and (5) signify the presence of two cointegrating vectors. As against this, m3 specifications imply the existence of two cointegrating vectors for specification (6), (8) and (10), one for specification (9) and three for specification (7). So, the above results suggest that though there exist a long run equilibrium relationship underlying the money demand functions, a more stable relationship is detected for m1 aggregates than that of m3 aggregates.

Table 4.15 presents the results of the Johansen-Juselius cointegration test for the sub-sample period: 1985:04 to 1991:06. The test results reject the null hypothesis of zero cointegrating vectors for all the money demand specifications. However, the test suggests

the existence of three cointegrating vectors for two m1 specifications (specifications (2) and (3)), two significant vectors for specifications (4) and (5) and one for specification (1). Whereas, the test find only two significant cointegrating vectors for four specifications (specifications (7), (8), (9) and (10)) and one significant vector for specification (6). The above results suggest that a long run equilibrium relationship exists underlying the money demand relationships for the chosen sample period and few specifications with m1 money as dependent variable and selected explanatory variables are more stable compared with the m3 counterpart.

The results for the second sub-sample period i.e., 1991:06 to 1995:10 are presented in table 4.16. While searching for significant cointegrating vectors, the results support the existence of long run equilibrium relationship for alternative money demand functions for the selected sample period as well. The results show that the null hypothesis of zero cointegrating vector could be rejected for specifications (1) and (5) of m1 specification and specifications (6) and (10) of m3 specifications. Whereas, specifications (2) and (3) for m1 specifications and (7) and (8) of m3 specifications are having more than or equal to three significant cointegrating vector. So, the result suggests that for the second sub period, which covers the 1990s, both the monetary aggregates are having stable long run equilibrium relationship.

4.6 Concluding Remarks:

In the present chapter, an attempt has been made to reexamine the issue of stability of demand for money in India. The empirical evidence on the demand for money in India supports the hypothesis of stability of the function. The empirical studies confirmed that the evidence of instability is due to misspecification (inadequate to capture the changes of financial innovation and deregulation in Indian money and capital markets which have taken place particularly in the eighties). The above evidence calls for a proper

examination of the issue of temporal stability of the money demand function under the changing scenerio of the Indian economy in the recent past.

The investigation into stability aspect of the demand for money has been attempted here with the help of the tests based on recursive residuals. They are CUSUM, CUSUM Square (BDE) and Harvey -Collier. The test results show that structural breaks had occured during the 1980s. And these breaks are suspected to have occured due to widening and depeening of the Indian financial system during 1980s. Further, the analysis of annual data reveals that m1 money demand functions are more prone to the breaks than the m3 functions. However, the analysis of monthly data reveals that structural shifts had occured during 1980s in the m3 functions in contrast to the m1 functions.

The search for long run equilibrium money demand relationship is also attempted here with the help of multivariate coitegration tests. Before going for cointegration tests, unit root tests are employed to check the presence of stochastic trends in the data. The persent study has used Dickey-Fuller, Augmented Dickey-Fuller, Phillips-Perron, Bayesian and KPSS unit root tests for the purpose. These unit root tests confirmed that the macroeconomic variables examined here were found to be differenced stationary. Hence, the initiation is taken for the analysis cointegration with the help of both Engle Granger two step and Johansen-Juselius test. The findings from Engle Granger test reveal that an equilibrium long run relationship does exists for either of the monetary aggregates (m1 or m3). However, for the sub-period of 1990s, long run trend relationship exist only for m1 function in contrast to that of m3. So the results suggest that either of the monetary aggregate act as a guide for monetary targeting during 1980s, but only m1 serves as the suitable monetary aggregate during 1990s. The test results from the use of Johansen-Juselius cointegration procedure confirms that there exist a stable long run equilibrium relationship among money, output, interest rate, stock prices and exchange rate.

Moreover, the procedure suggests that a more stable long run equilibrium relationship does exist for m1 function compared to those of m3 functions.

The stability of the money demand function is being questioned in an environment of deregulation, globalisation and rapid defusion of financial innovation during the 1980s. In view of this, the quantum of money channel seem to have lost some of their significance, suggesting the monetary authorities to shift out from the quantitative targeting to targeting the rate variables (i.e., interest rate, exchange rate). However, the findings of the existence of long run equilibrium relationship underlying money demand relation suggests that monetary authorities can have faith on the effectiveness of monetary transmission mechanism. But during the 1990s and in the future, narrow monetary aggregate will be an appropriate target variable for monetary targeting in India.

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Table 4.1

Recursive Residual Test of Structural Breaks: Annual Data: 1960-61 to 1995-96

Specifications*	Period of Structural Breaks	
	At 1% Level	At 5% Level
1	----	1976-77
2	----	----
3	----	----
4	----	1976-77 to 1984-85
5	----	1976-77 to 1982-83
6	----	1977-78 to 1986-87
7	----	----
8	----	----
9	----	----
10	----	----
11	----	----
12	----	----

Note: * Specifications (1) to (12) are same as listed in table 3.2(a) of chapter - III.

Table 4.2

**Rcursive Residual Test of Sructural Breaks for Deasonalised Monthly Series :
1981:04 to 1995:10**

Specifications*	Period of Structural Breaks	
	At 1% Level	At 5% Level
1	----	----
2	----	----
3	----	----
4	----	----
5	----	----
6	1989:03 to 1990:04	1988:09 to 1990:04
7	1988:08 to 1990:04	1988:08 to 1990:04
8	1988:07 to 1990:04	1988:07 to 1990:04
9	1989:02 to 1990:04	1987:12 to 1990:04
10	1989:01 to 1990:04	1987:11 to 1990:04

Note: *Specifications (1) to (10) are the same as listed in table 3.10(b) of chapter - III.

Table 4.3**Harvey - Collier Stability Test : Annual Data : 1960-61 to 1995-96**

Independent Variables	Dependent variables	
	LRM1	LRM3
lrgdp, dprate, lrmcap	0.0740 (0.9415)	0.5038 (0.6178)
lrgdp, callrate, vri, lrmcap	0.0223 (0.9824)	0.1553 (0.8776)
lrgdp, winfl, lreer	4.5256 (0.0001)	2.8803 (0.0071)
lrgdp, ie	5.5553 (0.0000)	3.7910 (0.0006)
lrgdp, ie, vri	5.3293 (0.0000)	3.8858 (0.0050)
lrgdp, ie, lreer	4.6747 (0.0005)	2.7744 (0.0093)

Note: The values inside the parentheses corresponding to the calculated t-values for the test, indicates the significance level.

Table 4.4**Harvey - Collier Stability Test for Deseasonalised Monthly Series : 1981:04 to 1995:10**

Independent Variables	Dependent variables	
	LASRM1	LASRM3
lasip, lascall, lasreer	2.8557 (0.0048)	0.5581 (0.5775)
lasip, lascall lasreer, lasrbi	0.9002 (0.3693)	1.4410 (0.1514)
lasip, lascall, lasreer, lasbse	1.4715 (0.1430)	1.6678 (0.0972)
lasip, lascall, lasrbi	4.7973 (0.0003)	1.8612 (0.0644)
lasip, lascall, lasbse	4.9357 (0.0001)	0.9426 (0.3472)

Note: Same as in table 4.3.

TABLE - 4.5
Unit Root Tests for Deseasonalised Monthly Series: 1981:04 to 1995:10

WITHOUT TREND					WITH TREND				
	DF	ADF	PP	BAYESIAN	DF	ADF	PP	BAYESIAN	
LASBSE	-1.3631	-0.4754 (24)	-1.1446	1.858 (8.710)	-4.2276	-2.4536 (24)	-3.8777	17.873 (6.213)	
LASRBI	-0.7177	-0.5213 (16)	-0.5887	0.515 (9.471)	-2.8319	-1.9697 (16)	-2.6135	8.020 (6.928)	
LASIP	-0.9218	-0.4635 (14)	-0.4751	0.850 (8.853)	-6.3719	-1.7214 (14)	-6.4471	40.693 (5.624)	
LASREER	-0.7310	-0.3348 (20)	-0.7549	0.534 (9.339)	-2.8839	-2.7656 (20)	-3.1456	8.317 (6.895)	
LASRM1	-0.6261	-0.5926 (12)	-0.6048	0.392 (10.740)	-3.7038	-2.6088 (12)	-3.8471	18.254 (6.254)	
LASRM3	-1.4031	-1.8312 (08)	-1.2088	1.969 (8.769)	-8.3383	-1.5616 (08)	-8.7419	69.527 (5.359)	
LASCALL	-4.3322	-2.3677 (12)	-3.9471	18.768 (6.141)	-4.6219	-2.6420 (12)	-4.3151	21.362 (6.044)	
ΔLASBSE	-13.2988	-4.2531 (17)	-14.6528	176.860 (5.136)	-13.2616	-4.2717 (17)	-14.6579	175.870 (5.131)	
ΔLASRBI	-10.7174	-4.8834 (15)	-10.6601	114.864 (5.183)	-10.6995	-4.8442 (15)	-10.6883	114.479 (5.177)	
ΔLASIP	-19.9776	-3.7284 (13)	-22.3843	399.104 (5.318)	-19.9268	-3.2220 (13)	-22.4163	397.076 (5.313)	
ΔLASREER	-12.5074	-4.2269 (18)	-12.5755	156.436 (5.125)	-12.4689	-4.2115 (18)	-12.5738	155.472 (5.119)	
ΔLASRM1	-16.0250	-5.6252 (11)	-16.7459	256.808 (5.125)	-15.9792	-5.6230 (11)	-16.7454	255.334 (5.174)	
ΔLASRM3	-22.5546	-8.6814 (06)	-32.1708	508.711 (5.427)	-22.5009	-8.8409 (06)	-32.3684	506.291 (5.421)	
ΔLASCALL	-13.9863	-3.4957 (13)	-15.2956	195.617 (5.186)	-13.9370	-3.4669 (13)	-15.2864	194.241 (5.180)	

Note: DF: Dickey Fuller; ADF: Augmented Dickey Fuller and PP: Phillips Perron. For Bayesian test, Schwartz statistics are

TABLE - 4.6
Unit Root Tests for Deseasonalised Monthly Series: 1985:04 to 1991:06

WITHOUT TREND					WITH TREND			
	DF	ADF	PP	BAYES IAN	DF	ADF	PP	BAYESIAN
LASBSE	-1.3631	-0.3288 (10)	-1.1446	1.858 (8.710)	-4.2276	-2.7630 (10)	-3.8777	7.873 (5.460)
LASRBI	-0.7177	-0.4251 (02)	-0.5887	0.515 (9.471)	-2.8319	-2.4648 (02)	-2.6135	3.461 (5.914)
LASIP	-0.9218	-0.1848 (10)	-0.4751	0.850 (8.853)	-6.3719	-1.5945 (10)	-6.4471	47.573 (4.406)
LASREER	-0.7310	-0.8081 (01)	-0.7549	0.534 (9.339)	-2.8839	-3.0286 (01)	-3.1456	5.533 (5.557)
LASRM1	-0.6261	-0.5535 (02)	-0.6048	0.392 (10.740)	-3.7038	-3.1475 (01)	-3.8471	13.493 (4.901)
LASRM3	-1.4031	-1.6757 (07)	-1.2088	1.969 (8.769)	-8.3383	-1.6967 (07)	-8.7419	73.901 (4.276)
LASCALL	-4.3322	-2.1469 (04)	-3.9471	18.768 (6.141)	-4.6219	-2.3192 (04)	-4.3151	15.149 (4.678)
ΔLASBSE	-13.6057	-9.2609 (03)	-15.2860	185.115 (5.112)	-13.2616	-13.2616 (03)	-14.6579	54.535 (4.286)
ΔLASRBI	-10.7727	-5.6442 (04)	-10.8154	116.051 (5.214)	-10.6995	-5.6157 (04)	-10.6883	52.309 (4.299)
ΔLASIP	-19.9790	-9.4716 (01)	-22.3686	399.162 (5.316)	-19.9268	-12.4430 (01)	-22.4163	193.584 (4.569)
ΔLASREER	-12.5584	-8.1468 (01)	-12.6273	157.714 (5.131)	-12.4689	-8.1187 (01)	-12.5738	80.704 (3.449)
ΔLASRM1	-16.0609	-8.9324 (01)	-16.6808	257.985 (5.181)	-15.9792	-11.9009 (01)	-16.7454	119.655 (4.418)
ΔLASRM3	-22.7879	-9.9774 (03)	-32.4901	519.288 (5.443)	-22.5009	-11.0141 (03)	-32.3684	219.514 (4.574)
ΔLASCALL	-14.0511	-9.3474 (01)	-15.2624	197.433 (5.143)	-13.9370	-11.3039 (01)	-15.2864	89.816 (4.287)

Note: DF: Dickey Fuller, ADF: Augmented Dickey Fuller and PP: Phillips Perron. For Bayesian test, Schwartz statistics are Presented inside parentheses in the corresponding column number (6). The values inside parentheses corresponding to

TABLE - 4.7
Unit Root Tests for Deseasonalised Monthly Series: 1991:07 to 1995:10

	WITHOUT TREND				WITH TREND			
	DF	ADF	PP	BAYES IAN	DF	ADF	PP	BAYESIAN
LASBSE	-1.3631	-0.5793 (08)	-1.1446	1.858 (8.710)	-4.2276	-3.3208 (08)	-3.8777	7.002 (5.066)
LASRBI	-0.7177	-0.6767 (01)	-0.5887	0.515 (9.471)	-2.8319	-3.8852 (01)	-2.6135	3.005 (5.746)
LASIP	-0.9218	-0.2716 (02)	-0.4751	0.850 (8.853)	-6.3719	-4.0857 (02)	-6.4471	10.533 (4.381)
LASREER	-0.7310	-0.3767 (15)	-0.7549	0.534 (9.339)	-2.8839	-2.4974 (15)	-3.1456	15.451 (4.460)
LASRM1	-0.6261	-0.6897 (01)	-0.6048	0.392 (10.740)	-3.7038	-3.7038 (01)	-3.8471	5.300 (4.866)
LASRM3	-1.4031	-0.9500 (01)	-1.2088	1.969 (8.769)	-8.3383	-5.0375 (01)	-8.7419	24.029 (4.041)
LASCALL	-4.3322	-2.6474 (03)	-3.9471	18.768 (6.141)	-4.6219	-2.9434 (03)	-4.3151	5.022 (4.690)
ΔLASBSE	-13.6057	-9.1152 (09)	-15.2860	185.115 (5.112)	-13.2616	-5.1132 (09)	-14.6579	64.362 (3.893)
ΔLASRBI	-10.7727	-10.072 (03)	-10.8154	116.051 (5.214)	-10.6995	-10.059 (03)	-10.6883	19.372 (4.055)
ΔLASIP	-19.9790	-12.472 (01)	-22.3686	399.162 (5.316)	-19.9268	-12.443 (01)	-22.4163	83.176 (3.967)
ΔLASREER	-12.5584	-4.2205 (12)	-12.6273	157.714 (5.131)	-12.4689	-4.2024 (12)	-12.5738	82.676 (4.275)
ΔLASRM1	-16.0609	-8.1967 (02)	-16.6808	257.985 (5.181)	-15.9792	-8.1646 (02)	-16.7454	62.035 (3.887)
ΔLASRM3	-22.7879	-10.977 (03)	-32.4901	519.288 (5.443)	-22.5009	-11.014 (03)	-32.3684	78.930 (3.947)
ΔLASCALL	-14.0511	-10.965 (03)	-15.2624	197.433 (5.143)	-13.9370	-10.931 (03)	-15.2864	56.983 (3.855)

Note: DF: Dickey Fuller, ADF: Augmented Dickey Fuller and PP: Phillips Perron. For Bayesian test, Schwartz statistics are Presented inside parentheses in the corresponding column number (6). The values inside parentheses corresponding to

TABLE - 4.8

KPSS Unit Root Test Statistics for Deseasonalised Series: 1981:04 to 1995:10

	WITH TREND				WITHOUT TREND			
	K=1	K=2	K=3	K=4	K=1	K=2	K=3	K=4
LASBSE	0.6491	0.4701	0.3810	0.3233	8.2724	5.5745	4.2202	3.4019
LASRBI	0.9285	0.6502	0.5116	0.4259	8.3217	5.5875	4.2175	3.3929
LASIP	0.7908	0.5859	0.4777	0.4106	8.6298	5.8056	4.3875	3.5345
LASREER	0.5463	0.3794	0.2968	0.2478	8.4396	5.6680	4.2813	3.4490
LASRM1	0.8283	0.5892	0.4647	0.3902	8.6955	5.8437	4.4149	3.5566
LASRM3	1.4127	1.0879	0.8877	0.7527	8.6342	5.8077	4.3883	3.5349
LASCALL	0.5892	0.4324	0.3517	0.2996	1.6273	1.1845	0.9558	0.8089
Δ LASBSE	0.0198	0.0209	0.0287	0.0447	0.0209	0.0223	0.0305	0.0475
Δ LASRBI	0.0361	0.0371	0.0474	0.0645	0.0372	0.0382	0.0788	0.0664
Δ LASIP	0.0148	0.0178	0.0213	0.0246	0.0147	0.0177	0.0212	0.0244
Δ LASREER	0.0336	0.0315	0.0317	0.0335	0.0345	0.0323	0.0326	0.0345
Δ LASRM1	0.0226	0.0277	0.0279	0.0317	0.0306	0.0375	0.0378	0.0428
Δ LASRM3	0.0067	0.0098	0.0129	0.0165	0.0268	0.0394	0.0516	0.0654
Δ LASCALL	0.0199	0.0233	0.0333	0.0418	0.0195	0.0228	0.0296	0.0409

Note: Here K refers to lag-length. The critical values for the test at 5% level of significance with trend and without trend are 0.146 and 0.463 respectively.

Δ is the difference operator.

TABLE - 4.9**KPSS Unit Root Test Statistics for Deseasonalised Series: 1985:04 to 1991:06**

	WITH TREND				WITHOUT TREND			
	K=1	K=2	K=3	K=4	K=1	K=2	K=3	K=4
LASBSE	0.1788	0.1406	0.1242	0.1122	5.4284	3.7338	2.8765	2.3471
LASRBI	0.4043	0.2957	0.2424	0.2075	5.4196	3.6869	2.8138	2.2823
LASIP	0.2016	0.1637	0.1454	0.1355	6.1247	4.1297	3.1261	2.5238
LASREER	0.8197	0.5675	0.4409	0.3648	5.9342	4.0068	3.0391	2.5468
LASRM1	0.1699	0.1272	0.1043	0.0915	6.1907	4.1710	3.1581	2.5493
LASRM3	0.4331	0.3931	0.3595	0.3327	6.1641	4.1664	3.1589	2.5520
LASCALL	0.2254	0.1876	0.1729	0.1643	3.4431	2.5607	2.1048	1.8030
Δ LASBSE	0.0205	0.0219	0.0323	0.0581	0.0205	0.0219	0.0323	0.0582
Δ LASRBI	0.0184	0.0198	0.0288	0.0503	0.0444	0.0476	0.0685	0.1170
Δ LASIP	0.0168	0.0206	0.0251	0.0290	0.8187	0.0229	0.0279	0.0322
Δ LASREER	0.0817	0.0754	0.0729	0.0747	0.3101	0.2854	0.2755	0.2808
Δ LASRM1	0.0241	0.0311	0.0306	0.0343	0.0629	0.0809	0.0794	0.0886
Δ LASRM3	0.0087	0.0129	0.0170	0.0216	0.0244	0.0363	0.0476	0.0603
Δ LASCALL	0.0138	0.0163	0.0228	0.0341	0.0198	0.0234	0.0326	0.0486

Note: Here K refers to lag-length. The critical values for the test at 5% level of significance with trend and without trend are 0.146 and 0.463 respectively.

Δ is the difference operator.

TABLE - 4.10

KPSS Unit Root Test Statistics for Deseasonalised Series: 1991:07 to 1995:10

	WITH TREND				WITHOUT TREND			
	K=1	K=2	K=3	K=4	K=1	K=2	K=3	K=4
LASBSE	0.1498	0.1088	0.0887	0.0775	1.3940	0.9852	0.7807	0.6604
LASRBI	0.1519	0.1089	0.0882	0.0765	1.3105	0.9185	0.7244	0.6103
LASIP	0.3262	0.2522	0.2169	0.1991	2.3035	1.6028	1.2495	1.0376
LASREER	0.0936	0.0709	0.0613	0.0574	0.3062	0.2298	0.1965	0.1811
LASRM1	0.3767	0.2725	0.2186	0.1868	2.3479	1.6221	1.2578	1.0385
LASRM3	0.0647	0.0582	0.0581	0.0611	2.5641	1.7612	1.3577	1.1146
LASCALL	0.3902	0.2909	0.2396	0.2078	0.8572	0.6263	0.5058	0.4311
ΔLASBSE	0.0652	0.0668	0.0682	0.0744	0.1507	0.1514	0.1516	0.1612
ΔLASRBI	0.0927	0.0854	0.0845	0.0849	0.2254	0.2034	0.1963	0.1928
ΔLASIP	0.0235	0.0260	0.0284	0.0365	0.0796	0.0870	0.0943	0.1189
ΔLASREER	0.0465	0.0441	0.0460	0.0511	0.0933	0.0881	0.0915	0.1007
ΔLASRM1	0.0478	0.0568	0.0583	0.0642	0.0733	0.0869	0.0891	0.0974
ΔLASRM3	0.0206	0.0256	0.0331	0.0413	0.0210	0.0262	0.0338	0.0422
ΔLASCALL	0.0319	0.0385	0.0484	0.0649	0.1479	0.1747	0.2124	0.2687

Note: Here K refers to lag-length. The critical values for the test at 5% level of significance with trend and without trend are 0.146 and 0.463 respectively.

Δ is the difference operator.

TABLE - 4.11

Cointegration Test: The Engle Granger Two-Step Procedure for Deseasonalised Monthly Series for the Period: 1981:04 to 1995:10

Specific ations*	WITHOUT TREND				WITH TREND			
	DF	ADF (K)	PP	BAYE SIAN	DF	ADF (K)	PP	BAYE SIAN
1	-8.2592	-6.0518 (01)	-8.3399	68.215 (5.395)	-8.2722	-6.0421 (01)	-8.3945	68.425 (5.379)
2	-8.2234	-5.1834 (04)	-8.1554	67.624 (5.410)	-8.2168	-5.1489 (04)	-8.1859	67.516 (5.398)
3	-8.7199	-4.4398 (10)	-8.6713	76.038 (5.331)	-8.7245	-4.4372 (10)	-8.7138	76.117 (5.320)
4	-8.4522	-6.9287 (01)	-8.3464	71.440 (5.383)	-8.4547	-6.9082 (01)	-8.3869	71.482 (5.370)
5	-9.0014	-4.0120 (11)	-8.9051	81.025 (5.303)	-9.0164	-4.0219 (11)	-8.9775	81.296 (5.291)
6	-9.5808	-5.6832 (01)	-9.9018	91.792 (5.288)	-9.5624	-5.6524 (01)	-9.9229	91.440 (5.276)
7	-9.4421	-4.9655 (03)	-9.7509	89.152 (5.103)	-9.4188	-4.9069 (03)	-9.7929	89.350 (5.276)
8	-9.4766	-4.6016 (04)	-9.7802	89.806 (5.103)	-9.4525	-4.5326 (04)	-9.7929	88.715 (5.288)
9	-9.3301	-5.6685 (01)	-9.5873	87.050 (5.118)	-9.3154	-5.6359 (01)	-9.6122	86.778 (5.293)
10	-9.5063	-2.5609 (11)	-9.7677	90.370 (5.104)	-9.4901	-2.6021 (11)	-9.7888	90.061 (5.266)

Note: DF: Dickey Fuller; ADF: Augmented Dickey Fuller and PP: Phillips Perron. For Bayesian test, Schwartz statistics are Presented inside parantheses in the coresponding column number (6). The values inside parantheses corresponding to to ADF statistics (column (4)) indicate appropriate lag length.

* Specifications (1) to (10) are the same as listed in table 3.10(b) of Chapter III.

TABLE - 4.12

**Cointegration Test: The Engle Granger Two-Step Procedure for Deseasonalised
Monthly Series for the Period: 1985:04 to 1991:06**

Specific ations*	WITHOUT TREND				WITH TREND			
	DF	ADF (K)	PP	BAYE SIAN	DF	ADF (K)	PP	BAYE SIAN
1	-6.6941	-3.5528 (01)	-7.1440	44.811 (4.323)	-6.6746	-3.5339 (01)	-7.1713	44.550 (4.298)
2	-6.3837	-2.9039 (10)	-6.6331	40.752 (4.339)	-6.3587	-2.9893 (10)	-6.6524	40.433 (4.317)
3	-6.6198	-3.7016 (01)	-7.0189	43.823 (4.326)	-6.6041	-3.6763 (01)	-7.0475	43.615 (4.302)
4	-7.0974	-4.8340 (01)	-7.2414	50.373 (4.293)	-7.1944	-4.8728 (01)	-7.3895	51.755 (4.290)
5	-7.5018	-4.7450 (01)	-7.6947	56.277 (4.293)	-7.6260	-4.8154 (01)	-7.8577	58.156 (4.273)
6	-9.7951	-4.8152 (03)	-10.122	95.943 (4.301)	-9.7301	-4.8006 (03)	-10.143	94.674 (4.287)
7	-9.7413	-4.8809 (03)	-10.142	94.893 (4.298)	-9.6744	-4.8502 (03)	-10.128	93.595 (4.283)
8	-9.7538	-5.7838 (02)	-10.095	95.136 (4.298)	-9.6899	-5.7535 (02)	-10.102	93.896 (4.283)
9	-7.6623	-4.6996 (01)	-7.8314	58.711 (4.294)	-7.6742	-4.7074 (01)	-7.9014	58.894 (4.277)
10	-7.9671	-4.2766 (02)	-8.1221	63.475 (4.282)	-7.9862	-4.2799 (02)	-8.1971	63.780 (4.267)

Note: DF: Dickey Fuller; ADF: Augmented Dickey Fuller and PP: Phillips Perron. For Bayesian test, Schwartz statistics are Presented inside parantheses in the corresponding column number (6). The values inside parentheses corresponding to to ADF statistics (column (4)) indicate appropriate lag length.

* Specifications (1) to (10) are the same as listed in table 3.10(b) of Chapter III.

TABLE - 4.13

Cointegration Test: The Engle Granger Two-Step Procedure for Deseasonalised Monthly Series for the Period: 1991:07 to 1995:10

Specific ations*	WITHOUT TREND				WITH TREND			
	DF	ADF (K)	PP	BAYE SIAN	DF	ADF (K)	PP	BAYE SIAN
1	-4.4885	-4.2906 (01)	-4.5258	20.147 (4.143)	-4.5172	-4.4692 (01)	-4.6024	20.405 (4.086)
2	-4.8708	-3.3446 (10)	-4.8574	23.725 (4.017)	-4.9591	-3.7641 (10)	-4.9842	24.593 (3.980)
3	-5.0462	-3.3826 (01)	-5.0434	25.465 (4.007)	-5.1371	-3.9284 (01)	-5.1716	26.385 (3.963)
4	-4.3990	-2.9609 (01)	-4.4036	19.351 (4.076)	-4.4912	-3.5545 (01)	-4.5270	20.171 (4.039)
5	-4.6446	-3.4553 (01)	-4.6423	21.591 (4.053)	-4.7389	-4.1903 (01)	-4.7655	22.457 (4.011)
6	-4.0328	-3.8150 (03)	-4.0299	16.263 (4.226)	-4.1411	-3.9677 (03)	-4.2200	17.135 (4.139)
7	-3.9937	-2.7509 (03)	-4.0108	15.950 (4.181)	-4.1848	-2.6427 (03)	-4.2479	17.513 (4.112)
8	-4.0891	-3.8306 (02)	-4.1071	16.721 (4.174)	-4.2731	-4.0612 (02)	-4.3343	18.260 (4.098)
9	-3.7717	-2.3582 (01)	-3.8024	14.224 (4.219)	-3.7903	-2.7493 (01)	-4.0446	15.763 (4.152)
10	-3.8812	-3.7149 (02)	-3.9057	15.064 (4.282)	-4.0717	-3.7254 (02)	-4.1384	16.575 (4.138)

Note: DF: Dickey Fuller; ADF: Augmented Dickey Fuller and PP: Phillips Perron. For Bayesian test, Schwartz statistics are Presented inside parantheses in the coresponding column number (6). The values inside parentheses corresponding to to ADF statistics (column (4)) indicate appropriate lag length.

* Specifications (1) to (10) are the same as listed in table 3.10(b) of Chapter III.

Table 4.14

**Cointegration Test: The Johansen-Juselius (JJ) Procedure for Deseasonalised
Monthly Series : 1981:04 to 1995:10**

Specifica tions*	Cointegrating Vector	Trace Statistics	Specifica tions	Cointegrating Vector	Trace Statistics
(1) Lag = 28	$r = 0$ $r \leq 1$ $r \leq 2$ $r \leq 3$	129.1073 58.7121 29.9227 6.6429	(6) Lag = 28	$r = 0$ $r \leq 1$ $r \leq 2$ $r \leq 3$	104.8846 51.5718 16.0653 0.4271
(2) Lag = 23	$r = 0$ $r \leq 1$ $r \leq 2$ $r \leq 3$ $r \leq 4$	209.2785 80.3297 29.6885 7.4297 0.0625	(7) Lag = 23	$r = 0$ $r \leq 1$ $r \leq 2$ $r \leq 3$ $r \leq 4$	203.7559 71.6969 33.9899 10.3698 0.2705
(3) Lag = 23	$r = 0$ $r \leq 1$ $r \leq 2$ $r \leq 3$ $r \leq 4$	186.2645 67.2326 33.1198 10.9697 0.0289	(8) Lag = 23	$r = 0$ $r \leq 1$ $r \leq 2$ $r \leq 3$ $r \leq 4$	98.7584 51.8552 29.3484 13.4609 1.5794
(4) Lag = 28	$r = 0$ $r \leq 1$ $r \leq 2$ $r \leq 3$	111.3611 53.2548 16.3261 0.2812	(9) Lag = 28	$r = 0$ $r \leq 1$ $r \leq 2$ $r \leq 3$	98.8622 26.2976 7.2042 1.1566
(5) Lag = 28	$r = 0$ $r \leq 1$ $r \leq 2$ $r \leq 3$	92.3407 36.4785 5.8238 0.2753	(10) Lag = 28	$r = 0$ $r \leq 1$ $r \leq 2$ $r \leq 3$	192.3729 46.0648 18.0149 4.7197

Note: * Specifications (1) to (10) are the same as listed in table 3.10(b) of chapter - III.

Table 4.15

**Cointegration Test: The Johansen-Juselius (JJ) Procedure for Deseasonalised
Monthly Series : 1985:04 to 1991:06**

Specifica tions*	Cointegrating Vector	Trace Statistics	Specifica tions	Cointegrating Vector	Trace Statistics
(1) Lag = 28	$r = 0$	175.6721	(6) Lag = 28	$r = 0$	121.6417
	$r \leq 1$	28.2458		$r \leq 1$	43.7206
	$r \leq 2$	10.9612		$r \leq 2$	14.9526
	$r \leq 3$	3.2832		$r \leq 3$	1.0600
(2) Lag = 23	$r = 0$	135.7963	(7) Lag = 23	$r = 0$	110.1012
	$r \leq 1$	66.9014		$r \leq 1$	49.2883
	$r \leq 2$	39.0860		$r \leq 2$	17.1523
	$r \leq 3$	13.0159		$r \leq 3$	4.3069
	$r \leq 4$	1.3751		$r \leq 4$	0.0297
(3) Lag = 23	$r = 0$	109.6859	(8) Lag = 23	$r = 0$	82.8886
	$r \leq 1$	59.4242		$r \leq 1$	53.1897
	$r \leq 2$	33.4986		$r \leq 2$	27.7762
	$r \leq 3$	15.0618		$r \leq 3$	10.8382
	$r \leq 4$	5.5962		$r \leq 4$	0.0197
(4) Lag = 28	$r = 0$	104.3607	(9) Lag = 28	$r = 0$	101.1002
	$r \leq 1$	47.7809		$r \leq 1$	54.1252
	$r \leq 2$	11.2238		$r \leq 2$	21.7875
	$r \leq 3$	0.6300		$r \leq 3$	1.1945
(5) Lag = 28	$r = 0$	116.4276	(10) Lag = 28	$r = 0$	106.0949
	$r \leq 1$	47.5197		$r \leq 1$	48.9177
	$r \leq 2$	8.3125		$r \leq 2$	15.4164
	$r \leq 3$	0.3599		$r \leq 3$	4.6542

Note: * Specifications (1) to (10) are the same as listed in table 3.10(b) of chapter - III.

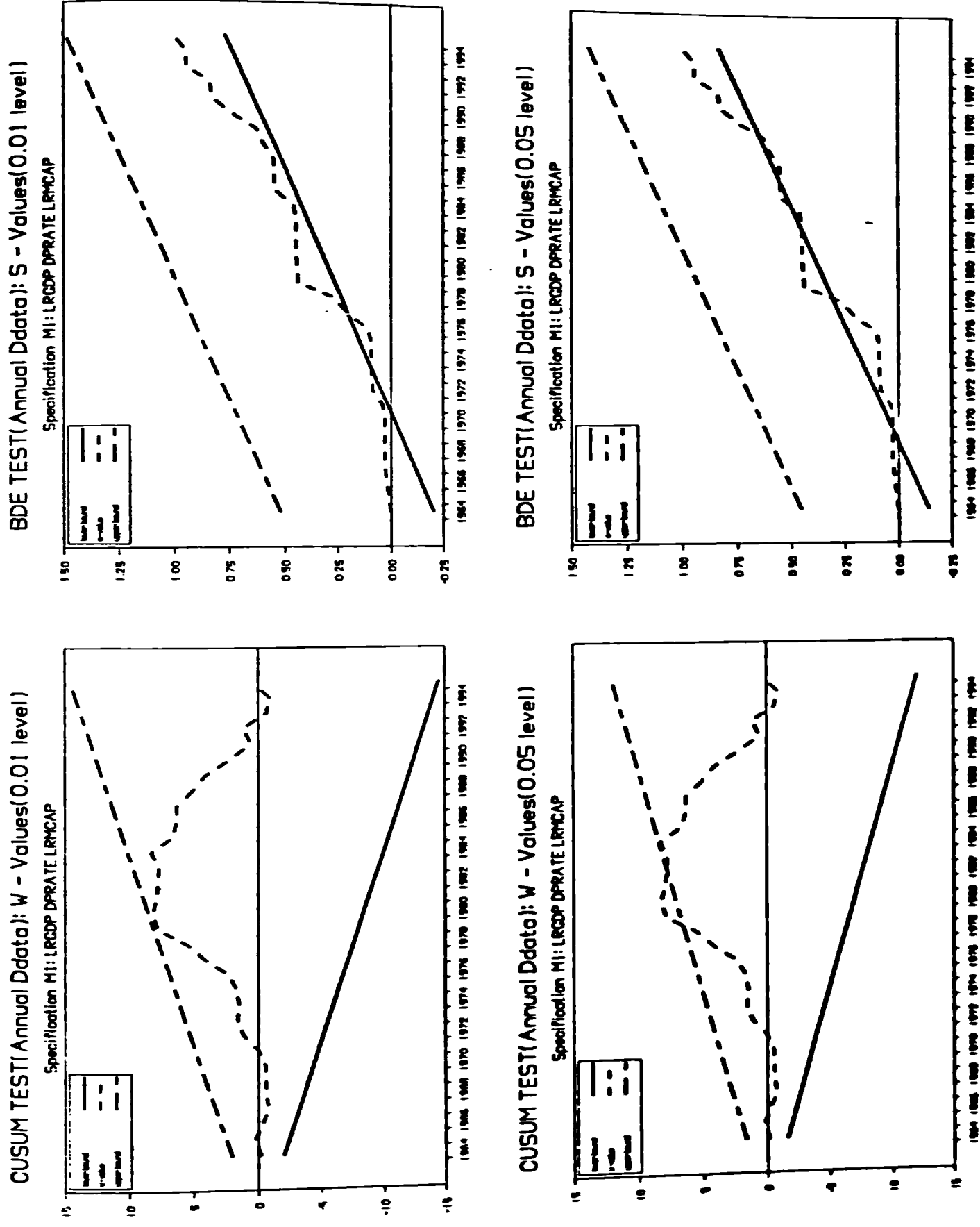
Table 4.16

**Cointegration Test: The Johansen-Juselius (JJ) Procedure for Deseasonalised
Monthly Series : 1991:07 to 1995:10**

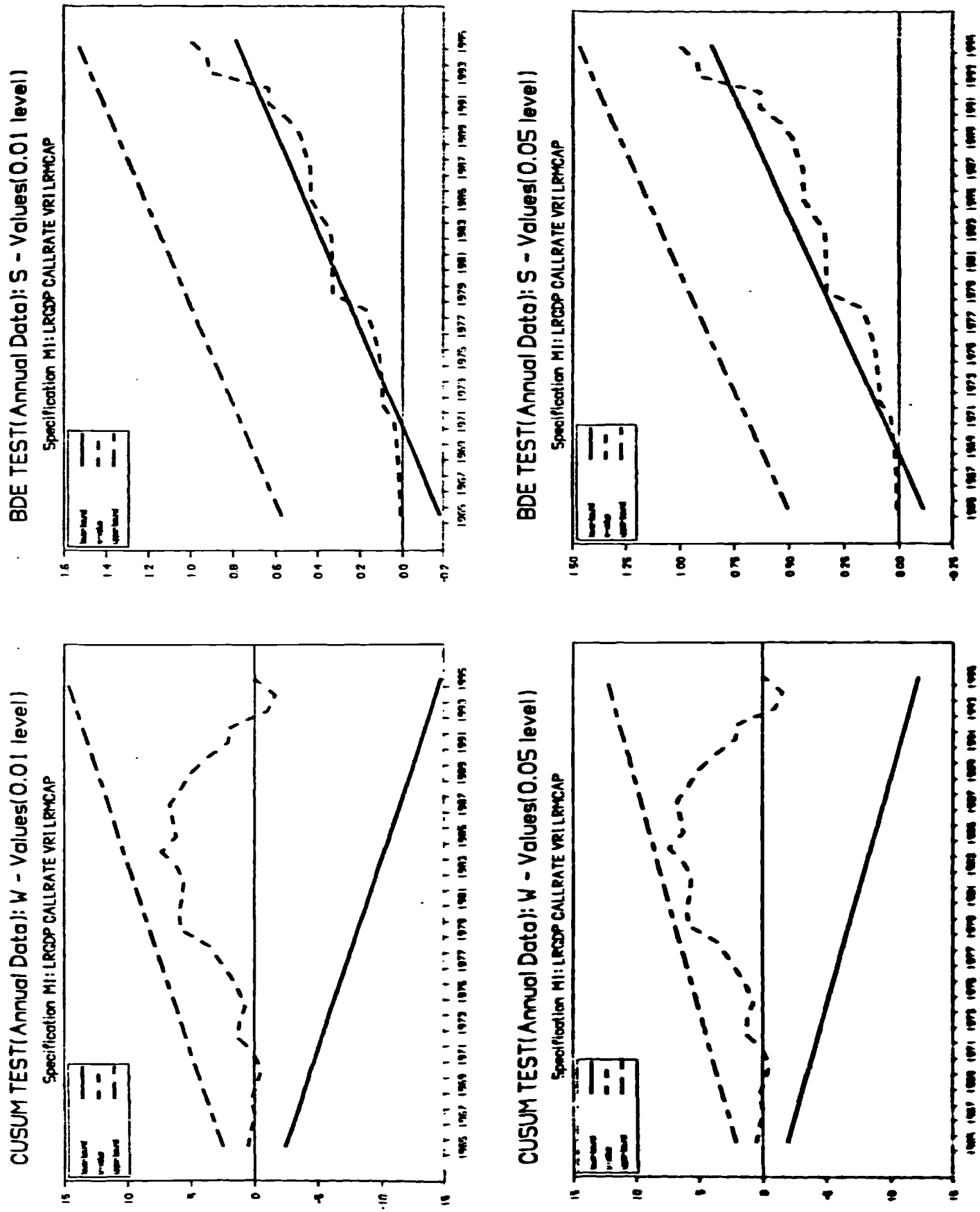
Specifica tions*	Cointegrating Vector	Trace Statistics	Specifica tions	Cointegrating Vector	Trace Statistics
(1) Lag = 28	$r = 0$	74.4302	(6) Lag = 28	$r = 0$	84.7469
	$r \leq 1$	33.3296		$r \leq 1$	23.9908
	$r \leq 2$	13.4372		$r \leq 2$	7.9843
	$r \leq 3$	2.3467		$r \leq 3$	0.0155
(2) Lag = 23	$r = 0$	132.2825	(7) Lag = 23	$r = 0$	133.0915
	$r \leq 1$	79.5505		$r \leq 1$	74.5272
	$r \leq 2$	44.2472		$r \leq 2$	44.6338
	$r \leq 3$	20.8781		$r \leq 3$	19.8538
	$r \leq 4$	3.6837		$r \leq 4$	0.5623
(3) Lag = 23	$r = 0$	155.6375	(8) Lag = 23	$r = 0$	120.1612
	$r \leq 1$	79.9999		$r \leq 1$	59.8533
	$r \leq 2$	42.6124		$r \leq 2$	31.3888
	$r \leq 3$	9.7404		$r \leq 3$	11.1377
	$r \leq 4$	0.3818		$r \leq 4$	0.0427
(4) Lag = 28	$r = 0$	70.3359	(9) Lag = 28	$r = 0$	69.4829
	$r \leq 1$	38.8446		$r \leq 1$	35.8658
	$r \leq 2$	9.1915		$r \leq 2$	11.5782
	$r \leq 3$	0.8146		$r \leq 3$	0.6842
(5) Lag = 28	$r = 0$	66.5946	(10) Lag = 28	$r = 0$	83.6079
	$r \leq 1$	33.1835		$r \leq 1$	28.2566
	$r \leq 2$	15.4907		$r \leq 2$	17.5609
	$r \leq 3$	2.5698		$r \leq 3$	0.5882

Note: * Specifications (1) to (10) are the same as listed in table 3.10(b) of chapter - III.

Graph - 1

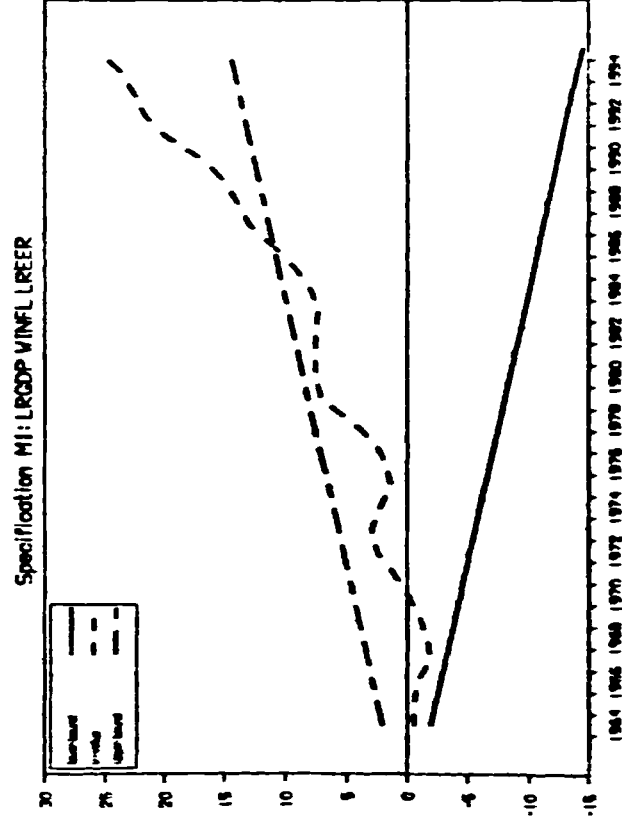


Graph - 2

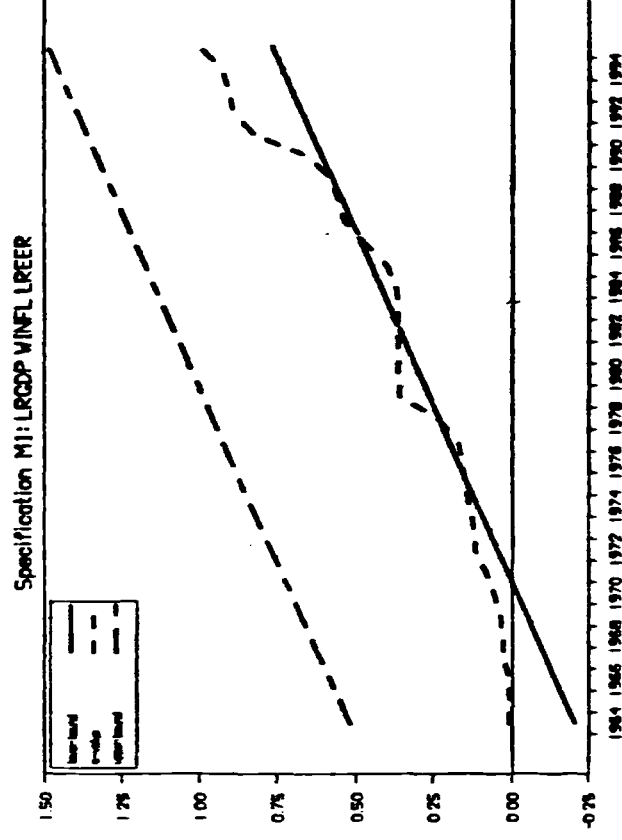


Graph - 3

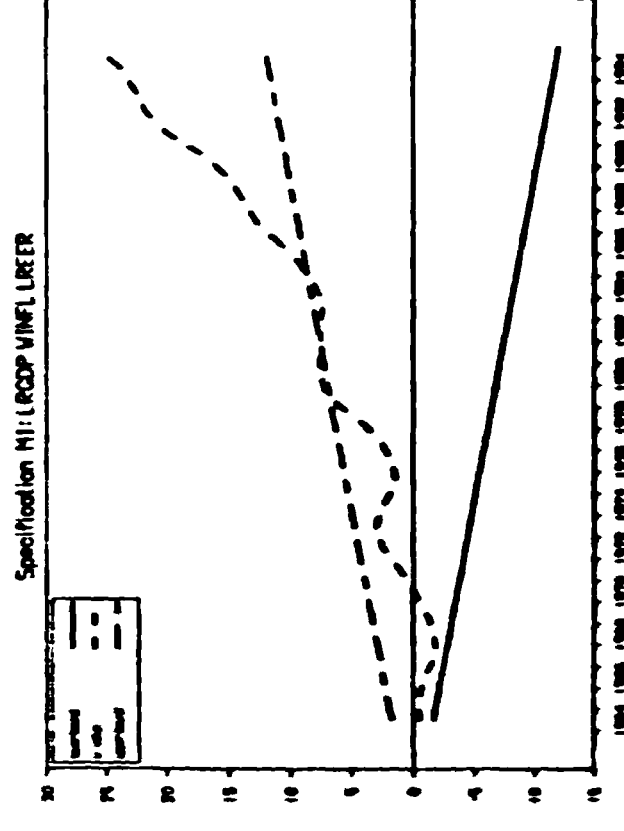
CUSUM TEST(Annual Data): W - Values(0.01 level)



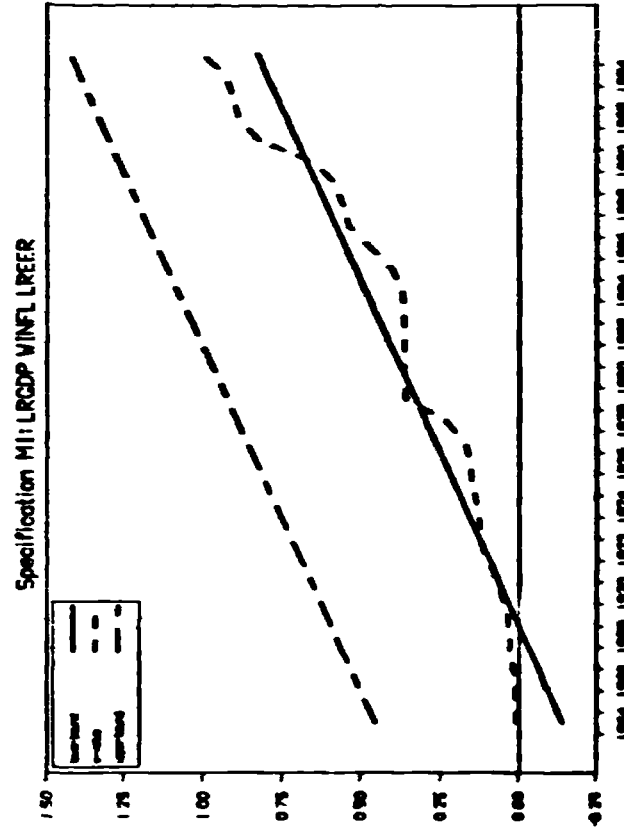
BDE TEST(Annual Data): S - Values(0.01 level)



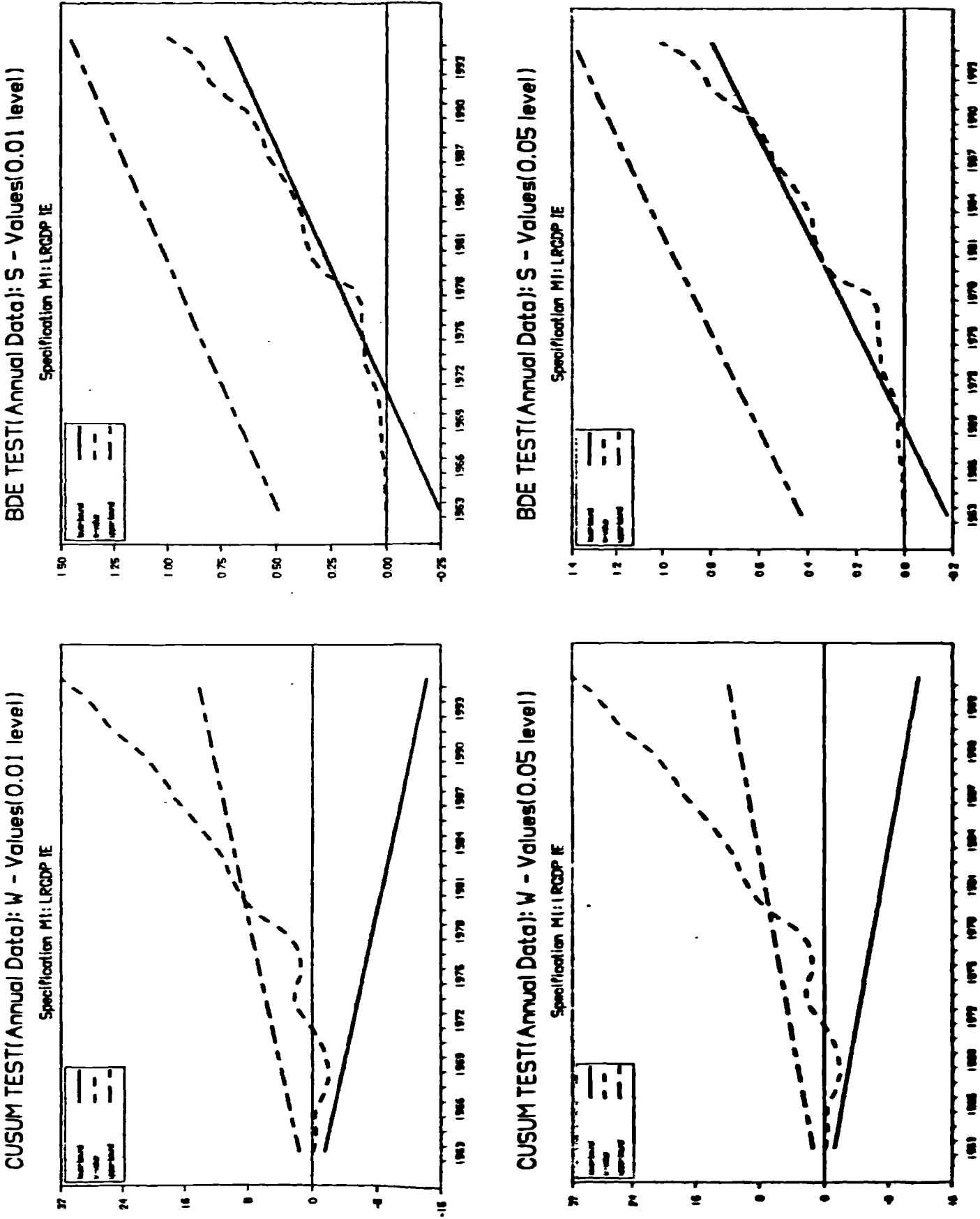
CUSUM TEST(Annual Data): W - Values(0.05 level)



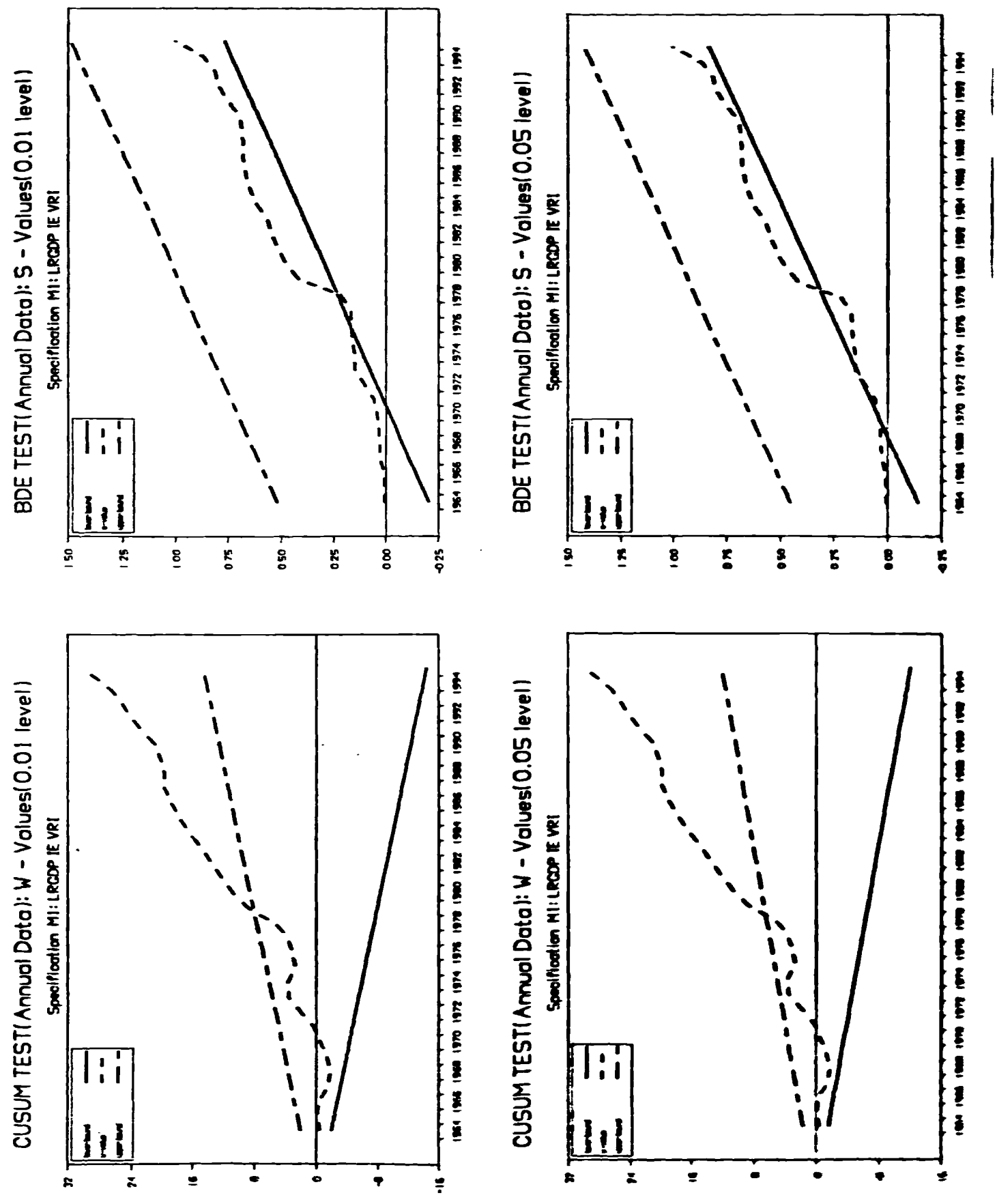
BDE TEST(Annual Data): S - Values(0.05 level)



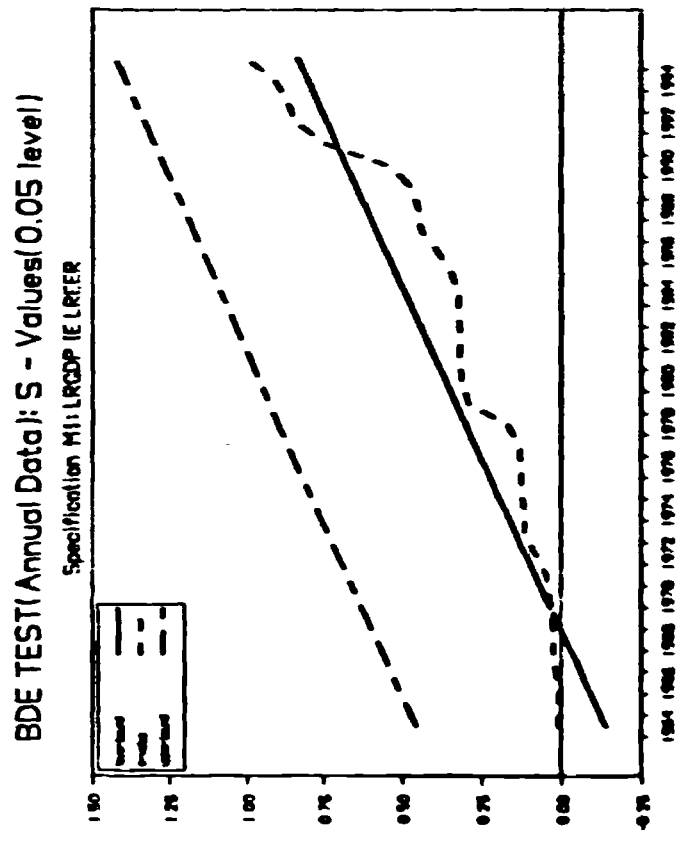
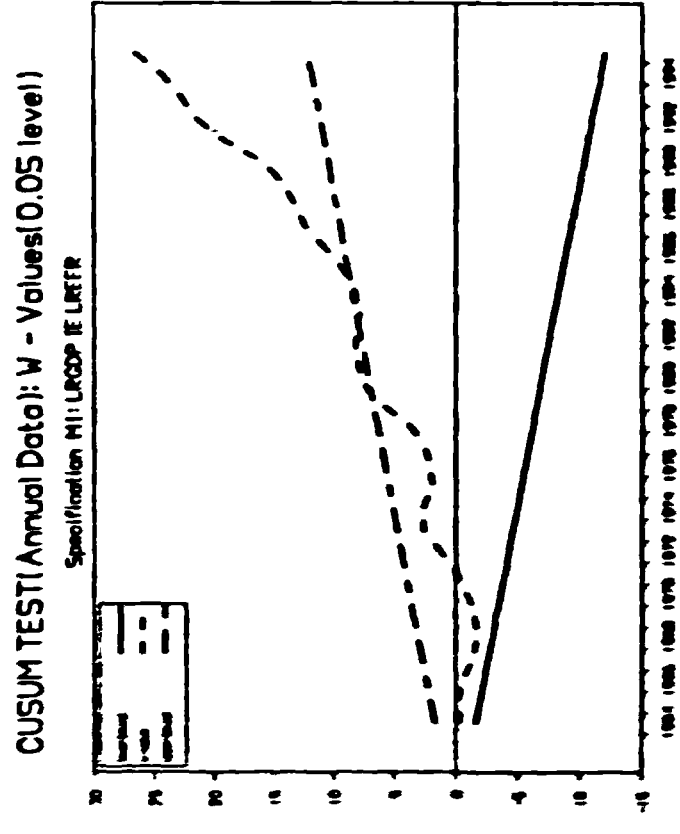
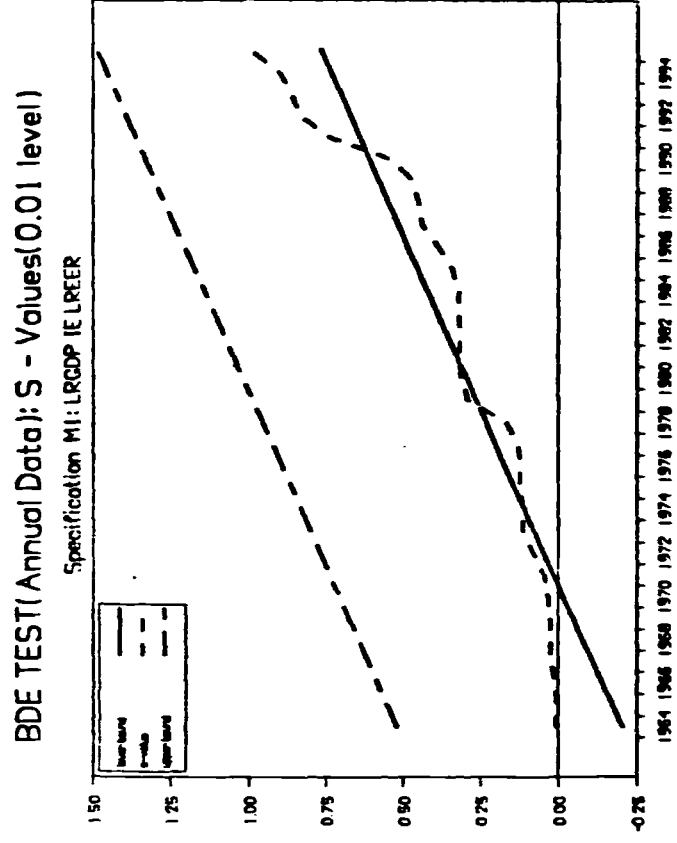
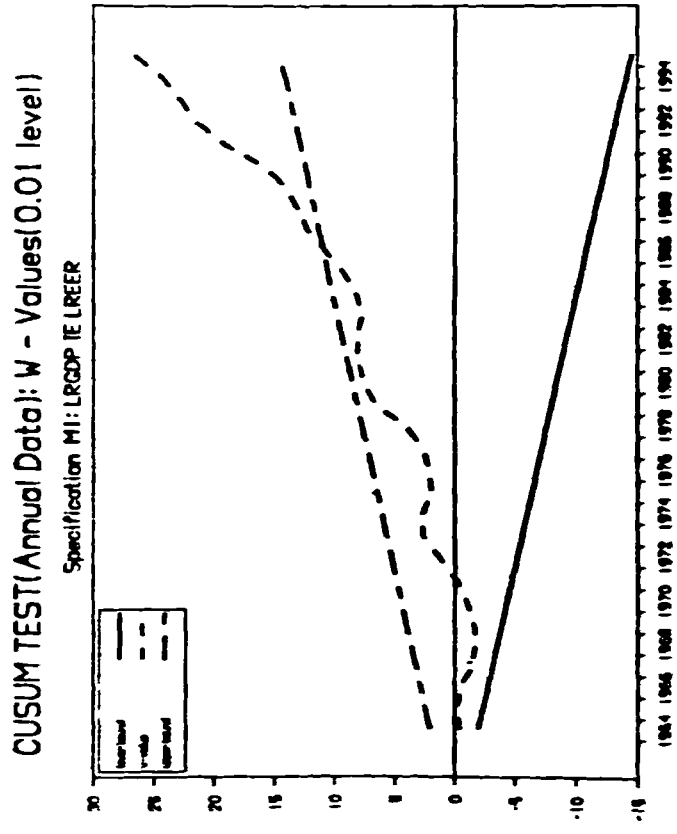
Graph - 4



Graph - 5

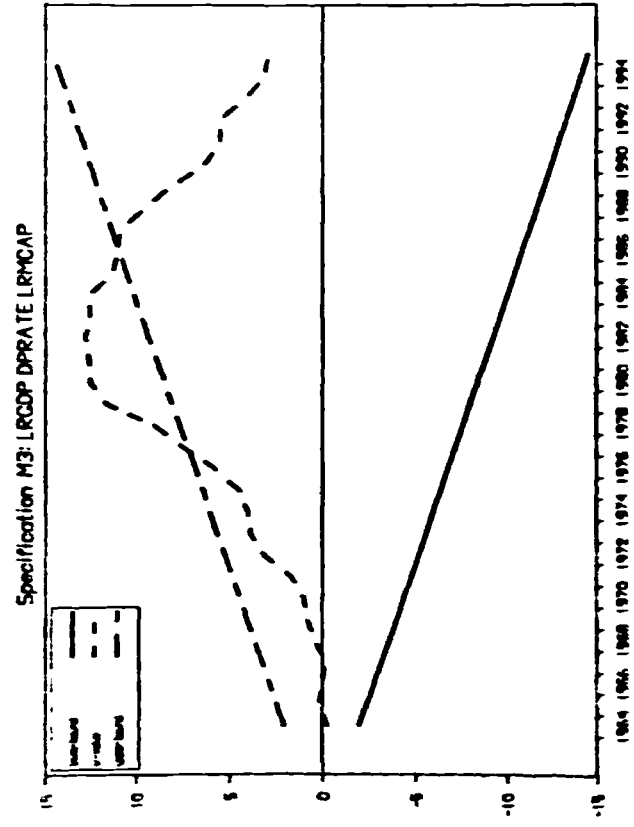


Graph - 6

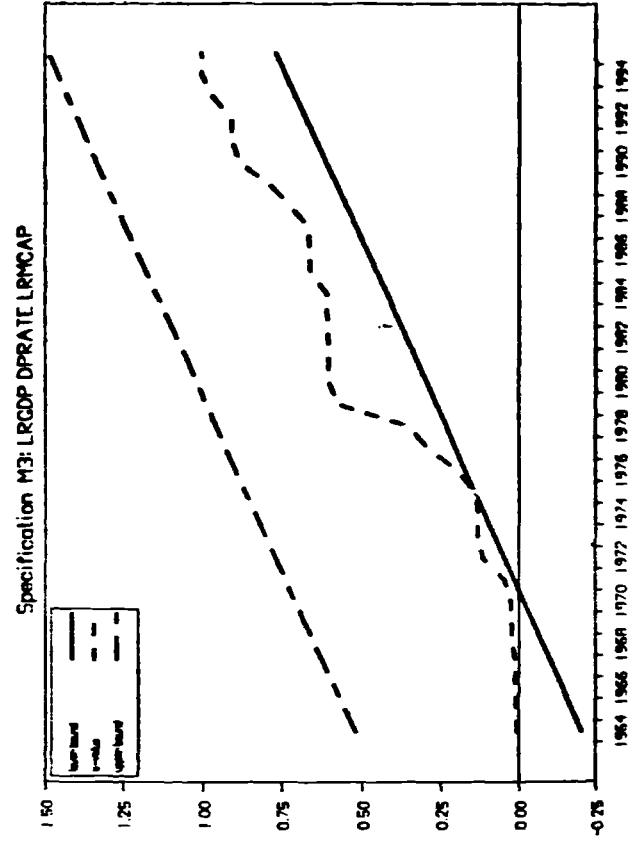


Graph - 1

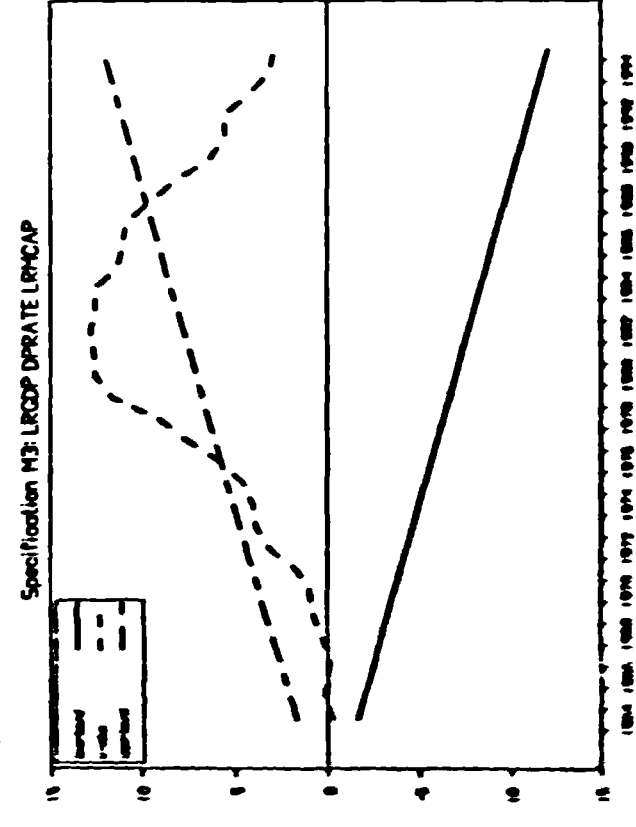
CUSUM TEST(Annual Data): W - Values(0.01 level)



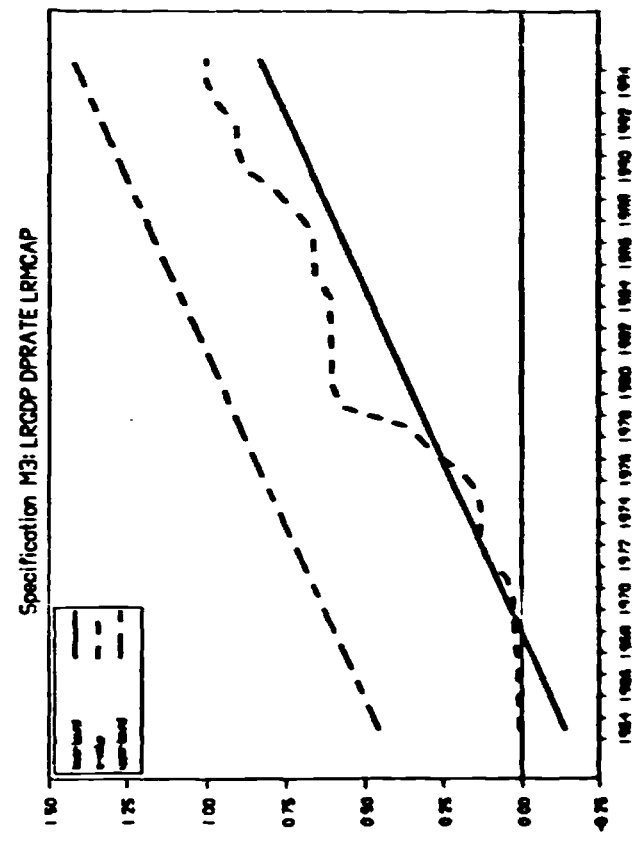
BDE TEST(Annual Data): S - Values(0.01 level)



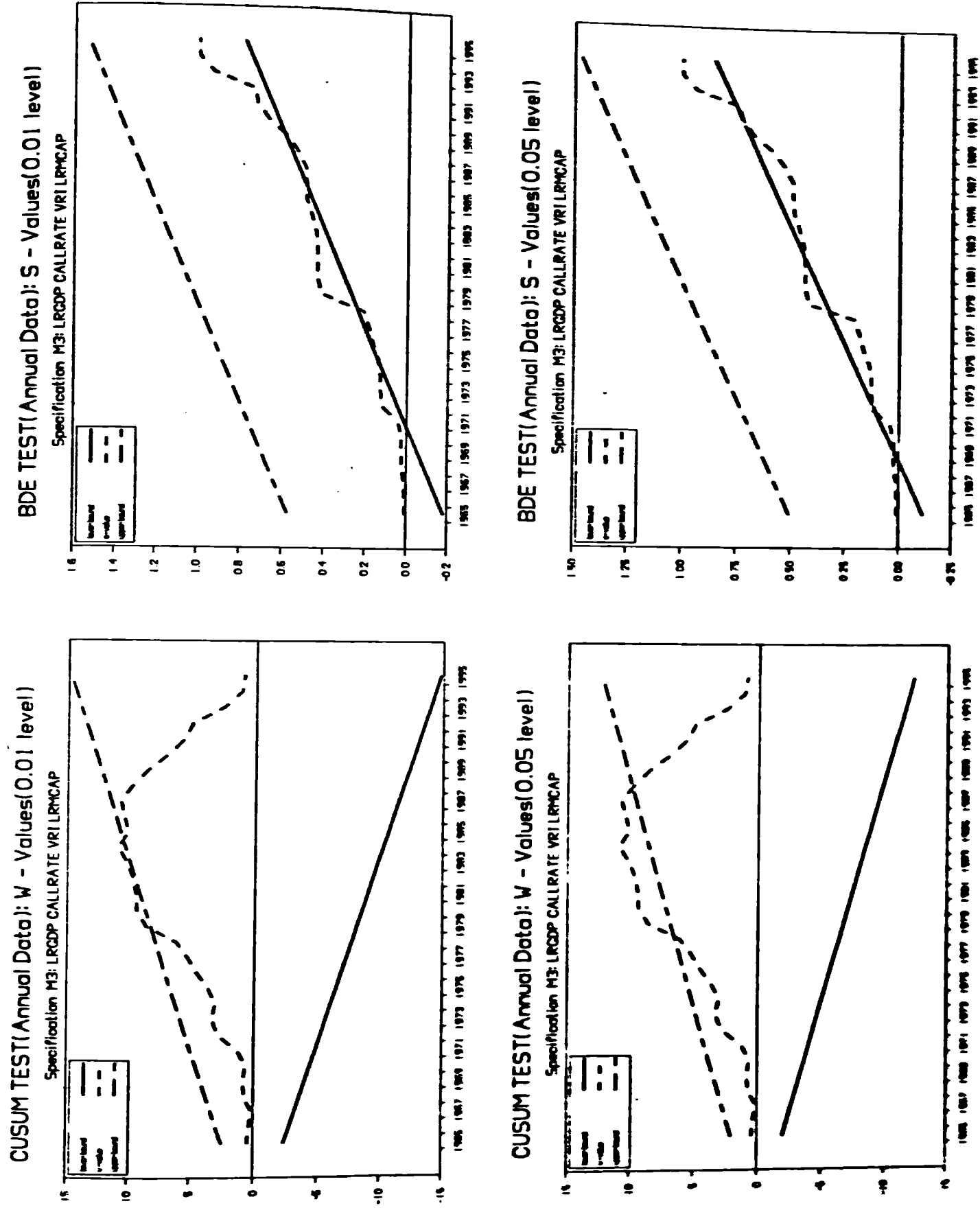
CUSUM TEST(Annual Data): W - Values(0.05 level)



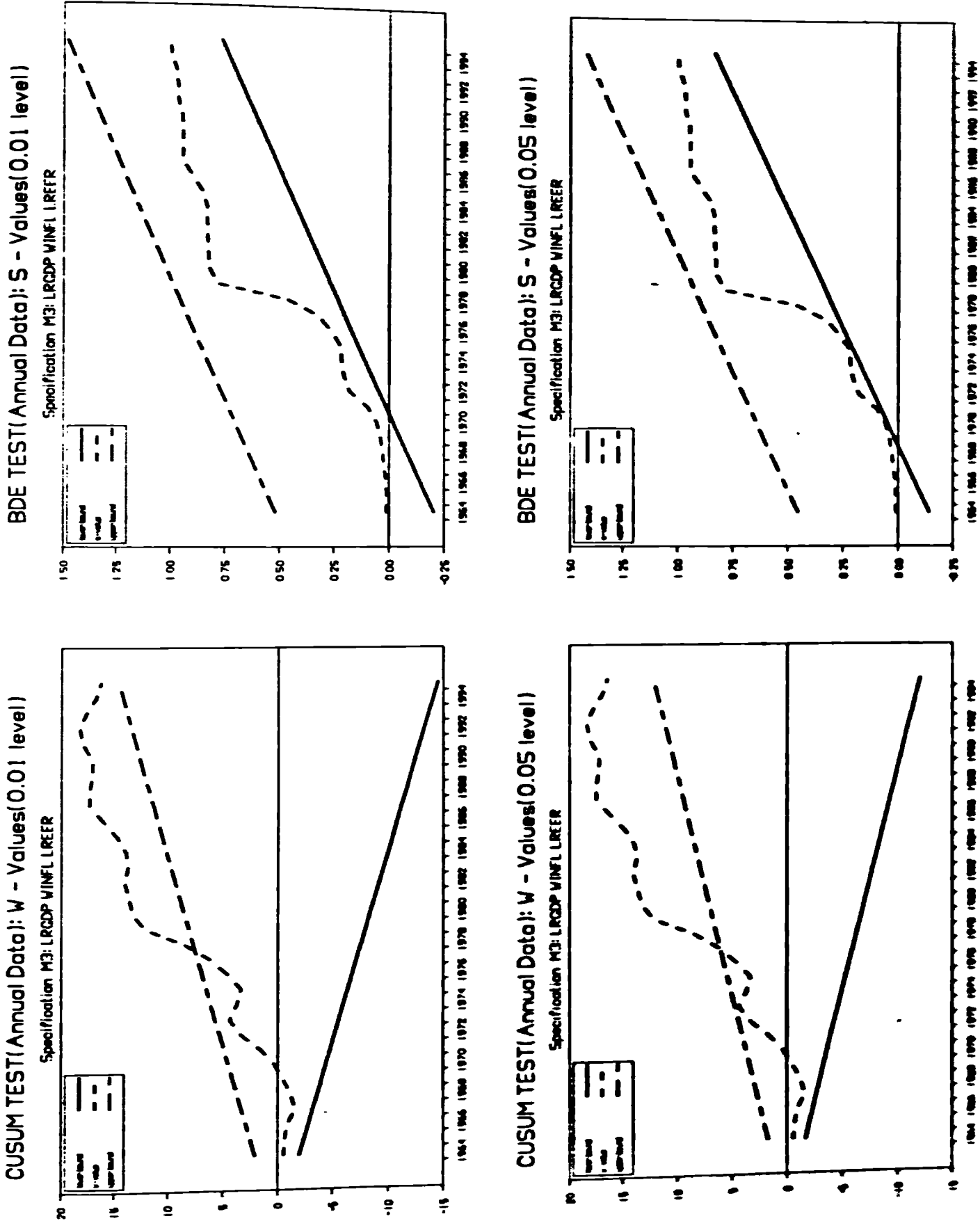
BDE TEST(Annual Data): S - Values(0.05 level)



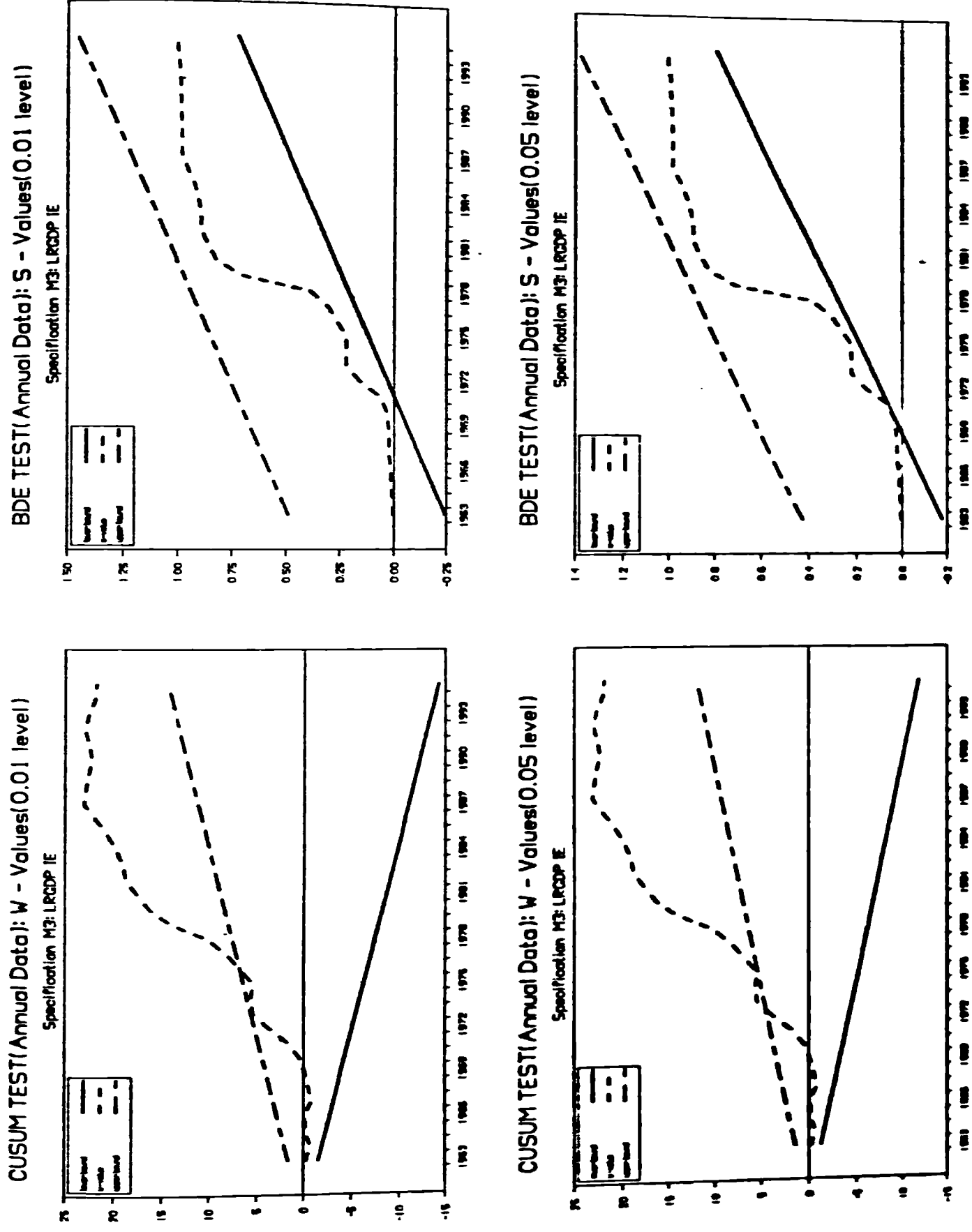
Graph - 8



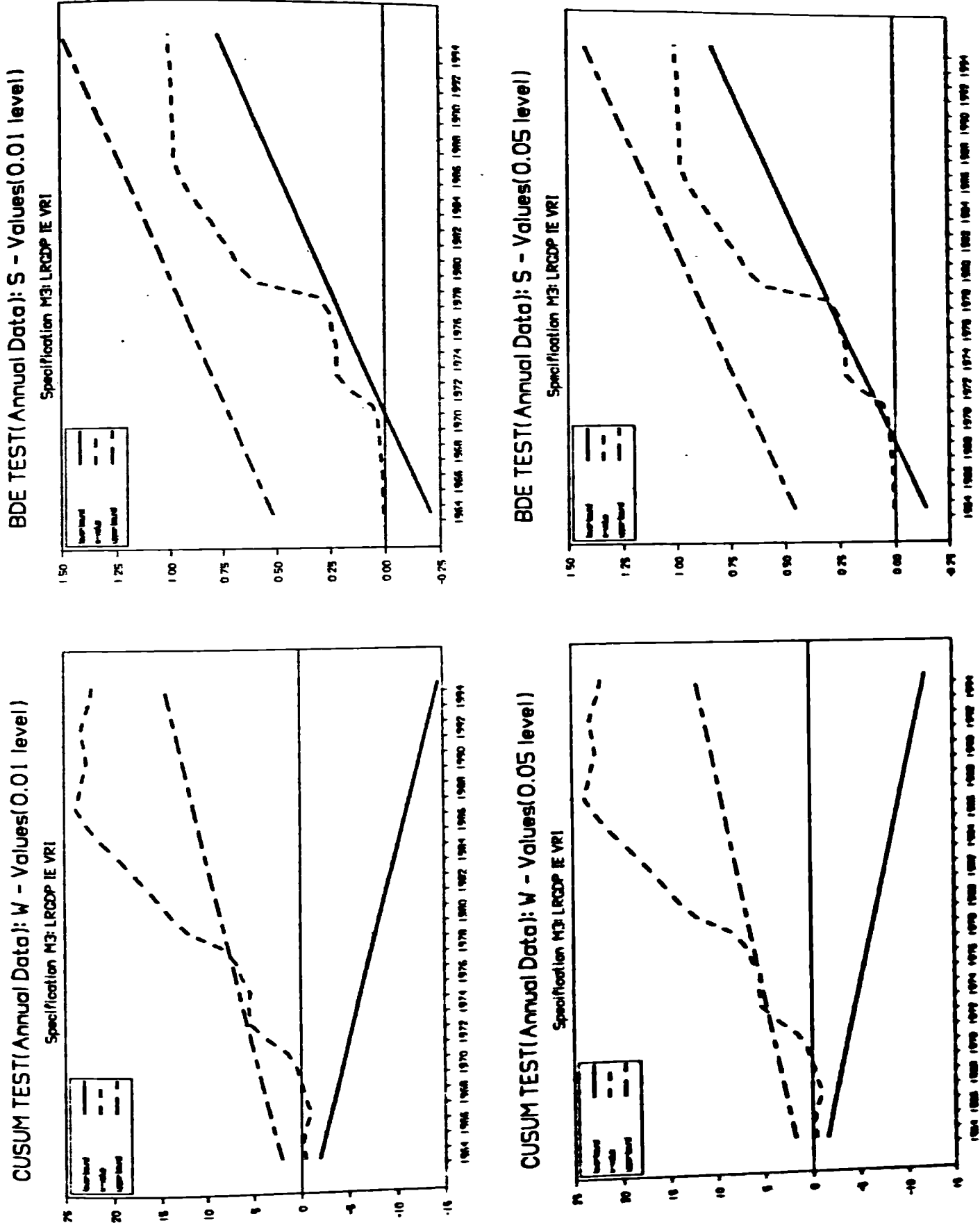
Graph - 9



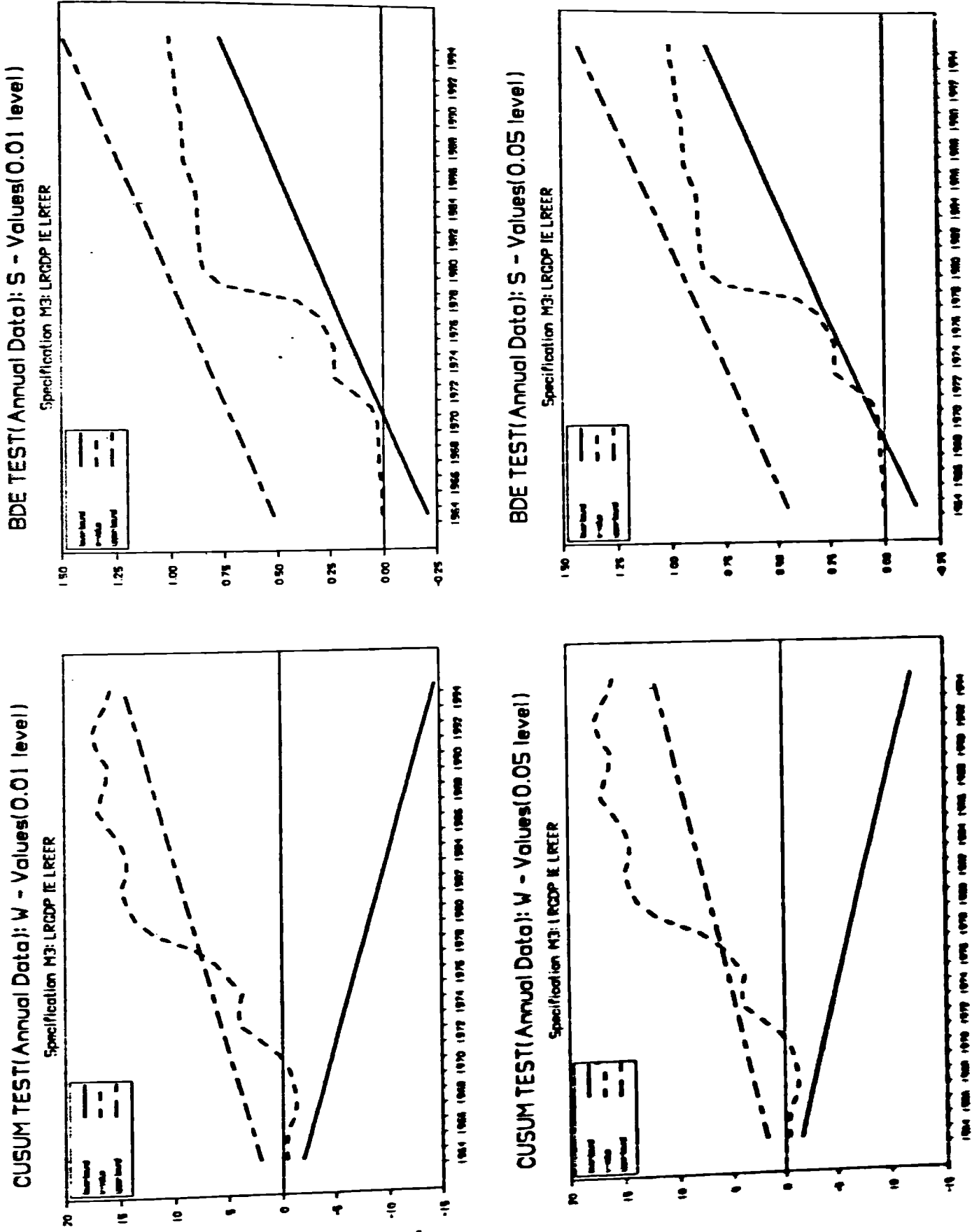
Graph - 10



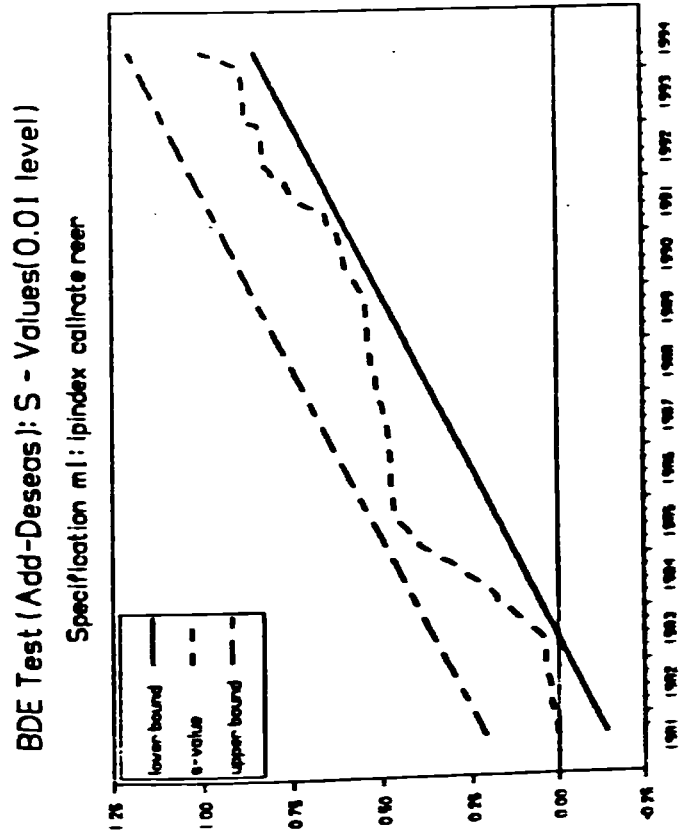
Graph - 11



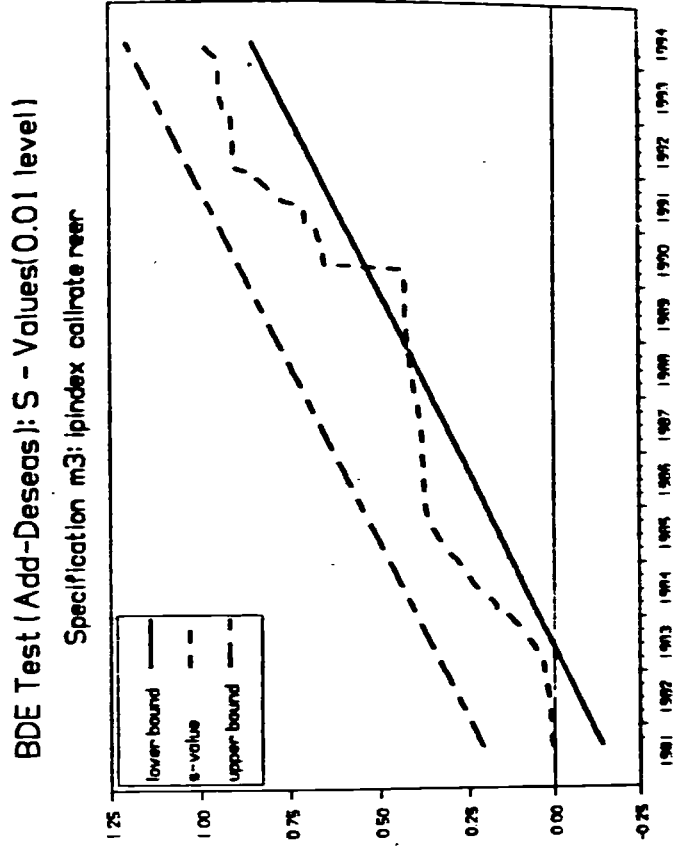
Graph - 12



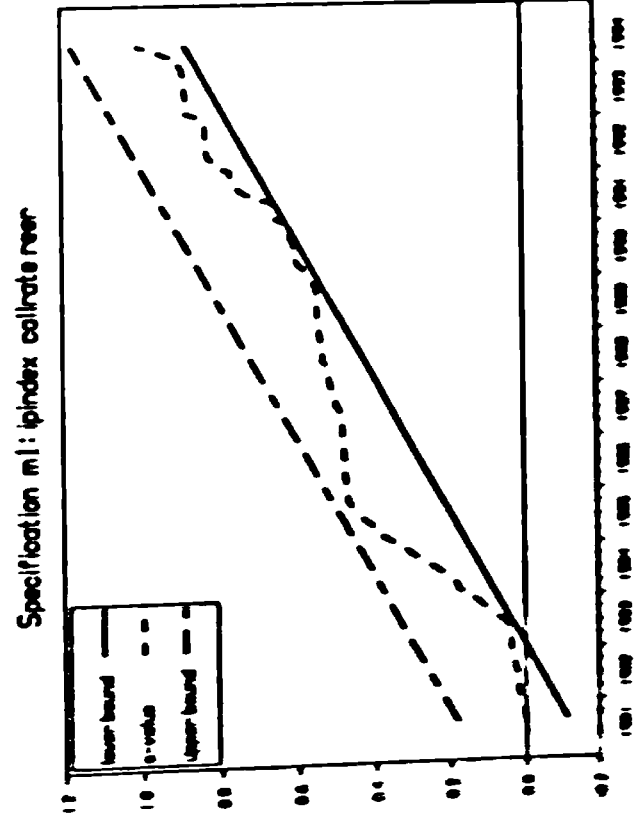
Graph - 13



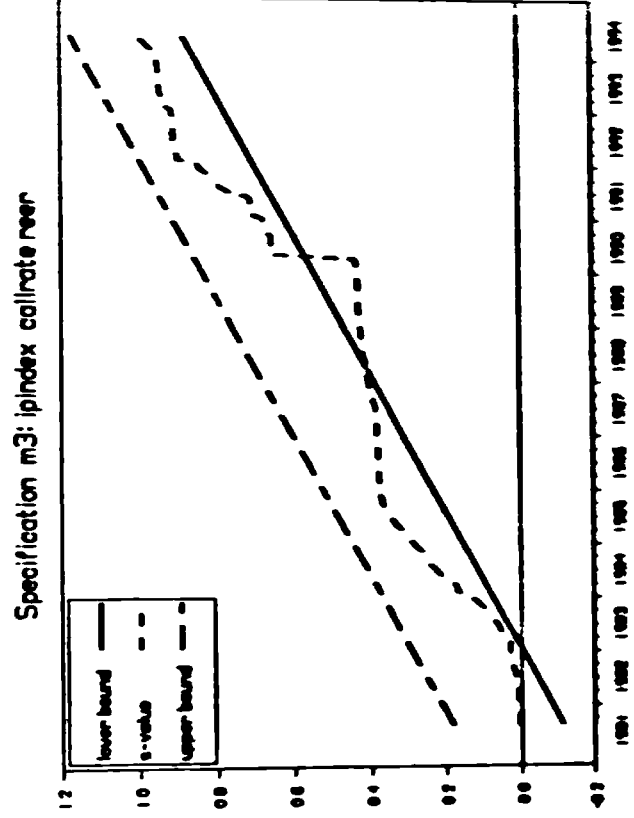
Graph - 18



BDE Test (Add-Deseas): S - Values(0.05 level)

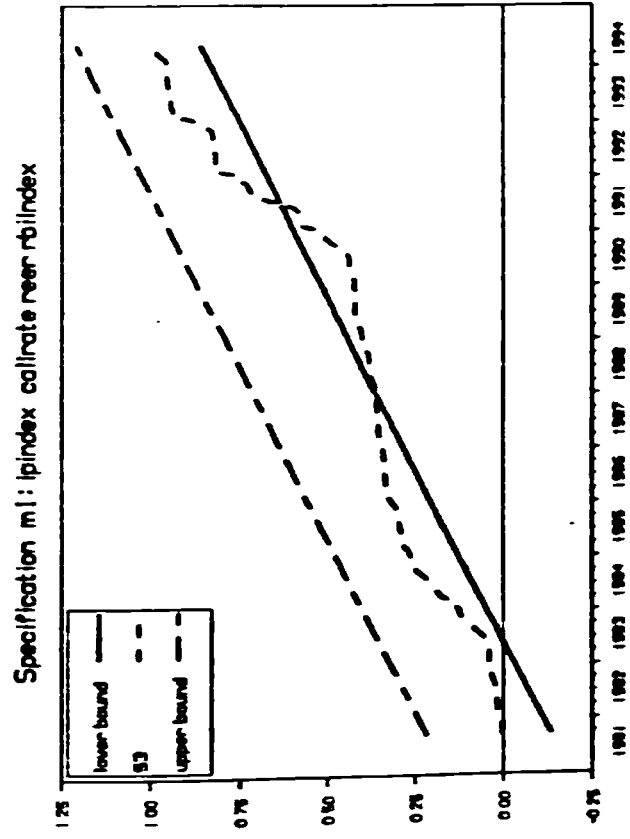


BDE Test (Add-Deseas): S - Values(0.05 level)



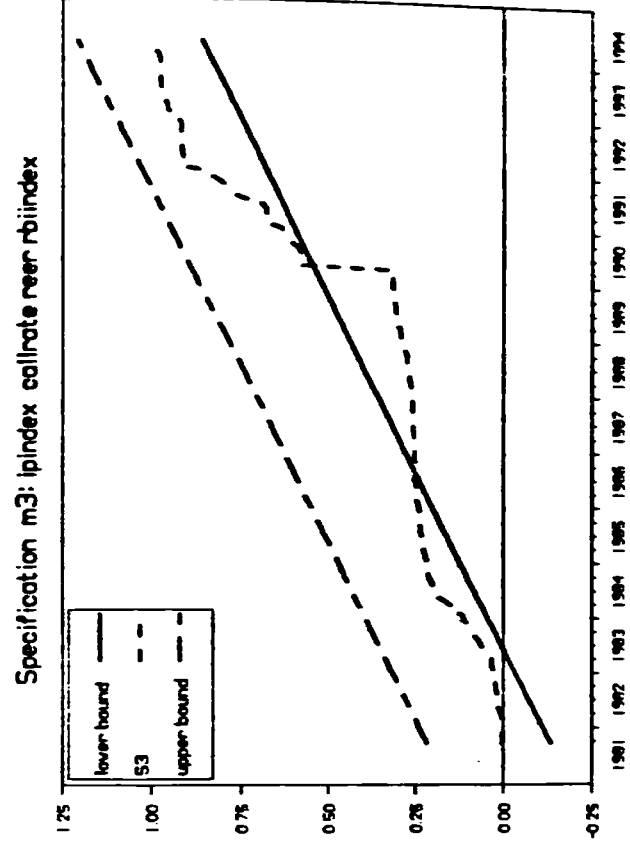
Graph -14

BDE Test (Add-Deseas): S - Values(0.01 level)

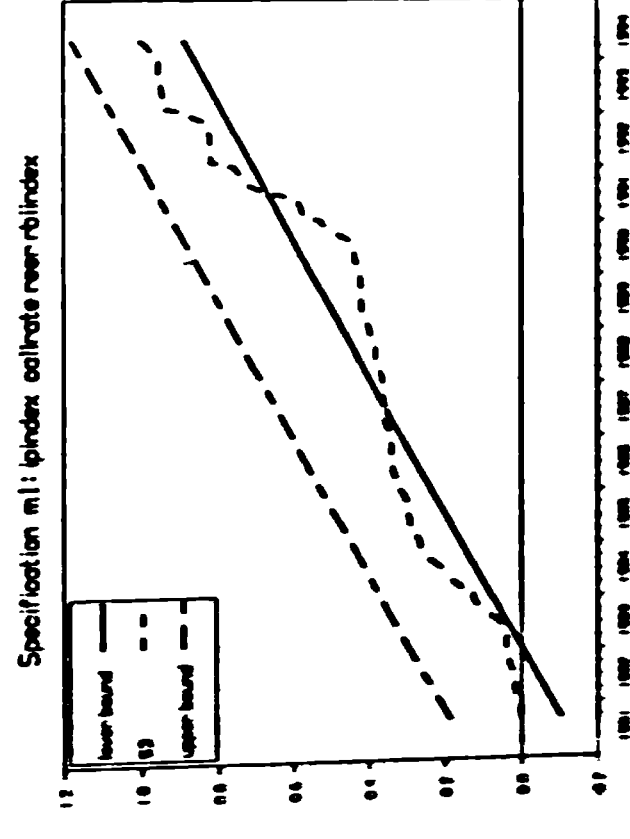


Graph -19

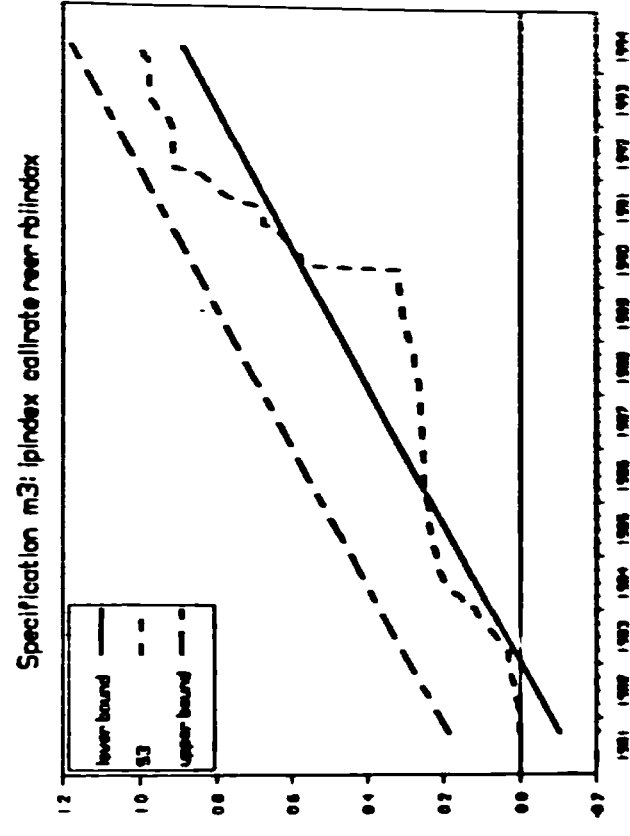
BDE Test (Add-Deseas): S - Values(0.01 level)



BDE Test (Add-Deseas): S - Values(0.05 level)



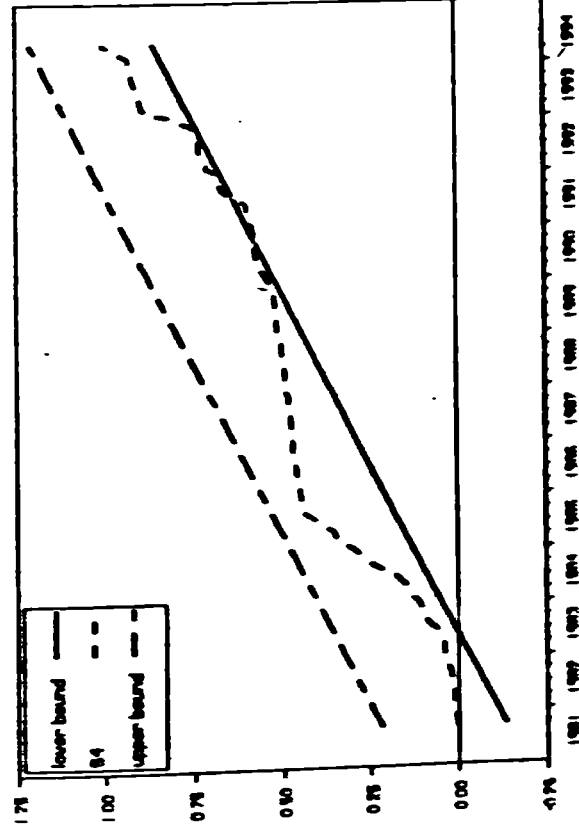
BDE Test (Add-Deseas): S - Values(0.05 level)



Graph - 15

BDE Test (Add-Deseas): S - Values(0.01 level)

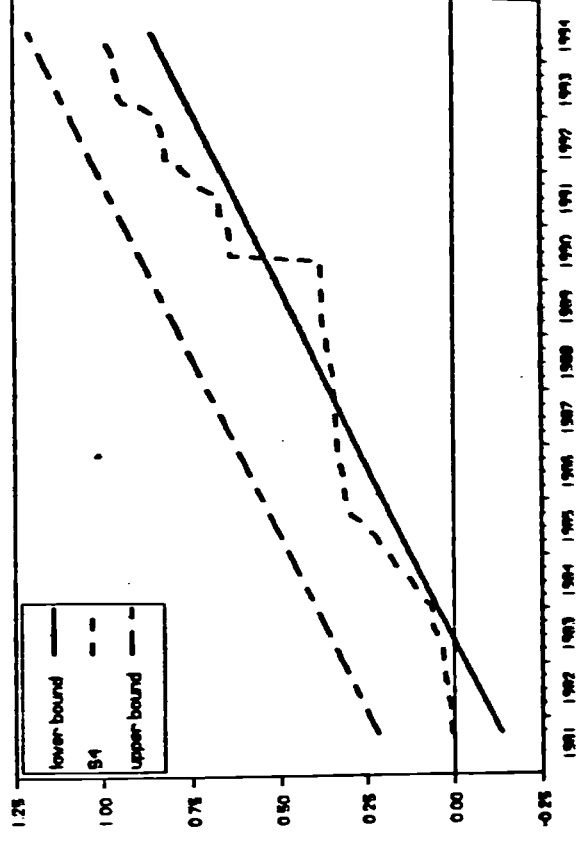
Specification m1: ipindex callrate near bseindex



Graph - 20

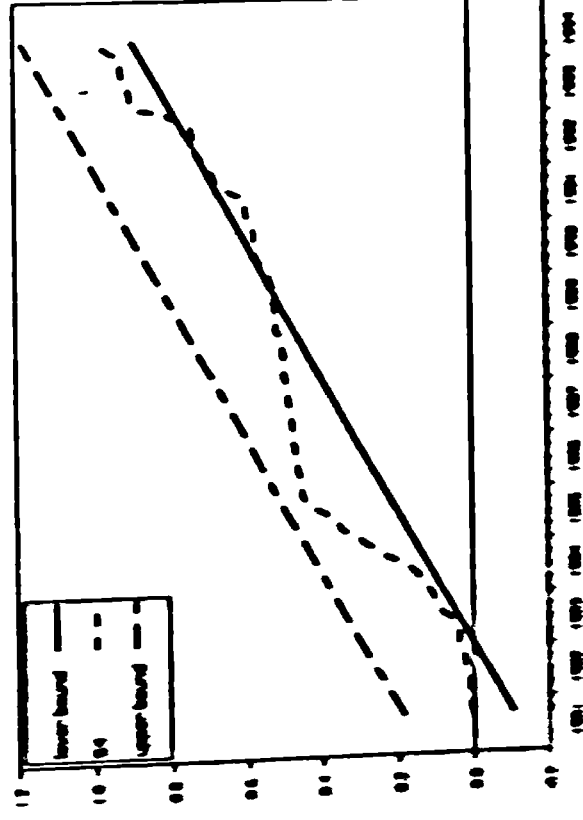
BDE Test (Add-Deseas): S - Values(0.01 level)

Specification m3: ipindex callrate near bseindex



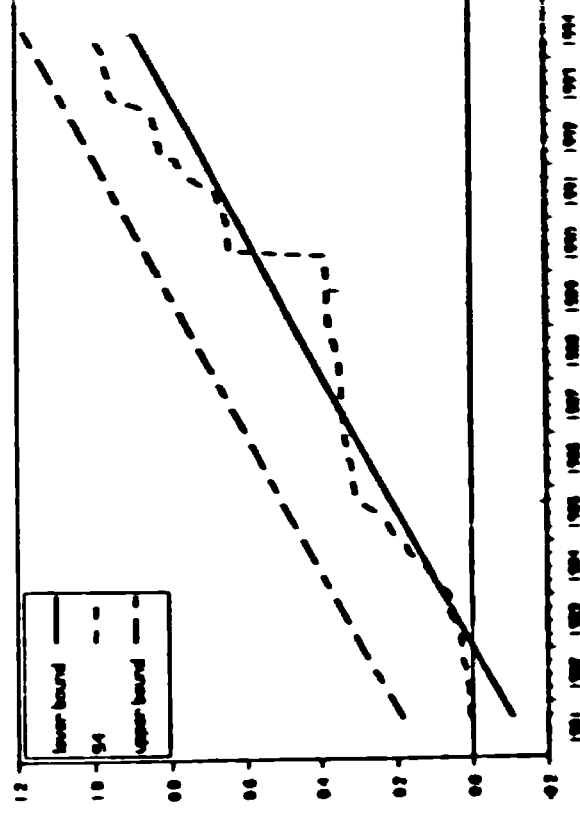
BDE Test (Add-Deseas): S - Values(0.05 level)

Specification m1: ipindex callrate near bseindex



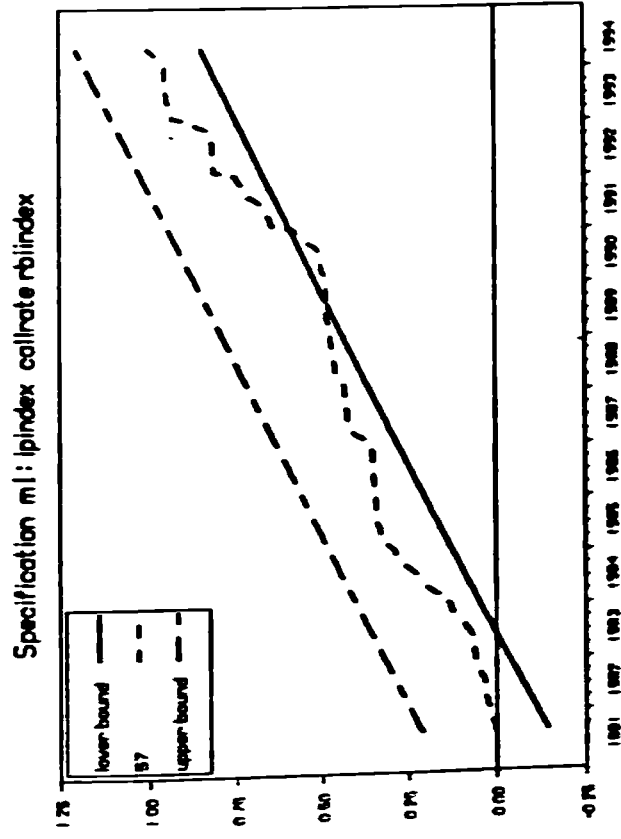
BDE Test (Add-Deseas): S - Values(0.05 level)

Specification m3: ipindex callrate near bseindex



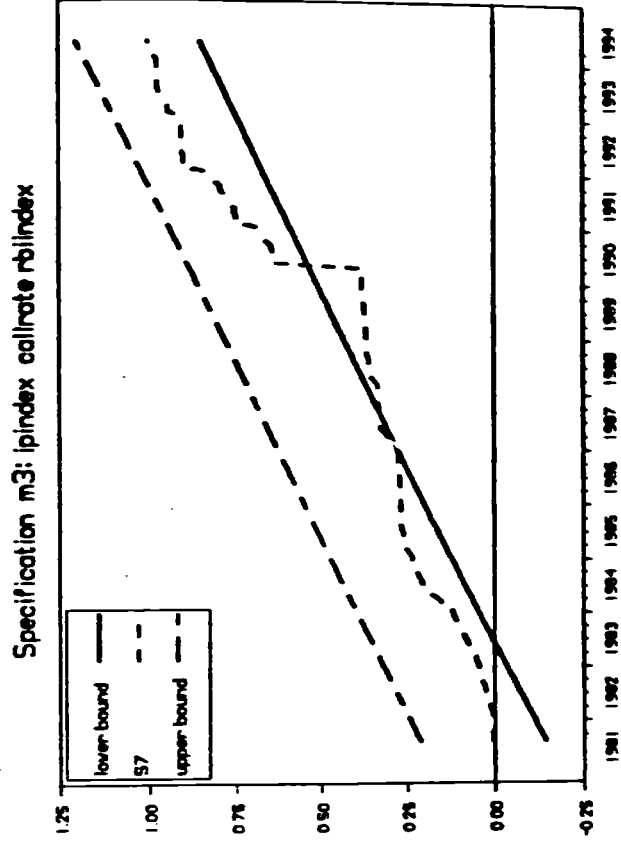
Graph - 16

BDE Test (Add-Deseas): S - Values(0.01 level)

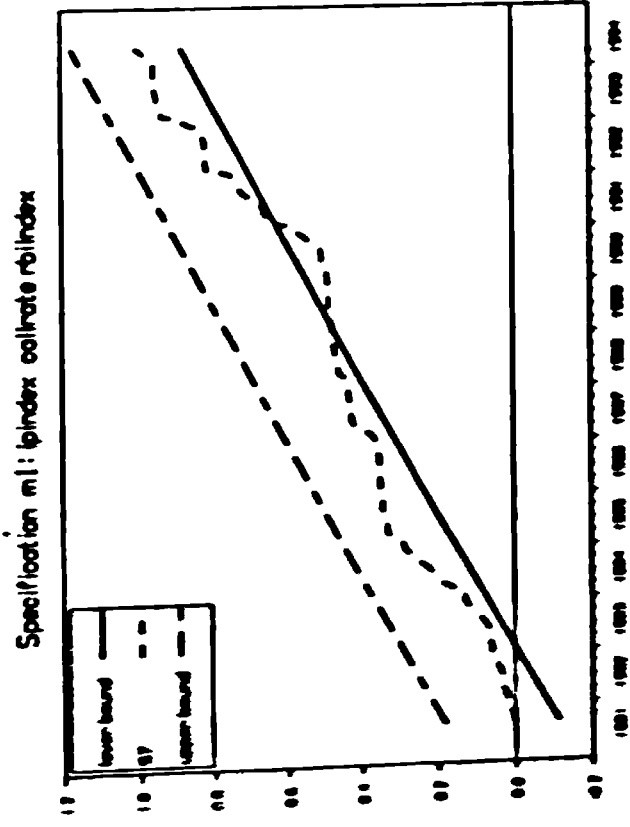


Graph - 21

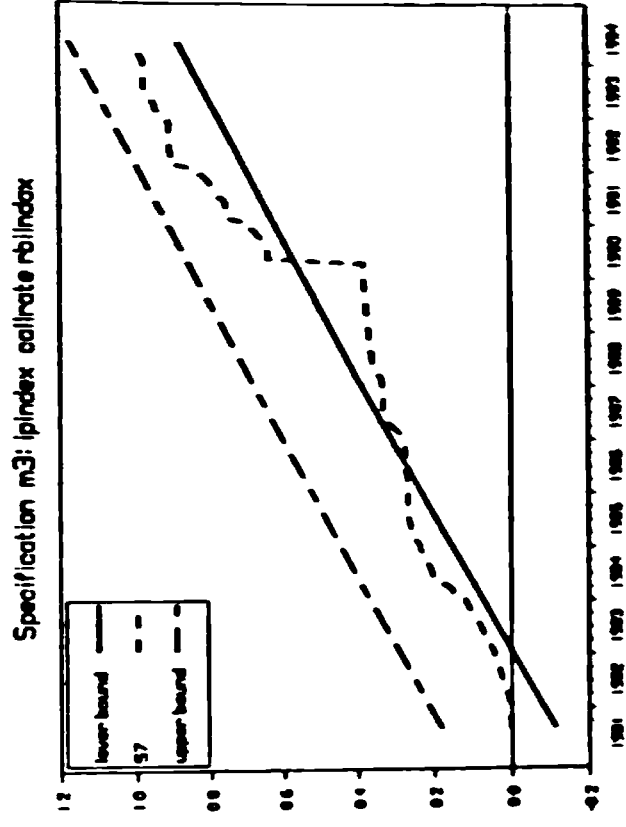
BDE Test (Add-Deseas): S - Values(0.01 level)



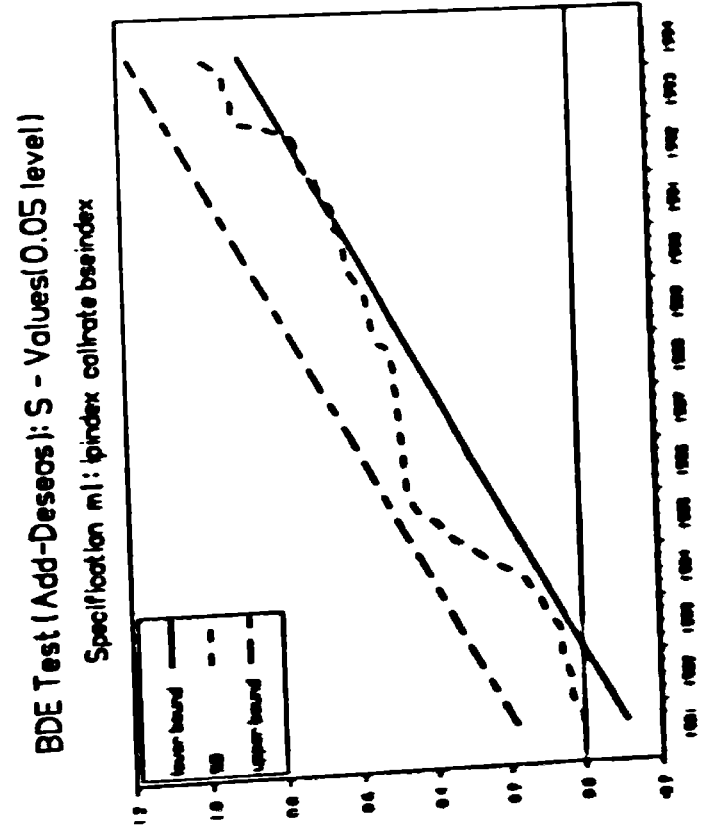
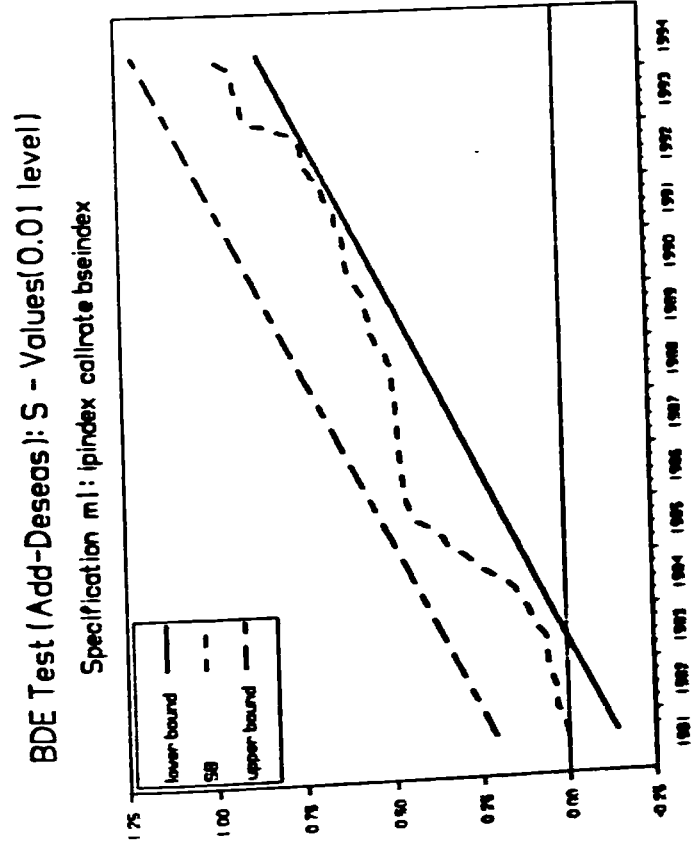
BDE Test (Add-Deseas): S - Values(0.05 level)



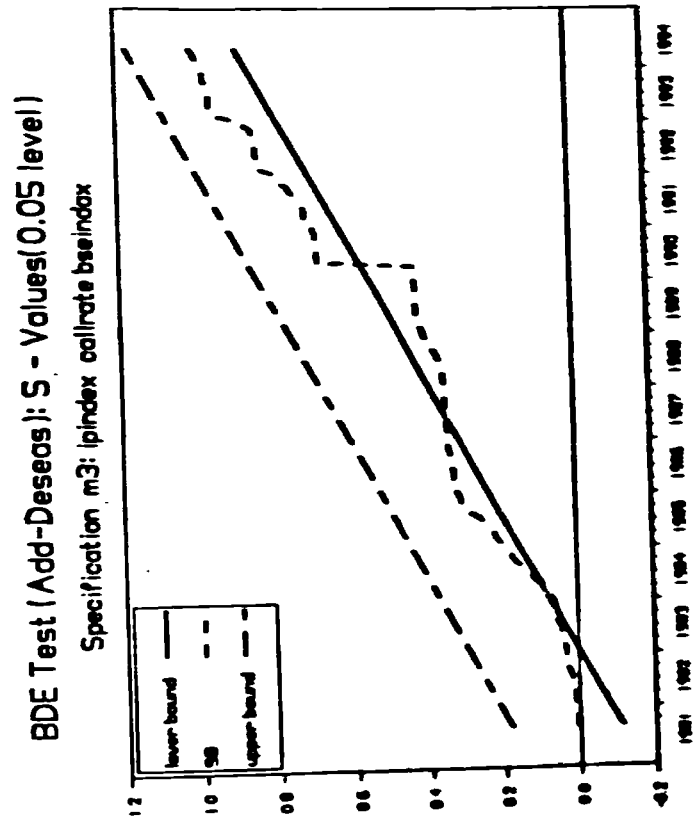
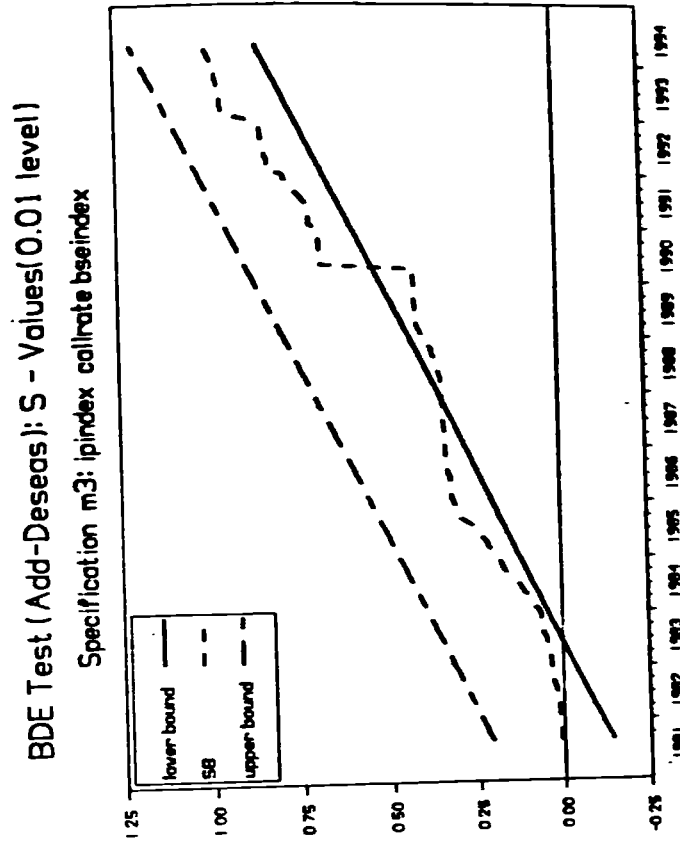
BDE Test (Add-Deseas): S - Values(0.05 level)



Graph - 17



Graph - 22



CHAPTER - V

BUFFER - STOCK APPROACH TO DEMAND FOR MONEY

5.1 Introduction

The conventional approaches to money demand implicitly assumes that the supply of money is equal to the demand for money. In other words, it is assumed that the money market is in equilibrium. Such a notion was uncontroversial when money supply was demand determined. But after the missing money episode of the UK in 1970s, the assumption had been contested. In this connection Artis and Lewis (1976) argued that large independent changes in money supply in UK during 1970s had led to disequilibrium in the money market. The causes for such a phenomenon had been several. An important factor was the competition and credit control reforms, which created a new spirit of competition in the banking system and abolished the direct control on bank advances. Another factor was budget deficits by the government which was largely financed by money creation in early 1970s.

Thus, the economic environment in the UK of the early 1970s created a situation in which the money stock could not automatically be assumed to be demand determined by interest rates and nominal income. The supply of money was independent of demand and effectively exogenous. In practice, shocks to the quantity of money, emanating from the external currency flow, banking sector reform in lending to private sector, policy changes initiated by the government very often contributed to the problem of monetary control.

Broadly speaking, in both the UK and the USA the period upto 1971 was one of optimism as far as establishing a stable money demand was concerned. It is widely viewed

that the pace of financial innovation in the mid 1970s has led to increasing doubt about the stability of money demand. A broadly similar pattern of events emerged in US with much debate centred on the period of "missing money" in the mid 1970s and declining velocity in the 1980s. Perhaps the 1980s can best be described as the "year of uncertainty" so far as the empirical characteristics of demand for money are concerned.

Throughout the 1970s and 1980s, there has been no major innovation in theories of demand for money that has led the monetary economists radically alter modelling strategy. Laidler (1984) has stressed the importance of precautionary motive in explaining the money holding in general, and the issues addressed led to the approach of "buffer-stock money". So, an important development in the literature during the 1980s has been the development and empirical implementation of buffer-stock model. And hence in the recent years there has been a large number of theoretical and empirical studies on the role of money as buffer stock.

The failure of the partial adjustment model in the mid 1970s in both the UK and USA and the research for replacement has been the main agenda since that time. Buffer stock model has firm microfoundations which can explain the events before and after the partial adjustment model and suggests a better insight to the problem of instability associated with the money demand function.

Buffer stock model explains the demand for money in the context of individual optimisation and the microeconomics of adjustment in the market for money. The model recognises that there are costs involved when money balances are adjusted and that these make it optimal for an individual, when faced with a deviation of money balances from long run equilibrium, to allow that departure to persist in the short run. One type (shock absorber) of buffer stock model introduces expectation into the analysis such that unexpected events in the present or expected events in the future induce deviation from

the long run equilibrium. Adjustment is not complete within one period and hence money balances are not always equal to the equilibrium values. Another type (forward looking) of model assumes that adjustment costs are sufficiently large that it is not optimal for the individuals to continuously adjust money balances back to equilibrium. Instead, the individual operates a rule which allows money balances to fluctuate within a band which brings them back to equilibrium when it reaches upper or lower limits.

The model which results from introducing expectations modify the original partial adjustment method to allow individuals to make expectations about future and to be capable of being surprised by the unexpected events. The correction to the money demand function was the proper treatment of expectations. By not dealing correctly with the expectations, the demand for money appeared unstable and distorted in relation to current conditions. It is because the buffer stock model is realistic in its treatment of the future in relation to the present and about the impact of the unforeseen events on quantity of money held, that it is able to provide a consistent micro-economic explanation of the demand for money which is stable, where other conventional models failed.

5.2 Money as a Buffer Stock:

The buffer stock approach attributed "money" as a appropriate asset to fulfil the role of shock absorber in individual's portfolio. Increase in the money supply, if well perceived by the individual portfolio holder as transitory may initially be absorbed into total money holding, before it is dissipated in the form of extra expenditure on goods and financial assets, in accordance with the transmission mechanism. The principle behind this approach was advanced by Laidler (1984), Knoster (1984) and Goodhart (1984).

The buffer stock concept of money is more relevant for a market economy where there are costs in gathering and processing information. Given that there are costs to find a buyer for assets, individual agent is expected to hold a fraction of his wealth in money

and hence, money acts as a "temporary abode of purchasing power". So, in an economy which is characterised by the existence of monetary exchange, the uncertainty might well manifest itself in unexpected variations in cash holdings. A discrepancy in actual and target money holding will force the agents to move towards his long run target demand for money by altering his current rate of flow of expenditure on goods, services and asset accumulation. That is to say "the discrepancy between actual and desired cash balances will set in motion a real balance effect" (Laidler, 1984, p.20).

Further, the buffer stock approach presupposes the need for the existence of an asset which can absorb the shocks during the interval period of discrepancy between the occurrence of shocks and subsequent action of the economic agents. This approach recognises that the unanticipated as well as anticipated events lead to changes in money holding. But unanticipated increase in the money supply, for example, will be unwillingly held by the agents though it forces the holders temporarily off the short run demand curves because the costs of transitory money holdings are less than those of portfolio adjustment for financial assets and definitely less than costs of adjustment in real assets.

Thus, economic agents may rationally and optimally decide to respond to the continuing stream of developments - "news and shocks", not by a thorough going, continuous reconsideration of their full economic dispositions, but by allowing such shocks to impinge initially upon certain assets/liabilities whose characteristics make them suitable to act as a buffer. Money being the most liquid assets, acts the buffer function best. Hence, the emphasis is on the function of money as a "medium of exchange" or "temporary abode of purchasing power".

Thus, the approach assumes that the agent's desired money holding is not a single valued function of its usual arguments but consists of a band of acceptable holdings. This band is marked by upper and lower thresholds such that, an adjustment is required only if

the actual holding crosses the boundary. In turn, the width of the band is determined by the economic variables, such as the scale and variability of cash flow. Once the money holding crosses the width, it starts purchasing a broad spectrum of assets - financial and real. Thus the analogy presupposes that with the passage of time, individual holding of money will spill over the purchase of spectrum of goods and hence real balance effects set into motion. Hence, the buffer stock approach is able to account for the broadly based monetary transmission mechanism.

According to the buffer stock approach, an exogenous increase in money supply must be anticipated and perceived to be permanent before it will cause individuals to make major adjustments in their overall portfolio. If the changes are unexpected and expected to be reversed in the future, individuals are not likely to incur the cost by changing the portfolio decisions by accommodating some real or financial assets into their portfolios only to reverse the process later. Instead, the extra balances will be absorbed into buffer stock money holdings.

In this sense, money holding at a particular time may comprise of a permanent or planned component and transitory or unplanned unexpected component which is related to unanticipated shocks. Satisfactory models of demand for money must take into account both the elements, so that if the transitory balance represents a substantial and volatile part of the total money balances, we might expect the conventional theories which fail to account the possibilities of these components, to show evidence of parameter instability over time.

5.3 Why Buffer Stock Money?

In 1973, Goldfeld examined the stability of money demand function using quarterly post-War data for the US. The estimates of the partial adjustment model for the US economy found that demand function was stable when (i) a narrow transaction definition

of money was used, (ii) a short term market rate of interest like treasury bill or commercial paper rates are used, (iii) measured income was used rather than permanent income, and (iv) lagged money was included to allow for incomplete adjustment in the short run. But starting from 1974:1, forecast from the Goldfeld's equation began seriously to over predict the real money balances. This evidence of systematic over prediction of the real money balances by the standard money demand function suggested that the demand for money has shifted down. This possibility was taken to mean that demand for money had become unstable in the sense that it had become more difficult to predict ex ante (Goldfeld, 1976). When the equation was reestimated using the post -1973 data, the following problems were revealed: (i) the coefficients on the lagged dependent variable became very large (implying long adjustment lags) and sometimes greater than unity (implying that money demand was dynamically unstable, (ii) the income elasticity for real income declined markedly, sometimes becoming insignificantly different from zero. The elasticities of interest rates becoming implausibly low and sometime statistically insignificant. All the above suggest for a dynamically unstable demand for money function. And the situation after 1973 leads to the case of "missing money" episode (Goldfeld, 1976).

Attempts have been made to focus on the financial innovation which led to the breakdown of the partial adjustment model. Hacche (1974) experimented the model by including the yield on certificates of deposits as an additional determinant. Goldfeld in US added the interest on NOW and thrift accounts in the specification and could remove the over prediction to a certain degree. The works by Artis and Lewis (1976), Goldfeld (1976) and Hacche (1974) have led to conclude that micro - theoretical correction to the functional form, not just adjustment to the empirical specification, would be necessary to restore stability of the demand for money function. New micro foundations of the demand for money function were required which could explain both the pattern of the past as well as financial innovation of the mid 1970s. This led economists like Laidler (1984), Knoster

(1984) and Goodhart (1984) to suggest a model where money balances serve as "buffer stock" or temporary abode of purchasing power. In this model, it is expected that the transitory income be absorbed passively in money holdings in the short run.

Among the characteristics of the Goldfeld (1976) equation, some of them are found to be troublesome. First, the estimated elasticities of income and interest rate are very low and the coefficient on the lagged dependent variable is close to unity. The absolute value of the long run interest elasticities are higher than the short run elasticities which may lead to the problem of interest rate overshooting in the short run. Secondly, the transmission mechanism in the model assumes that if the model is found to be stable, then innovation in the monetary policy have a predictable influence on price, interest rate and real income at each period. But Boughton and Tavlas (1990) pointed out that such an outcome is complex as the dynamics underlying the move back to equilibrium are complex and unpredictable. Third, the empirical estimation of Goldfeld type equation have yielded inaccurate prediction of real money balances. It is due to the fact that the partial adjustment mechanism does not take into account the short run impact of monetary shocks. Omission of such shocks, when they are considered as determinants of the demand for money, will certainly result in specification bias of the estimates.

The buffer stock model was developed as an alternative to the conventional partial adjustment model. It was devised to deal with each of these problems outlined above. The approach stressed the role of money as a shock-absorber that temporarily smoothens the response of the economy to monetary innovations. The model incorporates the money shock as a determinant of the money demand. By choosing so, the buffer stock model is able to deal with each of the three criticisms associated with the partial adjustment model.

The buffer stock approach suggests that monetary innovation leads to an increase in real cash balances, as economic agents move off the short run money demand curves.

Consequently, cash balances rather than interest rate adjusts in the short run and hence, interest rate overshooting does not occur in the short run. Secondly, by modelling the short run money demand directly, the buffer stock model is able to deal more statistically with the complicated nature of monetary transmission mechanism. The inclusion of the money stock variable in the model helps to deal with the specification bias of the conventional specification approach (partial adjustment approach).

Based on the above ideas, Cuthbertson (1985), outlined three important implications of the buffer stock approach to demand for money. They are: (i) unexpected changes in money supply will be willingly held at unchanged interest rate and "overshooting" need not necessarily occur; (ii) if transitory money holdings are a substantial and volatile part of the total money holding, we would expect our conventional theories which ignore such transitory balances to exhibit parameter instability over time and; (iii) long lags in the response of say, prices to money supply may be, in part, due to money initially being held as a buffer stock and gradually flows to the expenditure on goods and services, then to changes in interest rates, output and eventually to changes in prices.

Two properties of the buffer stock approach are noteworthy. First, the emphasis of buffer stock approach is placed on the short run or temporary nature of the buffer function of money. Goodhart (1984) emphatically stated that an unanticipated change in the money stock is willingly held temporarily and he argued that "an initial shock to the money supply is likely to be buffered in the short run only". Secondly, buffer stock adherents argue that the validity of this approach is an empirical matter. In this regard, Laidler (1984, p.27) argued that "the case of buffer stock approach ultimately rests as much as upon its empirical content as upon *a priori* reasoning".

5.4 Buffer-Stock Models

5.4.1 Single Equation Disequilibrium Models:

The conventional approach to demand for money makes the basic assumption that demand for money equals supply of it. In other words, supply of money is demand determined. However, money supply is treated independent or exogenous for modelling purpose in the recent literature. The impact of exogenous money supply is studied in the recent literature by inverting the function within the framework of single equation disequilibrium model. Precisely, each of the independent variables in the conventional model is treated as dependent variable in the model. The exponents of this approach (Artis and Lewis, 1976 and Goodhart, 1884) assume that the chosen dependent variable adjusts slowly to its long run value. If the supply of money is independent of its demand, agents are temporarily forced-off their long run demand function because of slow adjustment in the price, output and interest rates.

There are a number of statistical problems associated with the single equation model. One of them relates to an overshooting effect. However, Goodhart (1984) observed that when interest rate is regressed on money stock, "there is rarely any trace of overshooting". This may imply that the arguments in the demand for money (interest rate in the present case) are subject to slow adjustment. As a natural corollary, it is concluded that money might have been held as a buffer stock.

Inverted equation may not necessarily produce an exact reciprocal coefficient unless the correlation coefficient between money and interest rate is unitary. Therefore, it is statistically incorrect to invert the conventional money demand equation and draw inference of buffer stocks, as interest rate overshooting has not been evident. In this connection, the belief about short run interest rate overshooting is not shared by the advocates of buffer stock monetarists. Laidler (1982) convincingly argues that

overshooting refers to models in which interest rate is the dependent variable, while buffer stock theory refers to the money demand functions which can not be inverted. Cuthbertson and Taylor (1987) observed that "a major problem with this single equation disequilibrium money approach is that only one argument may be chosen as the dependent variable, whereas, on a priori ground, one might expect all the arguments of demand function to adjust simultaneously". Therefore, single equation disequilibrium model can not be relied upon for the purpose of investigating into the evidence of buffer stock money.

5.4.2 Multi Equation Disequilibrium Models:

The single equation disequilibrium models described above have statistical drawbacks in that only one variable can be selected as the dependent variable. However, the transmission mechanism of monetary policy is complex and subject to long and variable time lags and may be expected to involve adjustment in all of the arguments of the demand function. Therefore, any attempt to capture its operation in single equation framework, with either interest rate, or price, or real income as dependent variable is unsatisfactory. Such consideration of the development of buffer stock model, allows for a simultaneous adjustment of several expenditure and portfolio behaviour. This has led to formulation of multi equation disequilibrium model or complete disequilibrium models. The model have been empirically applied with some success to the UK economy by Davidson (1987) and for US economy by Laidler and Bentley (1983).

By and large, these models are estimated by "system method" such as three stage least squares, full information maximum likelihood etc. However, these models have not proved successful in explaining the flexible exchange rate in open economies, as they have been modelling it in the closed economies (Cuthbertson and Taylor, 1987). Moreover, the key problem associated with this type of approach is that the estimated coefficients in the money demand equation are conditional on the correct specification of the whole model

(Cuthbertson, 1988). Particularly, if one is interested to test whether the coefficients are stable over time, the system is not suitable as it complicates the exercise.

5.4.3 Forward Looking Buffer-Stock Model:

The conventional money demand models omit future values of the demand for money. Past values of the arguments may not proxy for future transaction. The adaptive expectations invoked in partial adjustment models are therefore considered inadequate to capture expectations about future. Kanninen and Tarkka (1986) developed a model in which money balances held by individuals are the outcome of optimising forward looking behaviour. They consider the role of expected future shocks to the money supply as well as current monetary injections. The model implies that any current injections, whether anticipated or not, ought to have a positive impact upon real balances held. While any anticipated future injections ought to have a negative impact upon current money holdings. The model is tested on the quarterly data covering the period from 1960-82, for broad money stock for five western economies: West Germany, Australia, the USA, Finland and Sweden. The econometric results provide evidence in favour of the shock-absorption view in the sense that they are superior to the conventional specification of the demand for money for the five above mentioned economies.

5.4.4 Carr and Darby's Shock-Absorber Buffer Stock Model:

The best known buffer-stock model is the shock-absorber model of Carr and Darby (1981). This model draws the distinction between expected and unexpected changes in money supply.

According to Carr and Darby an unexpected increase in the nominal money supply has little immediate influence on the price level but mainly affects real income and interest rates. Such an increase would cause the money stock (M_t) to rise which in turn would

cause the long run money demand (M_{dt}) to rise because of the changes in the real income and interest rates. The expected change in money supply, however, would only bring about an immediate and equiproportionate change in price level leaving all the real variables unchanged. This may be captured by the partial adjustment mechanism which is given by

$$M_t = \mu M_{dt} + (1 - \mu) M_{t-1} \quad \dots(5.1)$$

While (5.1) could adequately capture the expected rise in the money supply, it could not represent the response to unexpected rise. Because of this problem Carr and Darby replaced (5.1) by the following relation:

$$M_t = \mu M_{dt} + (1 - \mu) M_{t-1} + \beta Y_t + \theta(M_t - M_t^*) + u_t \quad \dots(5.2)$$

where, M_t^* is the expected money supply so that $(M_t - M_t^*)$ is unexpected supply. Y_t represents the transitory income. If θ in equation (5.2) is greater than zero(0), then unexpected increase in the money supply pushes the asset holders off the short run desired level of real balances given by (5.1). If β is greater than zero, then transitory income has the same effect.

5.5 Review of Empirical Studies:

Laidler (1980) estimated a shock absorber model using annual data for the period 1953-76. The unanticipated money term is found to be significant and the testing performance of the equation is found to be superior to that of conventional models.

In their empirical work Carr and Darby (1981), estimated the shock absorber model for eight industrial countries, including the UK and the US using quarterly data from 1957 to 1976. The anticipated money supply was modelled in terms of past values

of the actual money supply, using a univariate ARIMA process. The estimated coefficient of the unexpected money stock were always significantly different from zero and had the value between 0.6 and 1.3 supporting buffer stock money. The transitory income term was generally not significant and the coefficient of transitory income was positive and exceeded that of permanent income.

For the US, Laidler and Bentley (1983) incorporated a monetary disequilibrium term in equations for output and real rate of interest. Using annual data for the period 1954-78 and broad definition of money, the effect is found to be particularly strong in the output equation.

Mackinnon and Milbourne (1984) reformulated the Carr and Darby model and estimated the same for the US data. They used an autoregressive process to generate a series for anticipated series for the seasonally adjusted quarterly series for narrow money aggregate for the sample period 1953 to 1978. The parameter estimates imply a significant role for anticipated money and a significant but negative influence for unanticipated money, thus refuting the Carr-Darby's hypothesis.

Davidson (1984) estimated a series of equations for both financial and real variables. The residuals from the long run money demand relation were used to provide an estimate of disequilibrium error and tested the hypothesis that the previous period monetary disequilibria caused the current period adjustment in a wide range of economic variables. Using broad sterling M3 and M5 definition of money, and the data for the period of 1964-82, Davidson found that the lagged monetary disequilibrium effect was more noticeable in the equation for bank loans to the non-bank private sector, where it appeared with a negatively signed coefficient. Other significant effects were found in the equations for price level and private sectors net capital liabilities to overseas residents.

Monetary disequilibria appeared to have no effect upon real income, the exchange rate and the current account surplus.

Cuthbertson (1986) uses both Carr and Darby's and Mackinnon-Mailbourne type equations to test the shock - absorber hypothesis using quarterly data on M1 for UK over the period 1964 to 1981. A univariate fixed coefficient ARIMA model, estimated over the whole sample period was used to generate the expected variable for use in the real money demand equation. Evidence of misspecification is found in Carr - Darby type partial adjustment equation, although the coefficient of unanticipated money stock support the buffer stock hypothesis. All the Mackinnon-Mailbourne type imply (an improvement over Carr and Darby models) imply the rejection of buffer stock hypothesis

Cuthbertson and Taylor (1987) applied the model to quarterly UK data on M1 for the period 1963-83. The equation was estimated using the generated expected values for real income, price level and interest rate using a fourth order autoregressive process. The result yielded parameter estimates of the correct *a priori* sign lend supporting the view that forward looking variables should be included in the short run demand for money functions.

Cuthbertson (1988) used both autoregressive and vector autoregressive forecasting schemes for the independent variables of the demand for money function and the time horizon of four and eight quarters. Cuthbertson and Taylor (1990) used the kalman filter to incorporate a learning mechanism in an expectation generating function which is based upon a time trend with seasonal variation. An arbitrary eleven periods is chosen. Both the above studies used quarterly data on M1 for the period, 1964-79. In each case, the results were similar to those obtained by the earlier studies and again lend support to the buffer stock role of money. Again these studies found that the impact of

money holdings, of the expected future values of the arguments of money demand found to be much smaller than that resulting from corresponding unanticipated changes.

On the basis of the above studies, Cuthbertson and Taylor argued that the forward looking model was superior to other formulations which did not consider the role of the expected future values of the arguments of the money demand function.

Miller (1990), used both cointegration and error correction models to test the disequilibrium money hypothesis using quarterly US data for the period 1959-87. Miller felt that the results were broadly supportive of the disequilibrium money hypothesis, and that the apparent instability in the US money demand function, was due to periods of temporary disequilibrium in the money market, occasioned by instability in money growth rates arising out of a more exogenous money stock.

Boughton and Tavlas (1990) presented the empirical performance of two recent approaches (buffer stock and error correction approach) and compared them by estimating the functions for both narrow and broad aggregates for five large industrial countries - United States, United Kingdom, Germany, France and Japan. These estimates are also compared with the partial adjustment models. The major conclusion is that none of the three models are unambiguously superior to other. Moreover, the buffer stock estimates always do better within the sample period : 1973-1985 than the partial adjustment model and error correction model do still better. But in the post-sample forecasting tests, none of the broad money equations show any significant parameter instability. All the narrow money estimates, however, do show instability. These findings are consistent with the view that the instability of money demand in the 1980s has arisen from financial innovation that have affected primarily the allocation of assets within broad categories.

Boughton and Tavlas (1991) provide estimates of the demand for both narrow and broad money for the same five industrial countries. The data for the present study comprise of quarterly time series from 1963 through 1988 for all five industrial countries. Tests are performed in order to evaluate the parameter stability, post-sample predictive power, encompassing properties and economic implications of the models. The results are encouraging with respect to the newer models. It is very much clear that the partial adjustment is outperformed by both buffer stock and error correction models. In most of the cases, the unanticipated shocks to the nominal stock of money have a significant positive effect, while anticipated changes do not. The comparison between buffer stock and error correction model are less clear. However, error correction model offers promise as a more general approach.

5.5.1 Empirical Studies in India:

In the Indian context there are very few studies which have pursued the buffer stock approach to demand for money. Only recently, Paul and Kulkarni (1987) attempted to estimate demand for money using this approach. The study used quarterly data for the period from 1970:04 to 1980:04. The unanticipated money supply shock was incorporated as an extra variable in the estimation of conventional money demand function in addition to the usual variables such as gross domestic product, consumer price index, and 3 year deposit rate. The unanticipated money supply was generated using univariate Box-Jenkin's method. The results support that supply shock is significant in India. The authors interpreted that this evidence had been due to the absence of cheque transaction habit in the economy.

In a recent attempt Bhoi (1995) reported some results for the period 1960-61 to 1993-94, in which he estimated both partial adjustment and buffer stock models and presented a comparison of the two models on the basis of out of sample predictive power of models. Buffer stock demand for money (m_1 and m_3 aggregates) were estimated using

the Carr-Darby's model. The anticipated supply series were generated by regressing nominal money supply on gross domestic product, call money rate and whole sale price index and corrected for autocorrelation. The unanticipated series is derived by deducting the anticipated series from the actual series of monetary aggregates. The empirical findings on shock absorber model indicated evidence in favour of buffer stock money in India. The results suggested that about 40% of unanticipated change in money supply was willingly absorbed in the short run by the spending units. The shock absorber model seemed to have outperformed the partial adjustment model in many respects and therefore considered a better model to study the short run dynamics associated with the money demand relationship in Indian context. The out-of-sample predictive power of the shock absorber model was studied by repeating the estimation procedure with a break of sample at 1980-81. However, the out-of-sample predictive power of the shock absorber model was found to be weak perhaps reflecting the missing money aspect in the Indian context. The stability tests performed using intercept and slope dummies for 1980s, showed significant change in the behaviour of money demand during the period.

5.6 Buffer-Stock Estimates:

5.6.1 Modelling Approach:

Of all the empirical strategies that have been employed in modelling the buffer stock approach, the strategy that comes close to capturing the essence of the buffer stock notion is the Shock-Absorber model developed by Carr and Darby (1981). Though the shock absorber model also has some limitations in terms of estimation biases, the same may be overcome by adopting a proper estimation procedure.

The shock absorber approach formulates the demand for money as follows:

$$(M - P)_t = a_0 + a_1 Y_t + a_2 r_t + a_3 i_t + a_4 (M - P)_{t-1} + a_5 (M_t - M_t^*) + u_t$$

and

$$M_t^* = g'Z_t$$

where M , Y and P are logarithms of money, real GNP or GDP, and deflator of Y respectively. i and r are the short and long term interest rates. Z_t is a set of variables that the agents are assumed to have a systematic influence on the money supply, M_t^* is the anticipated money supply, and g is the vector of coefficient to be estimated. Accordingly, the term $(M - M^*)$ or $(M - g'Z_t)$ represents the unanticipated monetary component. The shock absorber specifications thus approximate Laidler's theoretical derivation of the buffer stock model which represents the microfoundation of monetary economics.

The shock absorber model contains at least two specification problems. First, some authors (e.g. Cuthbertson and Taylor, 1987) model the M^* component on the basis of rational expectation hypothesis. Swamy et.al. (1989), however, have argued that the rational expectation hypothesis is inconsistent with this type of model unless the distribution of M_t^* has both frequency and subjective interpretations, because it is a hypothesis about the formation of subjective expectations. The second specification problem associated with the shock absorber model is that the M_t^* component of the anticipated money supply variable is also the numerator of the dependent variable.

The procedure adopted here for estimating and evaluating the buffer stock model as follows:

First, the conventional partial adjustment models are estimated by using both narrow and broad definition of money for each of the 5 specifications. The study uses the alternative specifications that are presented in table 3.1(c) of chapter-III. For all the specifications the estimation period is from 1981:04 to 1995:10 and two of its sub-periods: viz., (i) 1985:04 to 1991:06 and (ii) 1991:07 to 1995:10. In the second stage, the money stock variable (unanticipated money stock series or the supply shock) was added to

the equations. Here the unanticipated money stock is generated by using the seasonal univariate ARIMA method.

5.6.2 Empirical Results:

5.6.2.1 Partial Adjustment Equations:

Since the partial adjustment model has been the most widely estimated model of demand for money, the estimates of this model may prove useful in comparing the buffer-stock results. In order to test common specifications of partial adjustment model, the equation for both narrow (m1) and broad (m3) aggregates incorporating only current values of real income and interest rate, exchange rate and share price indices are tested. The estimates of partial adjustment model of demand for money for monthly data are presented in three tables: 5.1, 5.2 and 5.3 for the period 1981:06 to 1995:10, its sub-periods 1985:04 to 1991:06 and 1991:07 to 1995:10 respectively.

As reported in table 5.1, the partial adjustment model results for the period 1981:06 to 1995:10, appear to be satisfactory according to the useful statistical criteria. The coefficients of real income are highly significant (at 1% level) and come out with expected positive sign in all the cases. However, the estimated coefficients are low (ranges from 0.19 to 0.21 for m1 and from 0.42 to 0.44 for m3 specifications). The interest rate variable comes out with expected sign without being significant for m3 specifications only. As with commonly observed estimates of the partial adjustment model, the coefficients of the lagged dependent money stock variables are found to be positive, with high values and significant. The coefficients range from 0.51 to 0.79 for the sample period.

Table 5.2 contains the estimates of partial adjustment model for the sub-period 1985:04 to 1991:06. Here the real income coefficients have expected positive sign

without being significant in most of the specifications. The call money rate bears expected sign for m3 specifications only. Further, the lagged dependent variable comes out with expected positive sign for all the specifications, the coefficients being significant only for m1 specifications.

The results of table 5.3 relates to the period 1991:07 to 1995:10. All the models have high $\bar{R}^2$ values. The estimated coefficients of lagged real money supply, interest rate and real income variable have the expected sign. Further, the income coefficients of m1 specifications are significant at 1% level. The coefficients of lagged dependent money stock are also significant at 1% level. The coefficients for m1 specifications ranges from 0.57 to 0.69 and that of m3 from 0.70 to 0.75.

5.6.2.2. Buffer - Stock Equations:

Table 5.4 reports estimates of buffer stock model for the sample period:1981:06 to 1995:10. From the table, it is evident that the addition of monetary shock or supply shock (unanticipated money supply variable) is found to be positive and significant at 1% level in all the specifications for both narrow and broad money equations. The coefficients of unanticipated money supply ranges from 0.27 to 0.30 for narrow money and from 0.90 to 0.91 for broad money specifications. In all the instances, magnitude of $\bar{R}^2$ (goodness of fit) and real income coefficient increased as a result of inclusion of the buffer stock term, implying that the model statistically is an improvement over the partial adjustment model.

The positive sign and significant coefficient of the monetary variable confirms the validity of buffer-stock approach in Indian context for the sample period. The magnitude of the coefficients reveal that about 30% of the narrow money and about 90% of the broad money stock are absorbed by the economic agents in the short run.

Table 5.5 presents the estimates of buffer stock model for the sub-sample period 1985:04 to 1991:06. The first five equations of the table have $m1$ as dependent variable in which the unanticipated components turn out to be insignificant though bearing positive sign. In these specifications, the income coefficients are also statistically insignificant. However, for $m3$ specifications the unanticipated variable comes out with expected positive and significant coefficients at 1% level. The coefficient ranges from 0.84 to 0.90. Here again, the income coefficients are statistically significant at 1% level in explaining the money demand variation.

Table 5.6 reports the estimates for the sub-period: 1991:07 to 1995:10. For this sample period also, the unanticipated money supply series has a positive and significant coefficient in both $m1$ and $m3$ specifications. The coefficient ranges from 0.64 to 1.007. In case of two equations (specifications (6) and (9) for broad money), the coefficients exceed unity. This would indicate overshooting following a monetary shock which may be inconsistent with the buffer stock theory.

The overall empirical findings on the shock absorber model indicate the validity of buffer stock money in India. The implication of this findings is that a major fraction of the unanticipated changes in money supply is willingly absorbed in the short run by the spending units.

5.6.2.3 Model Comparisons:

Table 5.7 presents $\bar{R}^2$, root mean square error (RMSE), Theil's "U" and Chow test statistics relating to the goodness of fit, in-sample predictive power and inter temporal stability of the models for the period: 1981:06 to 1995:10. These statistics are used to evaluate the relative performance of the two models. These statistics indicate that the buffer stock model has an edge over the conventional partial adjustment model.

Table 5.7 also presents the RMSE and Theil's "U" statistics to test the in-sample predictive power of the model. The statistics are presented for both the models and for all 10 estimated specifications. It is relevant to note that the smaller the value of these statistics, the better is the forecasting performance of the model. The test results obtained from the forecasting statistics reveal that all the calculated statistics are lower for the buffer stock model in comparison to the statistics of partial adjustment model. The present study also presents the RMSE and Theil's "U" statistics for the sub-period 1985:04 to 1991:06 and 1991:07 to 1995:10). The sub-sample statistics also confirmed that buffer stock model has better in-sample predictive power than the partial adjustment model.

On the whole, the shock absorber buffer stock model has seemingly out performed the partial adjustment model in respect of both narrow and broad money. The specification bias which seems to have been present in the partial adjustment model, has been reduced considerably as the parameters are now more precise. Moreover, the test statistics have improved and the in-sample predictive power has gone up.

Table 5.7 also presents the N-step recursive Chow test, derived from the recursive least square estimation to check model stability. For this test, each equation is first estimated over a sample period ending in 1987:10, and F-statistics is computed for the consistency of that estimate with the reminder of the sample (through 1995:10). The test is repeated sequentially with one period added to the initial sample each time, through the end of the sample period. What is presented here is the maximum F - statistics with the sample break at 1987:10.

The recursive Chow statistics reveal that all the m3 specifications are unstable. However, there is no significant difference between the two models from the stand point of model stability.

5.7 Concluding Remarks:

The buffer stock approach to demand for money studies the behaviour of economic units in response to the unanticipated shocks of money supply. There are variety of models used by researchers to study the evidence of buffer stock money. Out of which, the shock absorber approach proposed by Carr and Darby is more close to capture the essence of buffer stock notion. The methodology adopted here would therefore heavily depend and is more akin to that used by Carr and Darby. The empirical findings on the shock absorber model presented here indicate evidence in favour of the validity of buffer stock money in India. The implication on this findings in that , the economic units willingly absorb a major fraction of the unanticipated increase in the money supply in the short run.

A comparison of the partial adjustment and buffer stock on the basis of in-sample predictability of the model reveals that the shock absorber buffer stock model has out performed the conventional partial adjustment model and therefore could be used as an alternative paradigm in the study of money demand function in India. The stability test (Chow test) however, reveals that all the m3 specifications of both buffer stock and partial adjustment model are detected to be unstable.

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Table 5.1
Estimates of Partial Adjustment model of Demand for Money: 1981:06 to 1995:10

Independent Variables										
Dependent Variable	Constant	LASIP	LASCALL	LASREE R	LASRBI	LASBSE	LAGRM	$\bar{R}^2$	D.W	F
LASRM1	1.3626	0.1906* (4.7242)	-0.0008 (-0.1638)	-0.0400 (-1.3354)			0.7968* (18.7726)	0.99	1.03	6207
LASRM1	1.6240	0.2116* (5.2441)	0.0017 (0.3352)	-0.0064 (-0.2000)	0.0213* (2.6889)		0.7356* (15.4884)	0.99	1.06	5151
LASRM1	1.5620	0.2112* (5.1764)	0.0020 (0.3877)	-0.0085 (-0.2608)		0.0162 (2.3166)	0.7440* (15.5996)	0.99	1.08	5098
LASRM1	1.5716	0.2119* (5.2709)	0.0017 (0.3416)		0.0219* (3.0156)		0.7373* (15.8529)	0.99	1.06	6480
LASRM1	1.4937	0.2118* (5.2157)	0.0021 (0.4061)			0.0169* (2.6776)	0.7462* (15.9238)	0.99	1.08	6408
LASRM3	3.6405	0.4232* (5.6713)	-0.0099 (-0.9372)	-0.1028 (-1.5087)			0.5294* (8.2102)	0.97	1.82	1447
LASRM3	3.7481	0.4418* (5.9827)	-0.0119 (-1.1281)	-0.1540 (-2.6061)	0.0221 (1.4964)		0.5428* (8.4696)	0.97	1.83	1795
LASRM3	3.5902	0.4245* (5.7858)	-0.0077 (-0.7357)	-0.0752 (-1.1036)		0.0289 (2.2383)	0.5168* (8.0268)	0.97	1.84	1472
LASRM3	2.8285	0.4269* (5.7028)	-0.0089 (-0.8395)		0.0333 (2.5987)		0.5529* (8.8048)	0.97	1.83	1795
LASRM3	3.0055	0.4296* (5.8629)	-0.0067 (-0.6379)			0.0363* (3.2764)	0.5319* (8.4534)	0.97	1.85	1837

Note t-values are presented in the parantheses. LAGRM denotes the lagged money supply series.

* indicates 1% level of significance

Table 5.2
Estimates of Partial Adjustment model of Demand for Money: 1985:04 to 1991:06

Independent Variables										
Dependent Variable	Constant	LASIP	LASCALL	LASREE R	LASRBI	LASBSE	LAGRM	$\bar{R}^2$	D.W	F
LASRM1	3.3146	0.1163 (1.9716)	0.0393 (3.7558)	-0.1815* (-2.6847)			0.6983* (9.0424)	0.98	1.21	1046
LASRM1	3.5052	0.1233 (2.0247)	0.0361 (2.9370)	-0.1871* (-2.7168)	0.0072 (0.5049)		0.6761* (7.5688)	0.98	1.19	828
LASRM1	3.3164	0.1135 (1.8898)	0.0410 (3.3818)	-0.1855* (-2.6706)		-0.0034 (-0.2871)	0.7029* (8.8598)	0.98	1.22	826
LASRM1	1.2515	0.1237 (1.9438)	0.0334 (2.6151)		0.0009 (0.0669)		0.8146* (10.6346)	0.98	1.18	947
LASRM1	1.2718	0.1248 (1.9985)	0.0325 (2.6653)			0.0029 (0.2408)	0.8107* (11.3991)	0.98	1.18	947
LASRM3	14.2285	0.3279 (2.3804)	0.0060 (0.1904)	-1.0354* (-5.0859)			0.0234 (0.2048)	0.86	2.26	115
LASRM3	14.0081	0.2875 (2.0398)	-0.0239 (-0.6065)	-0.9939* (-4.8383)	0.0499 (1.2558)		0.0265 (0.2328)	0.86	2.25	93
LASRM3	13.6456	0.3223 (2.3307)	-0.0117 (-0.3041)	-0.9682* (-4.3880)		0.0311 (0.8030)	0.0369 (0.3187)	0.85	2.25	91
LASRM3	4.8759	0.5994* (4.1629)	-0.0456 (-1.0094)		0.0809 (1.7937)		0.2847 (2.4621)	0.82	1.86	83
LASRM3	4.7379	0.5991* (4.3351)	-0.0512 (-1.2126)			0.0955 (2.3773)	0.2843 (2.5003)	0.82	1.94	87

Note: t-values are presented in the parantheses. LAGRM denotes the lagged money supply series.
* Indicates 1% level of significance

Table 5.3
Estimates of Partial Adjustment model of Demand for Money: 1991:07 to 1995:10

Dependent Variable	Independent Variables										D.W	F
	Constant	LASIP	LASCALL	LASREE R	LASRBI	LASBSE	LAGRM	$\bar{R}^2$				
LASRM1	2.0403	0.3608* (3.2792)	-0.0055 (-0.6763)	-0.1491 (-1.4868)			0.6923* (6.4071)	0.91	1.01	123		
LASRM1	3.5557	0.3399* (3.4377)	-0.0016 (-0.2182)	-0.3453 (-3.2624)	0.0838 (3.5188)		0.5836* (5.7351)	0.92	1.28	125		
LASRM1	2.9954	0.3336* (3.2422)	0.0013 (0.1634)	-0.2465 (-2.4804)		0.0589 (2.8637)	0.6108* (5.8415)	0.92	1.30	116		
LASRM1	2.2789	0.3739* (3.4635)	-0.0027 (-0.3399)		0.0428 (1.9291)		0.5790* (5.1842)	0.91	1.01	128		
LASRM1	2.2442	0.3624* (3.3652)	-0.0001 (-0.0066)			0.0415 (2.0355)	0.5847* (5.3355)	0.91	1.05	129		
LASRM3	1.7875	0.2423 (2.5568)	-0.0129 (-1.6928)	-0.0371 (-0.4461)			0.7570* (7.8805)	0.93	1.08	164		
LASRM3	2.8176	0.2007 (2.2527)	-0.0118 (-1.6673)	-0.1907 (-2.0423)	0.0594 (2.9256)		0.7079* (7.8045)	0.94	1.26	154		
LASRM3	2.4093	0.1938 (2.1147)	-0.0089 (-1.2018)	-0.1214 (-1.4217)		0.0439 (2.5487)	0.7262* (7.9203)	0.93	1.30	148		
LASRM3	1.9757	0.2034 (2.2103)	-0.0119 (-1.6303)		0.0361 (2.0802)		0.7247* (7.7643)	0.93	1.14	179		
LASRM3	1.9287	0.1935 (2.0891)	0.0095 (-1.2753)			0.0344 (2.1441)	0.7309* (7.8913)	0.93	1.19	181		

Note. t-values are presented in the parantheses. LAGRM denotes the lagged money supply series.

* indicates 1% level of significance

Table 5.4
Estimates of Buffer Stock Model of Demand for Money: 1981:06 to 1995:10

Independent Variables											
Dependent Variable	Constant	LASIP	LASCALL	LASREE R	LASRBI	LASBSE	LAGRM	UNEXM	$\bar{R}^2$	D.W	F
LASRM1	1.3989	0.2049* (5.2046)	-0.0012 (-0.2161)	-0.0384 (-1.3230)			0.7858* (19.0208)	0.2737* (3.3566)	0.99	0.89	5276
LASRM1	1.6961	0.2298* (5.8655)	0.0017 (0.3587)	-0.0005 (-0.0170)	0.0239* (3.1269)		0.7159* (15.5534)	0.2969* (3.7216)	0.99	0.90	4634
LASRM1	1.6470	0.2318* (5.8554)	0.0002 (0.4773)	0.0002 (0.0072)		0.0197* (2.9156)	0.7200* (15.5574)	0.3063* (3.8046)	0.99	0.91	4599
LASRM1	1.6918	0.2298* (5.8914)	0.0017 (0.3607)		0.0240* (3.4194)		0.7161* (15.8642)	0.2970* (3.7388)	0.99	0.90	5595
LASRM1	1.6488	0.2318* (5.8866)	0.0024 (0.4793)			0.0197* (3.2241)	0.7199* (15.8055)	0.3063* (3.8259)	0.99	0.91	5553
LASRM3	3.7257	0.4363* (9.7281)	-0.0140 (-2.2022)	-0.1385* (-3.8577)			0.5419* (13.9227)	0.9163* (16.8318)	0.99	1.79	3950
LASRM3	3.6625	0.4254* (9.3825)	-0.0129 (-2.0096)	-0.1084 (-2.6192)	0.0130 (1.4481)		0.5340* (13.6309)	0.9115* (16.7700)	0.99	1.75	314
LASRM3	3.6330	0.4262* (9.5550)	-0.0116 (-1.8118)	-0.0923 (-2.2266)		0.0170 (2.1588)	0.5266* (13.4531)	0.9058* (16.7552)	0.99	1.74	3366
LASRM3	2.8059	0.4293* (9.3103)	-0.0118 (-1.8139)		0.0248* (3.1409)		0.5588* (14.4468)	0.9104* (16.4578)	0.99	1.77	3838
LASRM3	2.9159	0.4324* (9.5989)	-0.0103 (-1.5958)			0.0261* (3.8165)	0.5452* (14.0887)	0.9028* (16.5076)	0.99	1.76	3943

Note: t-values are presented in the parantheses. LAGRM denotes the lagged money supply series.and UNEXM denotes unexpected money supply series * indicates 1% level of significance

Table 5.5
Estimates of Buffer Stock Model of Demand for Money: 1985:04 to 1991:06

Independent Variables												
Dependent Variable	Constant	LASIP	LASCALL	LASREE R	LASRBI	LASBSE	LAGRM	UNEXM	$\bar{R}^2$	D.W	F	
LASRM1	3.3645	0.1281 (2.0371)	0.0397 (3.7717)	-0.1789 (-2.6262)			0.6866* (8.5420)	0.0685 (0.5630)	0.98	1.16	829	
LASRM1	3.6133	0.1394 (2.1197)	0.0359 (2.9095)	-0.1853 (-2.6775)	0.0089 (0.6175)		0.6563* (6.9457)	0.0827 (0.6653)	0.98	1.14	684	
LASRM1	3.3627	0.1255 (1.9382)	0.0408 (3.3527)	-0.1816 (-2.5858)		-0.0022 (-0.1823)	0.6903* (8.2718)	0.0642 (0.5140)	0.98	1.17	681	
LASRM1	1.4021	0.1423 (2.0736)	0.0332 (2.5919)		0.0031 (0.2086)		0.7910* (9.4418)	0.0959 (0.7393)	0.98	1.13	752	
LASRM1	1.4091	0.1431 (2.1346)	0.0326 (2.6637)			0.0046 (0.3686)	0.7881* (10.1844)	0.0989* (0.7657)	0.98	1.13	754	
LASRM3	11.0900	0.4219* (7.3989)	0.0061 (0.4724)	-0.7131* (-8.3170)			0.1290* (2.7158)	0.8461* (18.5126)	0.97	1.60	609	
LASRM3	11.0178	0.4043* (6.9194)	-0.0065 (-0.3968)	-0.6977* (-8.0952)	0.0210 (1.2776)		0.1296* (2.7410)	0.8406* (18.3903)	0.97	1.54	513	
LASRM3	11.1203	0.4223* (7.3387)	0.0071 (0.4451)	-0.7165* (-7.7524)		-0.0017 (-0.1067)	0.1283* (2.6587)	0.8467* (18.2777)	0.97	1.61	501	
LASRM3	4.5853	0.6252* (8.6992)	-0.0196 (-0.8700)		0.0396 (1.7470)		0.3131* (5.4210)	0.9097* (14.5639)	0.95	1.56	311	
LASRM3	4.5140	0.6289* (9.0499)	-0.0202 (-0.9472)			0.0428 (2.0879)	0.3132* (5.4751)	0.9002* (14.4222)	0.95	1.59	317	

Note: t-values are presented in the parentheses. LAGRM denotes the lagged money supply series and UNEXM denotes unexpected money supply series * Indicates 1% level of significance

Table 5.6
Estimates of Buffer Stock Model of Demand for Money: 1991:07 to 1995:10

Independent Variables											
Dependent Variable	Constant	LASIP	LASCALL	LASREE R	LASRBI	LASBSE	LAGRM	UNEXM	R ²	D.W	F
LASRM1	1.3490	0.2482* (2.7843)	-0.0071 (-1.1079)	-0.1773 (-2.2392)			0.8232* (9.3029)	0.7396* (5.4462)	0.94	1.04	165
LASRM1	2.5218	0.2474* (3.0114)	-0.0041 (-0.6870)	-0.3144 (-3.6593)	0.0601 (3.0246)		0.7288* (8.3464)	0.6467* (5.0173)	0.95	1.19	163
LASRM1	2.1131	0.2371* (2.8211)	-0.0019 (-0.3048)	-0.2473 (-3.1231)		0.0437 (2.6249)	0.7522* (8.5879)	0.6802* (5.2379)	0.95	1.23	156
LASRM1	1.3112	0.2734* (2.9639)	-0.0053 (-0.7832)		0.0217 (1.1435)		0.7323* (7.4443)	0.6805* (4.6983)	0.94	0.92	152
LASRM1	1.3604	0.2661* (2.9202)	-0.0033 (-0.4757)			0.0262 (1.5316)	0.7258* (7.6312)	0.6793* (4.7953)	0.94	0.93	156
LASRM3	1.0103	0.2000 (2.5859)	-0.0116 (-1.8717)	-0.0853 (-1.2505)			0.8574* (10.6556)	1.0036* (5.0364)	0.95	1.06	3950
LASRM3	1.2731	0.1949 (2.4835)	-0.0115 (-1.8374)	-0.1121 (-1.3197)	0.0117 (0.5369)		0.8401* (9.6266)	0.9275* (3.7735)	0.95	1.07	168
LASRM3	1.1864	0.1925 (2.4305)	-0.0108 (-1.6925)	-0.0998 (-1.3487)		0.0091 (0.5298)	0.8449* (10.0037)	0.9424* (4.0691)	0.95	1.08	168
LASRM3	0.6757	0.1960 (2.4767)	-0.0115 (-1.8288)		-0.0052 (-0.2912)		0.8606* (9.9442)	1.0072* (4.1935)	0.95	1.04	198
LASRM3	0.7643	0.1923 (2.4058)	-0.0114 (-1.7680)			0.0005 (0.0319)	0.8515* (10.0110)	0.9648* (4.1398)	0.95	1.04	197

Note: t-values are presented in the parentheses. LAGRM denotes the lagged money supply series and UNEXM denotes unexpected money supply series. * indicates 1% level of significance

Table 5.7

Model Comparisons: 1981:04 to 1995:10

Partial Adjustment Model:

Specifications	$\bar{R}^2$	RMSE	THEIL'S "U"	CHOW "F"
1	0.99	0.0244	0.001150	1.7351
2	0.99	0.0238	0.001125	1.6127
3	0.99	0.0239	0.001131	1.6379
4	0.99	0.0238	0.001125	1.5307
5	0.99	0.0240	0.001132	1.5544
6	0.97	0.0506	0.002176	11.9929
7	0.97	0.0502	0.002161	12.5612
8	0.97	0.0498	0.002143	12.6839
9	0.97	0.0506	0.002176	12.8651
10	0.97	0.0500	0.002151	12.9629

Buffer -Stock Model:

Specifications	$\bar{R}^2$	RMSE	THEIL'S "U"	CHOW "F"
1	0.99	0.0235	0.001112	1.5652
2	0.99	0.0229	0.001080	1.4239
3	0.99	0.0229	0.001084	1.4333
4	0.99	0.0229	0.001080	1.3448
5	0.99	0.0228	0.001084	1.3526
6	0.99	0.0306	0.001318	4.3444
7	0.99	0.0304	0.001309	4.5445
8	0.99	0.0302	0.001299	4.5456
9	0.99	0.0312	0.001336	4.6913
10	0.99	0.0306	0.001319	6.6990

Table 5.8

Model Comparisons: 1985:04 to 1991:06

Partial Adjustment Model:

Specifications	$\bar{R}^2$	RMSE	THEIL'S "U"
1	0.98	0.0178	0.000840
2	0.98	0.0177	0.000839
3	0.98	0.0178	0.000840
4	0.98	0.0186	0.000882
5	0.98	0.0187	0.000882
6	0.86	0.0576	0.002480
7	0.86	0.0570	0.002452
8	0.85	0.0574	0.002469
9	0.82	0.0659	0.002838
10	0.82	0.0649	0.002792

Buffer -Stock Model:

Specifications	$\bar{R}^2$	RMSE	THEIL'S "U"
1	0.98	0.0177	0.000838
2	0.98	0.0177	0.000836
3	0.98	0.0177	0.000838
4	0.98	0.0186	0.000879
5	0.98	0.0186	0.000878
6	0.97	0.0236	0.001015
7	0.97	0.0233	0.001003
8	0.97	0.0236	0.001015
9	0.95	0.0327	0.001406
10	0.95	0.0324	0.001393

Table 5.9**Model Comparisons: 1991:07 to 1995:10****Partial Adjustment Model:**

Specifications	$\bar{R}^2$	RMSE	THEIL'S "U"
1	0.91	0.0278	0.001269
2	0.92	0.0252	0.001154
3	0.92	0.0261	0.001194
4	0.91	0.0280	0.001279
5	0.91	0.0279	0.001275
6	0.93	0.0216	0.000900
7	0.94	0.0205	0.000859
8	0.93	0.0208	0.000869
9	0.93	0.0214	0.000893
10	0.93	0.0214	0.000801

Buffer -Stock Model:

Specifications	$\bar{R}^2$	RMSE	THEIL'S "U"
1	0.94	0.0221	0.001009
2	0.95	0.0203	0.000927
3	0.95	0.0207	0.000947
4	0.94	0.0231	0.001057
5	0.94	0.0229	0.001047
6	0.95	0.0171	0.000712
7	0.95	0.0170	0.000711
8	0.95	0.0171	0.000712
9	0.95	0.0173	0.000723
10	0.95	0.0175	0.000730

CHAPTER VI

OVERVIEW AND IMPLICATIONS OF THE STUDY

The identification of demand for money function plays a crucial role in the transmission mechanism of monetary policy. The temporal stability of the function is crucial if monetary policy is to have a predictable effect on the ultimate economic objectives. Further, money demand elasticities have been considered as critical inputs to regulate the conduct of monetary policy. Hence, demand for money has been subjected to extensive empirical scrutiny in many countries over the years.

Empirical research on demand for money has been truly extensive and covered various issues, with a view to resolve some of them for the conduct of monetary policy. However, the emergence of large money substitutes and growing volatility in the financial capital flows among countries have tended to erode the stability of the demand for money as traditionally defined in many countries. Though there has been continuous effort to reestimate the function, the matter is still in a flux. In a developing country like India, where the institutional, financial and deregulatory changes have taken place in the recent past, there have been serious doubts about the stability of the demand for money function. Though efforts were made to reestimate the money demand by taking into account the recent changes in various markets, they have not been successful due to various reasons. Hence the present study is initiated to examine some of the unsettled issues associated with demand for money in the Indian context.

The relation between the demand for real balances and its determinants is the fundamental building block of the theories of monetary economics. The relation produced many outstanding issues over the years and across countries. During the past few

decades, empirical effort has been made to study the behaviour of demand for money with a view to resolve some of the issues for the conduct of monetary policy. However, the findings of the various research studies remained inconclusive. The evidence that emerged, at least prior to 1970s, suggested that few variables such as income, interest rate and a suitable proxy for "opportunity cost" of holding money with appropriate allowance for lags were capable of providing plausible and stable explanations of demand for money. However, since the mid-1970s, it has been widely documented, especially for the United States, but elsewhere as well, that the conventional money demand equations began to over predict the actual money balances that led to the episode of "missing money".

This episode led to a veritable explosion of research across the globe to find out whether financial innovations, liberalisation and institutional changes in financial market led to shift in the money demand relationship. The period since mid-1970s, has been marked by unusual economic conditions in many countries including supply shocks, severe bouts of high and variable inflation, record high interest rates and deep recession. The period also coincided with wide spread adoption of floating exchange rates in many industrial countries, with substantial institutional changes brought about by financial innovation and deregulation. Thus the period since 1974, led to a severe empirical test of money demand function. This period succeeded in exposing a number of shortcomings in the existing specification of money demand relation. There are evidences of empirical attempts to restore the predictive power of the money demand function by modifying the existing specifications to account for changes brought about by financial innovations, and deregulations by adding the extra variables to capture the effects of financial innovation and deregulations into the function. While various research in this direction, yields considerable insight, matters are still in a state of flux.

The process of searching for stable function has been aided by a growing arsenal of econometric techniques which permitted more sophisticated examination of dynamics.

functional forms and expectations. It was felt that theoretical corrections to functional forms would be necessary to restore the stability of demand for money function. This called for a new microfoundation to the demand for money where money balances serve as a buffer stock or shock absorber. One would expect the transitory income to be absorbed passively into money holdings in the short run. Research was also carried out on the line of statistical refinement of existing conventional specification for examining and improving the money demand function as well. Of late, money demand has attracted the applications of time series models, especially multiple cointegration analysis.

In India, there has been several attempts over the years to resolve the issues associated with money demand relationships. In the initial phases, the efforts were confined to estimating money demand functions considering either the narrow definition or broad definition of money. Further, in some studies, demand for money was analysed by its major components, viz., currency, demand deposits and time deposits. Most of the studies supported the hypothesis of stable demand function for money with exception of instability for short period of time and for few specifications. The major explanatory variables included in the money demand function in the empirical studies were, measured income, permanent income, relative share of agriculture to non-agricultural income, interest rate on time deposits, yield on ordinary shares, yield on long term government bonds, inflationary expectations, real effective exchange rate, variability of rate of inflation, market capitalisation and degree of monetization. Further, empirical studies on demand for money showed that scale variable is a prominent determinant in explaining the real cash holding in India. The studies however, convincingly confirmed the interest insensitivity of the money demand function due to the administered interest rate during the period. Further, the recent studies, confirmed the role of inflationary expectations as a useful surrogate to the opportunity cost of holding cash in India. In an attempt to incorporate the effect of financial innovation and deregulation, studies included stock

prices, market capitalisation and real effective exchange rate and found them relevant and significant in explaining money demand in the changing framework.

While the studies in India upto 1970s, relied upon mainly regression analysis - simple or multiple, wherein demand for money was treated as a function of some variant of income and interest rates the eighties witnessed the emergence of partial adjustment models, and later the buffer-stock models which suggest that unanticipated changes in money supply affect the money holding and hence changes the traditional transmission mechanism. The nineties is characterised by the use of cointegration and error correction framework for finding the long run equilibrium relationship underlying the money demand function.

The main purpose of this study is to re-examine some of the issues associated with macro money demand function for India with special reference to the post 1980s, a period characterised by financial innovations encompassing changes in institutional arrangements providing an extensive network of financial infrastructure, a period in which new financial instruments are made available for households and corporate sectors for portfolio management. This period also witnessed development of financial markets, structural changes in the supply of financial services and deregulation and globalisation. Hypothesising that these changes have profound bearing on the behaviour of money demand, the investigation of the present study revolves round the following objectives. They are: (i) establishing the role of inflationary expectations, stock market operation and exchange rate changes in money demand function, (ii) examining the issue of temporal stability of money demand and of existence of long run equilibrium relationship, and (iii) to test the validity of buffer stock approach to money demand in India. The study uses both annual and monthly data. The monthly data is used to study the short run dynamics in the money demand function. The annual data corresponds to the period from 1960-61 to 1995-96 and the monthly data from 1981:04 to 1995:10.

In the present study, money has been defined in two ways, viz., "narrow" (m1) and "broad" (m3) money. For the annual data, real gross domestic product is chosen as the proxy for "scale" variable. Opportunity cost is proxied by call money rate, 1-3 year deposit rate, treasury bill rate, deposit yield rate, rate of inflation and inflationary expectations. Market Capitalisation (a measure of stock of financial wealth) and stock prices (RBI share index) have been included to capture the effect of stock market changes on the level of real cash balances. Further, to incorporate the external sector's influence, exchange rate variable (real effective exchange rate) is also introduced in the model. Variability of rate of inflation's is also tried out as an argument to capture the uncertainty on price front while formulating alternative specifications. Since, inflationary expectations and variability of rate of inflation are not directly observable, an iterative procedure is employed to generate them.

For the monthly data, index of industrial production has been selected as a proxy for "scale" variable and call money rate as a proxy for "opportunity cost" variable. The other variables chosen includes, RBI share index and BSE index (representing the stock market prices) and effective exchange rate. The monthly data on these variables are deseasonalised before being used in the analysis. The exercise on long run demand for money and buffer stock approach is carried out only on monthly data. The data on unanticipated money supply used in the analysis of buffer stock approach, is generated by following Box-Jenkins' univariate ARIMA method. The data have been collected from various issues of RBI Bulletin and Reports on Currency and Finance.

The alternative money demand specifications have been formulated by taking into account those variables which represent the changes of financial innovation, deregulatory changes and external sector reforms. The reformulated money demand specifications have been estimated using OLS techniques in semi-logarithmic form for both annual and

monthly data. Further, to have more accurate conclusions, some econometric refinements in respect of estimated money demand functions have been carried out by employing some diagnostic tests. They include: RUNS test to detect auto correlation, BPG and Harvey test to detect heteroscedasticity, Chi-Square test to check normality of the residuals and Ramsey's RESET test for investigating into possible misspecification in the function. Further, an investigation into the stability aspect of demand for money has been attempted with the help of tests based on recursive residuals. These are, CUSUM, CUSUM Square (BDE) and Harvey-Collier.

The search for long run equilibrium money demand relationship is also attempted using multivariate cointegration tests. Before going for testing equilibrium relationship, unit root tests are employed to test the presence of stochastic trend. These are Dickey _ Fuller (DF), Augmented Dickey Fuller (ADF), Phillips Perron (PP), Bayesian and KPSS unit root tests. The study examined the long run equilibrium relationship using cointegration tests with the help of both Engle-Granger two step procedure and Johansen - Juselius cointegration test.

The present study also tested the validity of buffer stock approach to the demand for money in India. Though there are various models to study the behaviour of economic units in response to unanticipated change in money supply, the shock-absorber model comes closer to capture the basic essence of the approach. Hence, in the present study, we have used Carr and Darby's shock absorber approach for investigating into the relevance of buffer stock approach to money demand in India.

The estimated results of the above tests are presented and discussed in details in chapter III, IV and V of this study. The major findings of the study are as follows.

From the alternative OLS money demand functions, it is found that the income elasticity ranges from 0.88 to 1.45 for m_1 while it ranges from 1.72 to 2.09 for m_3 . These results imply that in a developing economy like India, transaction demand for money is more important. The elasticity is more than unity in most of the cases implying that there are no economies of scale in holding money and a proportionate change in income requires more than proportionate change in money to sustain it. Further, income elasticities of demand for money are found to be significantly greater than one and in the neighbourhood of two, supporting the monetarists hypothesis that money holding is a luxury in India. The results show the statistical insignificance of the interest rate variables as a proxy for opportunity cost variable for monetary management in India. This may be attributed to the less developed money market, lack of representative interest rate or inability to model useful interest rates. Further, the significance of inflationary expectations implies that people do react in allocating their portfolio in favour of non-monetary assets as expected inflation rises. It confirms that physical assets (non-money assets) serve as substitute for money in developing country like India rather than financial assets as there are very few alternative financial assets available for wealth holders due to underdeveloped financial markets. The findings further support the presence of wealth effect of stock market prices in holding real cash balances. Further, a positive sign on the real effective exchange rate implies that a depreciation of the domestic currency decreases the demand for real money balances. This could mean that by rising general price level, the exchange rate depreciation reduces real wealth, and the demand for real balances. The effect more than offsets the absorption reducing effect. The absorption reducing effect implies that the exchange rate depreciation may lead to the rise in wealth on account of the better position of the debtors in terms of ownership claims on the rest of the world.

From the monthly estimates, which cover relatively more recent period which witnessed development in the capital market and introduction of new instruments in the market, the following conclusions may be drawn: (i) the demand for real cash balances is

positively and significantly related to the real stock prices, reflecting the presence of wealth or transaction effect. (ii) Secondly, the exchange rate variable confirms the existence of absorption reducing effects of exchange rate depreciation. This effect may be suggested to be a temporary, short run phenomenon, which may peter out in the long run.

Form the findings of diagnostic tests of annual data, it is clear that not many of the money demand functions have non-normal residuals. The problem of heteroscedasticity is not present in most of the money demand functions. Most of the specifications, however, are found to have autocorrelated errors. Whereas, for the sub-period data, very few suffer from the problem, the total sample result seem to show that most of the m1 money demand specifications suffer from misspecifications. In contrast, the results from the sub-periods show that all the m3 specifications are misspecified. The findings from monthly data reveal that most of the OLS money demand functions have non-normal residuals. Misspecification is found to be more prevalent in monthly specifications. This result is in direct contrast with the evidence of annual data where the problem of misspecification was confined to a few specifications.

The results from the recursive residual tests for temporal stability show the presence of structural breaks in the money demand functions during 1980s. Further, the tests show that m1 functions are more prone to breaks than the m3 functions. The structural breaks during the early 1980s are suspected to have occurred due to the widening and deepening of financial system in India. To supplement the results obtained from the recursive statistics, the plottings of CUSUM and CUSUM Square (BDE) have been used in this study. The plotting of the test statistics of both the tests also reveals that structural breaks have been visualised for m1 functions in contrast to the m3 money functions for which demand functions have been more or less stable. Harvey-Collier t-test for model stability supports the findings of CUSUM Square (BDE) test for annual data. The same set of recursive residual tests that are used for annual data, are also used for

monthly specifications for checking the temporal stability. From the findings, it is clear that structural breaks have occurred during 1980s and the breaks are more pronounced in case of m3 specifications than in those of m1. The plottings of BDE test statistics support the inference drawn by recursive residual statistics for structural breaks. The Harvey - Collier test result for monthly data supports the other recursive test results by and large. So, from the above results, it is clear that structural shifts have occurred in the m3 functions in contrast to that of m1 functions and the breaks have taken place during 1980s. The structural breaks in the money demand functions may be attributed to the financial innovations, stock market boom and globalisation of Indian economy during the period.

Cointegration tests are employed to check the presence of long run equilibrium relationship underlying the money demand function. Before the search of cointegration is initiated, it is necessary to check the order of integration of the macroeconomic variables of the money demand function by applying unit root tests. From the test results it is confirmed that all the variables examined are found to be differenced stationary i.e., integrated of order one (i.e, $I(1)$). Hence, the search for cointegration among the variables is initiated as the necessary condition (all the variables are being integrated of the same order ($I(1)$) in this case) is satisfied. The findings from Engle-Granger two step procedure reveal that an equilibrium long run relationship does exist for both the aggregates (m1 and m3) with suitable determinants for the total sample period. These findings thus support the use of either of the monetary aggregates as the guide for monetary targeting. However, the test results for the sub-sample period of 1990s show that long run trend relationship does exist for m1 money demand function in contrast to that of m3. So the findings of Engle Granger cointegration test suggests that either of the monetary aggregates serve as the guide for monetary targeting during 1980s and only m1 serves as an appropriate aggregate for monetary targeting during the 1990s. The present study also has used the Johansen - Juselius multivariate cointegration procedure to check the long run equilibrium relationship among money, output, interest rate, stock prices and

exchange rate. The multivariate approach used here allows for the specification of exogenous variables that improves the estimates of the short run dynamics and help to ensure stability of the system while enhancing the estimates of the cointegrating relationships themselves. By comparing the parameter estimates of the estimated systems with theoretical priors, the work identifies unique, well specified and stable cointegrating relationship underlying the money demand function. However, the test results further suggests that a more stable long run equilibrium relationship does exist for m1 functions compared to those of m3 functions.

The Buffer - Stock approach to money demand assumes that unexpected changes in the money supply are initially absorbed in the holdings of money balances, and over time are used to purchase a wide spectrum of assets and goods as real balance effects are set into motion. So the buffer stock approach to demand for money studies the behaviour of economic units in response to unanticipated money supply shocks. One popular model to the buffer stock approach viz., the Shock - Absorber model developed by Carr and Darby is more close to capture the essence of the buffer stock notion and hence used in this study to investigate into the validity of the approach in Indian context. The empirical findings of the shock absorber model confirm the validity of buffer stock money in India. The evidence suggests that economic units willingly absorb some fraction of unanticipated increase of money supply in the short run. Further, comparison between partial adjustment and buffer stock model on the basis of in-sample predictability of the model, reveals that the shock absorber model has out-performed the conventional partial adjustment model and therefore, could be used as an alternative paradigm in the study of money demand function in India. Further, the stability test using Chow test reveals that all the m3 specifications of both buffer and partial adjustment models are detected to be unstable compared to the m1 money demand functions.

The objectives of the monetary policy by and large coincide with the objectives of the overall economic policy. In India, there have been three major objectives of the economic policy. They are: economic growth, social justice and price stability. Though it is widely recognised that the objective of price stability is one that can be pursued most effectively by monetary policy, in practice, the monetary policy and credit policy have contributed significantly to the attainment of other objectives as well.

Monetary policy acts through influencing the costs and availability of credit and money. The effectiveness of monetary policy essentially depends on the institutional framework available for transmitting impulses released by the central bank. Further, the interrelationship between money, output and prices which constitutes the fundamental building block in most of the macro economic models lies at the core of monetary theory. The transmission mechanism can be better understood by analysing the interrelationship among money, output and prices which is captured in the form of demand for money function. To draw any implication of it in the context of the changes in institutional framework, one should analyse the stability of the money demand relation and the transmission mechanism. So in this connection, the analysis of money demand relationship supply much needed policy implications to the monetary authorities.

One major concern of the monetary authorities is to have a fairly accurate idea about the monetary transmission mechanism. Precisely, they are interested in the channels or routes through which the effects of the monetary policy get transmitted to the economy in general and the real sector in particular. Transmission channels are neither static nor uniform over time. Any changes in the institutional set up must have bearing on the mechanism and it is but natural for the transmission channels to undergo changes possibly making the earlier channels relatively less effective compared to the new ones. So it is important to know the channels on regular basis so that policy makers get much needed insight about the channels of monetary transmission well in time.

In literature, monetary transmission channels are discussed broadly under two major heads - quantum of money channels and price of money or interest rate channels. However, none of the channel of transmission mechanism operates in isolation. There is, in fact, a lot of feedback and interrelationship between the two which complicates the transmission mechanism. And again, environmental changes and institutional set up, gradual liberalisation of the financial markets lead to alter the monetary transmission mechanism. Hence, in a changed milieu, the adequacy of transmission mechanism is being questioned. The link between quantum of money and the real income has weakened and new routes - preferably the price of money channel has come up as a new routes of policy guidance for the monetary authorities. So the degree of strength / weakness of the various transmission mechanism for testing the efficacy of effective monetary policy should be tested with the test of money demand relation.

It is evident that the Indian economy had undergone phenomenal change in the financial systems since 1980s. In the light of these changes, we derive some implications for the monetary policy operations.

First of all, interest rate failed to emerge as a significant explanatory variable in the money demand function. Though administered interest rate structure has been dismantled gradually, still, it is awaiting for complete deregulation for the interest rate channel to emerge as distinctively as the most reliable channel of monetary transmission mechanism. Secondly, the stability of demand for money can not be accepted in an environment of deregulation, globalisation and rapid diffusion of financial innovations. In view of this the quantum channel seems to have lost some of its significance. Under such a situation, the monetary authorities have to constantly monitor alternative indicator rather than money stock alone.

In order to avoid the confusion which may be present during the transitional phase, and instead of waiting for the quantum channel to reopen the possibility under the perfect information system, it is suggested that there is a need to go for a complete deregulation of interest rates so that interest rate channel would emerge distinctly as the most reliable channel of monetary transmission mechanism.

Thirdly, under the price or cost of money channel, exchange rate is gradually emerging as an alternative route through which monetary impulses could be transmitted to the economy. Although, our external sector is small compared to the size of GDP, exchange rate is found to be significant in the money demand function in a number of specifications. This is expected as we have gradually moved towards market determined exchange rate.

Fourthly, the market capitalisation used as an explanatory variable in the money demand function turned out to be generally positive and significant. It would not be out of place to believe that long term asset market has emerged as a possible channel of monetary transmission which support the hypothesis that money is required for investment purpose.

Fifth, our result suggests that expectations about the future price level plays a crucial role in determining the current level of inflation or helps to attain the goal of price stability.

The results from the test of long run equilibrium money demand relationship suggest that either of the monetary aggregates can serve as the guide for monetary targeting whereas, only m1 serve as the better monetary aggregate during 1990s. Further, m1 money demand functions are more stable and hence can act as a better instrument for the operation of quantum channel of monetary transmission mechanism in India.

The buffer stock approach attempts to deal with the issue that the monetary transmission mechanism in the real world is more complicated in the conventional model. The approach analyses the portfolio adjustment process following a monetary innovation. It is this interconnection of stocks and flows that stretches the effects of shocks out in time, produces a diffusion over different economic categories and give rise to cyclical reaction mechanism. The stocks serve as buffer or shock absorbers of initial changes in rates of flow by expanding or contracting their nominal or desired state and they slowly alter other flows as holders try to rejoin the state. Monetary innovations can cause the economic agents to move off their short run money demand function, possibly giving rise to the long and variable transmission lags before equilibrium is restored.

APPENDIX - A

DESCRIPTION OF METHODS USED IN THE STUDY

A.1..Generation of Observation on Inflationary Expectations (IE) and Variability of Rate of Inflation (VRI):

In the present study, expected rate of inflation or inflationary expectations (IE) and variability of rate of inflation (VRI) has been considered as possible determinants of demand for money. A difficulty associated in this context has been that these variables are not directly observable. They have to be generated by making use of either some expectational hypothesis or compiled by means of survey data. The latter however, is ruled out in the Indian context as no such data are available. The only option left for a study of the present kind is to generate observations using some expectational hypothesis. Here, the "adaptive expectations hypothesis" has been used.

According to Cagan (1956), if X_t^e is an unobservable expected variable, then the expectation formation mechanism may be represented by the adaptive expectations hypothesis which is given by

$$X_t^e - X_{t-1}^e = \alpha(X_{t-1} - X_{t-1}^e), \quad 0 \leq \alpha \leq 1 \quad \dots(a1.1)$$

where, X_t is the observed value of X at time t and α is the coefficient of expectation, i.e., the proportion of expectational error taken to be permanent rather than transitory. Considering the above mechanism with a slight modification for the rate inflation (I_t) series, we have

$$I_t^e - I_{t-1}^e = \beta(I_t - I_{t-1}^e) \quad 0 \leq \beta \leq 1 \quad \dots(a1.2)$$

equation (a1.2) may also be written as

$$I_t^e = \beta I_t + (1 - \beta) I_{t-1}^e \quad \dots(a1.3)$$

If the value of β is known, then by assigning appropriate initial values for I_{t-1} , it is possible to generate observations on I_t^e using equation (a1.3). But the value of β is not known *a priori*. It has to be estimated. There are two ways of obtaining the parameter values. One way is to substitute the expression for I_t^e (in equation a1.3) in the money demand function in which the same appears as argument, and estimate the resultant non-linear money demand function. Using any of the non-linear estimation method, the estimates of both money demand parameters and coefficient of expectation could be obtained. A second method is to employ an iteration procedure which is employed in the present study.

The iterative method involves two steps. In the first step, appropriate initial value for the lagged expected variable I_{t-1}^e is chosen. In the present case $I_t^e = 6.71$ which is the average of the rates of inflation of four year preceeding the study period, i.e., from 1956-67 to 1959-60. Then the expression for I_t^e is substituted in a chosen money demand function. In the second step, values are assigned to the expectational parameter β on a trial and error basis starting from zero and adding an arbitrarily chosen small increment value (0.05) till the value of β reaches unity. For a given value of β and initial value of I_{t-1}^e , the demand for money function becomes a simple regression relationship as I_t^e become observable. The optimum value for β is chosen at that value of β in the range (0, 1) where the regression has the highest R^2 .

In the present study, after several experiments the optimum value for β is found to be 0.35 and the money demand relationship on the basis of which this value is fixed corresponds to specification (6) and (12) (of table 3.1(a)) for narrow (m1) and broad (m3) money respectively. Considering $\beta = 0.35$ and I^e_{t-1} , I^e_t series has been generated and used in all the money demand specifications. This however may involve some arbitrariness.

Following Blejer (1979), the variability of rate of inflation is calculated as:

$$V_t = \frac{1}{k} \sum_{i=1}^k |I_{t-i} - I_{t-i-1}|$$

where k denotes the lag ($k = 3$ in the present case) and I_t is the rate of inflation. The variability of rate of inflation (VRI) is generated using the same procedure as in the case of expected rate of inflation (I^e_t). That is, by using the "adaptive expectations" hypothesis.

$$VRI_t - VRI_{t-1} = \lambda (V_t - VRI_{t-1}), \quad 0 \leq \lambda \leq 1$$

The corresponding value for λ has been found to be 0.4 and the specification used has LRGDP, CALLRATE and VRI as independent variables.

A.2 Diagnostic Tests

A.2.1 Breusch-Pagan (B-P-G) Test for Heteroscedasticity:

Broadly, the tests for heteroscedasticity fall into two groups viz., (i) where the heteroscedasticity is assumed to be a specific function of exogenous variables and (ii) where the forms of heteroscedasticity is multiplicative in nature one can use the Harvey test. If

the heteroscedasticity is of an known but general functional form then the maximum likelihood test are useful. The non-specific tests for heteroscedasticity which are frequently use are Goldfeld-Quandt Test, Peak Test, Bruesch-Pagan Test, Harvey Test and White' s general heteroscedasticity. In the present study, we have used Bruesch Pagan Test and Harvey Test to detect heteroscedasticity. An overview of The Breusch Pagan Test is presented here.

$$\text{Let } \delta_i^2 = f(Z_i^T \alpha)$$

where $f(\cdot)$ is a general function independent of i . $Z_i^T = (Z_{i1}, Z_{i2}, \dots, Z_{ip})$ is a $p \times 1$ vector of observations on a set of exogenous variables usually related to the regressors and $\alpha^T = (\alpha_1, \alpha_2, \dots, \alpha_p)$ is a $p \times 1$ vector of corresponding parameter.

Further, the first element of Z_i^T is always assumed to be one, i.e., $Z_{i1} = 1$ for all i . Testing the null hypothesis of homoscedastic variance is then equivalent to testing

$$\alpha_0 = (\alpha_2, \alpha_3, \dots, \alpha_p)^T = 0$$

Let, $\hat{e}_i$ represents the i th OLS residuals and obtain

$$\hat{\delta}^2 = \sum_{i=1}^T \hat{e}_i^2 / T$$

Consider the equation: $(\hat{e}/\hat{\delta}^2) = \alpha_1 + \alpha_2 Z_{2i} + \dots + \alpha_p Z_{pi} + \epsilon_i$

Obtain RSS (Regression Sum of Squares) assuming normality of residuals, ϵ_i . Bruesch and Pagan (1979) shows that under H_0 : $1/2 (RSS) \sim \chi_{m-1}^2$ asymptotically.

Thus in application the computed value of χ^2 value at the chosen level of significance, one can reject the hypothesis of homoscedasticity, otherwise one may accept it.

A.2.2 Ramsey's Specification Error Test: RESET TEST:

For inclusion / exclusion of relevant / irrelevant variables in a relationship, a part from the traditional F-test, residuals also can be made use of for detecting misspecification whereas, Harvey and Collier (1977) discuss some non-parametric tests to detect functional misspecifications. However, the test which is widely used is the Regression Specific Error Test (RESET). In the present study we have used this test for detecting misspecification.

Ramsey's approach for testing the presence of biasing specification error is to analyse the distribution of Best Linear Unbiased Scalar (BLUS) residual under the competing hypothesis.

$$H_0 : \tilde{e} \sim N(0, I_{T-k})$$

$$H_1 : \tilde{e} \sim N(A^T \xi, \delta^2 I)$$

$$\text{where } \tilde{e} = A^T \xi = \alpha_0 + \alpha_1 q_1 + \alpha_2 q_2 + \dots + \alpha_p q_p + u$$

$$q_i \text{ is being defined as, } q_i^T = y^{(j+1)} A$$

p is a suitable order of approximation and $u \sim N(0, \delta^2 I)$. The procedure then is to apply the F - test for the hypothesis that all the α 's are zero. Under the null hypothesis of H_0 , the F test statistics is distributed as central F with $(p+1)$ and $(T - k - 1)$ degrees of freedom. It should be noted that the RESET is a general test to detect specification error arising from omitted variables, functional misspecification or error in the variable. And hence, it does not clearly point out the exact cause of misspecification.

A.2.3 Runn's Test of Autocorrelation:

The most extensively used test for autocorrelation error is the Durbin-Watson test. To overcome the problem of inconclusive region of the test, Durbin and watson proposed an approximation. However, it is suggested that a non-parametric test (known as the Run's test) for testing independence of errors in the AR1 process.

A "Run" is defined as an uninterrupted sequence of one symbol of attribute, such as '+' or '-'. Further, the length of the run is defined as the number of elements in the run. With these definitions let

N = total number of observations

N_1 = number of positive residuals (i.e., + symbols)

N_2 = number of negative residuals (i.e., - symbols)

n = number of runs.

Then under the null hypothesis of no autocorrelation, the number of runs follows an asymptotically normal distribution with mean and variance given by:

$$\text{Mean : } E(n) = \{2 N_1 N_2 / (N_1 + N_2)\} + 1$$

$$\text{Variance : } \delta^2(n) = 2 N_1 N_2 (2 N_1 N_2 - N_1 - N_2) / \{(N_1 + N_2)^2 (N_1 + N_2 - 1)\}$$

The null hypothesis is accepted with 95% confidence if

$$[E(n) - 1.966(n)] \leq n \leq [E(n) + 1.966(n)]$$

An advantage of the Run's test is that no assumptions are made about the type of distribution of the residuals.

A.3 STABILITY TESTS

A.3.1 CUSUM Square Tests (BDE):

Departure from model specification can be studied by making use of residuals. The plots of OLS residuals against time or the cumulative sums of residuals against time, may not fully reflect the sensitive departures in a model specification. Hence, Brown et al.(1975) made use of recursive residuals to examine departures in model specification. The details of the recursive residual test, alternatively known as Brown - Durbin - Evan (BDE) test or Cusum Square test, are as follows:

Let us consider the basic regression model

$$Y_t = X_t \beta_t + u_t, \quad t = 1, 2, \dots, n$$

where Y_t is $(t \times 1)$ vector of observations on the dependent variable, X_t is $(t \times k)$ matrix of observations on k independent variables, β_t is $(k \times 1)$ vector of parameters, and u_t is $(t \times 1)$ vector of observations on error terms. The suffix "t" is used for β also to indicate

possibility of its varying over the given "n" time periods. It is also assumed that u_t is normally distributed with mean zero and variance δ_t^2 . Now, the null hypothesis (H_0) of constancy of regression relationship may be written as:

$$H_0 : \beta_1 = \beta_2 = \dots \beta_n = \beta(\text{say})$$

$$\delta_1^2 = \delta_2^2 = \dots \delta_n^2 = \delta^2(\text{say})$$

Here the emphasis is more on detecting differences among β 's than among δ 's.

Let β_{t-1} be the OLS estimate of β based on the series of observations from period 1 through t-1. Then the prediction error for period t is given by

$$e_t = Y_t - X_t \beta_{t-1}$$

where X_t is a row vector containing t^{th} observation on all the independent variables. The recursive residuals, e_t^* , is defined as :

$$e_t^* = e_t / \{1 + x_t(x_{t-1}^T x_{t-1})^{-1} x_t^T\}^{1/2}$$

where x_{t-1} contains only the first t-1 rows of x_n . For a set of n given time series observations, there will be (n-k) x 1 vector of residuals. These residuals have a number of desirable properties. They are easy to compute and straight forward to understand intuitively as a form of prediction error. They also react distinctively to various departures from H_0 .

The next step is to define a statistics

$$S_t = \sum_{k+1}^t e_t^2 / \sum_{k+1}^n e_t^2, \quad t = k+1, \dots, n$$

where S_t is the ratio of the sum of square of one - period prediction residuals from $k+1$ period to t period, to the sum of squares of one - period prediction error from the $k+1$ to n^{th} period. The values of S_t therefore will be between zero and unity as indicated below.

$$S_t = 0 \quad \text{if } t < k+1$$

$$S_t = 1 \quad \text{if } t = n$$

Under H_0 , S_t will have a Beta distribution with approximate mean value,

$$E(S_t) = (t+k) / (n-k)$$

where "E" denotes expectations. This indicates that the plots of S_t against t should be along with its mean path. For a two sided test of hypothesis, a linear confidence interval for S_t is constructed. Accept H_0 if the values of S_t lie in the interval.

$$C_0 \pm (t-k) / (n-k)$$

where C_0 is distributed as Pyke's modified Kolmogorov-Smirnov statistics. The values for C_0 at various significance level are available in Brown et al.(1975) by entering the table at $m = (n-k) / 2$ when $(n-k)$ is even and interpolating linearly between $m = 1/2(n-k)-1/2$ and $m = 1/2(n-k) + 1/2$ when $(n-k)$ is odd.

A.3.2 CUSUM Test:

The CUSUM test is based on the statistic:

$$W_t = \sum_{i=k+1}^t e_i \sum_{i=k+1}^t e_i^* / \delta^2$$

$$\text{where } \delta^2 = (n-k-1)^{-1} \sum_{t=k+1}^n (e_t^* - \bar{e}^*)^2$$

$$\text{and } \bar{e}^* = (n-k)^{-1} \sum_{i=k+1}^n e_i^*$$

The test is performed by plotting W_t against t . Confidence bounds are obtained by plotting the two lines that connects the points $(k, \pm a\sqrt{T-k})$ and $(T, \pm 3a\sqrt{T-k})$. Values of a corresponding to 95% and 99% are 0.948 and 1.143 respectively. The hypothesis is rejected if W_t stays outside the boundaries.

A.3.3 Harvey - Collier Test:

This test proposed by Harvey and Collier(1977) is related to the COSUM test. Under the null hypothesis of model stability, the mean of e^* is normally distributed with mean zero and variance $\delta^2 / (n-k)$, where δ^2 is as defined in CUSUM test. The test procedure involves computing the t-statistics:

$$t = (n-k)^{1/2} s^{-1} \bar{e}^*$$

$$\text{where } s^2 = (n-k-1)^{-1} \sum_{i=k+1}^n (e_i^* - \bar{e}^*)^2$$

The calculated t is to be compared to t - distribution with $(n-k-1)$ degree of freedom.

A. 4 UNIT ROOT TESTS

A.4.1 Dickey Fuller (DF) and Augmented Dickey Fuller (ADF) Tests:

Dickey Fuller unit root procedure required the estimation of the following equation:

$$\Delta X_t = \mu + \alpha X_{t-1} + \sum_{i=1}^k \gamma_i \Delta X_{t-i} + \varepsilon_t \quad \dots (a4.1)$$

where, k is the value which ensures ε_t to be a white noise series, Δ the difference operator, α and γ parameters. The t statistics of α is the Dickey-Fuller "test statistics" (τ_α) though under the null hypothesis ($H_0 : X_t$ is $I(1)$) it does not follow the usual t -distribution. The test rejects the null hypothesis against its alternative ($H_1 : X_t$ is $I(0)$) if the α is significantly negative. The selected percentiles for the distribution of α are available in Dickey et al.(1986). This test procedure is known as Augmented Dickey Fuller (ADF) test. The DF test forms a special case of the ADF test when the summation part in the RHS of equation (a4.1) is deleted or when $k = 0$ (see Dickey-Fuller (1979)). For ADF test, the value of k is decided based on Akaike's Final Prediction Error (FPE) criterion in which the lag was allowed to vary upto 24.

A.4.2 Phillips-Perron (PP) Test:

Phillips and Perron (1988) have suggested an alternative test of unit root. The advantage of this test is that it is neutral to selection of lag-length in the ADF equation. Further, the error term over there could be serially correlated and heteroscedastic. Let us consider the equation:

$$\Delta X_t = \mu + \alpha X_{t-1} + u_t$$

The test statistic for α viz., τ_α is modified in this case to form Z_α statistic which is given by:

$$Z_\alpha = \tau_\alpha(\delta_u / \delta_{\tau l}) - 1/2 (\delta_{\tau l}^2 - \delta_u^2) \{ \delta_{\tau l} T^{-1/2} \sum_{t=2}^T (X_{t-1} - X_{t-1})^2 \}^{1/2}$$

where δ_u^2 is sample variance of u_t , T is sample size.

$$X_{t-1} = \sum_{t=1}^{T-1} X_t,$$

$$\text{and } \delta_{\tau l}^2 = T^{-1} \sum_{t=1}^T u_t^2 + 2T^{-1} \sum_{j=1}^{\ell} w_{jl} \sum_{t=j+1}^T u_t u_{t-j}$$

the weights $w_{jl} = (1-j) / (l+1)$

ensuring that the variance estimate $\alpha_{\tau l}$ is positive.

The remaining procedure is the same as in DF test. That is the calculated value of Z_α may be compared to τ_α tables.

A.4.3 KPSS Unit Root Test:

This test, due to Kwiatkowski et al. (1992) provides a test statistics under the null hypothesis of stationary and alternative of unit root to test that the series is differenced stationary. The test statistics are derived by computing the following statistics.

$$(1-T^2) \sum_{t=1}^T \{S_t^2 / \delta^2(I)\}$$

where, T is sample size, $S_t = \sum_{t=1}^T e_t$ and e_t residual from a regression from the variable equation say, Y_t , on an intercept and a time trend. Also $\delta^2(I)$ is a consistent estimator of the long run variance of Y_t and is constructed as in Kwiatkowski et al.(1992). The critical values for test statistics both with and with out trend at 5% level are presented in Kwiatkowski et al (1992).

COINTEGRATION TESTS

A.5.1 Testing for Cointegration: The Engle-Granger Two-Step Procedure:

At the least sophisticated level of economic theory lies the belief that certain combination of economic variables should not diverge from each other by too great an extent, at least in the long run. Thus, such variables may drift apart in the short run or according to seasonal factor, but if the continues to be too far apart in the long run, then economic forces, such as market mechnism or Government intervention, will begin to bring them togther. In some cases an economic theory involving equilibrium concepts might suggests close relations in the long run, possibily with the addition of yet further variables. The idea underlaying cointegration, allows specification of models that capture part of such beliefs, at least for a particular type of variable that is frequently found to occur in macroeconomics.

Consider initially a pair of series, X_t , Y_t each of which is $I(1)$ and having no drift or trend in mean. It is generally true that any linear combination of these series is also $I(1)$. However, if there exists a constant A , such that,

$$Z_t = X_t - AY_t$$

is $I(0)$, then X_t, Y_t will be said to be cointegrated, with A called the cointegrating parameter. If it exists, A will be unique in the situation now being considered. It follows that X_t and Y_t must have special relationships.

For testing the presence of cointegration, it is necessary to start with whether a series X_t is $I(0)$ and a useful test is provided by Dickey and Fuller (1981). The following regression is formed,

$$\Delta X_t = \beta X_{t-1} + \sum_{j=1}^p \gamma_j \Delta X_{t-j} + e_t$$

where p is selected large enough to ensure that the residuals e_t is empirical white noise. The test statistics is the ratio of $\bar{B}^{-1} \beta$ to its calculated standard error obtained from an ordinary least square regression. The null hypothesis is $H_0 : X_t \sim I(1)$. This is rejected if β is negative and significantly different from zero.

To test cointegration between a pair of series, that are expected to be $I(1)$, one method is to first form the cointegrating regression:

$$X_t = C + \alpha Y_t + e_t$$

and test whether the residuals e_t appears to be $I(0)$ or not. It might be noted that when X_t and Y_t are cointegrated, this regression when estimated using, say, OLS should give an excellent estimate of the true cointegrating coefficient, A in large samples. Here, the null hypothesis: $H_0 : X_t, Y_t$ is not cointegrated and are based on either of the unit root tests for testing the significance of the residuals. Whether the residuals e_t is stationary or not or whether X_t and Y_t are cointegrated or not is tested by comparing the calculated statistics with the tabulated statistics with different significance levels.

A.5.1.1 Generalisation: Many Variables Cointegration:

Let X_t be a vector of N component time series, each without trend in mean and each $I(d)$, $d > 0$. For the moment it is assumed that the d -differenced vector series is a zero mean, purely non-deterministic stationary process, so that there is a wold representation

$$(1-\beta)^d X_t = C(B)\epsilon_t$$

where this is taken to mean that both sides have the same spectral matrix and ϵ_t is an $N \times 1$ zero mean white noise vector with

$$\begin{aligned} E(\epsilon_t \epsilon_s') &= 0, & \dots t \neq s \\ &= G & \dots t = s \end{aligned}$$

So that only contemporaneous correlations can occur. Equation 4.12 is normalised by taking $C(0) = I_N$, the unit root matrix.

Then X_t will be cointegrated $CI(d,b)$ if there exist a vector such that

$$Z_t = \alpha' X_t \quad \text{is } I(d-b), \text{ for } b > 0.$$

The case considered in the earlier section has $N=2$, $d = b = 1$. Moving to general values of N , b , d , adds a large number of possible interrelationships and models. In particular, it is clear that α need no longer be unique, as there can be several "equilibrium" linkings $N > 2$ variables. If there are r vectors α , each of which produces Z 's integrated of order less than d , then r is called the "order of cointegration" and it is easily seen that $r \leq N-1$.

A.5.2 Joahnsen and Juselius (JJ) Procedure:

Until recently, much of the empirical work involving the estimation of cointegrating vectors utilised the single-equation error-correction technique proposed primarily by Engler and Granger (1987). While quite useful this techniques, suffered from number of problems. In the past few years, there has been a movement towards

estimating cointegrating relationship in a system of equations framework to make better use of all the information available in the long and short run fluctuation of each variables. Johansen (1988) outlined a method, which was later expanded by Johansen and Juselius (1990), that allowed for the testing of more than one cointegrating vector in the data for calculation of maximum-likelihood estimates of these vectors.

The Johansen-Juselius (JJ) methodology begins with a statistical model of the following form:

$$X_t = \Pi_1 X_{t-1} + \dots + \Pi_k X_{t-k} + \mu + \psi D_t + \varepsilon_t \quad \dots(1)$$

where X_t is a vector of p variables, ε_t is a vector of disturbances such that $\varepsilon_t, \dots, \varepsilon_n$ are $IIN(0, \Lambda)$, μ is a constant, and D_t is a vector of exogenous variables. The JJ technique decomposes the matrix Π ($p \times p$) to discover the information about the long run relationship between the variables in X . In particular, if Π has a rank of $0 < r < p$ then it can be written as $\Pi = \alpha \beta'$ where β' is a $r \times p$ matrix of r cointegrating vectors (so that the r variables $\beta_i' X_t$ are stationary and α is a $p \times r$ matrix of loading or speeds of adjustment. Johansen-Juselius design a maximum-likelihood estimator of obtaining estimates of α and β' . This procedure also yield two test statistics of the number of statistically significant cointegrating vectors. One test is called the λ -max statistic and compares the null of $H_0(r)$ with an alternative of $H_1(r+1)$. The second is the trace test, which examines the same null of $H_0(r)$ versus an alternative of $H_1(p)$.

In this framework, it is desirable to obtain atleast one cointegrating vector, (so that $r=1$) that establishes the model. If for example, $r = 2$, then one could in principle assume that the system is stable in more than one dimension. The test of hypothesis for the rank

of the impact matrix is conducted by the above mentioned two tests (the likelihood ratio trace test and maximum - eigen value lambda max test).

APPENDIX - B

DESCRIPTION AND SOURCES OF DATA

The time series data on all the variables used in the empirical analysis are either annual or monthly observations. The data on annual observations cover the period from 1960-61 to 1995-96 and that of monthly observations, it covers the period from April 1981 to October 1995. the data on monetary aggregates (such as M1 or M3) are suitably adjusted according to their definitional changes. All the monetary variables are measured in crores of rupees. The interest rate series are measured in terms of percentage changes per annum. In addition, the economic activity for annual data is measured by on income measure (Gross domestic Product) and for monthly observation, it is measured by index of industrial production. The exchange rate variable is measured by the real effective exchange rate. the financial wealth of stock market is proxied by market capitalisation and the stock market prices by BSE and RBI indices. The real quantity of these variables are obtained using relevant deflators.

B.1 Monetary Aggregates:

The data on both Narrow Money (M1) and Broad Money (M3) (as defined in Table 3.1 of Chapter III), are considered in this study for both annual and monthly observations. The analytical framework under which various monetary stocks are

compiled in India has undergone modest changes by the report of the Working Group on Money Supply in 1961, which was subsequently refined by the Second Working Group in 1977. Following the recommendations of the Second Working Group on Monetary concepts, the M1 and M3 are redefined since March 1978. Accordingly, about 85 percent of the savings deposits are being treated as part of the time deposits while the remainder being treated as demand deposits. This apart, prior to March 1970, only the liabilities of the State Co-operative Banks were included in the data on all Co-operative Banks.

In order to ensure the comparability of the data, this problem need to be resolved through adjustment which has been done by Singh et al (1982). This adjusted data on M1 and M3 have been taken from that article and from an article by Bhoi (1992) for the period from 1960-61 to 1989-90. For the subsequent periods, These data have been compiled from various of Report on Currency and Finance and RBI Bulletins.

B.2 Income Measures

For annual data , the income measure (the scale variables) is measured by the Real Gross Domestic Product (RGDP) at factor cost with base :1980-81 = 100. The data on this variable has been taken from Economic Survey, Government of India. For monthly observations, index of industrial production has been taken as a proxy for scale variable with base: 1980-81 = 100.

B.3 Interest Rate Variables

Interest rate variables are many and choosing from the alternatives may be sometimes arbitrary. Moreover, segment of the interest rate structure remained wholly administered for the greater part of the sample. Although there have been some efforts

towards liberalisation of interest rates , it is partial in most of the cases. The weighted average call money rate at Bombay has been chosen for our study. The call money rate is some what market related, although a ceiling discipline was imposed by the Indian Banks association from 1973 to 1989. Other interest rates that are used in the study include treasury bill rate, 1-3 year deposit rate and debenture yield rate. The data for call money rate is collected from Bhoi (1993) for the period till 1992. Rest of the data are collected from various issues of Reports on Currency Finance.

B.4 Stock market Prices and Wealth:

For annual data, only RBI share index with the base: 1980-81 = 100 has been chosen for the study. Where as, for monthly observations, both BSE and RBI indices with the base: 1980-81 = 100 has been selected. Real financial wealth proxied by a sum total of outstanding market capitalisation in the capital market and small savings deflated by WPI (Whole Sale Prices Index).

B.5 Exchange Rate

The exchange rate is measured in terms of 36 country weighted real effective exchange rate index published by Reserve Bank of India.

B.6 Price Variables

The price variable is measured in terms of whole sale price index (WPI) with base year 1980-81 = 100. Inflation rate is calculated from WPI data. Inflationary expectations and variability of rate of inflation has Been calculated from WPI. The description of methods for calculating these variables is presented in appendix-A (A.1).

B.7 Sources of Data

Bhoi, B K (1992), "Issues of Instability in Money Demand Analysis: A Perspective", RBI Staff Studies, No.9

Bhoi, B K (1993), "Analytics of the Recent Call Money Rate Behaviour in India", RBI Occasional Papers, Vol.14, No. 4, pp. 319-334.

GOI, Ministry of Finance, Economic Survey Annual)

RBI, Reserve Bank of India Bulletins (monthly)

RBI, Reports on Currency and Finances (annual)

Singh, A., Shethy, S.L. and Venktachalam, T.R. (1982), "Monetary Policy in India: issues and Evidence", Supplement to RBI Occasional papers, Vol. 3, No 1