ON SOME EMPIRICAL ASPECTS OF NEW MONETARY AGGREGATES FOR INDIA

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DEBASHIS ACHARYA

DEPARTMENT OF ECONOMICS

SCHOOL OF SOCIAL SCIENCES

UNIVERSITY OF HYDERABAD

HYDERABAD 500 046, INDIA

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Department of Economics,
School of Social Sciences,
University of Hyderabad,
Hyderabad-500 046

Date 5-6-'98

This is to certify that I, Debashis Acharya, have carried out the research embodied in the present thesis entitled "On Some Empirical Aspects of New Monetary Aggregates for India" 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

Signature of the Supervisor

(Signature of Candidate)
Name DEBASHIS ACHARYA
Enrollment No 95SEPH01

Head of the Department
HEAD
Department of Economics
University of Hyderabad
HYDERABAD-500 134

Dean of the School 5/6/98
प्रोफेसर तेजराम शर्मा
PROFESSOR TEJ RAM SHARMA
संकाय अध्यक्ष
DEAN
सामाजिक विज्ञान संकाय
School of Social Sciences
हैदराबाद विश्वविद्यालय
University of Hyderabad
Pin-500 046, भारत INDIA

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CHAPTER - I

INTRODUCTION, OBJECTIVES AND SCOPE OF THE STUDY

".....the problems with tests of money in the economy in recent years may be more due to bad measurement theory rather than to an instability in the link between the true money and the economy. Rather than a problem associated with the Lucas critique, it could instead be a problem stemming from the "Barnett critique""

Chrystal K A and R MacDonald(1994) p 76

1.0. INTRODUCTION

The conventional simple sum procedure to monetary aggregates, practised by almost all the central banks today, assumes perfect substitutability among the component monetary assets This assumption is unrealistic especially when there is ample evidence on imperfect substitution among component monetary assets Simple sum monetary aggregates, therefore, fail to account for substitution effects whenever there is a fluctuation in the relative prices of different monetary assets The microeconomic theory of monetary aggregation(Barnett(1980, 1982, 1987, 1992)) questions the very basis of simple sum scheme in terms of the latter's weak theoretical foundation Integrating economic aggregation theory, statistical index number theory and monetary theory the microeconomic theory of monetary aggregation successfully circumvents the problems inherent in the simple sum scheme and suggests Divisia monetary services indices as powerful alternatives to simple sum monetary aggregates One interesting feature of the Divisia monetary services indices lies in its ability to capture the entire liquidity services from the available spectrum of monetary assets by assigning weights(user cost evaluated expenditure shares) to different assets according to their degree of contribution to the monetary service flow of the economy. The convincing theoretical basis of these indices which has an intuitive appeal, has invited the attention of many monetary economists all over the world.

1.1. WHY MONETARY AGGREGATION?

The debate on "What is money of standard macroeconomics ?" started with the advocates of the theoretical approach school who emphasised on a particular function of money and accordingly identified the real world entities to be called "money" Prominent among the advocates include Fisher(1911), Yeager(1968), Johnson(1971), and Tobin(1980) Though the medium of exchange function of money was given universal importance, the disagreement still continued due to the different emphases put forth by different authors on functions of money The ambiguities inherent in this school of thought coupled with emergence of additional money market instruments possessing money like characteristics gave a different angle to the debate wherein monetary economists started looking for an empirically identifiable money The idea was to evolve certain policy criteria on the basis of which one could quantify the total money stock in the economy In this context one may refer to the Friedman-Meiselman dual criteria(1963) and the stable money demand function criteria(Rose(1985), Gordon(1984)) etc . The Radcliffe committee in the United Kingdom and Gurley and Shaw in the United States pointed out the difficulties in drawing a line between money and other money like assets considering them close substitutes of money However, in a later period, studies by Chetty(1969), Boughton(1981) and Husted-Rush(1984) evidenced empirically low substituion between money and money like substitutes Thus no empirical criterion could provide a unique definition of money

There was no controversy when monetary assets did not yield any interest *viz.*, the services rendered by them were purely transactions services. As a result they could be added together as simple sums. However, with the emergence of more and more interest bearing assets it became difficult to disentangle the transactions services from the investment services rendered by these assets The investment characteristic of the assets featured as the main reason for compositional shifts in an individual's assets portfolio because with an increase in the rate of return on other assets opportunity cost of holding money also increased This gave rise to an occasion for monetary aggregation Barnett's(1978) derivation of a formula for the price of money, the *user cost*, paved the way for applying index number theory to aggregate over different financial assets Barnett's(1980, 1982, 1987,) aggregation theoretic results combined with advances in statistical index number theory(Diwert(1976), Hulten(1973)) provided a convincing basis for the now popular monetary services indices such as the Divisia monetary services indices and the Fisher Ideal monetary services indices Following this *high road* of research in monetary economics(Barnett(1997)) researchers from many countries have focused on the relative empirical performance of these new monetary aggregates against the commonly adopted simple sum aggregates in explaining real activity in the economy Though evidences in general have been mixed in nature, Divisia monetary aggregates have been found to have a clear edge against their sum counterparts In fact, central banks such as the *Bank of England* and the *Federal Reserve Bank of St Louis* have started publishing Divisia money stock measures on a regular basis for monitoring their statistical behaviour along with the official simple sum aggregates

In view of these index theoretic developments on monetary aggregation in monetary economics literature and in the wake of the ensuing financial innovations in Indian money market it must be rewarding attempt to make a case for the above mentioned aggregation theoretic monetary aggregates in the Indian context Though few studies in the past (see Subrahmanyam and Swami(1991, 1994), Ramachandran(1993)) examined the relevance of these aggregates for India, the present study endeavours a reexamination of the whole issue in a renewed context The present study differs form the earlier ones in three important respects *viz.*, (i) in applying Varian's(1983) non-parametric test for testing weak separability ,and (ii) in constructing Rotemberg's Currency equivalent monetary aggregates for the first time in the Indian context and finally discovering some new groupings with certificate of deposit as an additional asset Accordingly, the objectives of the present study are formulated as follows

1.2. OBJECTIVES

(i) To re-examine the performance of Divisia monetary aggregates, following Barnett's(1982) three stage procedure for selection of optimal monetary aggregates

(ii) To test the validity of currency equivalent monetary aggregate originally conceived by Hutt(1963) and later developed by Rotemberg *et al* (1995) as an alternative to the broadest Indian money supply measure *viz* ,M4

(iii) To explore the feasibility of including some new assets like certificate of deposit in the existing monetary aggregates and study the properties of those aggregates

(iv) To make a comparison of the performance of Divisia monetary aggregates and their simple sum counterparts

(v) To analyse the implications of these aggregation theoretic results for the emerging money market in India

1.3. METHODOLOGY

The study spans over a period 1970 to 1996 for annual observations and from 1985 04 to 1996 09 for monthly observations. The rationale behind the choice of these time periods lies in the fact that the data set for these periods rationalised a well behaved utility function Both for annual and monthly experiments four monetary assets namely currency with the public(CU), net demand deposits(DD) and net time deposits(TD) with all commercial and co-operative banks and saving deposits with post offices (PD) have been considered For the period 1994 04 - 1996 07, a new asset called certificates of deposits has also been included in the analysis The number of observations is constrained due to the availability of the data on this asset as it was introduced only in June 1989

The first and foremost task of this study has been to identify some weakly separable groups Assuming real goods and services and leisure to be separable from monetary assets, the study investigates for separable monetary groups In this context Varian's(1983) nonparametric methodology has been employed for testing weak separability of a set of hypothesised monetary component groupings The hypothesization follows Barnett's recursiveness condition and hence considers currency as a common component in all the utility structures

In the second step, Divisia monetary aggregates are constructed along with their simple sum counterparts over the identified separable groups A new class of monetary aggregates called Currency Equivalent Monetary Aggregates(CEMAs) proposed and analysed by Rotemberg *et al* are also constructed for the first time in the Indian context

A simple information content test based on R^2 has been employed to test the information contained in these aggregates The goal variables considered include GDP, Price(WPI), and Index of Industrial Production(IIP) as proxy for the monthly income measure. The Davidson and Mackinnon(1981) J-test for non nested hypothesis is conducted to test Divisia versus sum aggregates in explaining a particular goal variable.

The superiority of a new monetary aggregate in relation to the conventional aggregates may be examined by testing for its stability in the demand for money framework For this purpose simple money demand equations involving these monetary aggregates are formulated and their stability is examined by the CUSUM squares plot (Brown, Durbin and Evans(1975)) For monthly specifications the Johansen-Juselius(1990) multivariate cointegration framework is also employed to study the long run equilibrium relationships underlying the money demand relationships Before going for cointegration as a prerequisite unit root tests have been conducted to check the stationarity properties of all relevant macroeconomic time series

1.4. ORGANISATION OF THE STUDY

The rest of the study is organised into five chapters Chapter II presents a critical survey of various issues in monetary aggregation Sections 2 1 and 2 2 discuss the basic tenets of the theoretical and empirical approaches to money definition respectively The approaches to weighted monetary aggregates are surveyed in section 2 3 A critical evaluation of all the approaches is attempted in section 2 4 Section 2 5 presents a review of some major evidences relating to the above approaches Studies focusing on financial innovations and Divisia monetary aggregates are presented in section 2 6 Money definition in the Indian context is reviewed in the last section Here, the official money stock measures as well as individual research efforts towards an appropriate measure of money for India are critically evaluated

Chapter III searches for some theoretically admissible groups of monetary assets by way of testing their weak separability from the rest of the assets. Following a brief introduction, section 3.1 elaborates the concept of weak separability Section 3 2 presents different methods of testing weak separability with a greater emphasis on Varian's(1983) non parametric approach to testing weak separability. This section also reviews some important previous studies which have employed this method for arriving at certain separable groupings Section 3.3 introduces the nature of the present study followed by description of data categories in section 3 4 Results of the non-parametric weak separability test are presented in section 3 5 and section 3 6 offers some concluding remarks

The relative performance of Divisia versus simple sum monetary aggregates is examined in Chapter IV Section 4 1 presents results from annual data spanning over the period 1970-1996 whereas monthly results from 1985 04 to 1996 09 are discussed in section 4 2 Section 4 3 summarises the results of some new aggregates(both Divisia and Sum) consisting of like Certificate of deposit(CD) as an additional asset for the very recent sample 1994 04-1996 07 for which data on CD are available Some concluding remarks are offered in section 4 4

A new monetary aggregate called the Currency equivalent monetary aggregate(CEMA) is exclusively dealt with in Chapter V The theoretical foundation of CEMA is discussed in section 5 1 Section 5 2 reviews available empirical evidences on CEMA. Empirical findings of the tests conducted are presented in Section 5 3 The tests include information content test, Davidson-Mackinnon J-test and stability of demand for money functions. Concluding remarks are offered in section 5 4

The last chapter(Chapter VI) summarises the findings of the present study. An analysis of the implications of the aggregation theoretic results (obtained in Chapters IV and V) for the emerging money market in India is also attempted in this chapter. The chapter concludes with some suggestions for the monetary authorities

CHAPTER-II

MONETARY AGGREGATION : A SURVEY OF MAJOR ISSUES AND EVIDENCES

Much ingenuity has been spent upon attempts to define the term money..All such attempts at definition seem to me to involve the logical blunder of supposing that we may, by settling the meaning of a single word, avoid all the complex differences and various conditions of many things, each requiring its own definition.

-----William Stanley Jevons
Money and the Mechanism of Exchange

2.0.INTRODUCTION

An attempt has been made in this chapter to trace the evolution of various approaches to money definition starting from the 1960s The specific purpose of this chapter is to provide the necessary background to the present study, by way of highlighting the basic features of the theoretical and empirical approaches to money definition and bring together evidences drawn from the previous work To facilitate the discussions, the chapter has been organised into seven sect ons The first section reviews the theoretical approaches to money definition while section 2 2 reviews the approaches to empirical definition of money The various approaches to weighted monetary aggregates are surveyed in section 2 3 followed by a critical evaluation of all the approaches in section 2 4 Section 2 5 presents a review of some major studies Studies focusing on financial innovations and Divisia monetary aggregates are presented in section 2 6 Money definition in the Indian context is dealt with in the last section

2.1 THEORETICAL APPROACH

The theoretical approach to money definition involves conceptualising money in terms of certain functions or characteristics and then identifying the real world economic entities which are consistent with the theoretical concept of money Unfortunately, there is no single function of money. Emphasis on different functions produces different monetary aggregates As a result, there is a considerable disagreement about how to define money In the literature, the medium of exchange, "liquidity" and "temporary abode of purchasing power" functions have been emphasised while defining money

Clower (1971), an advocate of the means of payment approach says that, in case of an organized market, the Walrasian auctioneer-coordinator being at the centre, there is no need for a specialized commodity to serve as a means of payment because all commodities are perfect substitutes The absence of a Walrasian auctioneer-coordinator necessitates a specialized commodity which should routinely serve as a means of payment Clower calls this commodity as money He favours trade credit as well as currency and demand deposits for inclusion in the broad connotation of money definition, for practical purposes in the United States and the United Kingdom He suggests credit cards overdraft facilities, travellers' cheques as well as book credits in trade credit for inclusion in money stock but rejects some substitutes like time deposits and other financial claims to qualify as money

Emphasizing on the means-of-simultaneous payment function of money, Schackle(1971) defines money as "the total of all those payments which could be made without the payers receiving or counting on the payments to be made by others Simultaneity must be insisted on here, lest we mix up quantity and velocity"(p 32) This definition of Schackle includes coins, notes, transaction deposits and time deposits at banks. Time deposits are included because the owner of the time deposit account could write a cheque on his demand account (having zero balance) as per the provisions. This is nothing but the overdraft facility. Money, here, is defined as the means of making payments. Increasing trade credit on the other hand puts off the making of payments Shackle therefore hesitates to consider trade credit as money. But he includes bank credit in the definition of money This implies that Schackle has a narrow view of encompassing the goods market only If the distinction between the goods market and the debt market is avoided then the transaction will not be complete until the bank overdraft is repaid and hence bank credit along with trade credit cannot be included in the stock of simultaneous means of payment

Johnson (1971) defines money as that which can routinely be exchanged for goods without creating a debt and a repayment obligation Money under this approach is a means of payment that does not create obligations against it Similarly, Yeager (1968) advocates that for a commodity to be money, it must serve as a medium of exchange and must circulate routinely This definition of money by Yeager assumes monetary theory as essentially a theory of exchange media For example, non bank travellers' cheques working as exchange media are not identified as money because they do not circulate routinely

The tangible medium of exchange approach originates from the writings of Black (1970) and Fama (1980) In their opinion, the entity functioning as a medium of exchange, if tangible could be called money For example they identify currency as the tangible money medium of exchange Fama s definition of money is implicit in his model In his model of unregulated banking, an accounting system of exchange operating through debits and credits acts as the method of paying for goods and services There is no need for a physical medium of exchange in this case The two features of an "ideal" system of payments as given by Fama are (i) accounting system of transactions maintained by banks, and (ii) charging competitively determined fees for services and paying competitive interest rates on deposit balances. This ideal system of payments does not need currency or any other physical medium of exchange and therefore accounting balances of the real world system are no money Then currency alone is money The question raised here is whether it is necessary for the medium of exchange to be tangible so as to qualify for money

Tobin (1980) points out two distinctive features of money viz (i) it is an "outside" asset, not generated by the private economy itself as the counterpart of private debt, and (ii) that its nominal or own rate of interest is institutionally or legally fixed and is not determined in markets To quote Tobin, "The story told by monetary theory would be quite different if 'money' were an inside asset, its nominal quantity and yield endogenous, or if people were induced to hold additional outside 'money' by an increase in a market clearing nominal interest rate on money itself"(p 319) Again quoting his words, "The nominal supply of money is something to which the economy must adapt, not a variable which adapts itself to the economy-unless the policy authorities want it to"(p 319)

According to the store of value function approach what matters is the liquidity That is to say in the presence of a whole range of liquid assets, cash may not be an obstacle in the path of household and business spending Spending here is constrained by liquidity but not by cash alone, as payments can be made through the available alternative liquid assets Variations in trade credits and debts created by nonbank financial intermediaries have a bearing upon the attempts of Central Banks to manipulate money supply for its desired effects on economic activity Therefore monetary policy should take into account the whole range of liquid assets instead of focussing on money stock alone

The above argument is in line with the view of Gurley and Shaw (1960) and Radcliffe Committee Gurley and Shaw argue that the monetary system is free from competition by other financial intermediaries only when money demand is limited to transaction services and no other financial assets can be substituted for means of payment. In reality, money faces competition as other financial assets are also held on demand. Money supply is then indeterminate. The degree of substitutability between money created by banks and financial assets created by other financial institutions therefore matters to find out the quantum of money supply at a given point of time

Friedman(1971) is the main advocate of the "temporary abode of purchasing power" approach He emphasized the "store of value" function of money According to him "the function of money as a temporary abode of purchasing power makes it seem entirely appropriate to include also such stores of value as time deposits not transferable by cheque"(p 9) In his words "The essential feature of a money economy is that it enables the act of purchase to be separated from the act of sale In order that the act of purchase be separated from the act of sale, there must be something which everybody will accept in exchange as general purchasing power But also there must be something which can serve as a temporary abode of purchasing power in the interim between sale and purchase"(p 9) Friedman favours the M2 aggregate (currency + demand deposits + time deposits of the public with commercial banks) as money that serves as a "temporary abode" Though the definition is consistent with the concept of temporary abode of purchasing power including only time deposits in it is not justified Any component' assets serving as medium of exchange can serve as temporary abode, but not vice versa

To sum up the functional or theoretical approach defines money through *a priori* reasoning Conceptualisation precedes measurement and identification follows conceptualisation. That is, a theoretical concept of money is developed first on the basis of certain specific functions performed by money and then a set of assets conforming to the concept is identified The collection of such assets is to be called as money

The basic limitation of the theoretical approach lies in different functions of money being emphasised by different authors which results in multiplicity of definitions. As no single asset can capture all the functions of money at a time one gets confused as to what ought to be called as money. It is perhaps right here to conclude by quoting A.P Andrew(1899), who says, "It is a singular and, indeed, a fact that, although money was the first economic subject to attract man's thoughtful attention, and has been the focal centre of economic investigation ever since, there is at the present day not even an approximate agreement as to what ought to be designated by the word The business world makes use of the term in several senses, while among economists there are almost as many different conceptions as there are writers upon money"(p 219)

2.2 EMPIRICAL APPROACHES

The ambiguities inherent in the theoretical approach and emergence of more money like(near money) entities gave a different angle to the money definition debate Monetary economists therefore started looking at the problem as an empirical matter They endeavoured to identify and quantify money stock measure, considering a constellation of monetary assets based on certain policy criteria

Basically, there are two ways of looking at the empirical approach to money definition If the purpose is to have a well defined money stock measure, then one has to select certain policy criteria and accordingly group the assets satisfying these criteria to call them as money These criteria are preconceived and preselected For example, that measure of money is the best which (a) has the highest correlation with national income, (b) has a stable demand function, (c) represents the best target for monetary policy, and (d) produces an adequate theory of demand for money The other way of defining money empirically basically involves aggregating different monetary assets available. The resulting monetary aggregate is the outcome of different permutations and combinations of the financial assets. The number of assets may be one or more.

The various approaches to an empirical definition of money may be classified into two broad groups *viz* ,(a) simple sum approach and (b) weighted aggregation approach. Under the simple sum approach, (i)Friedman-Meiselman(F-M) dual criteria, (ii)stable money demand function approach, and (iii)extension of simple correlation analysis are well documented in the literature The wighted aggregation approach may be sub divided into the following (iv)elasticity of substitution approach, (v)micro economic monetary aggregation approach, (vi) some ad hoc (alternative) approaches In the following sub-sections a brief note on the above mentioned approaches is made

2.2.0. F-M Dual Criteria

Friedman-Meiselman (1963) developed a dual criteria in order to arrive at an appropriate money definition According to them, an aggregate to be called as money should satisfy the following two criteria (i) It must bear the highest correlation with income and (ii) money income must be more highly correlated with the aggregate than with individual components of the aggregate

The dual criteria was applied to three components of money stock viz,currency, demand deposits and time deposits by Friedman- Meiselman, to check whether the inclusion of time liabilities in money satisfies the criteria The empirical results showed a higher correlation between the aggregate and income when the aggregate included time deposits rather than excluding it

The dual criteria was further extended by Kaufman (1959), Hullet (1971) and Schadrack (1974) to check for alternative definitions of money. Kaufman (1969) extended the dual criteria to alternative monetary aggregates observed in time lags upto four quarters and lead of one and two quarters with income Only a limited number of definitions satisfied the dual criteria.

A distributed lag model of the following form

$$Y_t = \alpha_0 + \sum_{i=1}^{n} \alpha_i X_{t-i} + \varepsilon_t$$

where Y_t and X_t represent income and monetary assets respectively and ε_t is white noise error, was introduced by Hullet (1971) in order to test the long run impacts of the money supply changes on money income The conclusion was in line with that of Kaufman's But the estimated regression coefficients changed significantly across the sample periods unlike Kaufman's study where the results were not even sensitive to alternative sample periods Hullet attributed his results to changes in the transaction technology in the financial market which resulted in changes in the degree of moneyness for various financial assets during the sample period 1953-68

Schadrack (1974) evaluated alternative monetary aggregates using three different criteria viz ,(i) strength of the relation between changes in money and income, (ii) stability of this relationship over time, and (iii) ability of the relationship to predict changes in income outside the sample periods The results were in favour of M2 comprising of currency outside the treasury Federal Reserve Banks and commercial bank vaults, demand deposits at commercial banks, foreign demand balances at Federal Reserve Banks and United States Government demand deposits at member banks, as it satisfied all the criteria for the period 1953 I through 1968 II and for different sub periods Hence, Schadrack advocated M2 as the most appropriate definition of money

2.2.1 Stable Money Demand Function Approach

This criterion selects a set of assets by identifying its most stable demand function with respect to a few theoretically appropriate explanatory variables. The logic behind this criterion is that if the demand for a monetary aggregate is a stable function of a few theoretically important economic variables such as income, interest, then changes in the aggregate are sufficiently predictable in terms of changes in these variables Alternatively, changes in money stocks may be manipulated to exert influence on economic activity via changes in income and rate of interest Thus a stable money demand function creates a conducive atmosphere for an efficient conduct of monetary policy

The major studies under this approach include those of Brunner and Melzter (1963, 1968), Rose (1985), and Roley (1985) The earlier studies identify the narrow money (M1) as generally stable The latter studies indicate that short-run money demand models are generally unstable because of coefficient instability, lag adjustment problems, single equation format etc But Rose (1985) attributed the poor performance of the earlier money demand equations to problems like employing traditional partial adjustment models, insufficient diagnostic testing etc Otherwise M1 is a stable reliable empirical monetary aggregate from the policy view point

Friedman and Schwartz (1970) while anlysing the US data observed drastic changes in the conditions of money supply with stable demand conditions and therefore laid emphasis on demand conditions Then they proposed the stable money demand criterion to select a particular collection of monetary assets from among a bunch of alternative allocations which will have the most stable demand function Meltzer(1963) opined that money should be defined in such a way that the stable demand function can be shown to have existed under alternative institutional arrangements and under changing social, political and economic conditions

Until the mid 70's the demand for money function was generally accepted to be stable and robust, irrespective of money definitions. Therefore, application of the stable demand criterion to define money by identifying a group of assets had no meaning. The question "what is money? " still remained unanswered

Laidler (1969) differed at this point whose suggestions changed the direction from stability to controllability To quote him, "the authority must be able to control the volume of that set of assets that most closely corresponds to the money stock of standard macro economics, at the same time the demand function for these stock of assets must be stable enough for the consequences of changing its volume to be predictable with a high degree of reliability"(p 509)

The inherent contradiction in the stable money demand approach was rightly pointed out by Osborne(1992) To quote him, "Belief in this proposition has led some monetarists to define money as that(set of liquid assets) which has a stable demand function This definition is rarely stated in so many words, but it is implicit in some of the best work on money demand, such as Laidler(1969 509-15 1977 149-52) Whether implicit or explicit, the definition puts the cart before the horse We have to define and identify money before we can test the stability of its demand This stability(if it exists) is to be demonstrated empirically, not deemed true axiomatically"

2.2.2 Extension of Simple Correlation Analysis

This approach basically aims at measuring moneyness of the near money assets Advocates of this approach, Timberlake and Fortson (1967), employed a regression model of the following form.

$$\Delta Y_t = \alpha_0 + \alpha_1 \Delta M_{1t} + \alpha_2 \Delta T_t + \varepsilon_t$$

where Y is nominal income, M_1 is currency plus demand deposits, T is time deposits, Δ is difference operator and α's are coefficients By computing the regression coefficients α_1 and α_2 they tried to find out the degree to which near moneys were near to money The three conditions listed by them were

(a) if $0 < \alpha_2/\alpha_1 < 1$, then T would have some degree of moneyness

(b) if $\alpha_2/\alpha_1 = 1$ then M and T are homogeneous assets

(c) if $\alpha_2/\alpha_1 < 0$, then it indicates that people reduce their transaction balances and buy time deposits

The estimated results yielded $\hat{\alpha}_1/\hat{\alpha}_2$ 7 997 for the period 1933-38 Hence, the aggregate comprising of time deposits seemed to be a better predictor of change in money income than the narrow money stock During the 1950s, the quantity $\hat{\alpha}_2/\hat{\alpha}_1$ was positive but there was no significant difference even after inclusion of time deposits

2.3 APPROACHES TO WEIGHTED MONETARY AGGREGATES

The weighted monetary aggregates basically aim at weighing different financial assets according to their degree of contribution to the monetary service flow of the economy The advocates of this approach raised their voice against the practice of simple sum scheme while constructing monetary aggregates. The simple sum scheme has been criticized by them on the following grounds: First, the simple sum scheme assumes perfect substitutability among different components of a monetary aggregate and accordingly assigns equal weights to them. But in reality the component monetary assets are found to be imperfect substitutes differing in their degree of moneyness, which has been supported by voluminous empirical evidences. Secondly, the simple sum aggregates measure the accounting stock, which is not an economic variable in any economy's structure Thirdly, the sum aggregates are incapable of capturing the flow of monetary services provided by the component assets At low levels of aggregation, the simple sum(narrow) aggregates entirely overlook the contribution of monetary substitutes to the flow of monetary services On the other hand, at higher levels aggregation, the sum(broader) aggregates do not change in response to one-for-one transfers between component assets and hence do not capture the interest elasticity of velocity of monetary services Regarding the simple sum (arithmetic average) index, Irving Fisher wrote over a half century ago that "the simple arithmetic average produces one of the very worst of index numbers, and if this book has no other effect than to lead to the total abandonment of the simple arithmetic type of index number ,it will have served a useful purpose The simple arithmetic [index] should not be used under any circumstances"(p 36)

Thus the simple sum measures may bring in distort ns in monetary aggregates The conventional monetary aggregates add up to accounting stocks only and therefore, are not suitable for meaningful economic analysis Friedman and Schwartz (1970) observed, "This (simple summation) procedure is a very special case of the more general approach In brief, the general approach consists of defining the quantity of money as the weighted sum of the aggregated value of all assets, the weights for individual assets varying from zero to unity with a weight of unity assigned to that asset or assets regarded as having the largest quantity of moneyness' the more general approach has been suggested frequently but experimented with only occasionally. We conjecture that this approach deserves and will get much more attention that it has so far received"(p 151)

Hence, the advocates of these approaches argued for weighted monetary aggregates as an alternative to the existing sum aggregates, apprehending the use of the latter for monetary policy

Approaches towards construction of weighted monetary aggregates can broadly be grouped into three *viz* ,

(i) Substitution approach

(ii) Micro economic monetary aggregation approach

(iii) Some ad hoc approaches such as

(a) The preference independence transformation approach

(b) The Roper and Turnovsky approach

(c) Turnover rate weighting approach

2.3.0 Substitution Approach

The main architect of this approach is Chetty(1969) who put forth the argument that each monetary asset has a certain degree of moneyness in it The problem here is not the selection of assets to be included in the measure of money stock but how much of each monetary asset is to be included Intuitively therefore monetary aggregates have to be constructed covering all assets being properly weighed in accordance with their degree of moneyness The weighing scheme employed by Chetty is dependent on the elasticity of substitution between different component assets The degree of moneyness associated with any financial asset is determined by elasticity of substitution between that asset and a reference asset which is considered to be the most liquid asset Under this approach, Chetty (1969) for the first time explicitly utilized the neo-classical utility maximization framework to estimate elasticities of substitution between liquid assets. The decision problem formulated by Chetty is of the form

$$\text{Max } U(m_1, m_2, \ldots m_n)$$

Subject to

$$\sum_i m_i / (1 + r_i) = W$$

where U( ) is a CES utility function, m_i is the money value ith liquid asset held at the beginning of the next period, r_i is the interest rate on liquid asset i , and W is the discounted value of current period's financial wealth Then the exact quantity aggregate is u(m) where $m = (m_1, m_2, \ldots, m_n)$ From the above discussion, it becomes clear that the substitution approach recognizes the direct relevance of microeconomic aggregation theory to monetary aggregation

2.3.1. Micro Economic Monetary Aggregation Approach

The substitution approach as a weighing scheme to arrive at an appropriate monetary aggregate has some deficiencies They include (i) econometric specification of parameterised functional form, (ii) estimation of its parameters, (iii) sensitiveness of the results to model specifications, use of data, estimation procedures These limitations have been overcome by proposing some innovative and novel approaches A new strand of research in the literature viewed the problem of monetary aggregation as preparation of a good monetary statistical index which is known as the user cost approach or the Divisia approach or the micro-economic theory of monetary aggregation approach. This approach has been made popular by Barnett and his collaborators in the 1980's.

Barnett's (1980) pioneering effort integrated economic aggregation theory, index number theory and monetary theory. However, the groundwork for Barnett's whole exercise of integration was done by Hulten(1973), Diewert(1976) and Barnett(1978) himself.

In economic aggregation theory, an aggregator function is either a utility function or a production function. An economic price aggregate P is solely a function of the component prices, i.e , $P = f(p)$, $p = (p_1, \ldots, p_n)$ where f is called the aggregator function Similarly, an economic quantity aggregate, Q is solely a function of the component quantities, i e ,$Q = g(q)$, $q=(q_1, \ldots, q_n)$, where g is called the aggregator function The product of P times Q must equal total expenditure on the components Therefore, knowledge of P helps in finding out Q and vice versa

The economic aggregation theory requires two important conditions to be satisfied They are (i) The proposed aggregate to bear a stable definition, the components of the aggregate must be weakly separable and (ii) The aggregator function must be linear homogeneous in its arguments The first condition is a necessary condition which may otherwise be called as the existence condition as it ensures the existence of an economic aggregate The second condition is a sufficient condition which ensures consistency between growth rate of the aggregate and growth rate of its components These two conditions when satisfied enable the economic aggregate to act as a variable in the economy's structure That is to say, the economy's structure can then be written as a composite function of the quantity aggregator function Q

In reality it is difficult to find out an exact economic price or quantity aggregate, since the aggregator function is not known Eventhough the aggregator function can be specified and estimated, the aggregates produced may not be acceptable to the monetary authorities for publication due to the aggregates' dependence on estimated parameters

This is where the theory of statistical index numbers comes to the rescue and helps in overcoming the conventional parametric problems as they do not contain any unknown functions. These index numbers are constructed so as to provide a close approximation to the economic aggregate at every instant of time

Diewert (1976) succeeded in unifying the economic aggregation theory with index number theory. He derived a new class of index numbers called superlative index numbers These index numbers possess good theoretical properties and provide high quality approximations to the unknown exact aggregates of economic theory A superlative index number is defined as "an index number consistent with (or exact for) a flexible aggregator function", where a flexible aggregator function is an aggregator function, capable of providing a second order approximation to an arbitrary twice differentiable linearly homogeneous function The Fisher's ideal index and the Divisia index fall in this category Hulten (1973) showed that in continuous time the Divisia index is always exact for any consistent aggregator function which is block wise homothetically weakly separable Tornqvst-Theil index is found suitable as it provides a discrete time approximation to the continuous time Divisia index and falls within the class of superlative index numbers

The established linkage between aggregation theory and index number theory paved the way for monetary aggregation Monetary aggregates now can be expressed as monetary statistical indices But again the problem arose due to non-availability of prices of monetary components since the index number contains both prices and quantities as its arguments Barnett's (1978) derivation of user cost of money helped in subduing this difficulty

Barnett applied the concept of user cost of a durable good to the monetary components and derived an appropriate formula The user cost of a durable good is the cost during one period of acquiring, using and disposing of the asset, i e., the user cost of any real durable good is nothing but its imputed one-period holding cost. Then the user-cost of the durable good is calculated by subtracting the discounted expected resale value of the depreciated good in the next period from the purchase price of the durable good in the current period. In simple terms, the user cost of a monetary asset can be written as $(R-r_i)$ where r_i is the own rate of return on the monetary asset i and R is the maximum available yield in the economy on any monetary asset The difference $R-r_i$ represents the opportunity cost of holding monetary asset i during that period Thus $R-r_i$ is the price paid in return for receipt of the services of the ith asset

Barnett's derivation of the current period user cost[1] π_{it} of m_{it} reduced to

$$\pi_{it} = P_t^* (R_t - r_{it}) / (1 + R_t)$$

where P_t^* is the current true cost of living index

The corresponding real user cost is given by,

$$\pi_{it}^* = \pi_{it} / P_t^*$$

The task becomes easier after obtaining the user cost of d fferent monetary assets

Supposing that π_1 π_2 π_n, are the user costs for the monetary assets with balances M_1 M_2 , M_n the moneyness associated with the ith asset is the corresponding user cost evaluated value share in the total Thus moneyness of ith asset is given by

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[1]The formula may be corrected for taxation which is as follows $\pi_{it} = P_t^*(R_t - r_{it})(1-\tau_t)/\{1+R_t(1-\tau_t\}$ where τ is marginal income tax rate, r_{it} is the own current period holding yield on component i, R_t is the maximum available expected holding period yield in the economy

$$S_i = \pi_i M_i / \sum_{i=1}^{n} \pi_i M_i$$

S_i is therefore the weight assigned to the asset in accordance with the contribution of the assets towards the economy's monetary service flow. Statistical index number theory is then used to construct the weighted aggregates Using Divisia Index (Tornqvst-Theil Index) the discrete time approximation to the continuous time Divisia index becomes

$$Q_t^* = Q_{t-1}^* \Pi_j [m_{jt} / m_{j,t-1}]^{1/2(s_{jt} + s_{j,t-1})}$$

where $S_{jt} = \pi_{jt} M_{jt} / \sum_k (\pi_k + M_{kt})$ is the expenditure share on component j during period t, and Π is the product symbol

Taking logarithms on both sides

$$\ln Q_t^* - \ln Q_{t-1}^* = \sum_j S_{jt}^* (\ln m_{jt} - \ln m_{j,t-1})$$

where $S_{jt}^* = 1/2(S_{jt} + S_{j,t-1})$

The growth rate of the Divisia monetary aggregate is a weighted average of the growth rates of the individual component assets The Divisia monetary aggregate could properly weigh the contribution of all segments of the money market to the monetary service flow of the economy Thus the fundamental problem of estimation of unknown parameters could be circumvented with the application of index numbers to the aggregation process Parameter free estimates could be obtained to closely approximate the economic aggregate The Divisia index was employed in most of the empirical exercises as it was the most informative one which aggregated over as much of the money market as possible

Following Barnett(1980a, 1987), the ideas underlying microeconomic monetary aggregation theory may be crystallised as follows In aggregation theory demanders of monetary assets are treated as maximizing intertemporal utility subject to a sequence of budget constraints expressed as an intertemporal transformation function. The utility function contains real monetary asset balances as arguments. Beginning with neoclassical consumer demand theory, one assumes that the utility function of each economic agent is blockwise weakly separable in the current period portfolio of monetary assets

Proofs in Barnett(1987) show that economic agent (for example a consumer) solves a simple conditional current period decision problem, since the first and second order conditons for solving that problem are included among the necessary condition for solving the economic agent's full intertemporal joint optimization problem The current period conditional decision is of the form

Maximize $u(m_t)$ (2 1)

Subject to $m_t^{*}\pi_t \quad y_t$ where $m_t^{*} \quad (m_{1t}, \quad , m_{nt})^{*}$, is the economic agent's current period real balances of the n monetary assets, $\pi_t \quad (\pi_{1t}, \quad ,\pi_{nt})$ is the vector of real user cost prices of those prices of those assets, and y_t is current period real expenditure on the services of monetary assets The function u is the weakly separable subfunction (category subutility function) that is nested within the full intertemporal transformation function or utility function The function u is monotonically increasing and strictly quasi concave

In the general case, the exact economic quantity aggregate produced by decision(2 1) is the distance function, treated as a function of m_t at fixed reference level u_0. The distance function $d(u_0,m_t)$ is defined in implicit form by,

$$u(m_t/d(u_0, m_t)) = u_0 \qquad (2.2)$$

The geometric interpretation of equation (2.2) is that $d(u_o,m_t)$ is the factor by which m_t must be deflated to reduce(or increase) the level of u to the fixed reference level u_o.

Deflated by its value in a base period, the distance function becomes the malmquist quantity index, which is dual to the famous Konus true cost of living index Thus it is clear from the above elaboration that the exact monetary quantity index for a consumer can be estimated by estimating the function u If u is linearly homogeneous then u itself is the quantity aggregator function If u is not linearly homogeneous then the distance function, which is derivable from u, is the exact quantity aggregator function Estimation of u however, produces an aggregate dependent on empirical specification of u and estimated parameters Goverment data producing agencies usually hesitate to use such kind of a method Instead they prefer using index numbers which are parameter and specification free

The solution to this practical problem therefore lies claerly in statistical index number theory which is nonparametric in nature Recent results from index number theory have proved the Divisia index to be the best available index as the Divisia index tracks the exact aggregator function without error In discrete time, the Tornqvist approximation to the Divisia index tracks the exact economic aggregat r function with very low error, regardless of whether u is homogeneous [2]

2.3.2. The *Ad hoc* Approaches to Monetary Aggregation

The monetary services of a liquid asset are the services valued by the asset holder other than the interest rate yielded by the asset However for specific purposes one may

[2]An excellent survey of microeconomic monetary aggregation theory is found in Anderson *et al.*, (1997)

need to evaluate the quantity of a single service such as liquidity rendered by an asset. But it is rarely possible to measure directly the quantity of one service produced by a multiservice asset. Theil's preference independence transformation enables one to untangle the jointness in service production. Barnett et al. (1981) directly applied this approach. One of the assumptions in Lancaster's(1966) consumer demand theory is that goods produce characteristics or services. And utility is a function of these characteristics or services rather than goods themselves. The preference independence transformation reveals the quantities of those services as functions of the quantities of the goods or assets.

The Roper and Turnovsky approach uses a simple IS-LM Keynesian macroeconomic model to produce the control theoretic solution to the optimum policy that maximizes a particular policy objective function. Roper and Turnovsky (1980) solve for the monetary aggregate that will produce that optimum policy if the aggregates growth rate is stabilized in terms of a constant growth rate rule. Hence, the optimum monetary aggregate equates maximization of the policy objective function with stabilization of the growth rate of the aggregate.

For example the optimal monetary aggregate may be that which minimizes the forecast variance in nominal income. Thus,

$$M(RT) = \sum_{i=1}^{n} \phi_{it} M_{it}$$

where RT refers to Roper and Turnovsky, M_{it} is the ith monetary asset during time t, and ϕ_{it} is the optimal weight for (ith) asset during time t. The optimal weights may be derived by minimizing the forecast variance in nominal income using a Vector Autoregressive (VAR) System.

In the Turnover Rate weighting approach, turnover rates are functions derived from the demand function for a monetary asset. In this approach, a monetary aggregate is produced using a Fisher Ideal index in monetary quantities and turnover rate which is just an arbitrary combination of component quantities and turn over rates. Spindt (1985) made use of this approach.

2.4. A CRITICAL EVALUATION OF APPROACHES

The approaches discussed above have some limitations. In this section, an attempt is made to present a critical evaluation of the approaches.

2.4.0. Substitution Approach

The substitution approach propounded by Chetty has been criticized on following grounds. First, Chetty's model is appropriate only in a two period world, as Chetty's prices do not measure the opportunity cost of acquiring a unit of the service flow and hence are not user costs. The model may have only limited applicability to a multiperiod world, because in a multiperiod world the user costs measure the price of a unit of the services of an asset. Secondly, the assumption of strong separability and theoretical inadequacy of CES form might have considerably biased Chetty's elasticity estimates upwards. Thirdly, this approach is sensitive to the specification of the model, sample size etc. and produces estimates which are not parameter free. Lastly in the Indian context as observed by Jadhav Chetty's model when applied to Indian data for the period 1945 to 1966 yielded unduly large elasticities of substitution. The elasticity of substitution as between narrow money (M1) and time deposits turned out to be as high as 34.7, which meant that the two were very good substitutes of each other. Or in other words the "moneyness" associated with currency or demanded deposits was as high as the moneyness of time deposits.

In the later periods, the substitution approach of Chetty and the model employed by him along with the underlying assumptions were criticized by Donovan, (1978) Boughton (1981) and Husted-Rush(1984), who suggested certain modifications such as the use of rental price of assets in lieu of interest rates, real values instead of nominal values of financial asets, an implicit rate of return for narrow money stock They showed interesting results by incorporating these changes in the original model

2.4.1. Micro Economic Monetary Aggregation Approach

This approach has also been subjected to criticism For instance Cockerline and Murray(1981) argued that the rates posted on savings deposits and other monetary assets may exaggerate the effective rate economic agents expect on their investments They also argued that the minimum balance requirements in certain accounts, early encashment penalties on some fixed term assets might tend to reduce the measured own rates of return on monetary assets Calculating user costs would be complicated if one wants to aggregate across assets with differrent maturity dates

Jadhav(1989) has raised certain questions which reflect his skepticism in sofaras the applicability of this approach to construct weighted monetary aggregates is concerned First under the user cost approach, "money" is regarded as a cap tal aggregate similar to Friedman s conception presented in his "Restatement of the quantity theory of money" (1956) Then, the demand for money by wealth holders is treated as a problem in capital theory In this sense, analytically, there is no distinction between a money good and any other capital good To quote Spindt (1985), "this conception of money is insufficiently narrow for the anlaytical and empirical purposes of some monetary economists who emphasize the primary significance of money's distinctive role as means of payment"(p.77). But, the user cost approach having a wide coverage of services besides general acceptability of money as a means of payment i.e., liquidity, divisibility, surety of nominal value etc., is subjected to conceptual imprecision.

Secondly, the construction of monetary aggregates is highly dependent on measurement of user cost (formula) of the relevant monetary assets. It is to be noted that the user cost is proxied by the formula $R-r_i$ where R is the expected maximum available yield on the chosen bench mark asset during time 't', r_i is own ate of return on the ith asset during time 't'. As Judd and Scadding (1982) have pointed out, this method of computing user costs is useful for a world in which interest rates on monetary assets are unregulated. But in countries like India where the interest rate is administered, the use of this formula may be problematic. Thus the use of this approach may bring in more problems though it is considered to be an improvement over the previous approaches to arrive at an appropriate money stock measure.

Thirdly, Barnett's user cost formula for monetary asssets has been criticized by McCann and Divid (1989) on the ground that it did not take into account the capital gain or loss due to changes in price level occurring at the beginning of a period as the budget constraint was expressed in nominal terms. Therefore they suggested an inflation adjusted user cost formula as an alternative to that of Barnett's. But the results of the exercise did not improve upon Barnett's previous results.

Lastly, as McCulloch (1990) pointed out, certain aspects were not touched upon by Barnett in his aggregation theoretic developments. For instance the sensitivity of Divisia indices to monetary disequilibrium is not addressed by Barnett. McCulloch cited the study by Davidson and Ireland (1990) in which the plausible inventory models of money demand predicted that most often most money holders were equally content with a broad range of money holdings. This implies a certain long-run average level of money demand but at any moment the money holders feel themselves under no compulsion to be on their demand schedule. How can the index number theory be applied here when money is not in the utility function?

Fisher, Hudson and Pradhan(1993) pointed out that weights on component monetary assets were very sensitive to interest rate changes A rise in interest rate increases the user cost of currency and therefore lead instantaneously to a higher weight Again as the higher interest rate causes investors to hold less cash in their portfolio, the weight for currency will fall over time Current weights are not optimal due to this lag unless investors adjust their portfolio instantaneously with corresponding changes in interst rates In the short run in a situation in which the amount of currency held by economic agents grows more rapidly than the amount of interest bearing assets, an increase in interest rates will instantaneously increae the weight for currency and reduce that on interest bearing assets, thereby leading to an increase in the superlative index growth rate Based on this reasoning Fisher *et al* concluded that the superlative index could be misleading indicator of the monetary policy stance

2.4.2. The *Ad hoc* Approaches

Among the *ad hoc* approaches, the Preference Independence Transformation is not free from parameters It requires specification of a utility function and estimation of its parameters

The Roper and Turnovsky aggregate originates from the policy objective function and it is not an outcome of the economy's structure Micro economic aggregation theory produces aggregates that exist and can be factored out of the economy's structure Thus the economy's structure is a composite function of the aggregates. In this sense the Roper-Turnovsky aggregate does not exist, as it is not an outcome of any structural function which is blockwise separable Therefore, this aggregate does not measure monetary services, liquidity or "money" in any meaningful sense As Jadhav (1989) observed, this approach attempts to measure money without prior conceptualisation. Moreover, with respect to different policy criteria, different money stock measures can be derived under this approach so that no single measure could be able to claim its superiority over others To quote Jadhav, "It has been pointed out that there is no generally agreed criterion as a standard for making judgement Roper-Turnovsky's criterion is only one of the several possible candidates"(p 52-53) Even after identifying a globally optimal criterion, monetary aggregates may differ across countries, time periods, functional forms and models The superior forecasting ability of the resulting monetary aggregates however, should not be surprising as it is very much embedded in their very construction

The aggregate constructed by Spindt (1985) from the turnover-rate weighting is entirely arbitrary, as an infinite number of function of monetary quantities and turnover rates can be found out which will produce arbitrary growth rates for the aggregate from the same component data

2.5. REVIEW OF MAJOR STUDIES

After discussing the basic tenets of the various approaches to money definition it would be of interest to survey the available empirical evidences under those approaches

Pointing out certain fundamental prob ems in Chetty's formulation of the utility maximization problem and his estimation procedures, Donovan(1978) derived a system of aggregate liquid asset demand equations from a household model of utility maximizing behaviour The improvements in his model were the application of the concept of the rental price of a durable good to the case of money and use of frontier developments in duality theory. Using the annual Canadian household data for 1952-74, the study showed substitutability of a lower order magnitude among monetary assets

Reestimating Chetty's model using an extended data sample Boughton(1981) He modified Chetty's model in several respects. He used real values of financial assets instead of nominal values and introduced implicit yield on demand deposits He also differenced the data by applying a consistent two stage estimator Relaxing the strong separability condition but retaining the homotheticity assumption, it was concluded that there was only a weak substitution between money (narrowly defined) and such assets as savings and time accounts at banks and thrift institutions

Certain theoretical and empirical flaws were pointed out by Husted-Rush(1984) in the Chetty-Boughton specification of the model They questioned Boughton's use of the implicit yield on demand deposits as an inappropriate measure of yield on narrowly defined money, since only a part of M1 consisted of demand deposits They formulated a consumer problem which involved allocation of current period savings and inherited wealth of the consumer between holds of money (M) and balances of a near money asset (T) The model was estimated by using both two stage and three stage least square techniques The interest rate used by the authors is measured by $R_{j\ m}$ $(d-i_j)/d$, where d is the discount rate proxied by the yield on long term BAA corporate bonds, j are time deposits, mutual savings bank deposits, savings and loan shares, m is money and i is rate on ith asset The results f the study ind cated still lower elasticities of substitution Thus the authors concluded that money was a unique asset having no close substitutes

Employing duality theory and a flexible functional form Subrahmanyam(1980 1993) presented a model for an empirical definition of money for the US household sector The study estimated Allen partial elasticities of substitution and cross-interest elasticities for seven financial and physical assets The elasticity results suggested the ranking of assets to be US Govt short term marketables(US), Savings and loan shares+mutual savings bank deposits(SM) and Time+Savings accounts at commercial banks(TS) and the empirical monetary aggregate to be M4=M1+US+SM+TS

An interesting paper by Subrahmanyam(1996) reexamined the substitutability among demand deposits and time deposits, using Indian annual data from 1951 to 1985 Incorporating the influence of bank branch expansion as a factor in a CES model, he estimated the elasticities of substitution which were found to be lower Ignorance of the branch expansion factor in a Chetty(1969) kind of model would have yielded higher elasticities of substitution

Application of information theory was made by Barnett and Spindt (1979, 1980) to compare the performance of Divisia index with that of the simple sum index They found the Divisia monetary aggregate performed better than the simple sum aggregate in terms of their information content for each of their choices of components for the monetary aggregate and for each of their choices of targets for policy

Barnett (1980) gave a comparative account of monetary aggregates constructed using two different approaches viz, (i) functi nal approach and (ii) index number approach In the functional approach, Chetty's CES specificat on of the model for the utility function was used and the elasticity of substitution between savings accounts across institutions was examined The functional quantity aggregator provided better approximation than the sum aggregates As the functional aggregator depends on the model specification and estimation of unknown parameters, the study employed Divisia index to construct parameter free approximations to monetary aggregates Barnett advocated the use of Divisia index as it performed better than the sum aggregates

Offenbacher (1980) estimating a linear logarithmic expenditure system for currency, demand deposits and time deposits less large Certificate of deposits (CDs) at commercial banks with US quarterly data for the sample period 1952-76, found a lower degree of substitution between means of payment assets and non means of payment assets. He made a case against simple sum aggregates Barnett *et al* (1981) considered an aggregate having transaction balances, pass book savings at the three institution types and at credit unions, small time deposits at the three institution types and negotiable and non negotiable large CDs at commercial banks as the components The velocity of the simple sum aggregate in this study was found to be declining while that of the Divisia aggregate was rising This was due to erroneous and inadequate weighting done by the sum aggregate for the transaction balances With the use of Divisia index the interest elasticity of money demand yielded the expected sign Incorporation of the elements of the unregulated money market satisfactorily stabilized the velocity of the Divisia aggregate This study therefore advocated the use of Divisia index (Tornquist-Theil) to compute monetary aggregates

Cockerline and Murray(1981) used Canadian data (f r the first time) to evaluate the empirical properties of Divisia m netary aggregates They c mpared Divisia aggregates versus sum aggregates in terms of their informati n content money-income causality, and stability of money demand functions The overall performance of the Divisia aggregates was unclear though the Divisia aggregates f owed smoother time paths than the summation aggregates For instance Divisia aggregates were found to be more stable in money demand equations but perfomed poorly in causlity tests and information content tests

Barnett (1982b laid down certain conditions to obtain an optimal monetary aggregate The conditions were (i existence condition (defining the condition under which an economic aggregate exists in aggregation theory), (ii) consistency condition, and

(iii) recursiveness condition. The steps suggested by him were to select an asset group satisfying the above conditions and choosing a proper index number formula. The last step involves selection of the optimal one from among the hierarchy of aggregates produced.

In the first stage, a theoretically admissible set of component assets is selected over which the monetary aggregates can be constructed. The first condition in this stage is the existence condition which states that the component group should be weakly separable. For example, let m be the set of assets available in the economy and let C be a subset of M. C is said to be a separable component group if and only if the marginal rate of substitution between any two assets in C is independent of the quantity of any good or asset not in C. All the separable subsets like C have to be obtained from M to get the admissible groupings. The consistency condition, (second in the first stage) says that an admissible component group C is a consistent component group, if the elasticity of substitution between any component asset in the group and any good or asset not in the group is independent of the good or asset that is not in the group. Every consistent component group is separable, but not every separable group is consistent.

Imposition of the restriction of linear homogeneity on the economic aggregate ensures consistency. The third condition is the recursiveness condition which stipulates that the components of each aggregate should be monetary assets only and not any other goods or assets. Though monetary asset as such is not defined in aggregation theory assets have to be selected by intuition. After obtaining the admissible grouping one switches over to the second stage where a proper index number formula is chosen and user costs of monetary assets are calculated. Finally the monetary statistical indices are computed. In the third stage, the aggregates obtained from the second stage are put to specific tests depending upon the application in which the aggregate has to be used. That aggregate which empirically works best is selected as the optimal monetary aggregate from a hierarchy of the nested aggregates

Mills (1983) developed a framework for providing an empirical assessment of alternative monetary aggregates in terms of their ability to predict future movements in nominal income and price level. He argued that considerable information is lost through aggregation but the conventionally defined monetary aggregates do provide a significant amount of information for predicting future values of the goal variables

Barnett (1984) compared the growth rates of the new Divisia monetary aggregates with those of the corresponding officially targeted sum aggregates for the period 79 11-82 8 The average growth rates of simple sum M2 and M3 were 9 3% and 10 0% respectively whereas the average growth rates of the Divisia M2 and M3 were 4 5% and 4 8% respectively The rate of inflation was 10% - 12% Hence, monetary policy was found to be tighter when measured by official sum aggregates On the otherhand, measured by the Divisia aggregates the monetary policy was found to be more volatile and tighter than the sum aggregates

Barnett et al (1984) again made a comparison between the perf rmance of the Divisia monetary aggregates and the simple sum aggregates and emphasised the relevance of the Divisia scheme Certain policy relevant criteria were chosen and the aggregates were put to different tests like Haugh-Pierce causality test Sims test approximate likelihood ratio test in the bivariate VAR etc The results could not suggest a uniformly best aggregate Divisia M3 and Divisia L (Federal reserve s highest level official aggregate which contains most of the national debt of short and intermediate maturity) acquired the most stable demand for money function The velocity function for Divisia M3 was found to be stable. In the reduced form comparison, sum M1 performed better than Divisia M1, but at a higher level of aggregation, Divisia aggregates outperformed the sum aggregates

Using Japanese quarterly data from 1971 to 1982, Ishida(1984) computed Divisia monetary aggregtaes and compared velocities of money and the money demand functions using these aggregates with those derived from the simple sum aggregates The main findings of the study were (i)there was a more stable relation between Divisia monetary aggregates and GNP than those between ordinary simple sum aggregates and GNP,(ii) the results from money demand estimations using Divisia aggregates also supported the fact that relations between Divisia monetary aggregates and GNP were stable In view of the ensuing financial innovations in Japan the results on the whole were suggestive of use of Divisia monetary aggregates especially at the higher levels of aggregation

The enormity of the criteria considered in the study perhaps posed a problem in inferring something concrete as no uniformly best aggregate could be suggested However, a favourable trend was set for the Divisia aggregates At higher levels, of aggregation' the performance of the Divisia aggregates was better than the s mple sum aggregates due to the increasing divergence between the time paths of the Divisia and simple sum aggregates

Serletis and Robb (1986) employed a quasi homothetic transl g utility framework on Canadian data (1968 to 1982) and estimated the degree of subst tutability between the services of money and checkable savings and time deposits The results further strengthened the evidences supporting the Div sia scheme Serletis (1987) systematically examined the appropriateness of the weak separability conditions using a flexible functional form interpretation of the quasi homothetic translog functional form and w th the help of the approximation analysis developed by Denny and Fuss (1977) The different tests of separability hypothesis were not conclusive, however On the whole, they suggested a narrow definition of money

Barnett (1987) developed models of monetary asset demand by consumers and firms individually. He also developed a model of monetary asset supply by financial intermediaries. All these models were based on the usual neoclassical tenets The models established that a unique correct monetary price aggregator (or a quantity aggregator) exists for each of the three economic agents- the consumer, the manufacturing firm and the financial intermediary, when the aggregator function is linearly homogeneous Aggregation theoretic results were also established under the conditions of homotheticity and non homogeneity These theoretical results yielded rigorous microeconomic foundations for both monetary and macro economics

Another Canadian study by Hostland, Poloz and Storer(1988) measured the information content of Fisher Ideal monetary aggregates The results showed the Fisher aggregates to contain less information than the summation aggregates The study found M1 to be the most informative aggregate for both nominal and real GDP

Barnett and Chen(1988) appl ed tests of mathematical chaos to four Divisia demand monetary aggregates, four Divisia supply monetary aggregates and their respective simple sum counterparts The aggregates corresponded to four standard official US money stock measures namely M1, M2 M3 and L The results showed Divisia demand monetary aggregates possesing the characteristics of mathematical chaos very clearly The Divisia demand monetary aggregate L, simp e sum supply aggregate M2 and Divisia supply monetary aggregate M2 were found t possess characteristics of mathematical chaos rather well, but with more noise These results were consistent with the relevant aggregation theory

Barnett, Hinich and Yue(1991) updated the Barnett(1982) approach to optimal monetary aggregation making use of the Poterba and Rotemberg(1987) extension [3]This

[3]Poterba and Rotemberg(1987) have demonstrated that estimation of theoretical economic monetary aggregator function is presently possible under risk aversion

updated approach of Barnett's involves four stages viz.,admissibility, approximation, monitoring and application. The details are as follows:

Step 1(Admissibility):

The first step seeks to identify theoretically admissible groups on the basis of blockwise weak separability tests. Models with intertemporal expected utility maximization should be used for conducting seprability tests. Moreover, inference regarding separability should be deduced from within the Euler equations for which the literature is yet to develop and apply the same to monetary data.

Step 2(Approximation)

After identifying separable monetary asset blocks, one should apply the best available statistical index number to aggregate over those components. The aggregate thus constructed should be made available to the public. Index numbers presently in use are from Diewert's superlative class. However assumpt on of perfect certainty or risk neutrality is inherent in these index numbers. The index number literature therefore need to be extended to allow for risk aversion.

Step 3(Monitoring)

On a continuous basis, the quality of these monetry services indices should be compared with estimated economic aggregator functions which are parametric in nature. Prametric estimations should also use the best available functional specification and econometric methodology.

Step 4(Application)

For the benefit of policy makers these aggregation theoretic aggregates should be introduced in demand for money functions and macroeconometric models. Instead of using linear Goldfeld type of demand for money functions, demand for money should be modelled by estimating Euler equations under the assumption of risk aversion

Barnett, Hinich and Yue(1989) carried out steps 2 and 3 of the above mentioned four step procedure using monthly component data from Fayyad(1986) They estimated economic aggregator functions using generalized methods of estimation(GMM) and obtained an exact theoretical rational expections monetary aggregate This aggregate was then used to adjudge the tracking capabilities of two statistical index numbers - the simple sum and the Divisia, both in time domain and frequency domain The authors found Divisia monetary aggregates tracking the estimated theoretical aggregate well, while the simple sum aggregate did not To sum up, this study advocated extensive use of available theoretical results from aggregation and index number theory by the government data producing agencies for constructing monetary data and emphasized the need f r continuously monitoring them

Considering the Australian monetary data for the period 1969 IV to 1987 III Horne and Martin(1989) examined the performance of weighted aggregates using the weights of Chetty , Roper-Turnovsky and Barnett The empirical results favoured Divisia aggregates over their simple sum counterparts

Belongia and Chalfant(1989 constructed Divisia and simp e sum aggregates over some weakly separable blocks of monetary assets for United States obtained from Varian s nonparametric tests The performance tests interms of controllability criterion and St Louis equation indicated the superiority of Divisia aggregates over simple sum aggregates Further, Belongia and Chalfant(1990) trying to solve the 1980's "velocity problem" prevalent in the United States, identified money stock mismeasurement as the cause for the breakdown of the historical relationships between the growth rates of M1 and both the price level and nominal income. They reviewed the monetary agregation approach to money definition and discussed the properties of two measures namely Divisia and money metric index(MMI) Divisia M1 velocity was consistent with a stable long run relationship with the aggregate price level while MMI velocity did not appear to be so The M2 velocity was found to be stable whereas M1 velocity was not

In the Swiss context, Yue and Fluri(1991), employing monthly data from 1976 6 to 1989 12 made a case for Divisia monetary indexes as monetary targets The study examined the potential usefulness of Swiss M1 ans M2 monetary aggregates compared to their Divisia counterparts M1 and Divisia M1 possesed the same characteristics in relation to the Swiss inflation Growth rates of both these aggregates were potentially controllable by the Swiss National Bank M2 and Divisia M2, however, differd remarkably in their empirical behaviour in relation to inflation and monetary base

Serletis and King(1993) examined the empirical relat onships between Divisia and summation aggregates, income and prices in Canada No monetary aggregate was found to be cointegrated with the price level or nominal income H wever the Granger causality tests found the growth rate of summation M2+ to be the best leading indicat r of inflation For real output sum M1 and Divisia M1 were the best indicators of real output

Belongia and Chrystal (1991) evaluated the performance f a monetary aggregate constructed from principles of economic and index number theory Varian s (1982) non-parametric demand analysis was sought for in the study t test for the weak separability of alternative asset groupings They examined the performance of the aggregates using cointegration technique and an aggregate spending equation The cointegration technique tested for the long-run relationship between the aggregate and both national income and price level. The results strongly favoured the use of Divisia scheme

With the advent of financial innovations and introduction of more and more new financial assets, the debate has veered around inclusion or exclusion of certain assets in the monetary aggregate. Some recent studies have taken up the issue. Collin and Edwards (1994) considered the case of an alternative monetary aggregate to M2 for the Federal Reserve Bank of St Louis, in cluding household holdings of bond and equity mutual funds

Subsequently, Barnett et al (1994) reacting to the question raised by Orphanaides *et al* (1994) regarding the inclusion of stock and bond funds, suggested to untangle the two discounted present values viz., discounted present value of monetary service flow and discounted present value of investment yield of stock and bond assets. In fact a growing collection of assets creates confusion. The new assets certainly contribute to the economy's monetary service flow though not fully. At the same time, the investment yield of these assets can not be considered as monetary services. Ignorance of these assets undervalue the economy's monetary service fl w and inclusi n of them endangers contamination of aggregates with non-monetary services

Pennacchi (1994) criticized the pract ce of expressing mult -good demand relations as a function of a linear combinat n of those goods in monetary economics whereas the other areas of economics have abandoned this practice. He appreciated the "model based" approach of Barnett (1980) to construct monetary aggregates. The current situat on, therefore warrants such a practice as the traditional measures of monetary policy are obscured by the continuous financial innovations

Chrystal and Macdonald(1994 compared the relative performance of simple sum and Divisia aggregates, taking seven countries viz the United States, the United Kingdom, Australia, Switzerland, Canada, Germany and Japan. The results from the St.Louis equations favoured Divisia aggregates against their broad simple sum counterparts. The overall results gave a clear edge to Divisia aggregates over the simple ones. The study suggested production of official Divisia index numbers for exhaustive test of their performance as indicators.

The performance of some Canadian weighted monetary aggregates was conducted by Longworth and Atta-Mensah(1995) mainly with Fisher Ideal aggregates for the period 1971-1989 using quarterly observations. Tests such as information content, forecasting performance of the aggregates in terms of prices, real output and nominal spending, stability of money demand relations etc., yielded results in favour of summation aggregates. Broad simple sum aggregates were found to predict inflaton best whereas real M1 emerged as the best predictor of real output. These evidences were in line with the earlier Canadian studies where weighted aggregates rarely performed better than the simple sum aggregates.

An intersting study by Belongia(1996a) identified the flawed measurement of the money stock as one of the important reasons of the unresolved monetary puzzles of the 1980s. Reiterating the long recognised weaknesses of the traditional simple sum measures, he replicated the following five studies by replacing the sum measures with Divisia aggregates.

(i) Rotemberg's estimates of money innovations

(ii) Cover's study of symmetric monetary influences

(iii) Kydland-Prescott evidence against monetary effects on output

iv) Robustness of results across sample periods

(v) Stock-Watson and Friedman-Kuttner results on Money Income causality

The empirical findings of the study implied that many of the monetary puzzles of the 1980s could hav been resolved if the use of the flawed simple sum measures had been abandoned. The study concluded by saying that the basic inferences about the direction, magnitude and significance of money growth could crucially depend on the chosen money stock measure and the choice of simple sum money measures might prove hazardous for the policy makers. Belongia(1996b) also presented a collection of country specific studies covering eleven countries including the core European Monetary union, where the procedure for creation of Divisia series and their analysis for the respective countries have been attempted

Belongia(1996b) also provided a collection of eleven country specific stud es on the utility of Divisia monetary aggregates covering the European Monetary Union area

2.6. FINANCIAL INNOVATIONS AND DIVISIA MONETARY AGGREGATES

The accuracy of Divisia monetary aggregates was quest ned by Koenig and Fomby(1990) in the wake of changes in payments techno ogy in the 1 7 s and 1980s which were attributed to introduction of new types of t ansaction accounts like other checkable deposits(OCDs) in the United States Innovations like automated teller machines, money market mutual funds accounts and money market deposit accounts were also referred to which might have disorted the pattern f growth of transaction balances in the late 1970s and early 1980s Assuming a specific functional form for the payments technology the authors explored an alternative aggregation procedure and obtained what they called a CES aggregate The CES aggregate was favoured in terms of the empirical results found This aggregate was much less sensitive to movements in OCD balances than was either the simple sum or the Divisia measure of household M1 balances

Ford *et al.*, (1992) raised a question *viz.*, "Do the Divisia monetary aggregates adequately capture the effects of all financial innovations such as introduction of new financial instruments and progress in transactions technology?" It is to be noted that if innovation in the financial industry is neutral in nature, the Divisia index can sucessfully measure the technological progress But most financial innovations in reality are non neutral in terms of their effects on the liquidity and productivity of different financial assets Proceeding in line with Koenig and Fomby(1990), the authors demonstrated through a model how Divisia monetary aggregates fail to adjust for the effects of financial innovations related to technological progress and introduct on of new monetary assets Three kinds of modified Divisia measures therfore were constructed by the authors employing two innovation variables in the construction of the Divisia indices, using a learning curve adjustment of the retail sight deposit interest rate and third by combining the above two to capture effects of innovations The results favoured modif ed Divisia aggregates as these modified aggregates outperformed the r corresponding innovation neutral Divisia indexes as indicators of the level of ec n m c activity

An excellent collection of seven country spec fic experiments with Div s a monetary aggregates was presented by Mullineux's(1996) The stud es in general searched for plausibility of empirical implementat n of the new y constructed Div sia monetary indices as intermediate targets However the co ect f studies differed from the earlier works in respect of introducing novel ideas such as financial innovat n, emergence of new financial instruments and changes in the payments habits due t electronification in the payments system The question raised in the wake f these innovations was " Do the Divisia indices instantaneously adjust for these changes?" which most of the studies tried to answer in this volume

The study of the United Kingdom by James Ford and Andrew Mullineux focused on the impact of financial innovation and technological progress such as introduction of automated teller machines (ATMs) and electronic funds transfer at point of scale(EFTPOS) on measurement of Divisia monetary aggregates. Slightly modifying the procedure developed in Ford et al(1992), the authors tried to incorporate electronification effects into the the Divisia monetary aggregates. Five different aggregates namely, simple sum, ordinary Divisia, a Divisia with technological progress, a Divisia with allowance for implicit interest on retail sight deposits and a Divisia incorporating both technological progress and the payment of implicit interest were constructed using components of Bank of England's M4 definition of money An assessment of these aggregates was made through cointegration tests and error correction modeling, the results of which seemed to have favoured Divisia M4 as it explained variations in output and price level better than the sum M4

Employing vector autoregressions and Engle-Granger cointegration tests, Eugenio Gaiotti found that financial innovation had a smaller effect on the substitutab l ty among different kinds of bank liabilities in Italy The study concluded that the simple sum M2 and its aggregation theoretic Divisia counterpart differed only marginally This conclusion is interesting especially when several current stud es have c me out with ev dences against the traditional aggregates

Presenting the case of Switzerland Genberg and Neftci focussed on the stabi ty of demand and supply relationships for money The use of recent nonparametric tests suggested by Darkhosku and Brodsku t check for the presence of structural shifts made the study different from the previous ones Divisia monetary aggregates were found t have more stable money supply multipliers whereas the difference was negligible with respect to structural stability of money demand relationships between simple sum and Divisia aggregates

The Japanese case of Divisia monetary aggregates with special reference to financial deregulation was examined by Hiriyama and Kasuya. Applying Stock-Watson dynamic OLS estimation procedure, the authors tested for cointegration between Divisia aggregates and a vector of real macro variables. Tests of structural stability had not been conclusive, however.

Belongia provided a descriptive account of the rapid financial innovation taking place in the United States and analysed its likely impact on the society at large. Maintaining that the Federal Reserves lost its grasp over the behavior of money stock due to different reporting requirements and introduction of deposit accounts with varying degrees of checking privileges, Belongia felt that there was a need to change both the reporting requirements of financial institutions and the approach to measurement of money.

Analysing the demand for Divisia and Simple sum M3, Gaab pointed out some shortcomings of computed Divisia monetary aggregates in practice in the context of Germany, 1960-93. The study analysed M3(used by the Bundesbank both as an indicator and an official intermediate target of monetary policy)and a Divisia index over the same components as of M3. Both the demand functions for Divisia and simple sum M3 showed remarkably robust behaviour in the face of financial innovation and deregulation in recent decades. The Divisia aggregate were shown to be stable over the simple sum M3 during the sample period under study i.e. 1960-1993. The simple sum M3 shows some instability in the 1990s. It was inferred that the Divisia aggregate could cope up better with financial innovation.

Presenting a survey of empirical evidences relating to France, Lecarpentier found that the Divisia monetary aggregates though found to be satisfactory could not outperform simple sum monetary aggregates.

On the whole, the above empirical studies threw light on the variety of experiences of countries in the area of new monetary aggregates under differing institutional and regulatory environments. Though the evidences in general supported the superiority of aggregation theoretic Divisia monetary aggregates , they could outperform their simple sum counterparts, giving a clear message that it is difficult to do away with the practice of traditional monetary aggregates by the central banks One of the conditions laid down by the microeconomic theory of monetary aggregation is to choose an array of weakly separable monetary assets The above stud es have missed out covering empirical works dealing with separability tests, parametric or otherwise

A recent study by Feldstein and Stock(1996) suggested two methods viz ,(i) a time varying parameter model and (ii) a switching regression model to automatically adjust compositional changes due to financial innovat ons while constructing monetary aggregates Experimenting with M2+stocks or bond mutual funds the authors found the new aggregates performing better only during the period 1992-93

2.7 EMPIRICAL DEFINITION OF MONEY IN INDIA

The developments in monetary aggregation theory in the international arena have also influenced the Indian stud es t a great extent The success of Divisia aggregates in countries like the US UK, Japan etc have motivated research in India While a few studies have exposed the limitations of the RBI money stock measures, a few others have examined the case for operationalisation of the weighted aggregates

The First Working Group of RBI (1961 emphasised the role of money as a liquid asset as well as a medium of exchange while going for a proper measure of money The group defined money comprising of currency with public, net demand deposits with banks and other deposits with RBI.

The Second Working Group (1977) favoured a wide range of assets and suggested four aggregates viz., M1, M2, M3 and M4 which are in the descending order of liquidity defined as:

M1 = Currency notes and coins with the nonbank public + demand deposits (excluding interbank deposits) of all commercial and cooperative banks + other deposits with the RBI which are in the nature of demand deposits)

M2 = M1 + Saving Deposits with Post Office Savings Banks

M3 = M1 + Time Deposits of all commercial and cooperative banks (excluding inter bank time deposits)

M4 = M3 + Total Deposits of the post office Savings Organisation (excluding National Savings Certificates)

The Second Working Group recognised the need " to all w f r suff cient disaggregation so as to permit d fferent combinat ns of assets to be employed for analysis depending on the end-use to which the data are likely to be put"(p 5) The group further felt that "the hard core of the monetary aggregates should continue to be basical y those assets possessing the quality of "superior l quidity' arising from the concept n of money as a medium of exchange"(p 7)

The liabilities of the non-bank financial inst tutions like life insurance corporation, general insurance corporation, development banks, investment companies, trust companies and the Unit Trust of India are not included in the above measures of money stock The reason as given by the Group is that there is qualitative difference between the operations of these institutions and those of the monetary institutions There is a clear demarcation implied by the above definitions between the money using sectors and the money producing sectors. The money using sector is the non bank public. The money producing sector comprises of the Government and the banking system including RBI.

M1 is the narrow money usually referred in the monetary economics literature. In M2, even though the non-chequable portion of post office savings ought to be included, owing to non-availability of data, all post office savings have been included in it. The time liability portion of saving deposits should have also been included in M2. But it is impracticable. The savings and time deposits of post offices could have been considered for possible inclusion in M3, but it is not done due to the following reasons (i) postal savings organisation does not come under the conventionally defined banking system, (ii) it is very difficult to collect information on a weekly basis from post offices, (iii) the deposits in the post offices are of different maturity periods in which case it becomes a daunting task to produce consolidated figures by aggregating them through weighted aggregation.

The saving deposit balances with the commercial banks have two components i.e. demand liabilities and time liabilities. According to the RBI rules, the portion of savings deposits balances which is allowed to be withdrawn without notice, has been classified as demand deposit. The rest of the balances is time deposit. In March 1975 the demand and time deposit portions of savings balance were 85.8 % and 14.2 % respectively. The time deposit portion of the saving balances which can be withdrawn is around 14% of total savings account balances. There has been significant changes in these figures of time and demand liability portions in recent years. However the Second Working Group has recommended for a quinquennial survey in this regard to watch the changing proportions of time and demand liabilities.

The RBI had instituted Non-Resident (External) Rupee Accounts which accept deposits in any type of deposit accounts in March 1970 for the benefit of the non-resident

Indians. In November 1975, the RBI again started a novel scheme, the FCNR (Foreign Currency Non-Resident Accounts) in pound sterling, U.S dollar, German mark, Dutch guilder and Japanese yen. The second working Group treats these deposit balances as time deposits for most purposes.

Government deposits and float are not considered as candidates to qualify for any of the four monetary aggregates Because, inclusion of float may lead to double counting Exclusion of government deposits with the RBI would help in drawing a line between the ultimate money producer from the ultimate money users The amount of unutilised credit limits, trade credit etc , have also been excluded due to data l mitat ons and on empirical grounds

The Indian quest for a better monetary aggregate started with Shergill (1980) who considered six alternative money stock measures including those suggested by the Second Working Group His findings confirmed that M1 d d not satisfy the Friedman- Meiselman dual criteria This study with Indian data from 1951 to 1973, could not suggest any uniformly best measure of the money stock However the M4 aggregate (currency + demand deposits + other deposits with RBI + t me deposits + total postal aving depo ts) was preferred to the conventional M1 aggregate

Kamaiah and Bhole (1982) using factor analytic technique w th four assets viz, currency with the public (CU) demand deposits w th the banking sector (DD time deposits with the banking sector (TD) and post office saving deposits SD for the sample period 1957 To 1977, concluded that narrow money should be considered in modelling the demand for money and monetary policy in the Indian context

Kamaiah and Subrahmanyam (1983) conducted canonical correlation analysis for two sets of variables. One set was currency with the public CU), demand deposits with the banking sector (DD), time deposits with the banking sector (TD) and post office and saving deposits (SD). The other set consisted of real income, expected real income, inflationary expectations, rate of inflation, variability of inflation rate, bazaar bill rate and private debenture yield rate. The empirical exercise for the period 1958 to 1978 and two of its sub periods viz,1951-71 and 1958-78 resulted in varying definition of money due to qualitative changes in the composition of money holdings and changes in banking habits.

Bhole (1987) suggested a single analytically or conceptually sound measure of money instead of having multiple measures of money. His argument was for a measure of money M including currency, current deposits with banks, saving deposits with banks, saving deposits with post office saving banks and other deposits with the RBI He advocated to revive the old practice of designating other financial assets as near-money assets which could be grouped into one or more aggregates to be called near money aggregates (NMAs) on the basis of their liquidity, maturity, marketability, risk etc. Two aggregates viz, NMA1 and NMA2 for India were tentatively suggested by him, NMA1 including fixed deposits with banks and time deposits with post offices and NMA2 including NMA1 and other deposits with post offices

Bhole suggested the following assets as potential candidates for money and made a case for their inclusion in the broad connotation of money The assets are (1) currency (CU), (2) other deposits with RBI (ODR) (3) Current deposits with banks (CDB), (4) Saving deposits with banks (SDB), (5) Saving deposits with post office saving banks, (6) Fixed deposits with post offices (FDB), (7)Time deposits with post offices (TDPO), (8) Other deposits with post offices (ODPO), (9) National saving certificates (NSCS), (10) Other certificates with post offices (OCPO), (11) Treasury bills (TB), (12) Commercial bills (CB), (13) Government bonds(GB), (14) Industrial bonds (IB), (15) Fixed deposits with non banking companies (FDCOS), (16) Trade credit (TC), (17) Unutilised credit limits (UCL), (18) Industrial shares(IS).

Rao(1983) suggested that SDB (saving deposits with banks)in rural and semi urban areas should be treated as time deposits because they represent savings. On the other hand, SDB in metropolitan and urban areas should be treated as demand deposits as there is every possibility of these deposits being used as transaction balances Bhole suggested to consider SDB as money without going for any division based on any criterion. Similarly Bhole examined the cases with the rest of the assets

Kamaiah and Ramachandran (1991) carried out an exercise using the F-M dual criteria and factor analysis Regulatory changes and financial innovations introduced in the money market which had possibly led to qualitative changes in financial assets, were identified to be the main causes for the varying definition

Kannan (1989) made a comparison of different weighted monetary aggregates obtained by him by using the methods of Chetty, Barnett, and Roper-Turnovsky, on the grounds of stability, predictability and causality tests with respect to the target variable He concluded that the best weighting method for constructing monetary aggregates was the Roper-Turnovsky method

Jadhav (1989) skeptically looked at the situation in India t operationalise weighted monetary aggregates He pointed out the discrepancies among the available alternative approaches to construct monetary aggregates His contention is that the empirical attempts in India have not come out with monetary aggregates which would decisively outperform the simple sum aggregates

Jadhav criticized Kannan's (1989 study on the following grounds First, Kannan has not taken into account the major shifts in the long term time series of demand and time deposits in 1978 As in India, there are two characteristics of saving deposits viz, i transaction characteristics (ii) saving characteristics The transaction balances should be merged with demand deposits and the residual with time deposits The Second Working Group (1977) recommended to lump that part of saving deposits which could be withdrawn without notice with demand deposits. As a result, around 85% of saving deposits (from 1961 to 1977) got merged with demand deposits

After 1st March 1978, with the changed accounting procedure the portion of saving deposits on which interest is paid was treated as time deposits and the residue as demand deposits Then the earlier break-up got reversed and around 85% of saving deposits was then treated as time deposits But the study by Kannan did not consider these problems and therefore the data series for demand deposits and time deposits as well as the estimated results are put to question Secondly, the study used the GDP deflator for the public administration sector as a proxy for interest rate on demand deposits, instead of computing "implicit" rate of return on demand deposits Lastly the study does not specify the reference rate of interest rate used for discounting while computing the user costs which has a definite impact on the final results

Experimenting with Indian data for the period 1950-51 to 1984-85 Subrahmanyam and Swami (1991) compared the quantitative performance of three superlative monetary aggregates viz Divisia, Diewert and Fisher Ideal, with two non-superlative ones viz, geometric and simple sum Surprisingly the results supported simple sum aggregates which were highly informative about the goal variable

In a recent attempt, Kamaiah and Ramachandran 1994 using annual time series data for the period 1950-51 to 1989-90 discovered theoretically admissible groups of monetary assets using Denny-Fuss approximation analysis The results of the study showed that only the components of M3-money formed a weakly separable block out of the four measures (M1, M2, M3 M4) suggested by the Second Working Group of RBI

The study found demand deposits as a distant substitute for rest of the components in M1 The study also recommended certain alternative separable groups for construction of monetary aggregates. The study seems to have violated Barnett's(1982) recursiveness condition while hypothesizing different utility structures for seprability test.

Subrahmanyam and Swami (1994) verified the theoretical consistency of M1, M2 and M3 as optimal groupings of their respective constituent assets for the period 1960-61 to 1988-89 The flexible translog dual cost function approach was employed with user costs of assets They concluded that M2 and M3 did not conf rm to the theoretical requirements of optimal grouping and therefore M1 remained as the residual aggregate with a very high elasticity of substitution between currency and demand deposits (including other deposits)

It is clear from the above discussi n that results of ind vidual research efforts towards an appropriate money defin tion in the Ind an context have been at gross odds with each other Earlier stud es focusing on simple sum aggregates did not come out w th any concrete suggestions Preliminary ev dences on Div sia aggregates also could not establish the superiority of these aggregates

2.8. CONCLUDING REMARKS

The above discussion on basic ideas underly g different approaches to money definition and associated evidences suggest that the issue is st riddled w th several conceptual and empirical problems However the microeconomic monetary aggregation school emerges as the only convincing approach to a proper money definition due t s theoretical rigour The accumulated empirical evidences across countries seem in support of it

CHAPTER - III

ASSET SEPARABILITY : SOME NONPARAMETRIC EVIDENCE

3.0. INTRODUCTION

As noted earlier, the first step of Barnett s(1982) three stage procedure for selection of optimal monetary aggregates is to identify weakly separable groups of monetary assets for possible aggregation to form economic monetary aggregates Weak separability ensures the existence of an economic monetary aggregate, and hence testing weak separability among different assets becomes a basic requisite towards obtaining a meaningful monetary aggregate In the literature both parametric and non-parametric approaches are employed to test weak separability A few studies in the Indian context (Ramachandran and Kamaiah (1994), Subrahmanyam and Swami (1994)) have already tested separability of assets for monetary aggregates M1 M2 M3 and M4 as given in the Second Working Group of the RBI using parametric tests It has been observed that the parametric tests are sensitive to use of particular functional forms approximating the underlying utility functions The non-parametric tests, however circumvent this problem as the results of these tests are independent of any functional form and parameter estimates The tests can also handle a relatively large number of goods It may be noted that to date, there are no studies relating to India examining separability of assets using the non-parametric approach Hence an attempt is made in this chapter to re-examine the issue of separable monetary asset blocks in the Indian context using the non-parametric tests suggested by Varian(1982,1983

3.1. WEAK SEPARABILITY

The first and foremost task in the process of identifying a monetary aggregate is to confirm weakly separable monetary asset groupings. That is to say, a monetary aggregate can be formed only with financial assets that are weakly separable from other available financial assets as well as real goods and services, in the representative agent's preferences.

Following Blackorby *et al* (1978), weak separability may be defined as follows. Let (P, R) and (Q, M) be two vectors of prices and goods where R and M represent some arbitrary bundles of real goods and monetary assets respectively P and Q represent the prices of the real goods and monetary assets respectively Then, we say the agent's utility function U(R, M) is said to be weakly separable in M, if it is possible to find a "subutility function" say V(M) and a macro utility function U(R, V) which is strictly increasing in V, such that

$$U\,(R,M) = \overline{U}\,(R,\,V(M)) \qquad (3\ 1)$$

A necessary and sufficient condition of weak separability is that the marginal rate of substitution between any two pairs of assets in V(M) is independent of the amount of consumption of any good outside V(M) A detailed discussion on weak separability may be found in Deaton and Muellbauer(1980)

The criterion of weak separability may be illustrated with the following utility maximaization problem involving a two-stage budgeting procedure

Let U_t be the consumer's utility function in period t expressed as a function of real goods(R_t), leisure(L_t) and monetary assets(M_t) Let Y_t be total expenditure or full income in period t , P_r , commodity prices, P_l , price of leisure and P_m , monetary asset rental prices. Now, the utility maximization problem may be formulated as follows:

$$\text{Maximize: } U_t = U_t\,(R_t\,,L_t\,,M_t\,) \qquad (3.2)$$

subject to: $P^*_r R_t + P^*_l L_t + P^*_m M_t = Y_t$ (3.3)

where * refers to equlibrium values.

Let us assume that the total expenditure is predetermined within the framework of an intertemporal model of consumer demand in which it is assumed that the utility function is intertemporally separable. If utility is weakly separable in consumption, leisure and monetary services, then it may be rewritten as,

$$U = U[V_1(R), V_2(L), V_3(M)] \quad (3.4)$$

Equation(3.4), then, implies the following three demand functions

$$R_d = f(P_r, Y_r), Y_r = P^*_r R = F(P_r, P_m, P_l, Y) \quad (3.5)$$

$$L_d = g(P_l, Y_l), Y_l = P^*_l L = G(P_r, P_m, P_l, Y) \quad (3.6)$$

$$M_d = h(P_m, Y_m), Y_m = P^*_m M = H(P_r, P_m, P_l, Y) \quad (3.7)$$

The subscript "d" in equations (3.5) to (3.7) refers to the demand function for the respective commodity vector and *s in the equations refer to equilibrium values. Y_r, Y_l and Y_m refer to expenditure on real goods, leisure and monetary goods repectively. Weak separability implies a two-stage model for consumer behaviour. First the consumer allocates expenditures among the various broad categories of goods determining Y_r, Y_l and Y_m where equations 3.5, 3.6 and 3.7 are obtained. In the second stage the consumer allocates expenditures among the goods within each broad category based only on the relative prices of the goods in that category. This is referred to as the concept of a utility tree in Deaton and Muellbauer(1980). Therefore the two-stage budgeting procedure is not an accurate description of consumer behaviour if weak separability conditions are not satisfied.

3.2. TESTING WEAK SEPARABILITY

There are two ways of testing separability viz., (i) parametric tests and (ii) non-parametric tests Parametric tests involve estimation of parameters by way of estimating a particular functional form assumed for the indirect monetary services utility function Non parametric tests, on the other hand, are directly appl cable to the data for checking whether the data set rationalises a well behaved utility function.

3.2.1 . Parametric Tests

Parametric tests require a functional form f r the opt mizing agent s preferences estimate a model and perform hypothesis tests for d fferent structures of separab l ty This may be illustrated with the help of a representative consumer's allocat n problem which is as follows

Maximize $U(X_{1t}, X_{2t}, \quad , X_{nt})$ (3 8)

Subject to

$$\sum_{i=1}^{n} P_{it} X_{it} \quad M_t \qquad (3 \quad)$$

$$i \quad 1\,2 \qquad n$$

where X_{it} is the ith monetary asset in period t P_{it} is the user cost associated w th the ith asset in period t and M_t is expend ture monetary assets period t The user c st is the one period foregone interest opportunity cost expressed a

$$P_{it} = (R_t - r_{it}) \quad (1 + R_t$$

where R_t is the yield on a bench mark asset and r_{it} is the yield on the ith asset period t

This problem may be analyzed via its dual problem i e budget constrained maximization of the indirect utility function The indirect function expresses monetary services as a function of the monetary asset prices and the budget allocation to monetary services, M_t Accordingly, this problem may be rewritten as

Maximize

$$G = G(P_{1t}, P_{2t}, \ldots, P_{nt}, M_t), \qquad (3\ 10)$$

Subject to

$$M_t = \sum_{i=1}^{n} P_{it}X_{it} \qquad (3\ 11)$$

$$i = 1\ 2, \ldots n$$

where G is the indirect monetary services utility function

The use of this indirect function has one advantage viz demand equations are functions of prices which are obtained directly from the first order conditions by applying Roy's identity

A particular functional form may be assumed for the above indirect utility function (eqn (3 10)) and demand equations derived and subsequently estimated Then by imposing the restriction of equality among Allen elasticities of substitution, an approximate weak separability test is conducted The hypothesis implies equality within each set of Allen partial elasticities of substitution σ_{ij}s that is constructed by pairing all the assets in the separable subgroup with a given asset not in the separable group For instance if assets 'i' and 'j' are separable from asset k then the hypothesis implies that $\sigma_{ik} = \sigma_{jk}$ That is to say, if the marginal rate of substitution of asset i for asset j is not influenced by the holdings of asset 'k', then assets 'i' and 'j' are equally substitutable with 'k' Functional forms that have been used in the past include Generalized Leontief (Donovan 1978), Translog (Ewis and Fisher 1984), Fourier Flexible form (Ewis& Fisher 1985) etc

However, the basic limitation of the parametric approach is that the results are conditional on a particular functional form specified for the utility function. Moreover, a joint hypothesis is always tested under this approach viz., testing derived restrictions along with the maintained hypothesis of functional form. This amounts to confusion in case of violations of axioms of neoclassical consumer theory. It becomes very difficult to confirm whether it is particular functional form or data or the consumer theory that is being rejected. A quick review of the results obtained from parametric approaches to testing weak separability of monetary assets reveals that they(results) are not robust. Most of the studies assumed separability of real goods from monetary assets and proceeded testing separability among various proposed subgroups of monetary assets. Since the focus of the present chapter is on the non-parametric approach to separability, a review of studies which have employed the parametric approach is not attempted here.

3.2.2. Non-Parametric Tests

Varian (1982) developed a systematic non-parametric approach to test different utility maximization hypotheses, weak separability and homotheticity. This approach is based on the revealed preference theory of consumer behaviour. Varian(1982) reformulated Afriat's(1967) theorem in terms of his Generalized Axiom of Revealed Preference (GARP) and Homothetic Axiom of Revealed of Preference (HARP).

Given a set of monetary asset quantities $X^i = (X^i_1, X^i_2, \ldots X^i_k)$ and its corresponding user costs $P^i = (P^i_1, P^i_2, \ldots P^i_k)$, Afriat's (1967) theorem tries to answer the following question. Are these observed user costs and quantities are consistent with the maximization of a well-behaved utility function?

Afriat's (1967) Theorem:

(a) There exists a non-satiated utility function that rationalizes the data.

(b) The data satisfy the axiom of transitivity, that is, $P^r X^r \geqq P^r X^s$, $P^s X^s \geqq P^s X^t$, ..., $P^q X^q \geqq P^q X^r$ implies $P^r X^r = P^r X^s$, $P^s X^s = P^s X^t$, ..., $P^q X^q = P^q X^r$

(c) There exists utility indexes U^i and marginal utility indexes $\lambda^i \geqq 0$, $i = 1, 2, ..., n$ such that,

$U^i \leqq U^j + \lambda^j P^j (X^i - X^j)$ for $i, j, = 1,2, ..., n$

(d) There exists a nonsatiated, continuous, monotonic, concave utility function that rationalizes the data

Varian developed an equivalent formulation of the transitivity axiom(axiom (b)) as mentioned above and called it the Generalized Axiom of Revealed Preference (GARP)

The following definitions were given by Varian (1982). Given an observation X^i and a bundle X,

Definition 1 - X^i is directly revealed preferred to X written X^i D X if $P^i X^i \geq P^i X$

Definition 2 - X^i is strictly directly revealed preferred to X, written as X^i S X, if $P^i X^i > P^i X$

Definition 3 - X^i is revealed preferred to X, written as X^i R X, if $P^iX^i \geqq P^iX^j$, $P^jX^j \geqq P^jX^l$, ,$P^mX^m \geqq P^mX$ for some sequence of observations (X^i , X^j , ...,X^m) In this case R is called the transitive closure of the relation D.

In terms of the notations and definitions given above, GARP can be stated as follows If X^iRX^j then $P^iX^j \leqq P^jX^i$ for i, j. =1,2. n where P^j is a vector of m prices, X^i and X^j are vectors of m associated goods, n is the number of observations and R means revealed preferred A violation of GARP occurs if for some X^iRX^j, the condition X^jSX^i is true, that is, a violation of GARP occurs if X^i is shown to be revealed preferred to X^j

Varian (1983) proved the following theorem which outlined the conditions required to satisfy weak separability

(a) There exists a weakly separable, nonsatiated continuous concave, monotonic utility function that rationalizes the observed data

(b) There exist utility indices U^i, V^i and marginal utility ind ces $\lambda^i > 0$ $\mu^i > 0$ (i 1 2 n) that satisfy the Afriat(1967) inequalities $U^i \leqq U^j + \lambda^j P^j (X^i - X^j) + (\lambda^j \quad \mu^j)(V^i - V^j)$ and $V^i \leqq V^j + \mu^j q^j (Z^i - Z^j)$ for i, j = 1, 2, ,n

(c) The data (q^i , Z^i) and (P^i , 1 μ^i ,X^i ,V^i) satisfy GARP for some choice of (V^i μ^i) that satisfies the Afriat (1967) inequalities

The conditions stated above (i e (a) to (c)) are equivalent and may lead to a three-step test procedure, which may be used to ascertain whether any proposed subgroup of financial assets form a separable group

Step-1

In this step, the whole data set is checked for consistency with GARP (Generalized Axiom of Revealed Preference). If the data set is consistent with GARP, then it is consistent with utility maximization.

Step-2

Here, the task is to test for consistency with the necessary condition for weak separability. The necessary condition is that all goods in the macro utility function and the array of financial assets in the monetary subutility function are consistent with GARP.

Step-3

The last step warrants consistency with the sufficient conditions. One sufficient but not necessary condition for weak separability is consistency with what Varian (1983) called the Afriat Inequalities.

If the data pass the three steps mentioned above, then the assets in the monetary subutility function can constitute an economic monetary aggregate. If a hypothesized preference structure fails to meet the necessary condition for weak separability, then assets in the proposed subutility function cannot form a theoretically admissible group. If the hypothesized preference structure (or utility function in other words) meets the necessary condition for weak separability but fails to meet the Afriat sufficient condition, the proposed monetary subutility function may still be considered as a separable group so as to constitute an economic moneatry aggregate. In the present study, the three-step procedure is implemented by using Varian's(1991) software routine NONPAR.

3.3. SOME PREVIOUS WORKS

The studies of Swofford and Whitney (1986, 1988, 1995), Belongia and Chalfant(1989), Belongia and Chrystal(1991) which have applied the non-parametric tests, to identify separable monetary asset blocks, merit attention in this context

Using the U S quarterly real percapita data for the period 1969 I - 1979 IV on monetary assets and their associated user costs, Swofford and Whitney(1986a) found no violations of GARP for entire data set But some subutility function revealed violations of GARP In another attempt, the same authors(1986b) took consumption of durable goods, nondurable goods and services along with 27 monetary assets in the overall utility function for the period 1970 1 - 1985 2 in the U S context The data were in real per capita terms The data set met the necessary conditon and could be rationalized by a well-behaved utility function The utility function was found to be weakly separable in consumption goods and leisure Relatively liquid monetary assets met the necessary conditions for weak separability from other goods, thereby favouring a narrow monetary aggregate

In yet another attempt Swofford and Whitney (1988) performed non parametric tests on real per capita goods consumption, leisure and monetary assets for the period 1970-1985 using both annual and quarterly observations Among the important results, annual real per capita data on consumption goods leisure and monetary assets could be rationalized by a well-behaved utility function, whereas with quarterly data, utility maximization held good only with relatively liquid monetary assets upto and including small-time deposits It was believed that the less liquid assets used in the study were not adjusted to optimal levels within a quarter The results also indicated weak separability of the utility function in consumption goods and leisure and in monetry assets with annual data. Finally for no grouping the study could obtain homothetic preferences.

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Assuming real goods and services and leisure to be separable from monetary assets, Belongia and Chalfant(1989) searched for weak separable blocks over financial assets alone The assets considered by them were currency, demand deposits, NOWs, Super NOWs, MMDAs, MMMfs, and Savings(SVGs) Several groups such as (C, DD), (C, DD, NOWs), (C, DD, NOWs, Super NOWs) and (C, DD, NOWs, Super NOWs, MMDAs, MMMFs) emerged as separable groupings

Searching for an admissible monetary aggregate for the United Kingdom, Belongia and Chrystal(1991) applied Varian's non-parametric test to examine the separability conditions for five assets viz , currency, non-interest bearing sterling sight deposits, private sector interest-bearing retail deposits, wholesale deposits and interest bearing building society deposits The results were indicative of the entire group as a weakly separable block and an additional asset group containing non-interest bearing sight deposits, interest bearing retail deposits and interest bearing building society sight deposits also formed a weakly separable block

Again Swofford (1995) analyzed Friedman and Schwartz money using revealed preference approach The study took the assets that Friedman and Schwartz (1970) considered in their study of U S monetary history, and tested for consistency with weak separability The study reached the same conclusion as that of Friedman and Schwartz (1970) who found that currency, demand deposits, and time deposits issued by commercial banks met the criteria to form an aggregate Additional evidence from the study supported Friedman and Schwartz's notion that a broader monetary aggregate might have been appropriate after World War II

3.4. EMPIRICAL ANALYSIS

The present study uses annual data for the period spanning over 1970 to 1996 and monthly data from 1985 04 1996 09 Four financial assets viz , currency with the public (CU), net demand deposits of the public held by banks (DD), net time deposits of the public held by banks(TD)and saving deposits with post office savings banks (PD) are considered for the separability test The assets are measured in real *per capita* terms

Here Varian's nonparametric tests are conducted with a two-fold objective First, to discover certain theoretically admissible groups for further analysis of economic monetary aggregates Secondly, to examine the consistency of official definitions of money as given by the Second Working Group (SWG) of the RBI, with economic theory of aggregation i e to see whether the components of M1, M2, M3 and M4 form weakly separable blocks The study also attempts to include a new asset namely certificate of deposit(CD) for the period 1994 04 1996 07 and searches for some separable combinations with this new asset The number of observations are constrained due to the availability of data on this asset for a longer period of time It is to be noted that this asset is introduced only after June 1989, and RBI started publishing the data from 1994 onwards

It is to be noted here that the hypothesization of utility structures for weak separability tests follows Barnett's(1982) *recursiveness condition* which states that the components of each utility structure must include currency(legal tender) and must not include any good or asset that is not a monetary asset Economic aggregation theory does not dictate use of this condition However, violation of this condition results in a large number of weak separable groups in practice and therefore it could be difficult to choose from among such a large class of weak separable groups Applying conventional views from monetary theory, this condition restricts the number of theoretically admissible component groups More specifically this condition, "restricts the domain of possible components to "monetary assets" and requires the collection of admissible component groups to be nested about "hard core money", defined here by its legal tender property"(Barnett(1982) p 697)

As Varian's (1983) revealed preference test required data on both prices and quantities of the financial assets, Barnett's (1978) user cost formula is used to generate prices for these assets The formula for the user cost of say ith monetary asset takes the form

$$\Pi_i = (R - r_i) / (1 + R)$$

where Π_i is the user cost of the ith asset, R is the bench mark rate and r_i is rate of return of the ith asset The above formula denotes the discounted interest foregone by holding a rupee's worth of the ith asset

Regarding rate of return on individual assets, currency being the most liquid amongst all assets, the rate of return on it is assumed to be zero For demand deposits an implicit competitive rate is constructed using Klein's (1974) methodology The formula employed for constructing this rate is

$$r_{DD} = r_T \ [1 - (BR / DD)]$$

where r_T is 91 day treasuring bill rate and BR is bank reserve held against demand deposits, 12 month deposit rate is used as a proxy for time deposit rate In case of postal savings deposits, the rate of interest per annum on post office savings bank accounts with limits of investment lying between a minimum of Rs 20/- and a maximum of Rs 50,000, is used In the absence of such a rate commercial bank 3 months savings deposit rate is used For certificate of deposit, its own rate of return is used

Theoretically R, the benchmark rate should be the rate on a particular asset which is completely illiquid and does not provide any monetary service The rate on human capital may serve the purpose since it does not render any monetary service in a world where there is no slavery system However, due to difficulties associated with such a measurement, the present study proxies R by taking the rate of return on the highest yielding asset in period t and calculates user costs for each asset in that particular time period In the absence of any direct measurement of a benchmark rate, one can only construct proxy measures, which need not be rate of return on only one asset Thus, rates of return like long term goverment bond yield rate , company deposit rate, yield on private debentures and UTI dividend rates have served this purpose for different time periods in the study The highest available rate from among these rates in a particular year is considered the benchmark for that year

3.4.1. Evidence from Annual Data

The non-parametric test results for the annual sample 1970-1996 are summarized in the following table (table3 1)

Table 3.1
Non Parametric Test Results
Annual Data(1970-1996)

Hypothesized Utility Structure (1)	Necessary Condition(GARP) (2)	Sufficient Condition(Afriat Inequalities) (3)
U1=U[PD, TD, V(CU, DD)]	V	----
U2=U[PD, DD, V(CU, TD)]	S	S
U3=U[DD, TD, V(CU, PD)]	S	S
U4=U[PD, V(CU, DD, TD)]	S	S
U5=U[TD, V(CU, DD, PD)]	S	S
U6=U[DD, V(CU, TD, PD)]	S	S
U7=U[CU,DD, TD, PD)]	S	S

Foot Note In columns (2) and (3) above S indicates that the specified utility function satisfies that particular condition and V indicates violation of the same

The entire data, when tested, reveal no violations of GARP and thus meet the necessary conditon for weak separability The data also satisfy Afriat inequalities, the sufficient conditon of weak separability Hence, it may be concluded that the data can be rationalized by a well-behaved utility function In other words the data is consistent with the utility maximization hypothesis

Next, as shown in the above table, seven different utility functions have been hypothesized containing the four assets viz , CU,DD,TD and PD The hypothesization follows Barnett's recursiveness condition and therefore includes currency as a common element in all the preference structures All the preference structures except U1, consistently pass the necessary and sufficient conditions of weak separability and form theoretically admissible groups

The first preference structure, where currency and demand deposits enter the subutility function fails to meet GARP, the necessary condition. It can, therefore be inferred that components of simple sum M1 as defined by the RBI SWG(1977) and published by RBI do not form a weakly separable block. The validity of this asset group to constitute an economic monetary aggregate is questioned by economic aggregation theory.

The components of M3 as defined by the RBI SWG(1977) are the same as those in the subutility function of the macro function U4 which consistently pass GARP without revealing any violations and also satisfy the Afriat Inequalities. The preference structure is consistent with separability and hence (CU,DD,TD) forms a weakly separable block.

The utility structure U5 contains CU, DD, and PD and consistently pass the necessary and sufficient conditions of weak separability. This combination closely correspond to the official M2 as defined by the RBI SWG(1977).

The data used in this study confine to monetary assets only. Assuming that monetary assets are weakly separable from real goods it can be said that M4 components as defined by the SWG(1977) form a weekly separable block as the entire data set consistently pass both GARP and Afriat Inequalities, the necessary and sufficient conditions respectively.

In addition to the separable blocks identified above, some more weakly separable groups which consistently pass Varian's (1983) three step test and meet both the necessary and sufficient conditions are discovered. They are preference structures, U2, U3, and U6 with (CU,TD), (CU,PD), and (CU,TD,PD) as respective weakly separable monetary asset groups The viability of these newly obtained admissible groups is examined in Chapter IV by testing their performance as suitable economic monetary aggregates

Investigation with an annual sub-sample from 1980 to 1996 yielded the following results which are summarized in table 3 2

Table 3.2
Non Parametric Test Results
Annual Data (1980-1996)

Hypothesized Utility Structure (1)	Necessary Condition(GARP) (2)	Sufficient Condition(Afriat Inequalities) (3)
U1=U[PD, TD, V(CU, DD)]	S	S
U2=U[PD, DD, V(CU, TD)]	S	S
U3=U[DD, TD, V(CU, PD)]	S	S
U4=U[PD, V(CU, DD, TD)]	S	S
U5=U[TD, V(CU, DD, PD)]	S	S
U6=U[DD, V(CU, TD, PD)]	S	S
U7=U[CU,DD, TD, PD)]	S	S

Foot Note Same as in Table 3 1

Preference structures hypothesized in table 3 2 were the same as in table 3 1 In addition to separable groupings found in table 3 1 (CU DD) was found to form a weakly separable block in this sub sample

3.4.2. Evidence From Monthly Data

Separability tests for the monthly data from 1985 04 1996 09 was carried out in two phases, breaking the sample at 1990 12 This would facilitate having 1991 01-1996 09 as a period which coincides with the period of economic liberalization in India Accordingly, the results of the tests for samples 1985 04-1990 12 and 1991 01-1996 09 are presentd in tables 3 3 and 3 4 respectively

Table 3.3
Non Parametric Test Results
Monthly Data(1985:04-1990:12)

Hypothesized Utility Structure (1)	Necessary Condition (GARP) (2)	Sufficient Condition(Afriat Inequalities) (3)
U1=U[PD, TD, V(CU, DD)]	V	----
U2=U[PD, DD, V(CU, TD)]	V	----
U3=U[DD, TD, V(CU, PD)]	S	V
U4=U[PD, V(CU, DD, TD)]	S	S
U5=U[TD, V(CU, DD, PD)]	S	V
U6=U[DD, V(CU, TD, PD)]	S	V
U7=U[CU,DD, TD, PD)]	S	S

Foot Note Same as in table 3 1

As shown in the above table, groupings (CU, DD, TD) and (CU, DD, TD, PD) pass both the conditions of separability viz., GARP and Afriat inequalities and form theoritically admissible groups Preference strucutures U3, U5, and U6 satisfy the necessary condition only Combinations (CU, DD) and (CU, TD) violate GARP

Table 3.4
Non Parametric Test Results
Monthly Data(1991:01-1996:09)

Hypothesized Utility Structure (1)	Necessary Condition(GARP) (2)	Sufficient Condition(Afriat Inequalities) (3)
U1=U[PD, TD, V(CU, DD)]	S	V
U2=U[PD, DD, V(CU, TD)]	V	----
U3=U[DD, TD, V(CU, PD)]	S	S
U4=U[PD, V(CU, DD, TD)]	S	S
U5=U[TD, V(CU, DD, PD)]	V	----
U6=U[DD, V(CU, TD, PD)]	V	----
U7=U[CU,DD, TD, PD)]	S	S

Foot Note Same as in table 3 1

It is clear from this table that for the sample 1991 01 1996 09 groupings (CU, DD, TD) and (CU, DD, TD, PD) form weakly separable groups as they satisfy both the necesary and sufficient conditions of separability Grouping (CU DD), the official M1 satisfy the necessary condition only Utility structures U2, U5, and U6 violate GARP, the necessary condition of weak separability

3.4.3. Evidence From Extended Monthly Data:1994:04-1996:07

In this sub section we are presenting the non-parametric evidence for separable groups, in which a new asset namely certificate of deposit is added Since data on this new asset could be obtained only from 1994 04, the sample range is confined to 1994.04 to 1996 07 The test results are summarized in the following table (Table3 5)

Table 3.5
Non Parametric Test Results
Monthly Data (1994:04-1996:07)

Hypothesized Utility Structure (1)	Necessary Condition (GARP) (2)	Sufficient Condition(Afriat Inequalities) (3)
U1=U[PD, CD, V(CU, DD)]	S	S
U2=U[DD, CD, V(CU, PD)]	S	S
U3=U[DD, PD, V(CU, CD)]	S	S
U4=U[CD, V(CU, DD, PD)]	S	S
U5=U[PD, V(CU, DD, CD)]	S	S
U6=U[DD, V(CU, PD, CD)]	S	V

Foot Note Same as in table 3 1

As shown in the above table, the data set as a whole satisfies both GARP and the Afriat sufficient condition Two new weakly separable groups *viz* , (CU, CD), and (CU, DD, CD)are obtained for the sample 1994 04-1996 07 as the utility strucutres U3 and U5 satisfy both necessary and sufficient conditions for weak separability The combination (CU, PD, CD) satisfies the necessary condition but fails to satisfy the sufficient condition

3.5. CONCLUDING REMARKS

The search for separable groups employing Varian's(1983) non-parametric procedure among different financial assets yielded the following results The study identified components of M2, M3 and M4 as defined by the Second Working Group(1977) as weakly separable groups for annual data 1970-1996 Some new separable groups were also obtained in the process for this period suggesting construction of alternative monetary aggregates against the existing practice at the central monetary authority level Interestingly, all the official money supply measures viz , M1, M2, M3, and M4 were found to be theoretically admissible groups for the sub-sample 1980-1996 as the groupings satisfied both the necessary and sufficient conditions for weak separability However, the test results of monthly observations yielded only M3 and M4 as weakly separable groups The monthly evidence therefore seemed to be in favour of broader aggregates Results from the extended monthly data with the new asset Certificate of deposit(CD) indicated (CU, CD) and (CU, DD, CD) as two new separable groups

The entire data set satisfied all the required conditions and therefore could be rationalized by a well-behaved utility function This implies that the failure of specific functional forms in satisfying different axioms of neoclassical consumer behavior as has occurred in some past studies, indicates either a rejection of the particular specification or of a particular grouping and not a rejection of utility based money demand analysis

Homothetic preferences could not be obtained either for the entire data set or for any of the tested groupings as the test revealed maximum number of violations This was tested using Varian's (1983) Homothetic Axiom of Revealed Preferences (HARP) The implication of this finding is that studies relying on homethetic functional forms such as a constant elasticity-of-substitution function are misspecified

CHAPTER - IV

EMPIRICAL PERFORMANCE OF DIVISIA VERSUS SIMPLE SUM AGGREGATES

4.0. INTRODUCTION

After accomplishing the task of testing separability of assets, one tends to proceed to the second and third stages of Barnett's(1982) procedure to optimal monetary aggregation The second stage stipulates construction of monetary aggregates using a superlative index number such as the Divisia, Fisher Ideal etc ,[1]. In the third stage, the empirical performance of the aggregates in relation to real macro variables is to be examined This chapter endeavours construction of Divisia monetary aggregates over the separable groups identified in Chapter - III and conducts some "standard" performance tests to assess the relative advantage of the Divisia monetary aggregates over their simple sum counterparts

As noted in chapter III, for annual data(1970-1996) the grouping (CU, DD) does not conform to weak separability Similarly, for monthly data from 1985 04 1996 09 the groupings (CU, DD) and (CU, DD, PD) do not pass the weak separability test These groupings therefore fail to form theoretically admissible monetary asset blocks It is to be noted here that the above mentioned groupings viz , (CU, DD) and (CU, DD, PD) closely correspond to the official money stock measures M1 and M2, published by the Reserve

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[1]The Divisia index is used in almost all the empirical studies relating to monetary aggregation due to its good statistical properties.

Bank of India[2] But Divisia aggregates are constructed over these groups along with the separable blocks at least to explore the superiority of the index.

Thus the asset groupings considered for the annual data 1970-1996 are the following

(i) M1 = (CU, DD)

(ii) M2 = (CU, DD, PD)

(iii) M3 = (CU, DD, TD)

(iv) M4 = (CU, DD, TD, PD)

(v) M5 = (CU, TD, PD)

(vi) M6 = (CU, TD)

(vii) M7 = (CU, PD)

For the monthly data 1985 04 to 1996 09, the asset groupings are

(i) M1 = (CU, DD)

(ii) M2 = (CU, DD, PD)

(iii) M3 = (CU, DD, TD)

(iv) M4 = (CU, DD, TD, PD)

4.1. EVALUATION OF COMPARATIVE PERFORMANCE

To analyse the relative performance of the aggregates(both Divisia and Simple sum) based on the grouping mentioned above, the information content test, Davidson-Mackinnon J-test , and estimation of demand functions for these aggregates, have been

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[2]This result is in line with Belongia and Chrystal(1991) and Belongia(1995) wherein the same problem was encountered (*viz.*, the official monetary aggregates fail to satisfy the weak seprability test) in the context of the United Kingdom, the United States, Japan and Germany

conducted[3] Before the results are discussed, let us briefly discuss the tests which are used in the present chapter

4.1.1. Descriptive Statistics and Information Content

The mean and standard deviation of the growth rates of the monetary aggregates are used to see how fast the aggregates grow The standard deviation(sd) tells us which aggregates fluctuate more, the Divisia or the simple sum In particular, from the sd figures some inference may be drawn regarding the weighting schemes inherent in the Divisia monetary aggregates and regarding the sensitivity of these aggregates to changes in interest rates

The information content of a monetary aggregate(M) relative to a goal variable(G) may be defined as

$$I(G/M) = -0.5 \log[(1-R^2{*}) / (1-R^2)] \qquad (4.1)$$

where R^2* and R^2 are, respectively, the coefficients of determination for the following regression equations

$$G = A_p(L)\, G + B_q(L)\, M + u \qquad (4.2)$$

$$G = A_p(L)\, G + v \qquad (4.3)$$

[3]These tests, however do not exhaust the list of tests used in the previous studies The other tests used are the St.Louis reduced form equations to examine the relative importance of monetary versus fiscal actions, the dispersion dependency diagnostic test etc.. The present study has not used these tests due to some reasons. First, in the absence of monthly goverment expenditure data it is difficult to conduct the St.Louis kind of a test. Secondly, the scope for aggregation error is less when we construct aggregates using separable groups obtained from nonparametric test. So we do not attempt a dispersion dependency diagnostic test to check for aggregation error.

where u and v are error terms and A_p and B_q are polynomials in L, respectively[4], L is lag operator The variables are measured in terms of their growth rates. For a given level of R^2, equation (4 1) suggests that the measure of information content rises with an increase in R^2* Hence, the R^2* for the estimated models is used to rank the monetary aggregates implying the information content in them for the goal variables For the information content test, the goal variables chosen for the present purpose are nominal Gross Domestic Product(GDP), real GDP and Whole sale price index(WPI) The objective is to test whether nominal money contains any information for nominal income and prices and real money balances for real income

4.1.2. Davidson-Mackinnon J-Test

Next, Davidson-Mackinnon J-test for non-nested hypothesis is conducted to compare a Divisia aggregate with its sum counterpart in explaining a particular goal variable The basic idea behind the test is to use the same equation containing the goal variable to be explained in one case with the Divisia aggregate and in another case with the Simple sum aggregate The test determines whether the Divisia model adds explanatory power to the sum model and *vice versa* A description of this test method is presented in appendix A The t-statistics are used to check for the rejection of one model over the other and then the reverse

4.1.3. Money Demand Test

The fact that "A stable demand for money is a prerequisite for an efficient conduct of monetary policy" is well emphasised in the literature of monetary economics In other words a stable relationship between money, income and interest rates is encouraging for monetary targeting. A choice between competing monetary aggregates as monetary

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[4]p and q are the optimal lag lengths chosen on the basis of Final Prediction Error Criterion due to Akaike(1969).

targets can therefore be made by estimating the demand for money functions and examining the relationship between the aggregates and real national income For this purpose, simple money demand functions are formulated and estimated by ordinary least squares method

The model estimated here is of the following form

$$\ln(M/P) = \alpha_0 + \alpha_1 \ln(GDP/P) + \alpha_3 r + u \qquad (4\ 6)$$

where M is Divisia or Simple sum monetary aggregate, GDP is nominal gross domestic product, P is the price represented by the Whole sale price index(WPI), r is the opportunity cost variable proxied by 12 month time deposit rate for simple sum aggregates and by Divisia user cost dual for Divisia aggregates

The model stability is examined through CUSUM square plots developed by Brown, Durbin and Evans(1975) In the CUSUM squared test the test statistic *viz*, CUSUM square(S_t) is plotted against time and the plot is examined in terms of the 95% confidence interval around its mean $E(S_t)$ If the cumulative sum(S_t) plots strays outside the confidence bounds, the null hypothesis of no parametric instability is rejected, *viz*, a structural shift in the parameters is said to have occurred at the corresponding break point(s) Details of the CUSUM squared test is presented in appendix-A

For the monthly data, we also employ the Johansen-Juselius cointegration test in order to examine the long run relationship underlying the money demand functions, searching for the existence of at least one cointegrating vector As a prerequisite for this test KPSS unit root test due to Kwiatkowski, D, Phillips, P C B, Schmidd, P and Shin, Y(1992), has been conducted to ensure that the variables considered in the analysis are non-stationary Details of the KPSS unit root test and the Johansen-Juselius test are presented in the Appendix-A.

4.2. ANALYSIS OF RESULTS:

4.2.1. Annual Data

The mean and standard deviation figures of money growth rates(both Divisia and Simple sum) are presented in table 4 1 As the figures show DM1 and DM2 fluctuate less than their sum counterparts Fluctuations in the growth rates of all other Divisia monetary aggregates are far more than their sum counterparts

The results of the information content test are reported in table, 4 2 It is clear from table 4 2 that nominal simple sum M7 contains the highest information for nominal GDP whereas the information content of real Divisia M1 is the highest for real GDP and that of nominal Divisia M3 is the highest for prices(WPI) For nominal GDP as the goal variable all Divisia aggregates except DM7 are ranked higher than their simple sum counterparts Similarly excepting SM2 and SM7 all Divisia aggregates are ranked higher than their sum equivalents with respect to WPI In case of real GDP however, sum aggregates appear in higher ranks than the Divisia ones except RDM1 Thus the overall results indicate a clear edge for Divisia aggregates

In the Davidson-Mackinnon J-Test, the goal variables chosen to be explained by different monetary aggregates are real GDP, nominal GDP, and prices(WPI) The J-test results are presented in tables 4 3, 4 4 and 4 5 for goal variables real GDP, nominal GDP and Prices respectively. Rejection of a specification against the other is judged with the help of t-statistics quoted in the parentheses in the tables Rejection of both the hypotheses imply neither model provides complete specification No conclusion can be drawn if none of the specifications is rejected Rejection of one specification against the other implies the dominance of the latter on the former It is evident from table 4 3 that for the goal variable real GDP the test results do not say anything conclusive as the cases are either of rejection or nonrejection of both the hypotheses It is therefore difficult to say which aggregate should be preferred to what With respect to nominal GDP(see table 4 4), the test favours the Divisia model in case of DM5 versus SM5 whereas rest of the cases are are not conclusive Table 4 5 summarises results for goal variable WPI, where, in three cases *viz* , DM4 versus SM4, DM5 versus SM5 and DM6 versus SM6 simple sum aggregates dominate their Divisia counterparts Rest of the cases do not yield any conclusion

The results of money demand estimations through OLS are presented in table 4 6 As shown in the table, both income and opportunity cost coefficients bear the expected signs excepting DM1, DM2, DM3, and DM4 where the opportunity cost variable though insignificant bears a positive sign In DM7 and SM7 specifications the opportunity cost coefficients exhibit expected signs and statistically significant The income coefficients in all the specifications are significant at 1% level The income elasticity is greater than unity in all the money demand specifications All the Divisia money demand elasticities are greater than the simple sum money demand elasticities DM3 DM5, DM6 and DM7 specifications have a better fit than their sum counterparts as indicates by the R^2

The in-sample predictivity of the above money demand relations is examined by calculating Theil's U statistics When compared with Divisia money, simple sum money seems to have better predictive power in all specifications As has been mentioned in section 4 1.3 to investigate the stability aspect of the above money demand relationships CUSUM square plots are used The plots presented in figures (1) to (14) correspond to aggregates DM1, SM1, DM2, SM2, DM3, SM3, DM4, SM4, DM5, SM5, DM6, SM6, DM7, and SM7 respectively It is clear from the figures with 95% confidence intervals that all money demand relationships with Divisia as well as Simple sum aggregates are stable throughout the sample except DM7 and DM2. DM2 specification shows a minor kink around the year 1984 whereas DM7 specification shows a major kink during the period 1976 to 1984 indicating a presence of structural breaks around those periods

4.2.1.1. Concluding Remarks

The overall results of the above discussed tests for annual data reveal the fact that Divisia monetary aggregates do not seem to outperform their simple sum counterparts However, performance of the Divisia aggregates are at least as good as that of simple sums To be more specific evidence from the J-test has been mixed in nature Information content tests show slight dominance of Divisia aggregates and Divisia money demand stability is as good as that of simple sums'

4.2.2 Monthly Results

Monetary aggregates that are constructed on monthly observations are as the following

M1 = CU + DD

M2 = CU + DD + PD

M3 = CU + DD + TD

M4 = CU + DD + TD + PD

The empirical performance of these aggregates are examined through (i) information content test, (ii) Davidson-Mackinnon J-test and (iii)Money demand test including testing long run money demand relationships by using Johansen cointegration procedure

To begin with table 4 7 summarises the descriptive statistics of the growth rates of the monetary aggregates The standard deviation figures of growth rates of Divisia M1 to M4 are less than those of simple sum M1 to M4 indicating less fluctuation in Divisia growth rates This may be due to the weighting procedure inherent in the Divisia indices which smoothens out the growth path of the aggregates

The methodology followed in the case of monthly data remains the same as that followed in the annual context The goal variables chosen here are Index of Industrial Production(a proxy for monthly income measure) and Whole sale price index(WPI) The results based on the coefficient of determination(R_*^2) are summarised in table 4 8 It is evident from the table that Divisia monetary aggregates have significant information content with regard to the goal variables IIP and WPI In particular, nominal DM2 contains the highest information for IIP and nominal DM1 contains the highest information for WPI All nominal Divisia aggregates are ranked higher than their Simple sum equivalents with respect to IIP Similarly with WPI all Divisia aggregates again are ranked higher than the Simple sum ones Real sum M2(RSM2) however, has the highest information content for IIP But all other real Divisia aggregates contain more information than their simple sum equivalents as evident in the higher ranking in the table The results therefore imply that the Divisia aggregates have an edge over their simple sum counterparts as the former are always ranked higher than the later

Results of Davidson-Mackinnon J-test are summarised in the tables 4 9 and 4 10 for the goal variables WPI and IIP respectively. As shown in table 4 9 with goal variable

WPI in the specification, in two cases *viz.*, SM3 versus DM3 and SM4 versus DM4 Divisia money dominates simple sum money In rest of the cases, it is not possible to draw anything conclusive Similarly in case of IIP as the goal variable, Divisia M4 dominates simple sum M4 The other cases are again either of rejection or non rejection of both the hypotheses

Formulation of the demand for money function is the same as that in the annual analysis The scale variable is proxied by the Index of Industrial Production, in the absence of monthly GDP figures The opportunity cost variable is call money rate for the simple sum aggregates and respective Divisia price duals for the Divisia aggregates Table 4 11 presents the OLS estimates of demand for money functions In all the specifications (having both Divisia and simple sum) income and opportunity cost variables exhibit signs that are consistent with theory All the income coefficients are positive and significant at 1% level The income elasticities are greater than unity except that of DM2 and SM2 where the elasticity is close to unity Theil's U statistics imply in-sample predictivity to be better in simple sum cases than the Divisia specifications

The stability of these relationships are examined using CUSUM square plots Figures 15 to 22 present the CUSUM square plots with 95% confidence intervals underlying the money demand relationships of SM1, DM1, SM2 DM2 SM3 DM3 SM4 and DM4 respectively It is clear form the figures that all four simple sum money demand relationships are unstable as kinks are observed during the period 1988-1991 indicating presence of structural break(s) around that period Interestingly, all the corresponding Divisia money demand relationships are stable throughout the sample This may be attributed to the theoretical superiority of the aggregates in the sense that the aggregates account for portfolio changes and internalise the resulting substitution effects with the advent of financial innovations.

4.3. LONG RUN MONEY DEMAND RELATIONSHIPS

To test long run relationships underlying the money demand relationships the Johansen-Juselius(J-J) multivariate cointegration test seems to be appropriate especially in a monthly context The existence of at least one cointegrating vector ensures a long run relationship among monetary aggregates, real income and interest rates As the J-J procedure is designed for variables which are not stationary it is obligatory to conduct some unit root test to check stationarity properties of the series To this end, KPSS unit root tests (due to Kwiatkowski, D, Phillips, P C B, Schmidd, P and Shin, Y(1992)) are conducted to ensure that the variables used in the cointegration analysis are not stationary

KPSS provide a straight froward test of the null hypothesis of stationarity against the alternative of a unit root The KPSS unit root test statistics for variables in levels and variables in differences are presented in tables 4 12 and 4 13 respectively 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 requires statistically significant values more than 0 146 for with trend and 0 463 for without trend It is clear from the tables that the statistics for variables in levels with trend and without trend are more than the critical values and the statistics for variables in their first differences are less than the critical values which means that all variables are non stationary *viz* integrated of order one(I(1))

The Trace statistics of the J-J estimates suggest the existence of two cointegrating vectors among monetary aggregates, index of industrial production and opportunity cost variables for all the specifications as the null hypothesis of one or less cointegrating vectors is rejected at 5% significance level The λ max statistics too suggests existence of two cointegrating vectors excepting DM1 and DM2 specifications the as the null hypothesis of one or less cointegrating vectors is rejected at 5% significance level. Both these statistics for selection of number of cointegrating vectors along with the two estimated cointegrating vectors are presented in table 4 14 The cointegrating vectors in general exhibit signs in accordance with theoretical precepts dp1, dp2, dp3 and dp4 in table 4 14 refer to the divisia price duals of DM1, DM2, DM3 and DM4 respectively Lag length employed is chosen by Akaike's Information criterion

4.4. MONETARY AGGREGATES WITH AN ADDITIONAL ASSET

In this section four new monetary aggregates (two simple sum and two Divisia) consisting of a new asset called certificate of deposit(CD) with CU and DD are constructed It is to be noted that the nonparametric weak separability tests conducted in Chapter III yielded (CU, DD) and (CU, DD, CD) as two new weakly separable groups Here, we do not consider time deposits as a component as the data on time deposits published by the RBI includes certificate of deposit(CD) too Therefore, the purpose is to treat certificate of deposit as a separate asset and the separability inference also strengthens the case Then the extended aggregates constructed are as the following for the monthly sample from 1994 04 to 1996 07

SM = SIMPLE SUM (CU+CD)

DM = DIVISIA (CU+CD)

SMN = SIMPLE SUM (CU+DD+CD)

DMN = DIVISIA (CU+DD+CD)

Before proceeding to the empirical performance of these aggregates it is necessary to make a note on the instrument in brief which is attempted in the following sub section

4.4.1. A Note on Certificate of Deposit

Certificate of deposit(CD) is a relatively new money market instrument in the Indian money market CDs have been introduced in India in June 1989 Following the suggestion of the Vaghul working group(1987) recommended introduction of CDs in India Subsequently the RBI permitted banks to issue CDs in June 1989 The objective was to further widen the range of money market instruments and to give investors greater flexibility in the deployment of their short term surplus funds Bhole(1992) traces the evolution of CDs in India and other countries A comparative account of the operational aspects in India and other countries is also presented in Bhole(1992)

Following Bhole(1992) the main features of the instrument may be summarised as follows

(a) CDs are transferable, negotiable, short term, fixed interest bearing maturity dated highly liquid and riskless money market instruments
(b) CDs can be issued to individuals, corporations, companies, trusts, funds and associations and NRIs
(c) The maturity period of CDs varies from 3 months to 1 year and the rate of interest on it is also market determined

4.4.2. Performance of Extended Monetary Aggregates

The descriptive statistics of the growth rats of the aggregates are presented in table 4 15. It is clear from the table that Divisia aggregates grow slowly and fluctuate less that their sum equivalents This is an expected theoretical property of Divisia aggregates wherein the actual contribution of the newly added assets to the total liquidity flow is properly captured On the other hand simple sums with new assets may be misleading some time showing a sudden spike in the aggregate's growth. This fact is supported by the plots given in figures 23 to 26 Figures 23 and 25 show the trends in(DM, SM) and (DMN, SMN) whereas figures 24 and 26 show growth rates of (DM, SM) and (DMN, SMN) respectively As evident from these graphs in certain periods the growth paths of Divisia aggregates are just the opposite to that of the sum aggregates

Information content test results show that for IIP, the nominal sum aggregates are ranked higher than their Divisia counterparts Aggregates SMN, RDMN contain the highest information for prices and IIP respectively SMN also contains the highest information for IIP The sum aggregates therefore have higher ranks than the Divisia ones

Coming to the money demand estimations, OLS results show that in all specifications of the extended aggregates, interest rates or Divisia price duals bear expected signs They turn out to be statistically insignificant in cases of SM and SMN whereas for DM and DMN they are found to be insignificant However the income coefficients are statistically significant in all the cases Also, the income elasticity is more than unity in all cases except that of DM So far as the in sample prdictivity is concerned DM can predict better than SM whereas SMN has better predictivity power than DMN

The stability of the relationships is examined with the help of CUSUM square plots with 5% confidence bands As shown in figures 27 to 30 Divisia money demand for both the extended aggregates is stable The simple sum money demand relationships on the other hand are not stable as is clear from the kinks observed

4.5. SUMMARY OF RESULTS AND CONCLUDING REMARKS

The results of different tests conducted with the annual data in general show that the sum aggregates perform as good as their Divisia counterparts However, the information content test and J-test results are mixed for some groupings For these tests the Divisia aggregates dominate their simple sum equivalents

The results of monthly data clearly establish the superiority of the Divisia aggregates in terms of their information content, the J-test and money demand test The money demand relatioships with simple sum money experience structurel breaks around the period 1990-91 whereas those of the Divisia money are stable throughout The structural shift thus observed in the simple sum case may be attributed to the ensuing financial innovations The stability of the Divisia money demand is due to its theoretical superiority, especially its ability to internalise the substitution effects caused by portfolio shifts in a period of financial innovations

The long run money demand relations of the two aggregates are examined by using the the Johansen-Juselius(J-J) cointegration test The J-J results indicate existence of two cointegrating vectors in all cases thereby establishing the fact that there exists a long run relationship underlying all the money demand functions(both Divisia and simple sum)

We also considered a relatively new asset, the certificate of deposit(CDs) for possible inclusion in monetary aggregates as a separate entity The data published by the RBI on time deposits(TD) includes this instrument Though CD is basically a kind of fixed deposit, it is different from other term deposit components of TD in one respect viz the rate of return on it is market determined. As our weak separability tests in chapter III evidenced (CU, CD) and (CU, DD, CD) as theoretically admissible groups, we tried to form some economic monetary aggregates using these combinations While studying properties of these aggregates, we found the Divisia aggregates have a reasonably stable demand specification. To avoid collinearity we avoided addition of time deposits as a component to the above mentioned groupings

To conclude, the theoretical superiority of the Divisia monetary aggregates can be realized better at higher levels of aggregation with a widened asset base with more interest yielding assets under consideration. The tests that are used in this chapter to provide a comparative account of the empirical performance of these aggregates do not exhaust the tests previously employed in the literature. Due to data limitations some of these tests like the St. Louis could not be conducted. For instance we do not have data on monthly government expenditures which is necessary for studying the relative importance of monetary versus fiscal actions.

Table 4.1

Descriptive Statistics of Growth rates of Monetary Aggregates

(Annual Data)

Monetary Aggregates	Mean	Standard Deviation
DM1	14.48	4 79
SM1	14.73	4 84
DM2	14 09	4 66
SM2	14.17	4 67
DM3	16 06	3 28
SM3	17.21	2 75
DM4	15 74	3 26
SM4	16 84	2 73
DM5	15 57	3 21
SM5	16 83	2 57
DM6	15 95	3 27
SM6	17 28	2 61
DM7	13 02	4 43
SM7	12 83	4 33

Table 4.2

Monetary Aggregates Ranked according to

their Information Content(Based on $\overline{R}^2$*)

(Annual Data)

Rank	Nominal GDP	Real GDP	WPI
1	SM7	RDM1	DM3
2	DM7	RSM1	DM4
3	DM2	RSM7	SM2
4	DM1	RDM7	DM2
5	DM5	RDM2	DM6
6	SM2	RSM6	DM5
7	SM1	RSM2	DM1
8	DM6	RSM5	SM4
9	DM4	RSM3	SM3
10	DM3	RSM4	SM5
11	SM5	RDM6	SM6
12	SM4	RDM3	SM7
13	SM6	RDM5	DM7
14	SM3	RDM4	SM1

Note Prefixes "D", "S", and "R" refer to Divisia, simple sum and "in real terms" respectively

Table 4.3

DAVIDSON AND MACKINNON(1981) J TEST

H_0 : GOAL = βDIVISIA + U_0

H_1 : GOAL = γSUM + U_1

GOAL = REAL GDP

(Annual Data)

RDM1 v RSM1	Reject H_0 (-3 59)	Reject H_1 (5 23)	Neither model provides complete specification
RDM2 v RSM2	Do not reject H_0 (-0 51)	Do not eject H_1 (1 03)	Cannot reject either specification
RDM3 v RSM3	Reject H_0 (-3 53)	Reject H_1 (5 71)	Neither model provides complete specification
RDM4 v RSM4	Reject H_0 (-3 02)	Reject H_1 (5 15)	-do-
RDM5 v RSM5	Reject H_0 (-2 73)	Reject H_1 (5 54)	-do-
RDM6 v RSM6	Reject H_0 (-3 37)	Reject H_1 (6 26)	Neither model provides complete specification
RDM7 v RSM7	Reject H_0 (-4 98)	Reject H_1 (5 45)	-do-

Note:Figures in parentheses are t-statistics.

Table 4.4

DAVIDSON AND MACKINNON(1981) J TEST

$$H_0 : GOAL = \beta DIVISIA + U_0$$

$$H_1 : GOAL = \gamma SUM + U_1$$

GOAL = GDP

(Annual Data)

DM1 v SM1	Reject H_0 (-2 75)	Reject H_1 (4 15)	Neither model provides complete specification
DM2 v SM2	Do not reject H_0 (-0 06)	Do not eject H_1 (0 53)	Cannot reject either specification
DM3 v SM3	Reject H_0 (-2 12)	Reject H_1 (4 06)	Neither model provides complete specification
DM4 v SM4	Reject H_0 (-1 86)	Reject H_1 (3 71)	-do-
DM5 v SM5	Do not Reject H_0 (-1 35)	Reject H_1 (3 71)	Summation model rejected but Divisia model is not
DM6 v SM6	Do not reject H_0 (-1 62)	Reject H_1 (4 11)	-do-
DM7 v SM7	Do not reject H_0 (-1 27)	Do not reject H_1 (-1 06)	Can not reject either specification

Note:Figures in parentheses are t-statistics.

Table 4.5

DAVIDSON AND MACKINNON(1981) J TEST

H_0 : GOAL = βDIVISIA + U_0

H_1 : GOAL = γSUM + U_1

GOAL = WPI

(Annual Data)

DM1 v SM1	Reject H_0 (-2 89)	Reject H_1 (-2 61)	Neither model provides complete specification
DM2 v SM2	Reject H_0 (2 96)	Reject H_1 (4 57)	-do-
DM3 v SM3	Reject H_0 (2 24)	Do not reject H_1 (-1 34)	Divisia model rejected but sum model is not
DM4 v SM4	Reject H_0 (2 32)	Do not reject H_1 (-1 47)	-do-
DM5 v SM5	Reject H_0 (2 63)	Do not reject H_1 (-1 58)	-do-
DM6 v SM6	Reject H_0 (2 57)	Do not reject H_1 (-1 45)	-do-
DM7 v SM7	Reject H_0 (2 23)	Reject H_1 (-2 16)	Neither model provides complete specification

Note:Figures in parentheses are t-statistics.

Table 4.6

OLS Estimates of Money Demand Functions
(Annual Data)

Dependen tVariable	Constant	Real GDP	Opportuni ty Cost	$\overline{R}^2$	D.W.	Theil's U
DM1	-8 97	1 15* (14 99)	0 006 (1 24)	0 98	1 25	0 004635
SM1	-5 86	1 36* (19 79)	-0 021 (-1 47)	0 98	1 24	0 002553
DM2	-7 53	1 11* (13 95)	0 003 (0 61)	0 98	1 20	0 004091
SM2	-4 60	1 26* (19 81)	-0 022 (-1 78)	0 98	1 39	0 002361
DM3	-11 52	1 48* (14 93)	0 002 (0 85)	0 98	0 53	0 00554
SM3	-9 97	1 76* (12 96)	-0 003 (-0 118)	0 96	0 27	0 004662
DM4	-10 95	1 42* (15 33)	0 002 (0 77)	97	0 58	0 005196
SM4	-9 24	1 71* (13 67)	-0 006 (-0 23)	0 97	0 31	0 004246
DM5	-11 45	1 49* (22 21)	-0 0006 (-0 32)	0 98	0 58	0 004747
SM5	-9 61	1 72* (14 08)	-0 006 (-0 26)	0 96	0 30	0 004246
DM6	-12 27	1 56* (21 65)	-0 0006 (-0 27)	0 98	0 52	0 005159
SM6	-10 48	1 79* (13 18)	-0 003 (-0 12)	0 96	0 26	0 004729
DM7	-4 96	1 08* (17 24)	-0 02 (-2 14)	0 98	1 02	0 003943
SM7	-2 69	1 07* (18 24)	-0 003* (-2 87)	0 97	1 42	0 002267

Note Values inside parentheses are t-statistics
* indicates significant at 1% level

Table 4.7

Descriptive Statistics of Growth rates of Monetary Aggregates

(Monthly Data)

Monetary Aggregates	Mean	Standard Deviation
M1	1 28	1 67
M2	1.24	1 60
M3	1.39	3 08
M4	1 36	2 73
DM1	1 27	1 65
DM2	1.24	1 59
DM3	1 32	1 04
DM4	1 31	1 03

Table4.8

Ranking of Aggregates according to their

Information Content Based on $\bar{R}^2$*

(Monthly Data)

RANK	IIP	WPI	IIP
1	DM2	DM1	RM2
2	SM2	SM1	RDM2
3	DM1	DM2	RDM1
4	SM1	SM2	RSM1
5	DM4	DM3	RDM4
6	DM3	DM4	RDM3
7	SM4	SM3	RSM4
8	SM3	SM4	RSM3

Table 4.9

DAVIDSON AND MACKINNON(1981) J TEST

H_0 : GOAL = βDIVISIA + U_0

H_1 : GOAL = γSUM + U_1

GOAL = WPI

(Monthly Data)

SM1 v DM1	Do not reject H_0 (-0.25)	Do not reject H_1 (0 46)	Can not reject either specification
SM2 v DM2	Do not reject H_0 (2.16)	Do not reject H_1 (-1 97)	-do-
SM3 v DM3	Do not reject H_0 (0 29)	Reject H_1 (4 91)	Summation model rejected but Divisia model is not
SM4 v DM4	Do not reject H_0 (0 36)	Reject H_1 (-8 44)	-do-

Note: Figures in parentheses are t-statistics

Table 4.10

DAVIDSON AND MACKINNON(1981) J TEST

H_0 : GOAL = βDIVISIA + U_0

H_1 : GOAL = γSUM + U_1

GOAL = IIP

(Monthly Data)

SM1 v DM1	Do not reject H_0 (-1.32)	Do not reject H_1 (1 41)	Can not reject either specification
SM2 v DM2	Reject H_0 (-3 16)	Reject H_1 (3 24)	Neither model provides complete specificaton
SM3 v DM3	Do not reject H_0 (0.463)	Do not reject H_1 (0 462)	Can not reject either specification
SM4 v DM4	Do not reject H_0 (-2 17)	Reject H_1 (-4 33)	Summation model rejected but Divisia model is not

Note: Figures in parentheses are t-statistics

Table 4.11

Money Demand Equations (Estimated by OLS)

(Monthly Data)

Monetary Aggregates	Constant	IIP	Opp Cost	R^2	D.W	Theil'sU
DM1	0.15	1.03* (46.69)	-0.002 (-0.81)	0.97	1.12	0.003807
SM1	5.29	1.02* (60.29)	-0.0001 (-0.22)	0.97	1.08	0.001933
DM2	0.36	0.98* (48.68)	-0.002 (-0.84)	0.97	1.12	0.003667
SM2	5.66	0.97* (60.00)	-0.0001 (-0.20)	0.97	1.09	0.001820
DM3	-0.11	1.07* (65.14)	-0.0009 (-1.38)	0.97	1.04	0.003730
SM3	5.91	1.11* (62.50)	-0.001 (-1.87)	0.97	0.98	0.001837
DM4	-0.02	1.05* (65.17)	-0.0009 (-1.33)	0.97	1.04	0.003660
SM4	6.05	1.09* (62.61)	-0.001 (-1.89)	0.97	0.99	0.001793

Note: Figures in parentheses are t-statistics.

* indicates significant at 1% level.

Table 4.12
KPSS Unit Root Statistics
for Variables in Levels
(Monthly Data)

	Without Trend				With Trend			
Variables	k=1	k=2	k=3	k=4	k=1	k=2	k=3	k=4
lrdm1	6.7551	4.5548	3.4516	2.7887	0.3797	0.2719	0.2178	0.1855
lrdm2	6.7424	4.5468	3.4458	2.7843	0.3824	0.2734	0.2188	0.1861
lrdm3	6.0167	4.5847	3.4732	2.8055	0.8165	0.5751	0.4517	0.3756
lrdm4	6.7982	6.7982	4.5825	3.4716	2.8043	0.8041	0.5661	0.4446
lrm1	6.7571	4.5565	3.4530	2.7899	0.3722	0.2707	0.2172	0.1852
lrm2	6.7418	4.5468	3.4460	2.7846	0.3793	0.2716	0.2176	0.1853
lrm3	6.8112	4.5907	3.4776	2.8089	0.8792	0.6168	0.4827	0.3999
lrm4	6.8086	4.5891	3.4765	2.8089	0.8621	0.6048	0.4734	0.3923
liip	6.5874	4.4516	3.3780	2.7315	0.4916	0.3599	0.2914	0.2485
scallr	0.5174	0.3968	0.3309	0.2849	0.3912	0.3010	0.2519	0.2174
dp1	2.9147	2.0556	1.6032	1.3145	0.9590	0.6922	0.5489	0.4537
dp2	3.0318	2.1219	1.6467	1.3474	0.9882	0.7058	0.5556	0.4578
dp3	1.0267	1.0267	0.6991	0.5345	0.4357	0.9678	0.6594	0.5043
dp4	1.0147	0.6909	0.5283	0.4307	0.9695	0.6605	0.5052	0.4119

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. "l" and "r" refer to "log" and "real" respectively.

Table 4.13
Kpsss Unit Root Statistics
for Variables in First Differences
(Monthly Data)

	Without Trend				With Trend			
Variables	k=1	k=2	k=3	k=4	k=1	k=2	k=3	k=4
Δlrdm1	0.0316	0.334	0.354	0.040	0.025	0.026	0.028	0.032
Δlrdm2	0.031	0.032	0.034	0.039	0.025	0.027	0.028	0.033
Δlrdm3	0.103	0.114	0.133	0.161	0.046	0.052	0.061	0.074
Δlrdm4	0.099	0.110	0.128	0.154	0.046	0.052	0.061	0.074
Δlrm1	0.034	0.036	0.038	0.043	0.025	0.027	0.029	0.333
Δlrm2	0.032	0.034	0.036	0.041	0.026	0.027	0.295	0.338
Δlrm3	0.143	0.160	0.189	0.228	0.057	0.064	0.077	0.094
Δlrm4	0.136	0.152	0.181	0.217	0.057	0.064	0.076	0.093
Δliip	0.061	0.068	0.080	0.091	0.047	0.052	0.061	0.069
Δscallr	0.015	0.020	0.029	0.036	0.012	0.016	0.023	0.029
Δdp1	0.095	0.119	0.193	0.235	0.017	0.224	0.037	0.464
Δdp2	0.109	0.135	0.213	0.253	0.019	0.024	0.039	0.485
Δdp3	0.262	0.265	0.266	0.261	0.085	0.087	0.088	0.087
Δdp4	0.263	0.266	0.267	0.261	0.084	0.087	0.088	0 087

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 "l" and "r" refer to "log" and "real" respectively.

TABLE 4.14
Johansen-JuseliusCointegration Test
for MoneyDemand Stability
(Monthly Data)

System	Null	Trace	λ Max	Cointegrating Vectors
lrdm1, liip, dp1	r = 0	56.7589*	34.2778*	[1.00 1.08 -0.003]
	r≤ 1	22.4811*	14.8724	[1.00 1.03 -0.01]
	r≤2	7.6087	7.6087	
lrdm2, liip, dp2	r = 0	57.6486*	35.2070*	[1.00 1.03 -0.003]
	r≤ 1	22.4416*	15.1643	[1.00 0.98 -0.01]
	r≤2	7.2773	7.2773	
lrdm3, liip, dp3	r = 0	65.2624*	37.6669*	[1.00 1.20 0.006]
	r≤ 1	27.5954*	21.0456*	[1.00 1.08 -0.001]
	r≤2	6.5498	6.5498	
lrdm4, liip, dp4	r = 0	65.2622*	37.3940*	[1.00 1.21 0.005]
	r≤ 1	27.8682*	21.3311*	[1.00 1.06 -0.001]
	r≤2	6.5371	6.5371	
lrm1, liip, callr	r = 0	56.6435*	30.9629*	[1.00 1.06 -0.002]
	r≤ 1	25.6806*	18.4036*	[1.00 1.07 -0.009]
	r≤2	7.2770	7.2770	
lrm2, liip, callr	r = 0	57.3178*	31.7669*	[1.00 0.99 -0.002]
	r≤ 1	25.5508*	18.3590*	[1.00 1.01 -0.009]
	r≤2	7.1918	7.1918	
lrm3, liip, callr	r = 0	79.1165*	46.0506*	[1.00 1.07 -0.01]
	r≤ 1	33.0659*	25.7730*	[1.00 1.43 -0.005]
	r≤2	7.2929	7.2929	
lrm4, liip, callr	r = 0	79.2642*	45.6772*	[1.00 1.06 -0.01]
	r≤ 1	33.5870*	26.3317*	[1.00 1.12 -0.005]
	r≤2	7.2553	7.2553	

Note: * denotes significant at 5% level. "l" and "r" refer to "log" and "real" respectively

Table 4.15

Descriptive Statistics of Growth rates of

Extended Monetary Aggregates

(Monthly Sample 1994:04 1996:07)

MONETARY AGGREGATES	MEAN	STANDARD DEVIATION
SM	2 29	3 72
DM	1 07	2 48
SMN	1 92	2 57
DMN	1 07	1 92

Table 4.16

Extended Aggregates ranked according to their

Information content base on $\overline{R}^2$.

RANK	IIP	WPI	IIP
1	SM	SMN	RDMN
2	SMN	SM	RSM
3	SM	DM	RSMN
4	DM	DMN	RDM

Table 4.17
OLS estimates of Money Demand Equations for Extended Aggregates (Monthly Sample 1994:04 1996:07)

Monetary Aggregates	Constant	IIP	Opp. Cost	R^2	D-W.	Theil's U
DMN	-0.13	1 10* (9 94)	-0 0006 (-0 25)	0 85	0 69	0 002969
SMN	-1.25	2 17* (11 41)	-0 004* (-2 06)	0 86	0 89	0 002914
DM	2.04	0 48* (5 48)	-0 002 (-1 21)	0 51	0 74	0 003711
SM	-1.42	1 94* (8 88)	-0 005 (-1 92)	0 76	0 81	0 003863

Note * indicates significant at 1% level

Figure 1. Divisia M1 (Annual Observations)

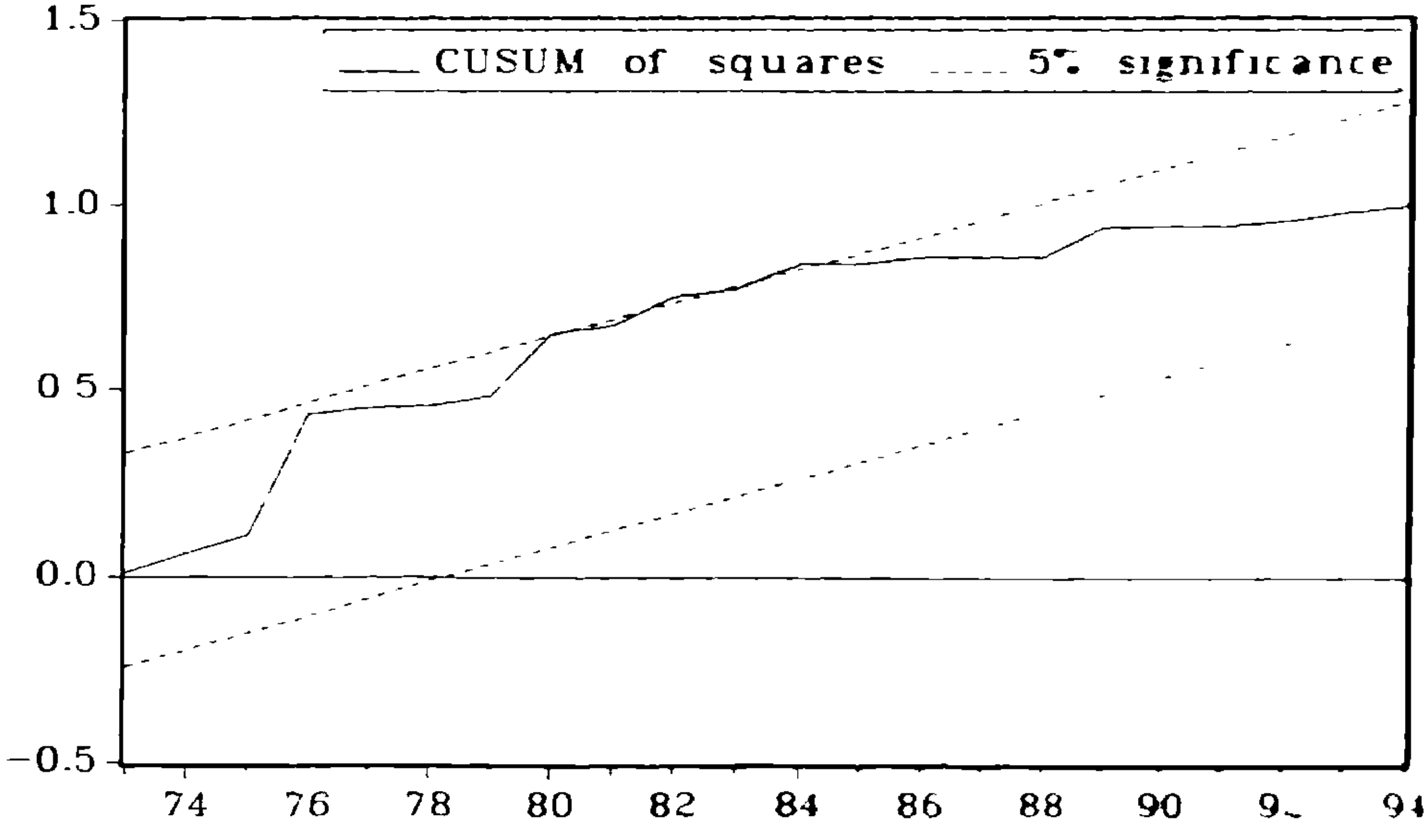


Figure 2 .Simple Sum M1 (Annual Observations)

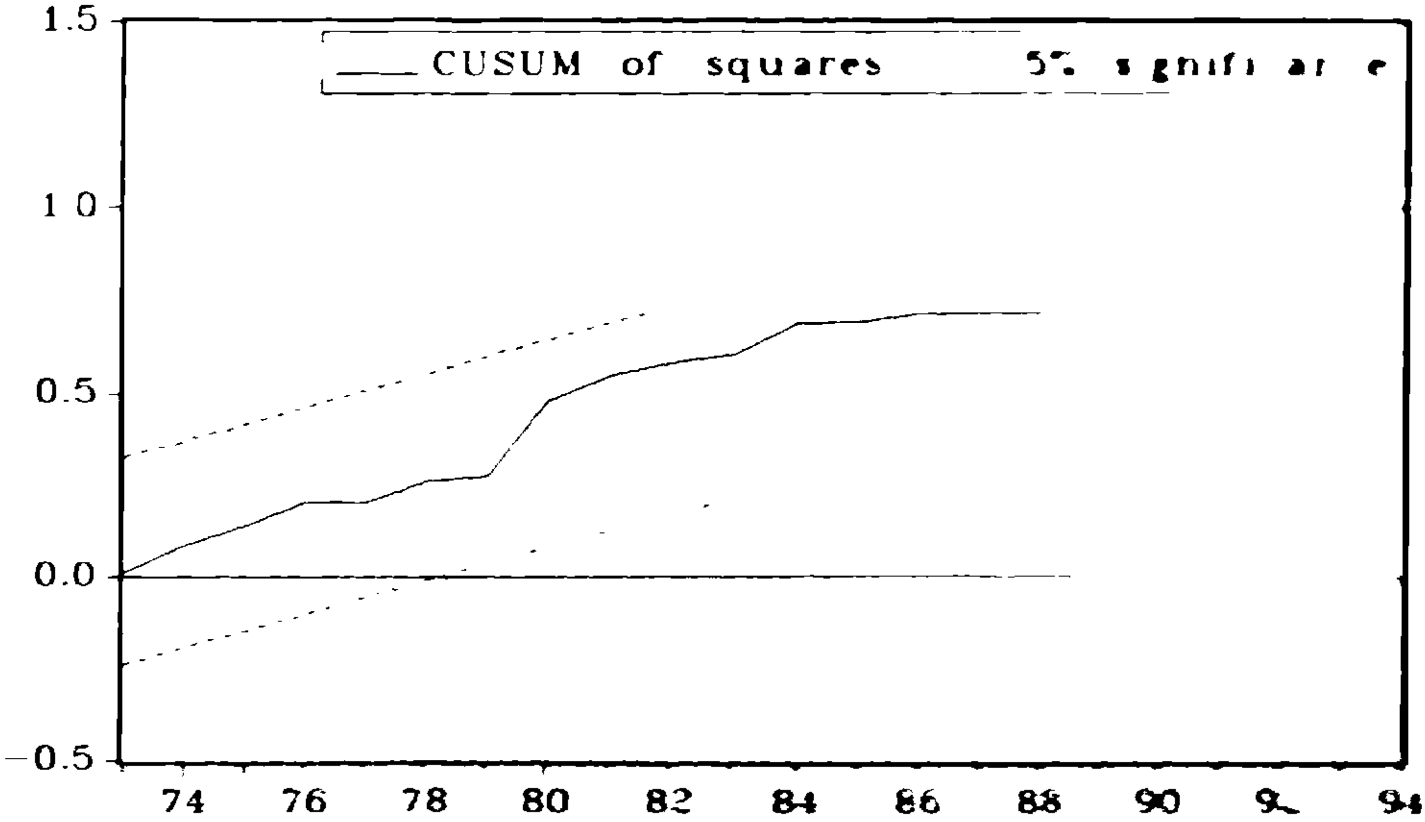


Figure 3. Divisia M2 (Annual Observations)

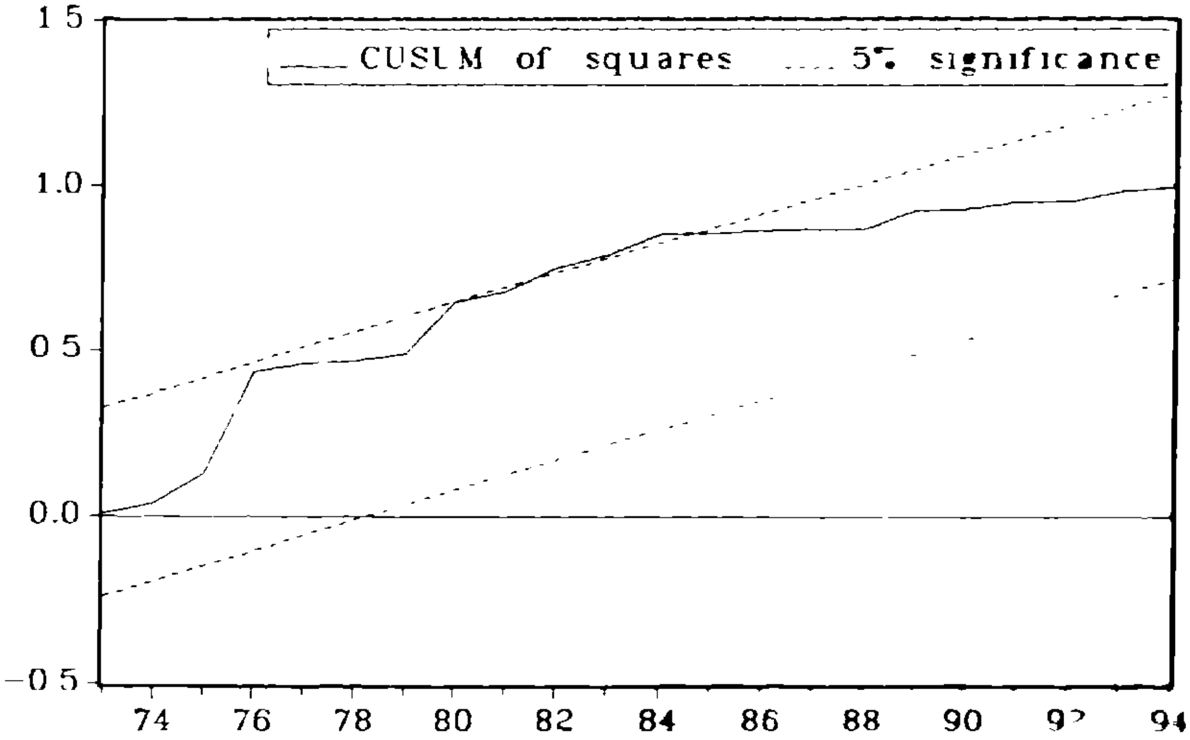


Figure 4. Simple Sum M2 (Annual Observations)

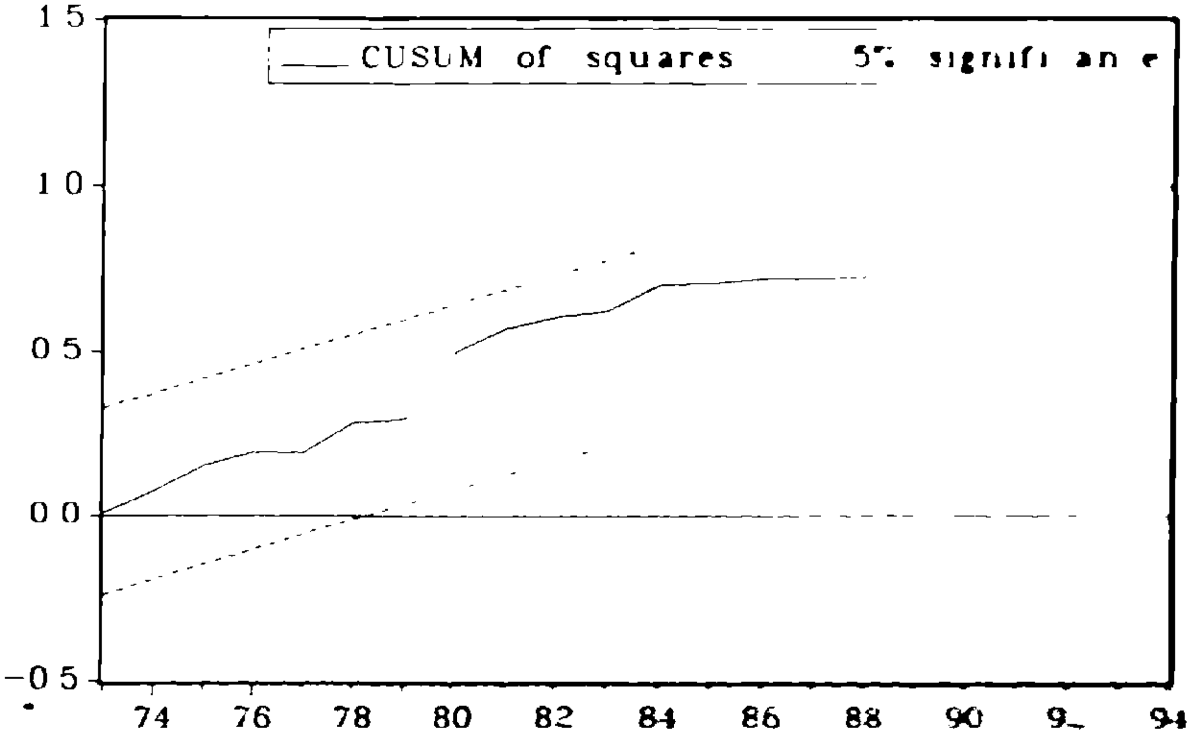


Figure 5. Divisia M3 (Annual Observations)

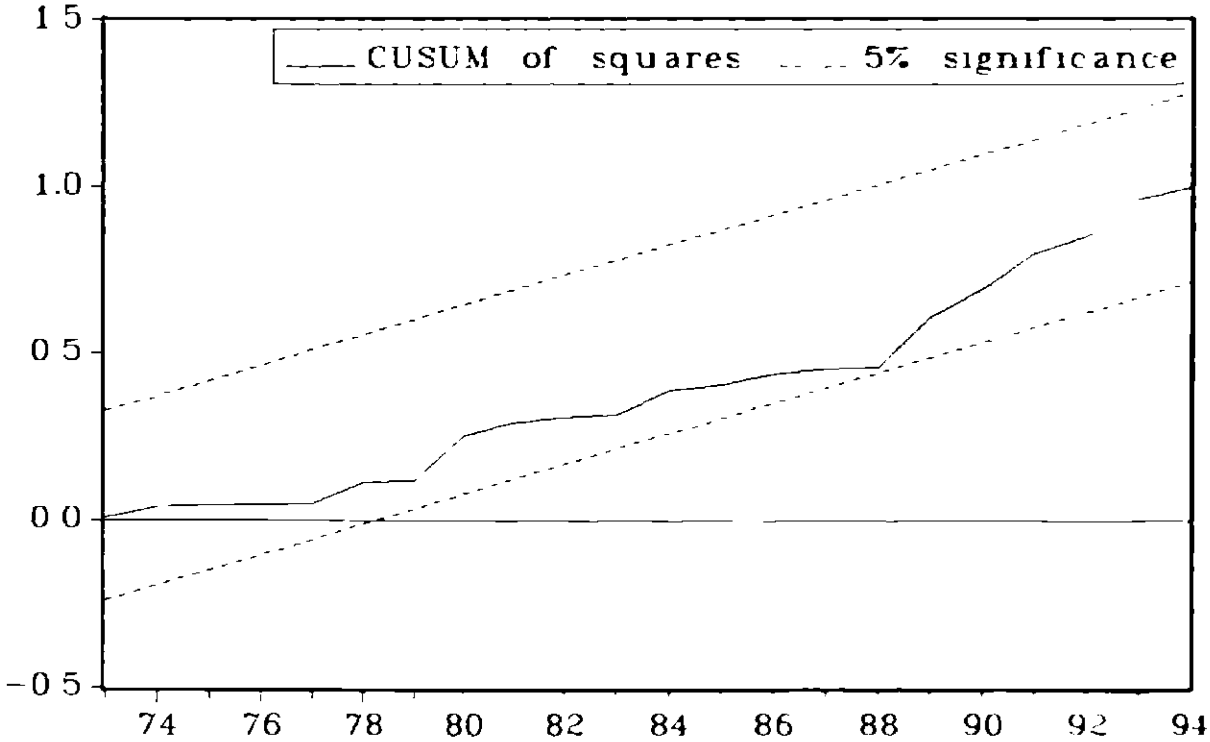


Figure 6. Simple Sum M3 (Annual Observations)

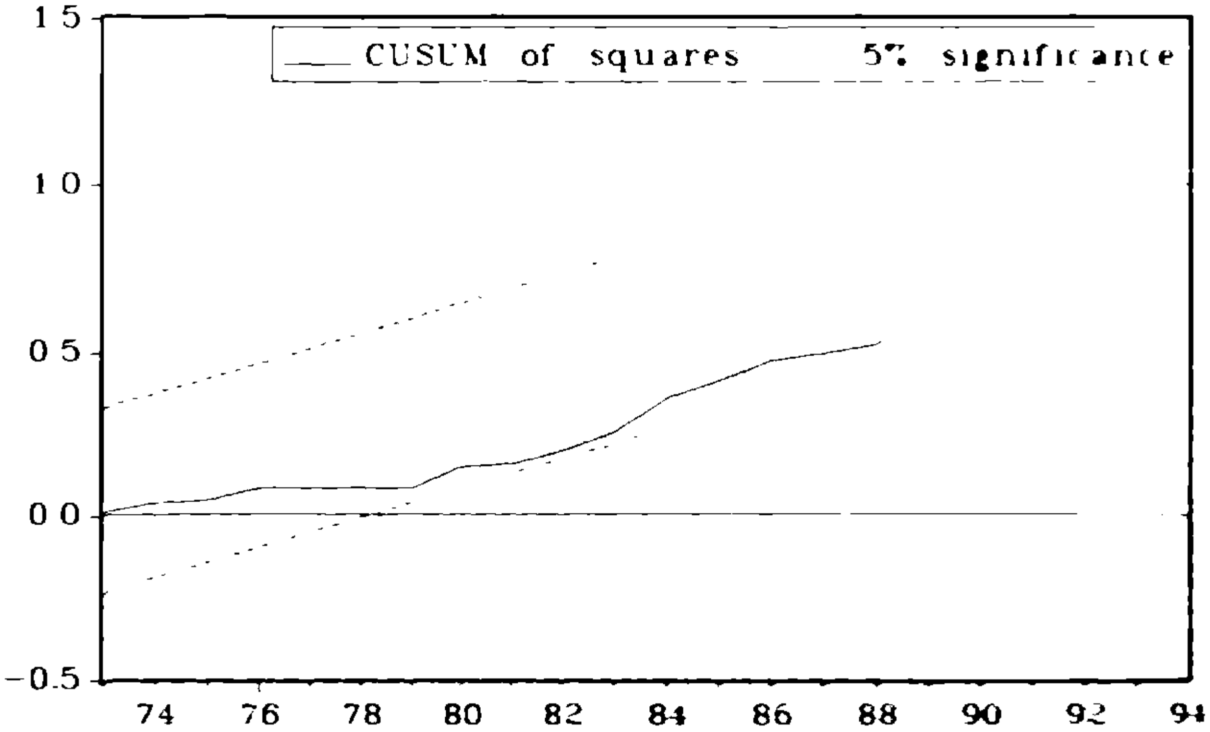


Figure 7. Divisia M4 (Annual Observations)

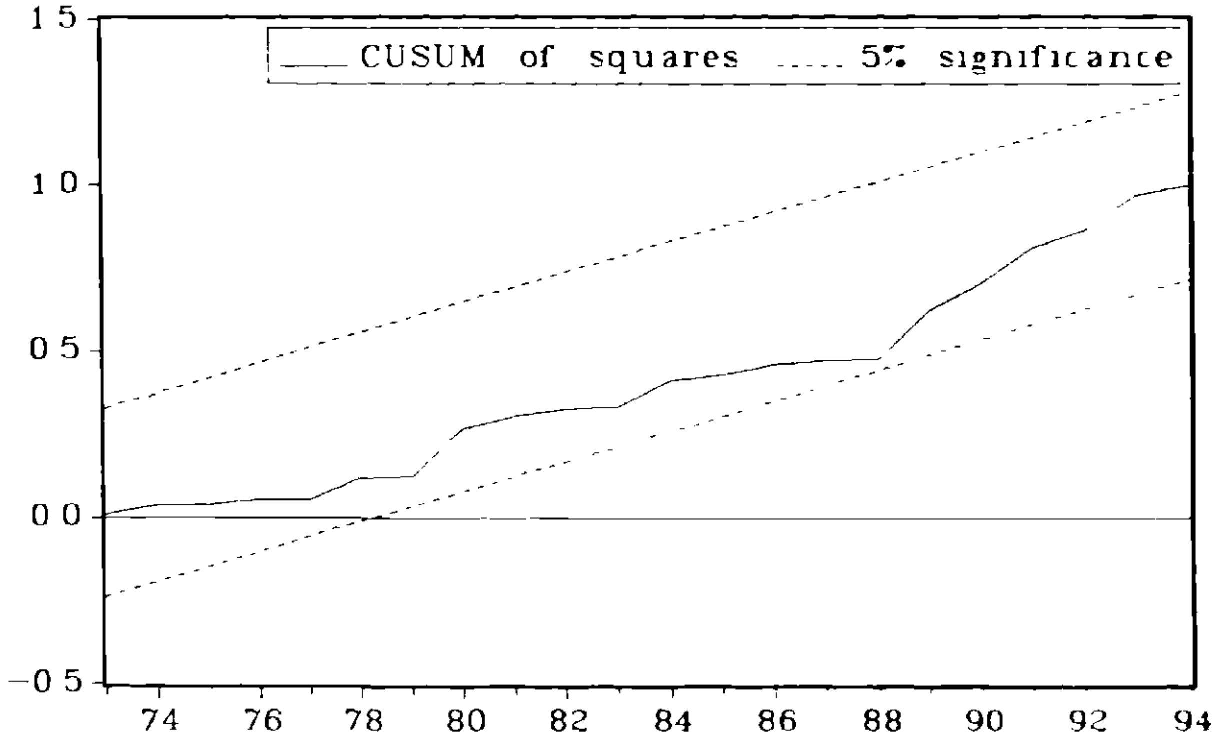


Figure 8. Simple Sum M4 (Annual Observations)

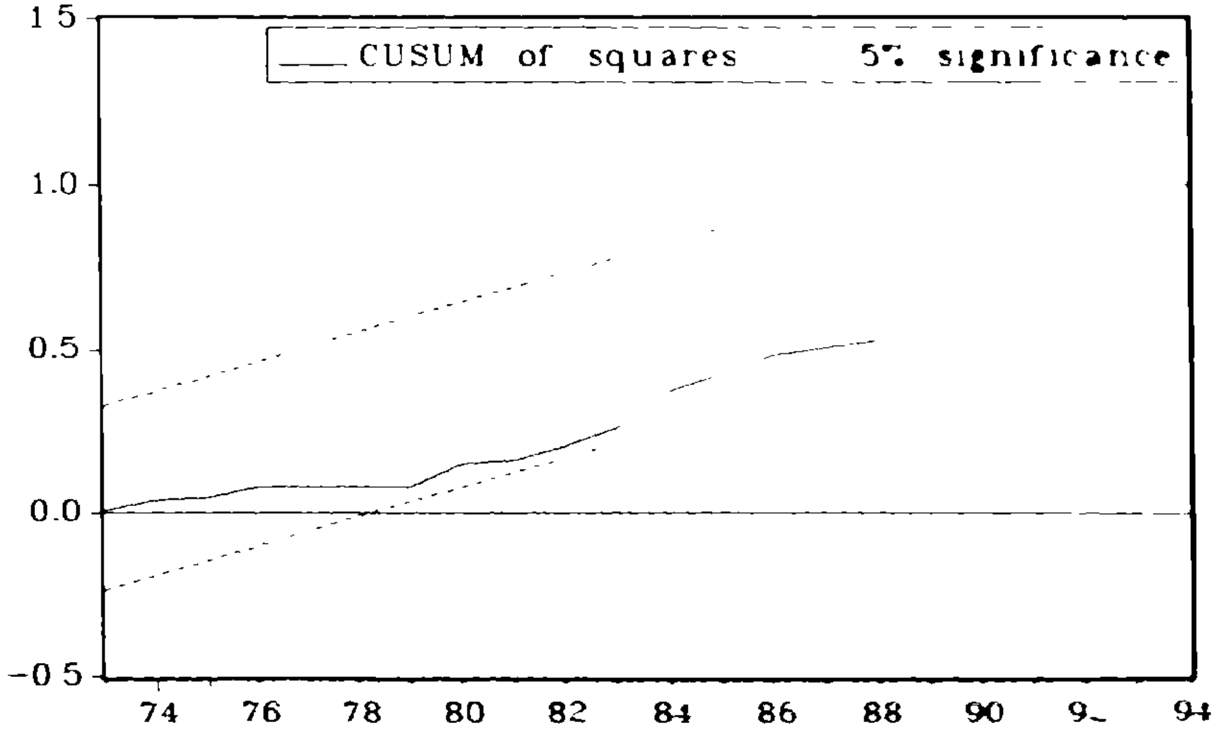


Figure 9. Divisia M5 (Annual Observations)

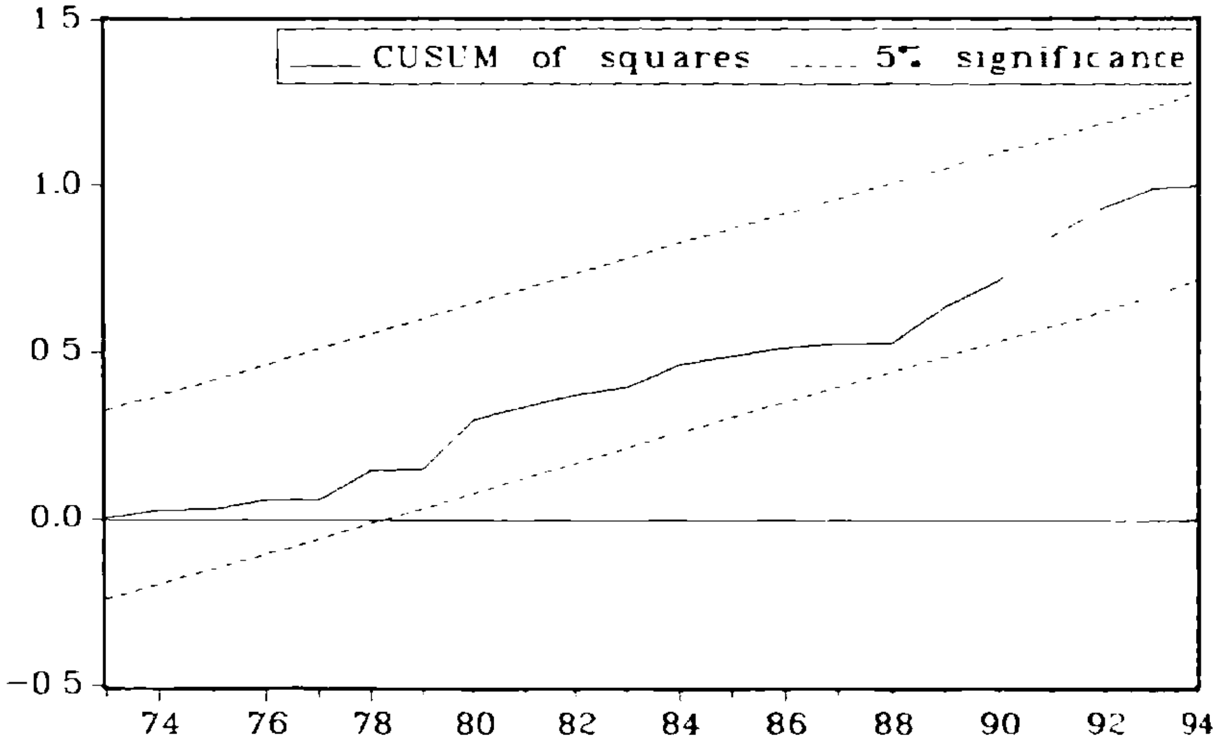


Figure 10. Simple Sum M5 (Annual Observations)

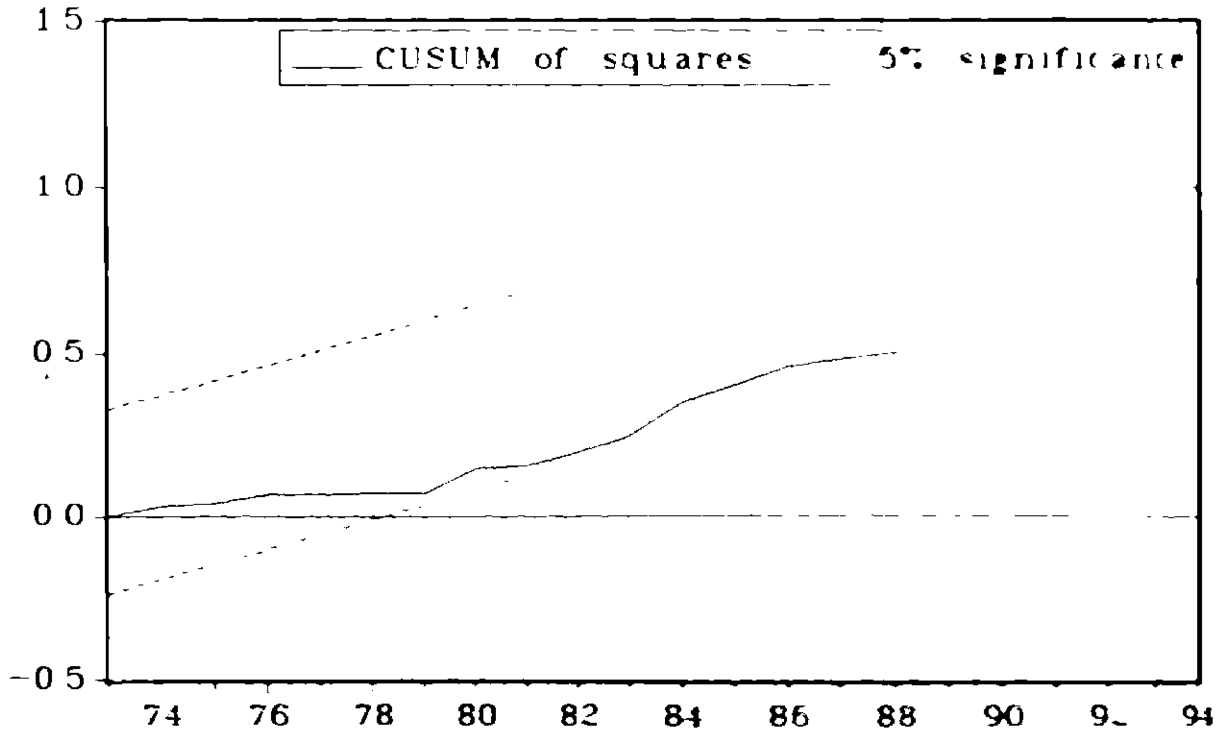


Figure 11. Divisia M6 (Annual Observations)

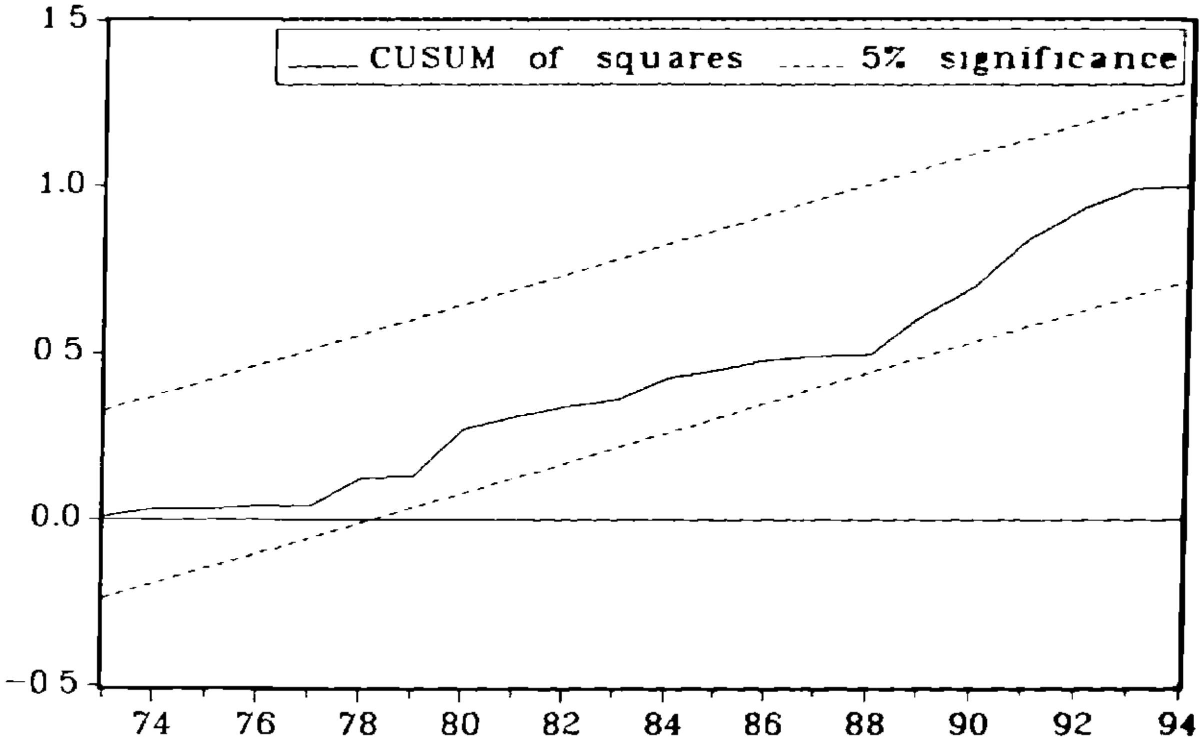


Figure 12. Simple Sum M6 (Annual Observations)

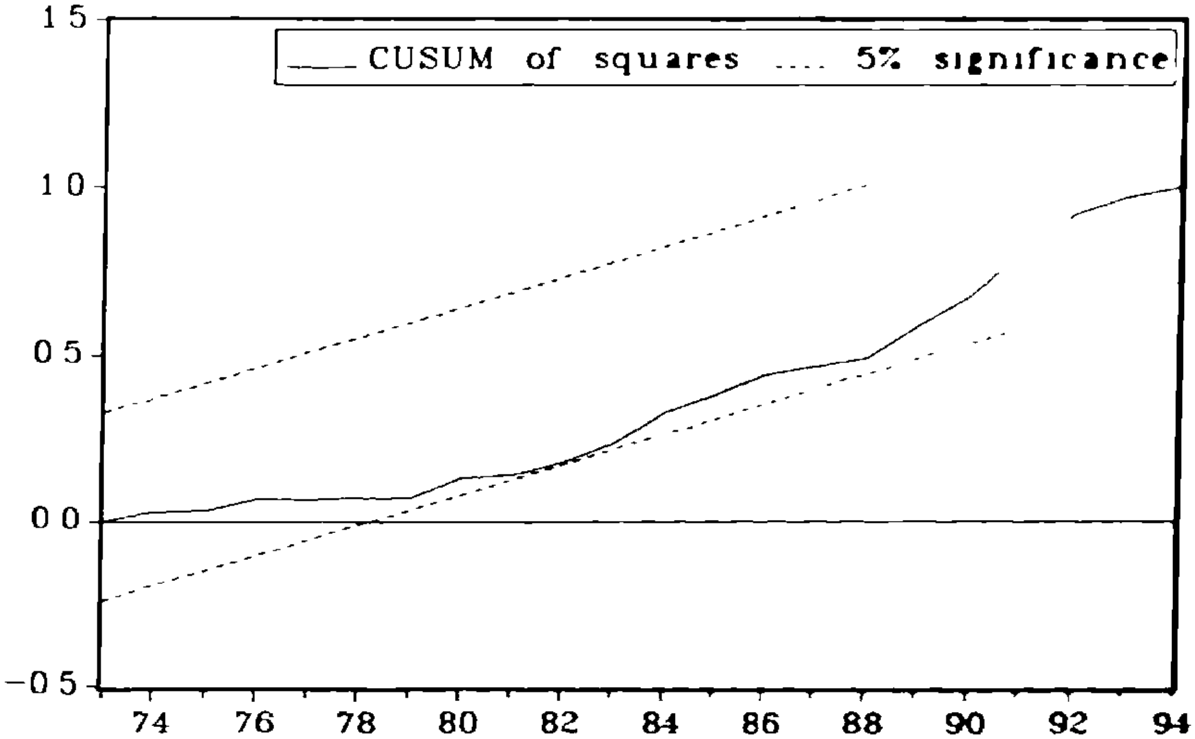


Figure 13. Divisia M7 (Annual Observations)

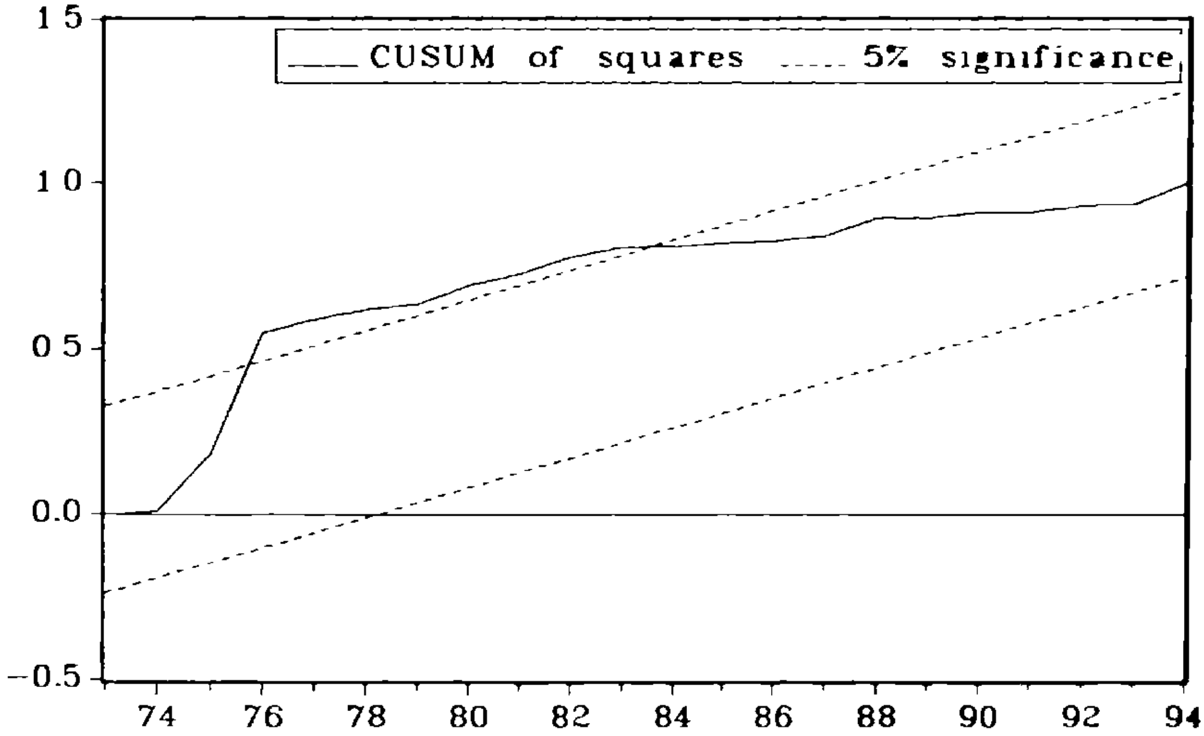


Figure 14. Simple Sum M7 (Annual Observations)

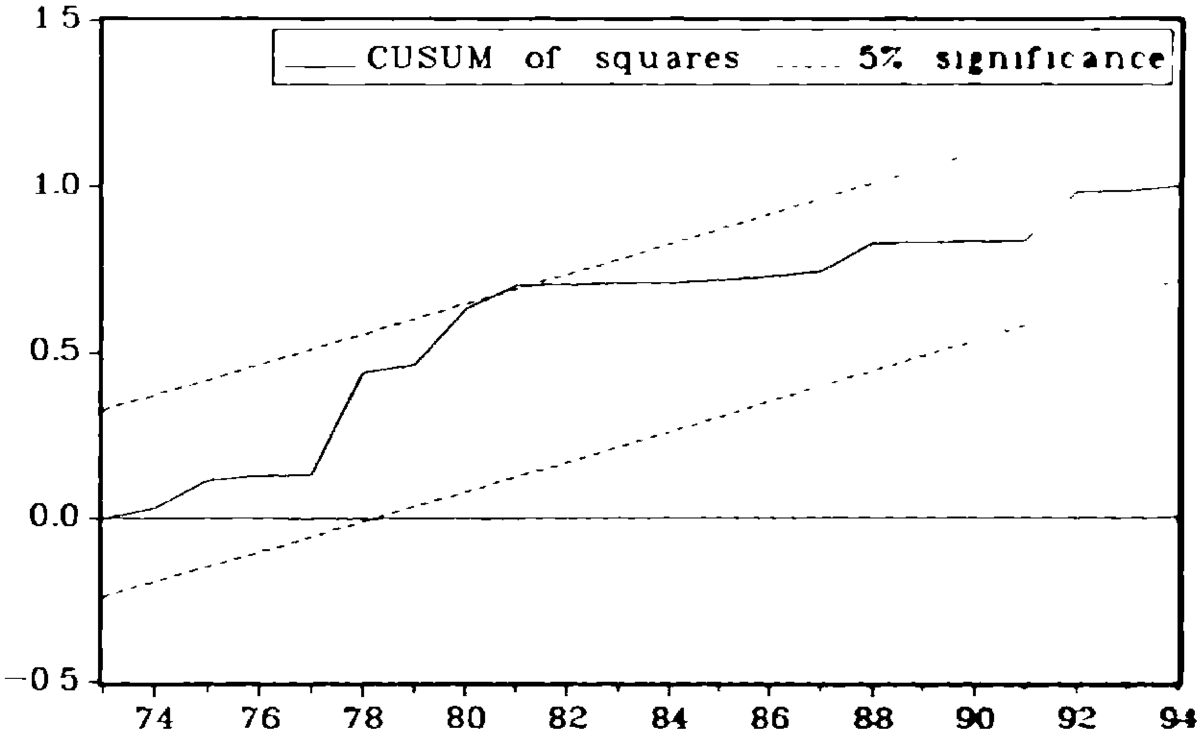


Figure 15. Simple Sum M1 (Monthly Observations)

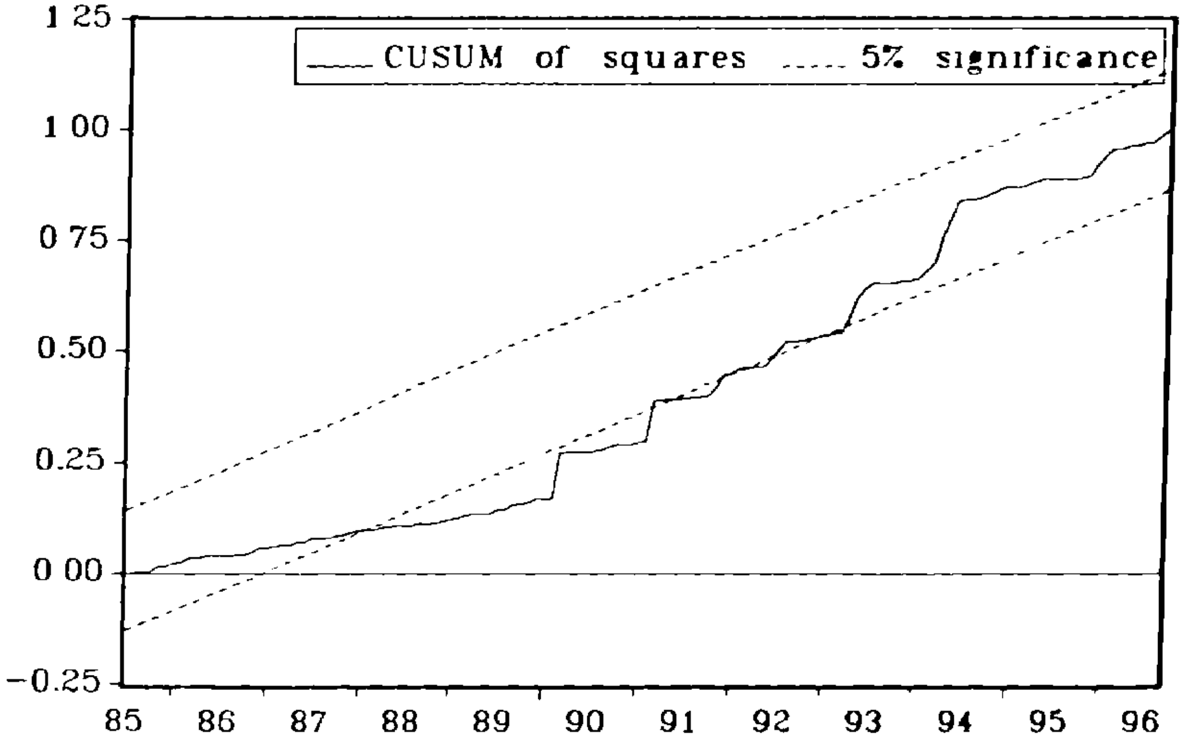


Figure 16. Divisia M1 (Monthly Observations)

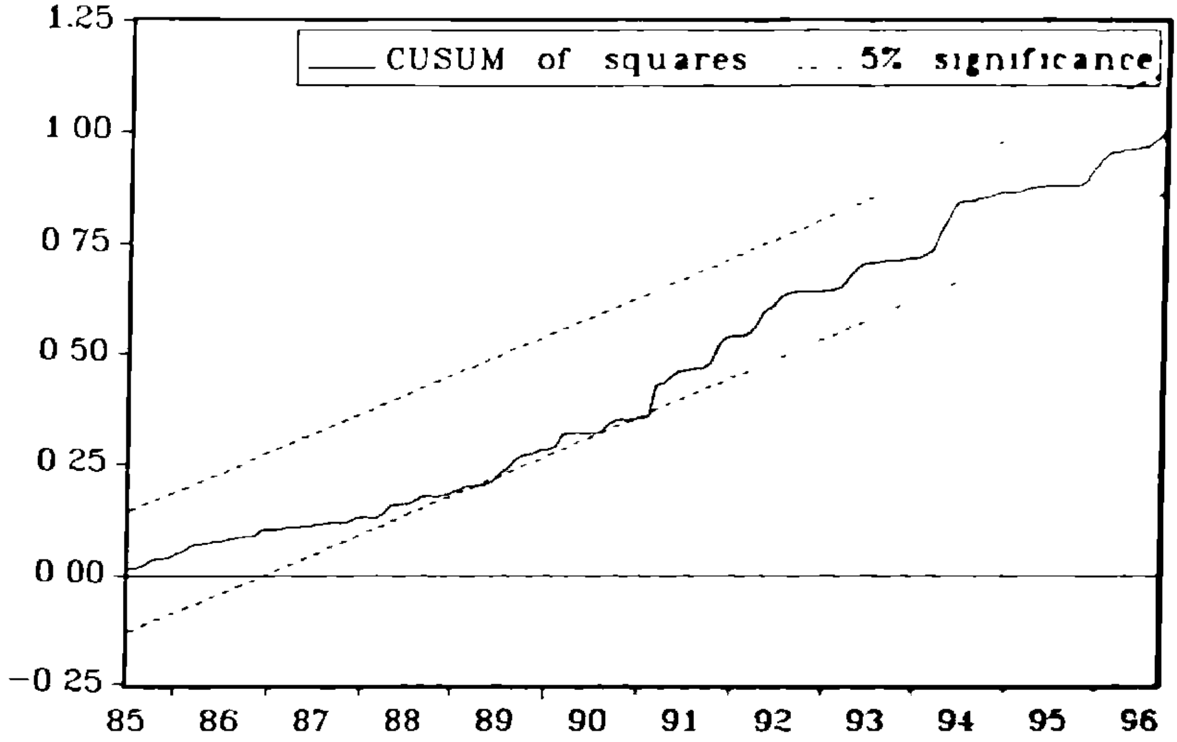


Figure 17. Simple Sum M2 (Monthly Observations)

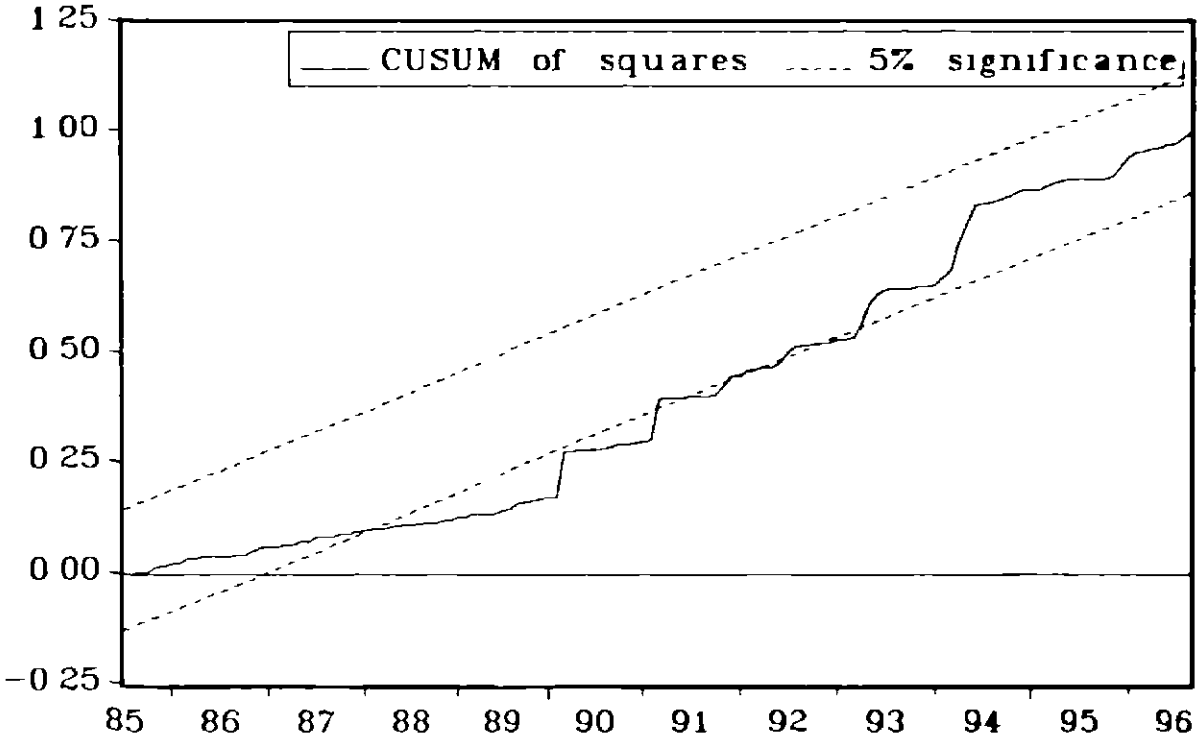


Figure 18. Divisia M2 (Monthly Observations)

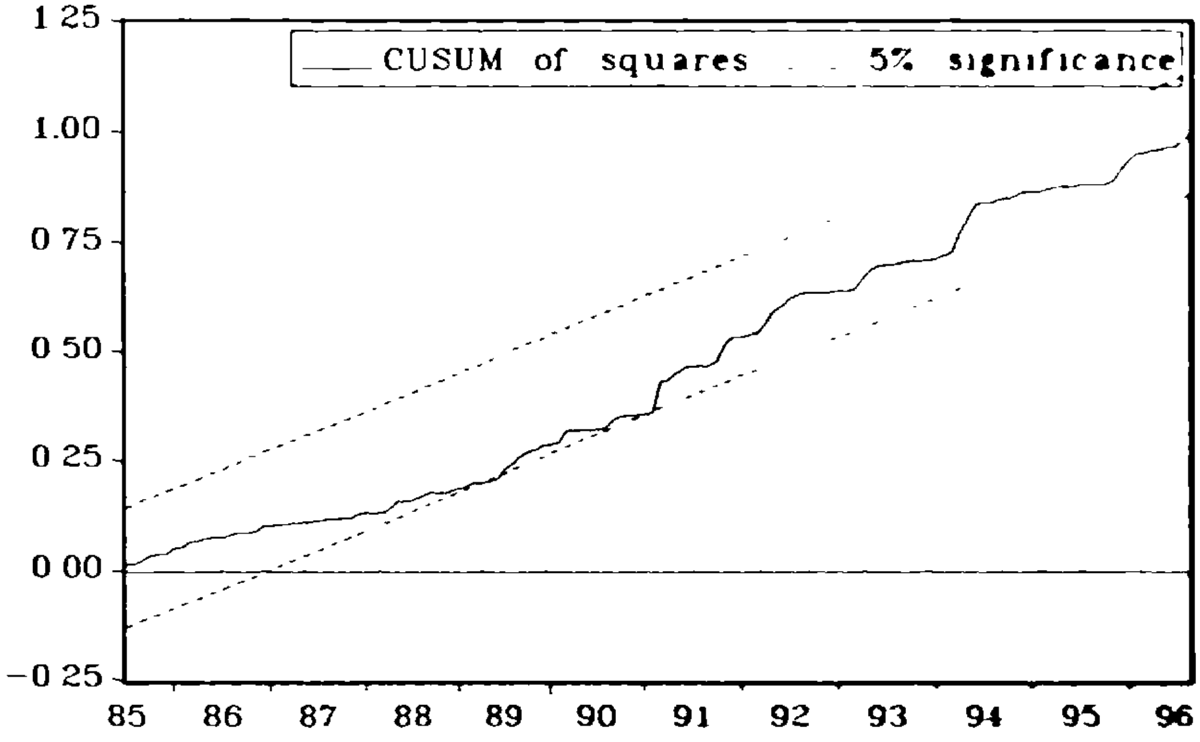


Figure 19 Simple Sum M3 (Monthly Observations)

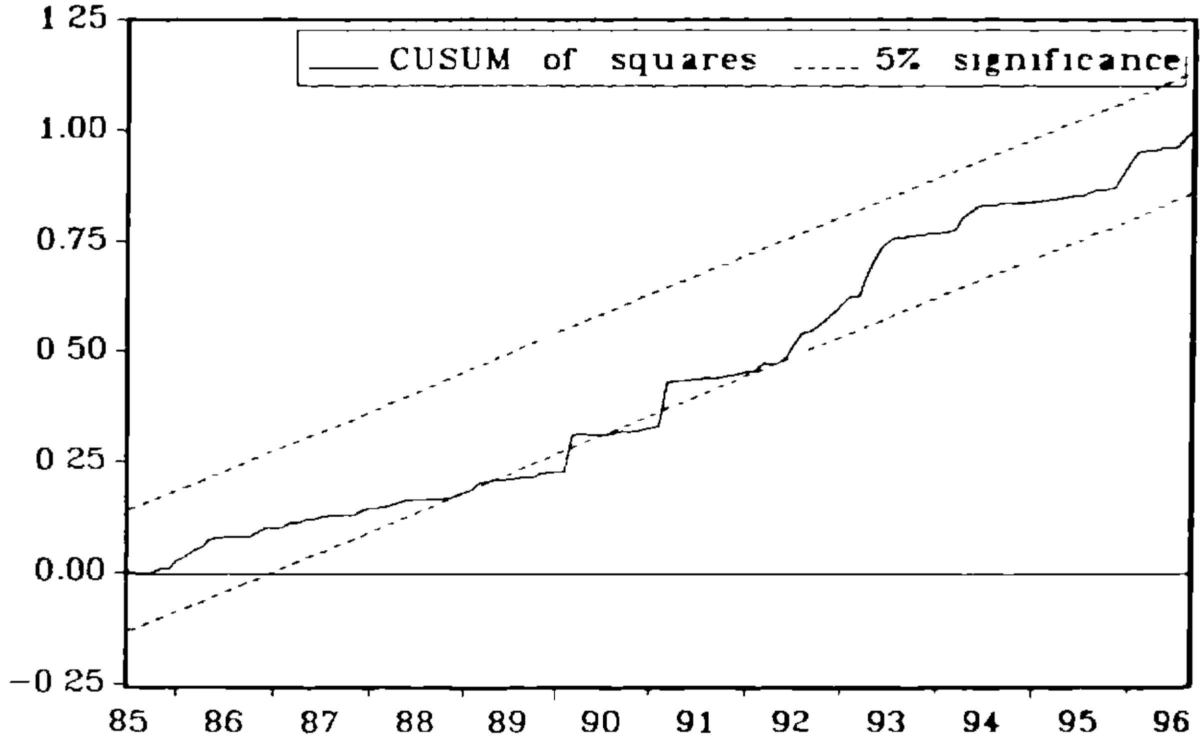


Figure 20. Divisia M3 (Monthly Observations)

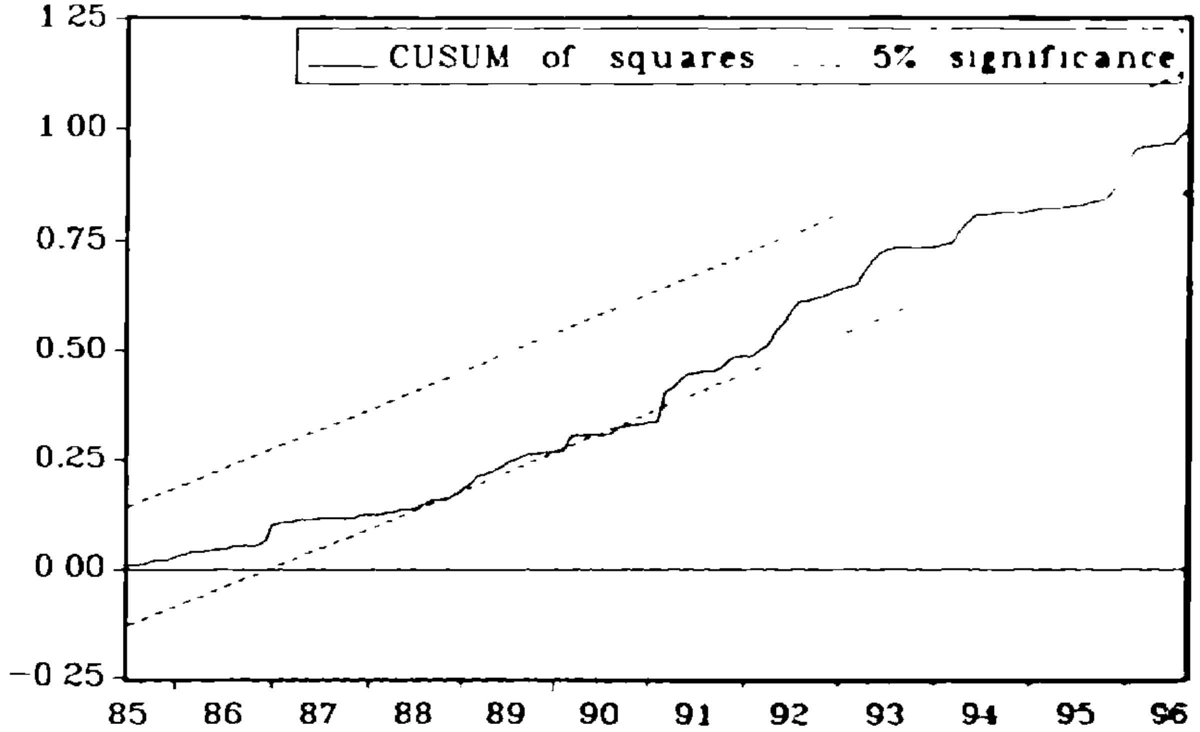


Figure 21. Simple Sum M4 (Monthly Observations)

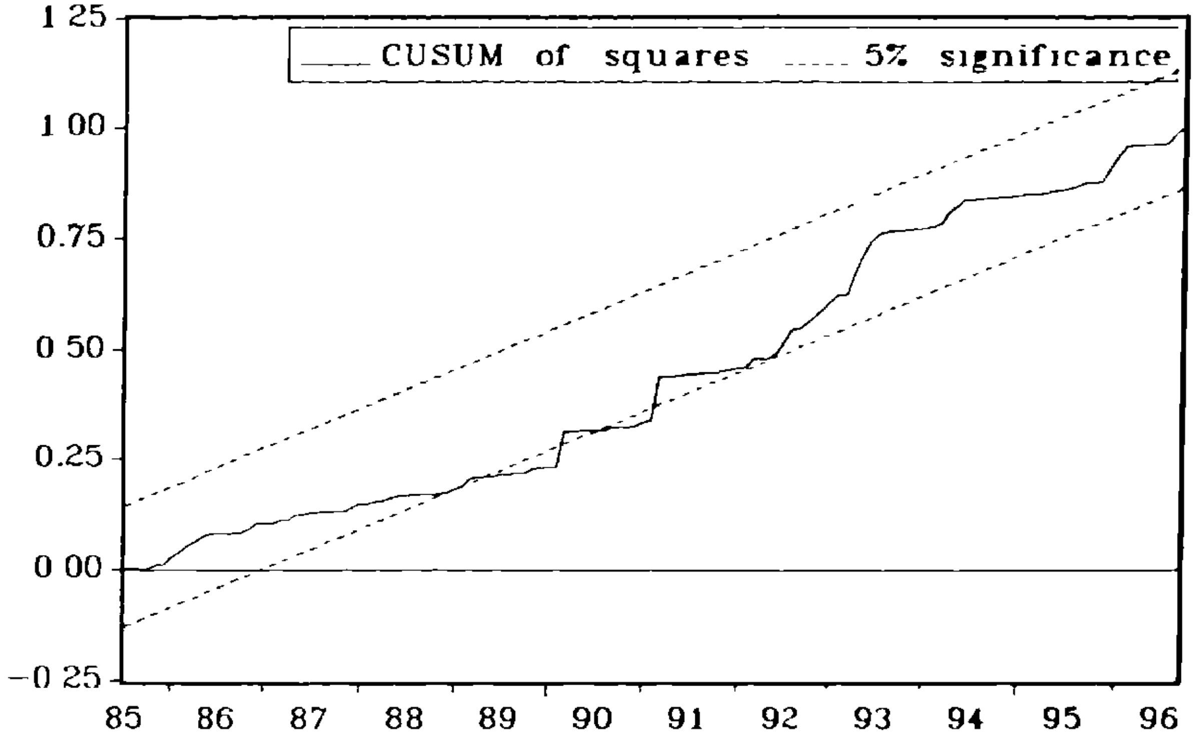


Figure 22. Divisia M4 (Monthly Observations)

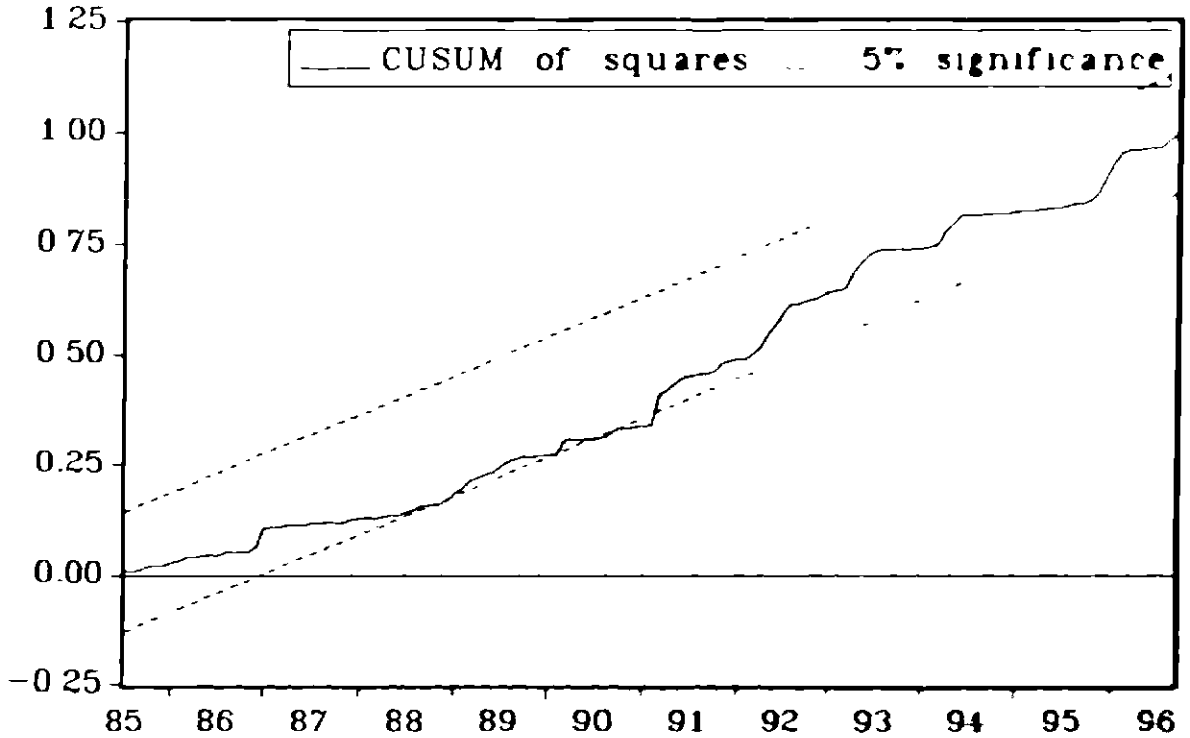


Figure 23 Time Path of DM and SM

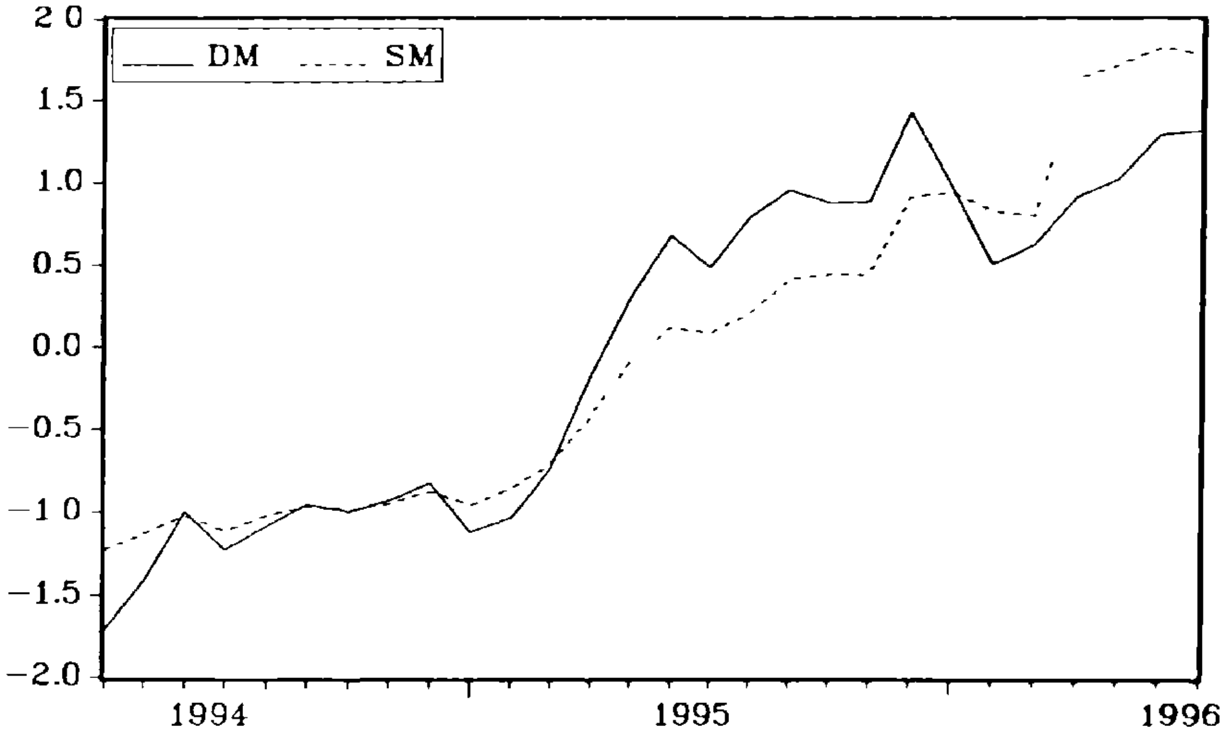


Figure 24 Growth Rates of DM and SM

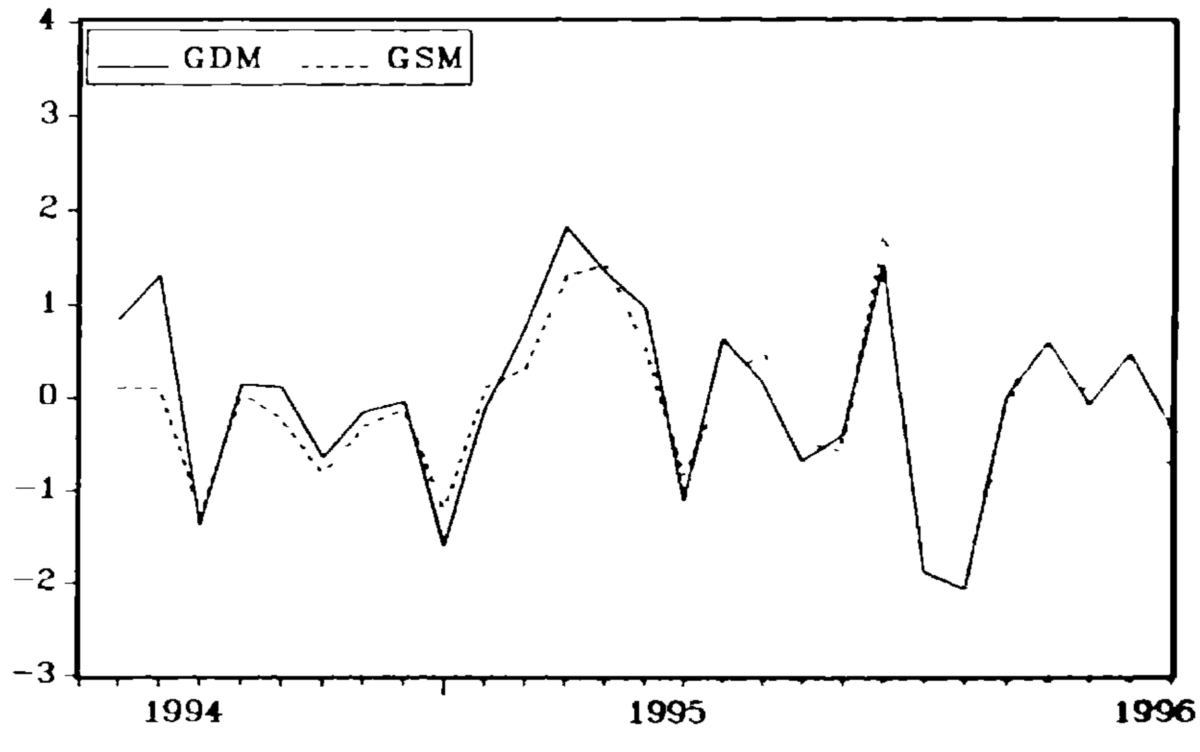


Figure 25. Time Path of DMN and SMN

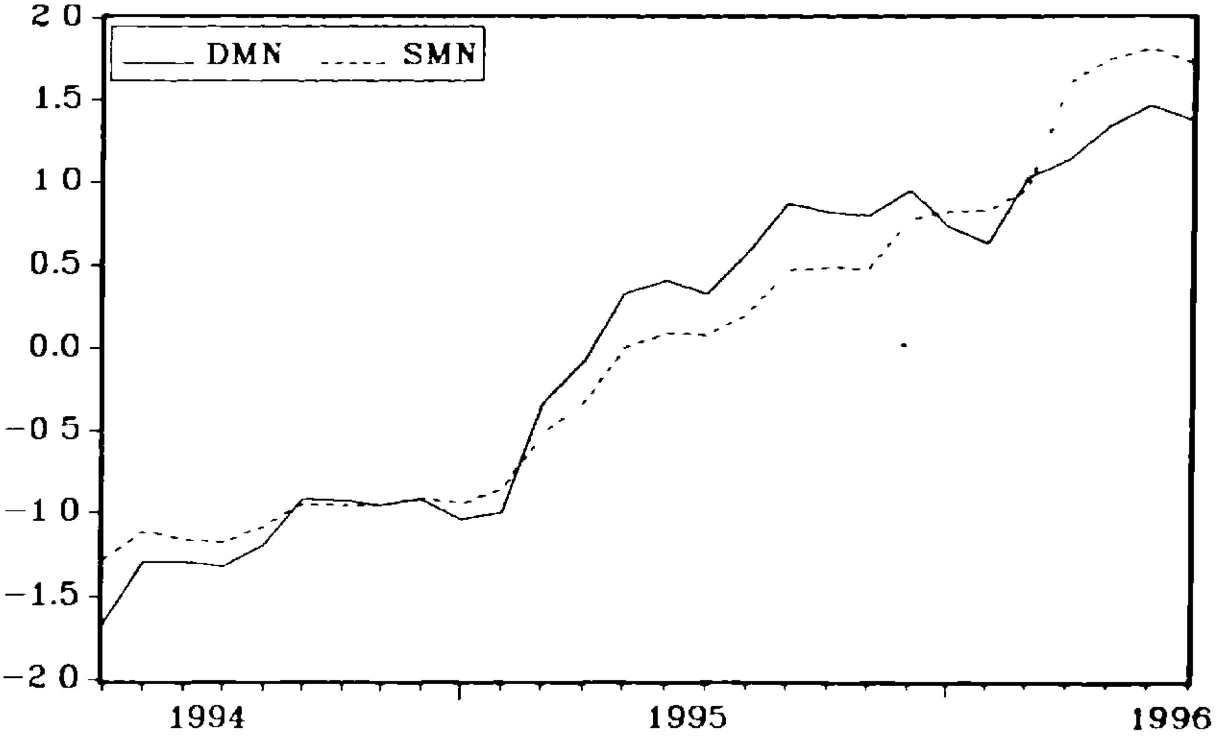


Figure 26. Growth Rates of DMN and SMN

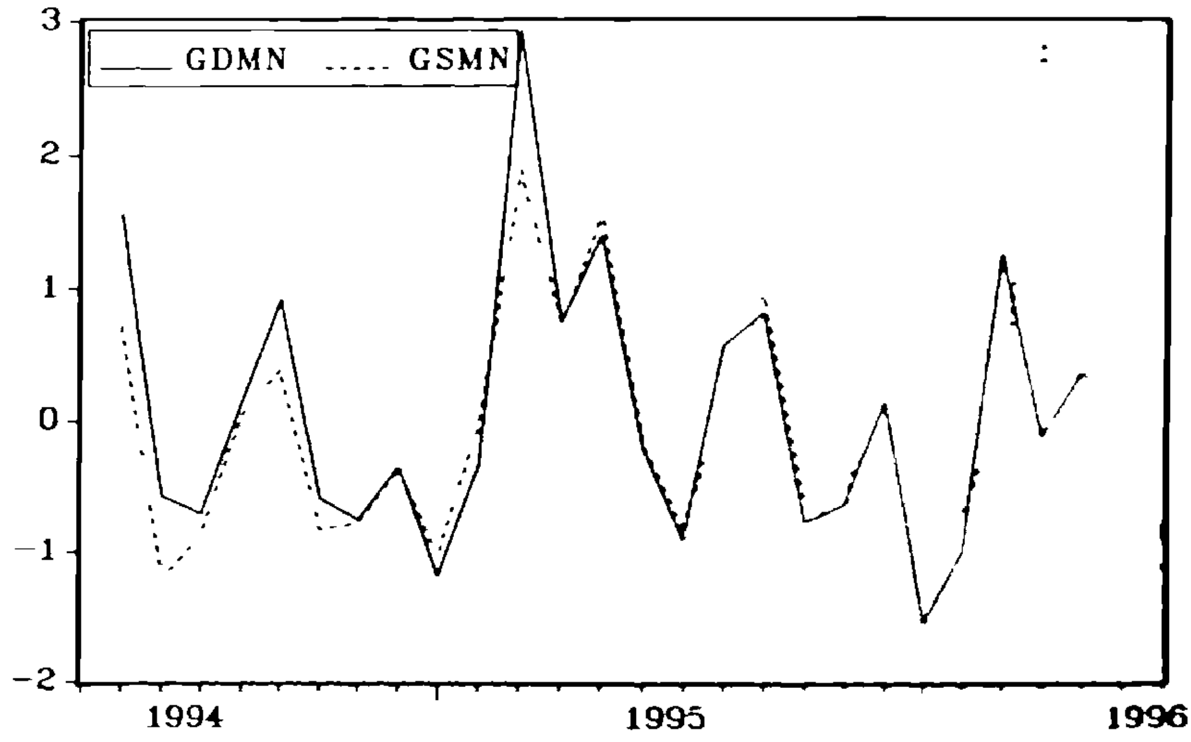


Figure 27. CUSUM Square Plot of DM

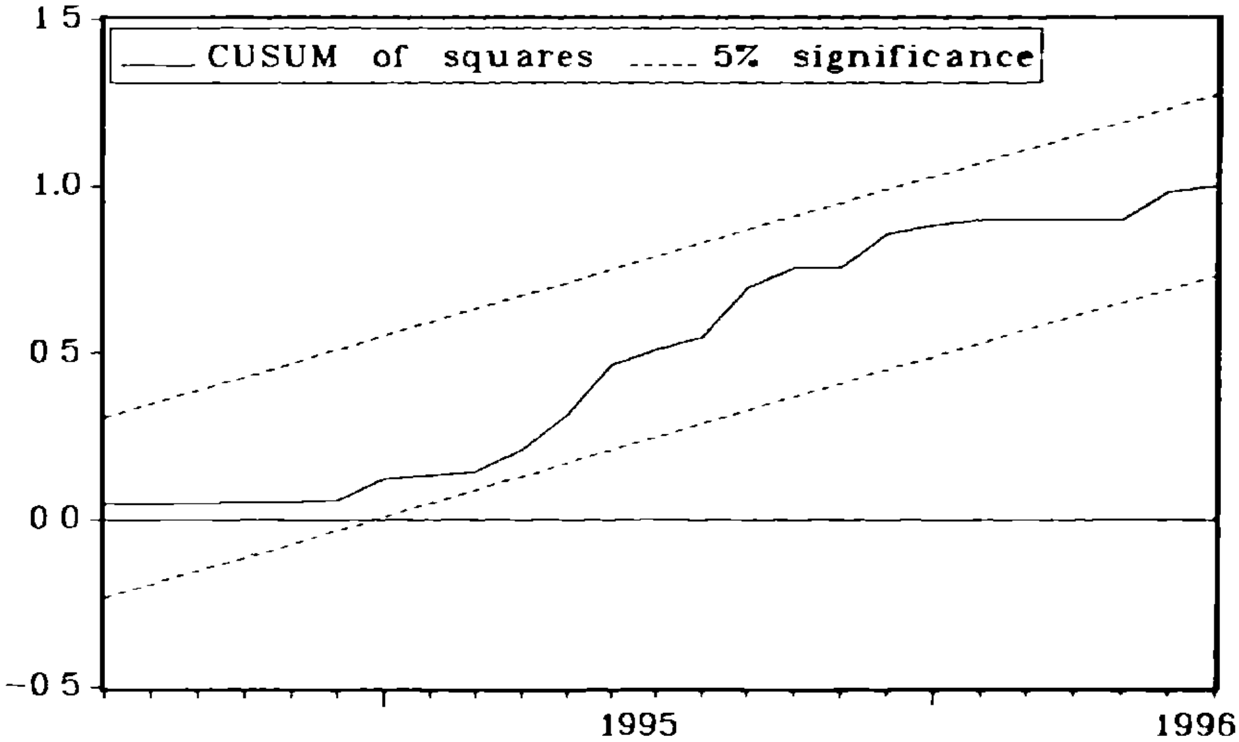


Figure 28. CUSUM Square Plot of SM

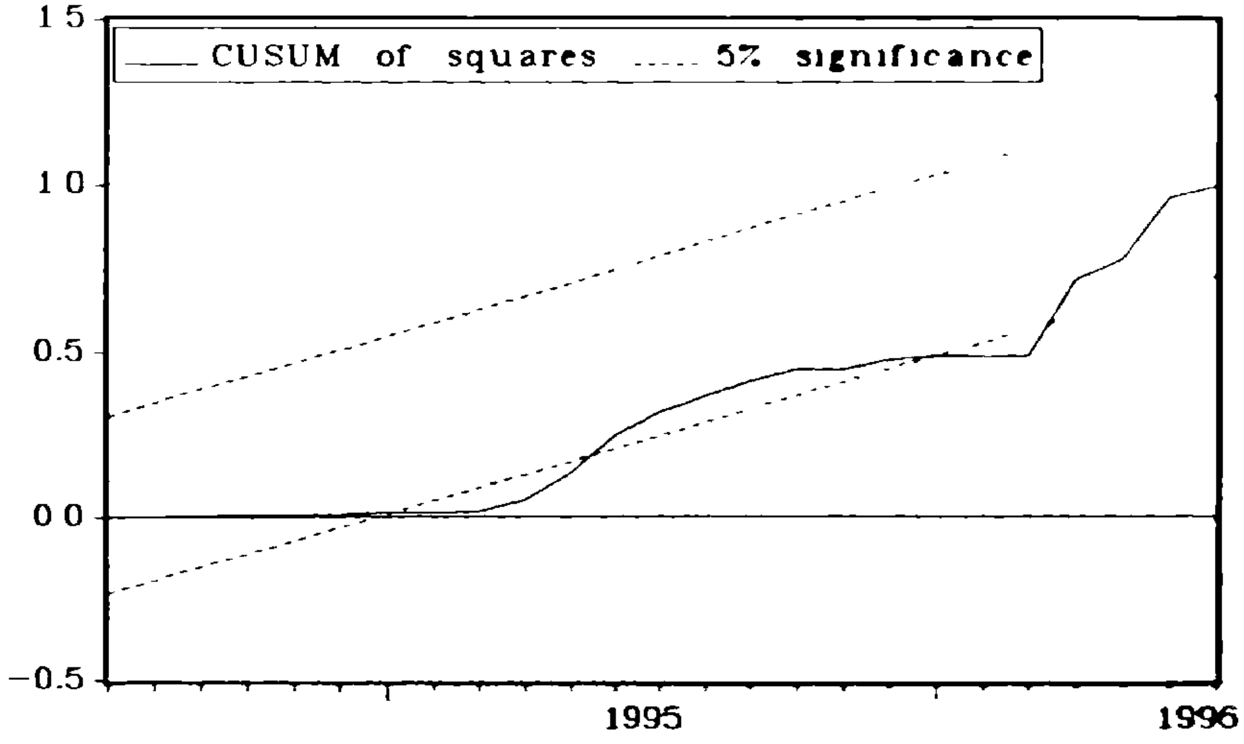


Figure 29. CUSUM Square Plot of DMN

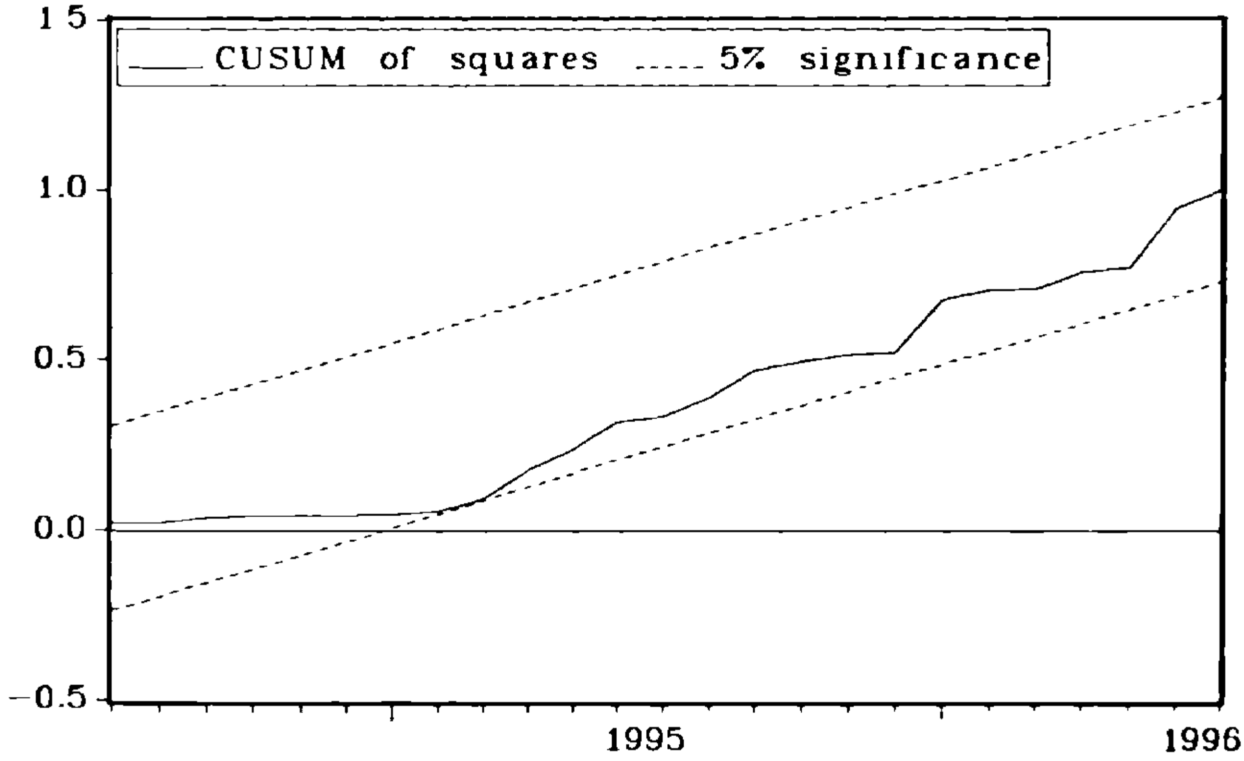
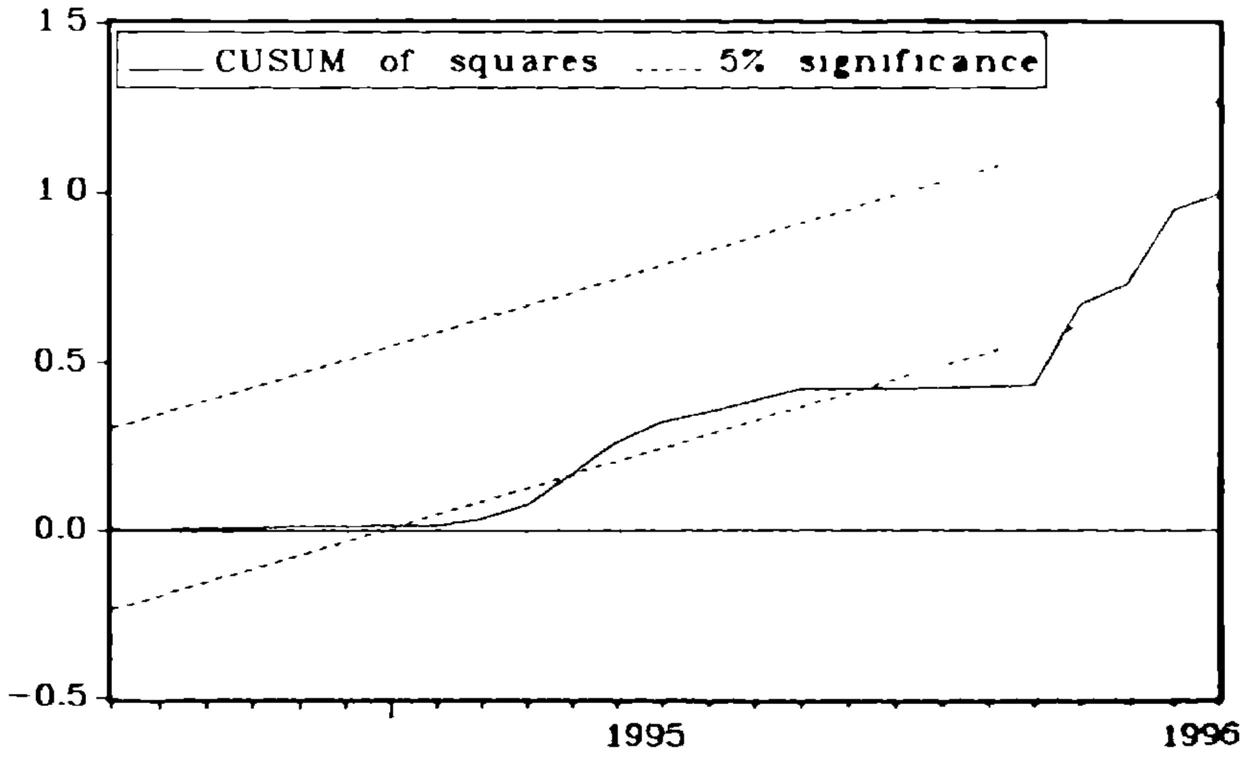


Figure 30. CUSUM Square Plot of SMN



CHAPTER - V

CURRENCY EQUIVALENT MONETARY AGGREGATES

5.0. INTRODUCTION

In this chapter an attempt is made to examine the empirical performance of a new monetary aggregate called the Currency equivalent monetary aggregate(CEMA) The assets considered here are (i) currency with the public(CU), (ii) net demand deposits with all commercial and cooperative banks(DD), (iii) net time deposits with all commercial and cooperative banks(TD), (iv) post office savings deposits(PD) The rest of the chapter is organised as follows Section 5 1 breifly discusses the theoretical basis of CEMA and reviews the available evidences on the aggregate In section 5 2 empirical findings of some standard tests regarding the performance of the aggregates are presented A comparison between CEMA and its simple sum counterpart is also presented here Concluding remarks are offered in the last section

5.1 THEORETICAL FOUNDATION OF CEMA

The currency equivalent monetary aggregate (CEMA) is a time varying weighted average of the stocks of different monetary assets, the weights being each asset's yield relative to that on a benchmark "zero liquidity asset" The CEMA represents the stock of currency that would be required by households to obtain the liquidity services that they get from the whole spectrum of monetary assets. The aggregate is also invariant to changes in asset characteristics and equals the sum of individuals' CEMA holdings CEMA was originally concieved by Hutt(1963) and later developed by Rotemberg(1991) Rotemberg *et al* , (1995) derived the aggregate from a utility framework. CEMA is given by

$$\text{CEMA} \equiv \sum_{i} ((r_t^b - r_t^i) / r_t^b)\, m_t^i \qquad (5\ 1)$$

where r_t^b is rate of return on a benchmark asset, r_t^i rate of return on ith monetary asset, m_t^i is the ith monetary asset, $(r_t^b - r_t^i) / r_t^b)$ is weight assigned to the ith asset

As shown in Rotemberg *et al*(1995) the aggregate is derived from an individual's expected lifetime utility function in period "t" say V_t and is given by

$$V_t = E_t \sum_{j=0} \beta^j\, U(C_{t+j}, L_{t+j}) \qquad (5\ 2)$$

where E_t takes expectations as of time t, β is an intertemporal discount factor, C_t is consumption, L_t is the aggregate of liquidity services and U gives the level of instantaneous utility The function U is assumed to be concave in both arguments

The aggregate of liquidity services is given by

$$L_t = f(m_{0,t}, m_{1,t}, \ldots, m_{n-1,t}, \alpha_t). \qquad (5\ 3)$$

where $m_{0,t}$ denotes the amount of currency held at time t and $m_{i,t}$ represents the amount of asset i held at t α_t , the time varying parameter captures the variations in the liquidity services provided by the assets due to changes in their characteristics over time

Assuming f to be additively seprable in currency and other monetary assets and linear homogeneous, Rotemberg *et al*.,(1995) proved that the aggregator function f in (5 3) is equivalent to the expression (5.1). Though the derivation considers the level of liquidity held by an individual, the sum of the L's held by all individuals is simply (5.1) applied to aggregate asset holdings Thus CEMA is a measure of total money stock in the economy Currency is assigned a weight of one in CEMA and the weights assigned to other assets decline towards zero as the assets' interest yield increases The very construction of the aggregate, however, solves the problem of joint services(liquidity and interest yield) rendred by assets and the dilemma to inlude a particular asset or not This aggregate has certain advantages First, it is capable of yielding comparable levels of liquidity even when tastes and asset characteristics change over time Secondly, it can also be used to compare money holdings across individuals, states and nations The separability assumption inherent in CEMA implies that in principle CEMA can be computed with observations at a single point of time Finally, CEMA simplifies estimation of money demand equation in the sense that it studies the demand for total liquidity in the economy

Barnett(1991) showed that Rotemberg's CEMA could be directly derived from economic theory, treating it as a measure of the economic stock of money under stationary expectations CEMA tries to measure the monetary capital stock whereas Barnett's(1980, 1982) Divisia aggregates and the theoretical aggregates derived by Barnett Hinich and Melvin(1989) measure monetary service flow in the economy Barnett(1991) says, " I shall refer to the CE index as the *Rotemberg Money Stock* I prove that Rotemberg is indeed correct in viewing his index as a measure of the economic stock of money The Rotemberg money stock is a special case of the money stock measure derived in Barnett(1978, eq 2, p 148,1980, eq3 3,1981, eq7 3, p 196) In particular, my measure of the stock of money reduces to the Rotemberg money stock under the assumption of stationary expectations", CEMA , thus, discounts the monetary service flow to present value, if expectations are stationary Since no parametric modeling of expectation formation is required for stationary expectations, CEMA can be directly produced from the available current period data.

Barnett's(1991) proof goes in the following manner The economic stock of money defined by Barnett(1987) is the discounted present value of expenditure on the services of monetary assets Barnett(1978) derived the discounted present value in the following manner

During period s, let p_s^* be the true cost of living index, let M_{is} be nominal balances of monetary asset i, let r_{is} be the nominal expected holding period yield on monetary asset i, and define $m_{is} = M_{is}/p_s^*$ to be real balances of monetary asset i The current period is defined to be period t, so that $s \geq t$ The discount rate for period s is defined to be

$$p_s = \begin{cases} 1, & s=t \\ \prod_{u=t}^{s-1} (1+R_u), & s>t \end{cases} \qquad (5\ 4)$$

As shown in Barnett(1978), if the planning horizon T approaches infinity the following definition for the economic stock of money is obtained

Under the assumption of risk neutrality, the conomic stock of money during period t is

$$V_t = \sum_{s=t}^{\infty} \sum_{i=1}^{n} \left[(p_s^* / p_s) - (p_s^*(1+r_{is})) / p_{s+1}\right] m_{is} \qquad (5\ 5)$$

Substituting (5.4) and $m_{is}=M_{is}/p_s^*$ into equation (5 5) Barnett(1991) obtained the

$$V_t = \sum_{s=t}^{\infty} \sum_{i=1}^{n} \left[(R_s - r_{is}) / \prod_{u=t}^{s} (1+R_u)\right] M_{is} \qquad (5\ 6)$$

Next assuming stationary expectations so that $r_{is} = r_{it}$, $R_{is}=R_{it}$ for all s≥t and $(M_{1s}, M_{2s}, \ldots, M_{ns}) = (M_{1t}, M_{2t}, \ldots, M_{nt})$ for all s ≥ t, Barnett shows that equation (5.6) be reduced to

$$V_t = \sum_{i=1}^{n} \sum_{s=t}^{\infty} \left[(R_t - r_{it}) / (1+R_t)^{s-t+1}\right] M_{it}$$

$$= \sum_{i=1}^{n} ((R_t - r_{it}) / R_t) M_{it} \qquad (5\ 7)$$

$$\text{since } \sum_{s=t}^{\infty} (R_t - r_{it}) / (1+R_t)^{s-t+1} = ((R_t - r_{it}) / R_t)$$

Hence CEMA is equal to the economic stock of money[1]

5.2. SOME EVIDENCES ON CEMA

Since CEMA has been proposed only recently, there has not been extensive literature in this area Chrystal and Macdonald(1994) studied the properties of CEMA alongwith other Divisia and simple sum aggergates for seven countries namely the United States, the United Kingdom, Australia, Germany, Switzerland, Canada and Japan The real currency equivalent measure(RCE) featured significantly in the real output equation This finding was in line with a previous work by Belongia(1993) where significant influence for this measure was also witnessed The Akaike information criterion (AIC) test in a St Louis framework favoured the currency equivalent measure in two cases viz M1A versus CE and M1 versus CE

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[1]It may however be noted that CEMA and Divisia index measure two different variables and therefore neither is a substitute for the other as has been pointed out by Barnett(1990). As a measure of the stock of money, Rotemberg's CEMA might be a major improvement over the official simple sum aggregates.

Rotemberg *et al*, (1995) using US monetary data examined empirically the performance of CEMA in relation to real macro variables The assets considered in the study were currency, demand deposits, travelers' checks which do not yield interest and other checkable deposits, savings accounts at commercial banks, money market accounts at commercial banks and money market accounts at thrift institutions which yield interest Tests of Granger causality, Engle-Granger cointegration showed CEMA to predict output movements better than simple sum aggregates such as M1 and M2 The robustness of the bivariate results was examined in a VAR framework, where monetary impulses were found to permanently raise prices and temporarily raise output and lower unemployment

5.3. EMPIRICAL FINDINGS

In the present study, currency equivalent monetary aggregate is constructed over four assets namely, CU, DD, TD, and PD for the monthly sample 1985 04 to 1996 09 For the purposes of comparison, its simple sum counterpart which closely corresponds to the official M4 as compiled by the RBI is also constructed The performance of CEMA is evaluated through the information content test, the Davidson-Mackinnon J-test and money demand stability test The results of different tests conducted are as follows

5.3.1. Descriptive Statistics and Information Content

The mean and standard deviation of the growth rates of monetary aggregates and goal variables are given in the following table

Table 5.1

Monetary Aggregates	**Mean**	**Standard Deviation**
CEMA	1 408	2 512
M4	1 359	2 733
Goal Variables		
IIP	O 664	4 544
WPI	0 622	0 546

It is clear from the standard deviation figures that simple sum M4 fluctuated more than the CEMA

The aggregates are ranked according to their information content based on R^2 as shown in the table below

Table 5.2

Aggregates Ranked according to

Information Content based on $\overline{R}_*^2$

Rank	**IIP**	**WPI**	**IIP**
1	CEMA	CEMA	RCEMA
2	M4	M4	RM4

For all the goal variables CEMA has the highest information content

5.3.3. The J-Test

This test is used to examine the relative performance of CEMA versus its simple sum counterpart in explaining the goal variables such as IIP and WPI Results of the J-test is summarized in the following tables(from 5 3(a) to 5 3(c))

Table 5.3(a)
The J-Test : Goal Variable = IIP
H_0:Goal = β CEMA + μ_0,
H_1 :Goal = μ SUM + μ_1

M4 vs CEMA	Do not reject H_0 (-2 20)	Reject H_1 (60 04)	Sum model rejected but CEMA model is not

Note:Figures in parentheses are t-statistics

Table 5.3(b)
The J-TEST:Goal Variable = WPI
H_0:Goal = β CEMA + μ_0,
H_1 :Goal = μ SUM + μ_1

M4 vs CEMA	RejectH_0 (-19 92)	Reject H_1 (-8 44)	Neither model provides complete specification

Note Figures in parentheses are t-statistics

Table 5.3(c)

The J-TEST:Goal Variable = IIP

H_0:Goal = β CEMA + μ_0

H_1 :Goal = μ SUM + μ_1

RM4 V RCEMA	Reject H_0 (8 77)	Do not reject H_1 (2 08)	CEMA model rejected but sum model is not

Note Figures in parentheses are t-statistics

As evident from the above tables nominal CEMA dominates simple sum in explaining IIP whereas real sum M4 dominates real CEMA in explaining IIP However with respect to WPI the test results are inconclusive

5.3.4. Demand for Money Estimations

Simple demand for money equations are formulated here using IIP as the monthly income measure(scale variable) and call money rate as a proxy for the opportunity cost variable Table 5 4 below presents the OLS estimates

Table 5.4

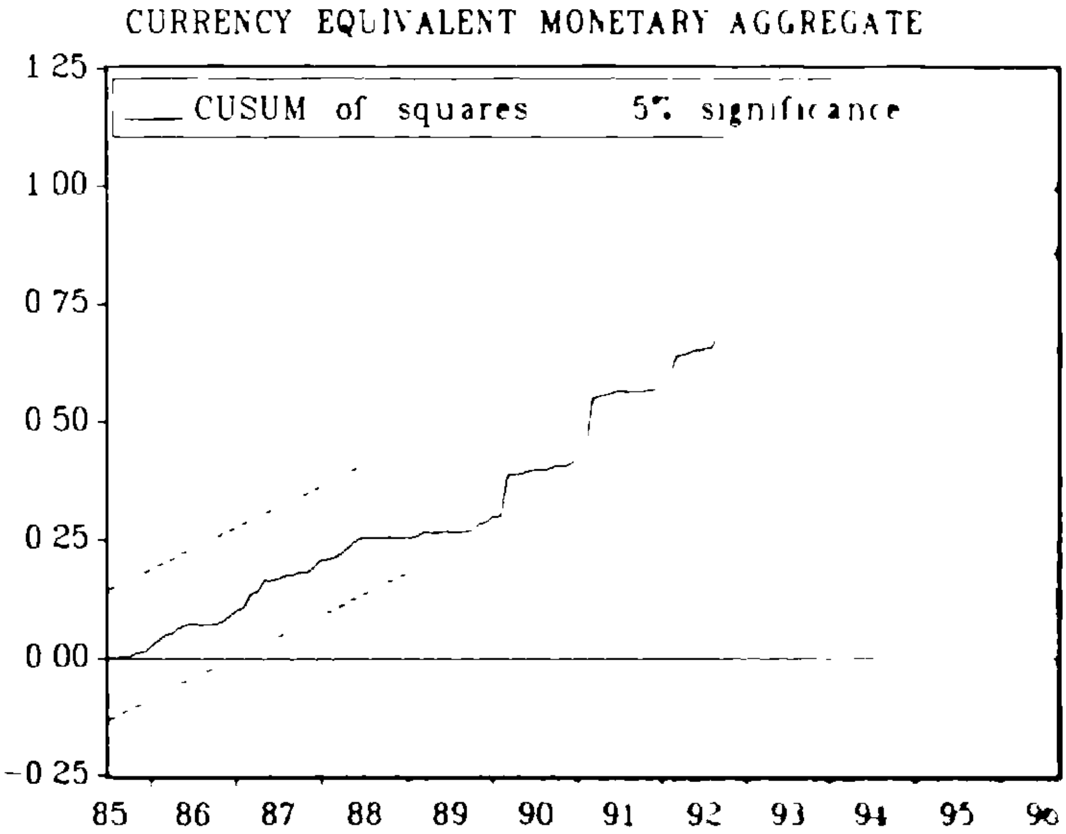
OLS Estimates of Demand for Money Functions

Monetary Aggregates	Constant	IIP	Call rate	R^2	D-W	Theil's U
SM4	6 05	1 09* (62 61)	-0 001 (-1 89)	0 97	0 99	0 001793
CEMA	5 96	1 04* (49 38)	-0 0001 (-0 01)	0 95	0 64	0 002243

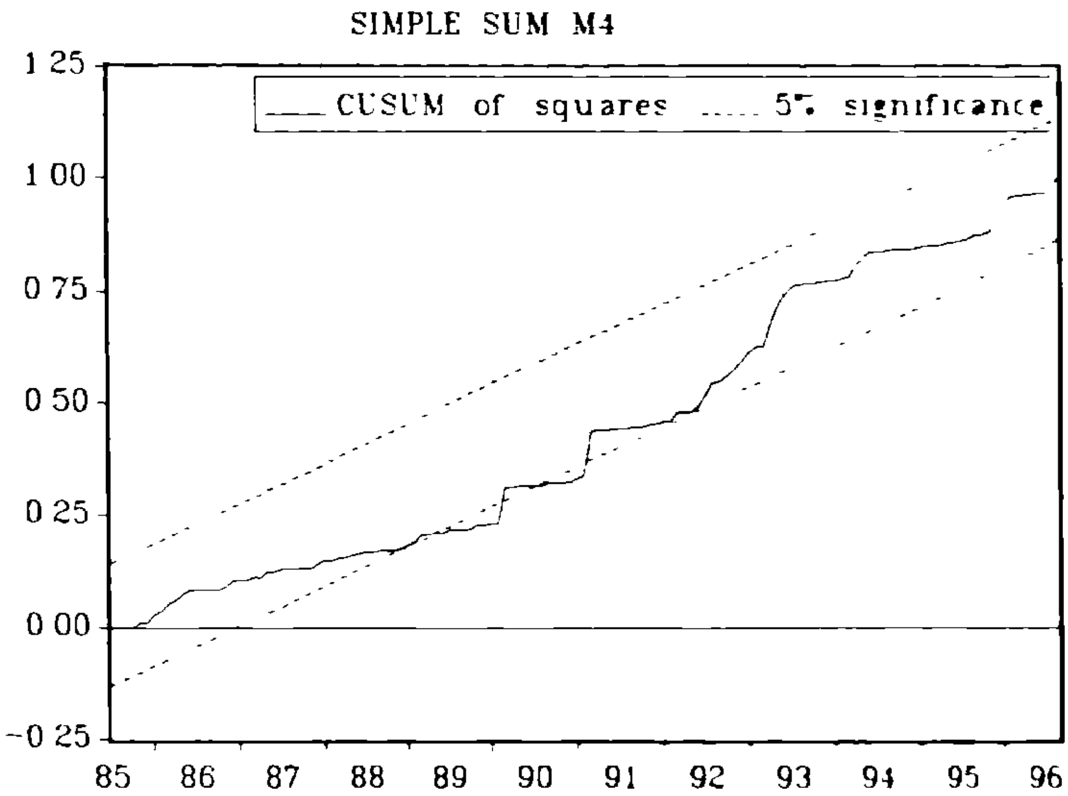
Note * indicates significant at 1% level

In both the specifications the scale and oppurtunity cost variables bear theoretically expected signs The coefficient of income variable is positive and statistically significant at the 1% significance level The income elasticity is greater than unity. The $\overline{R}^2$ value indicates that the simple sum equation has a better fit Simple sum M4 also seems to have more in-sample predictivity compared to CEMA as implied by the Theil's U statistics The stability of the above relationships is examined through CUSUM square plots which are presented in Graphs 5 3 and 5 4 below

Graph 5.1



Graph 5.2



As shown in the above plots, the demand for CEMA is stable throughout the sample with 5% significance band, whereas the demand for simple sum M4 experinces a structural break around the year 1989-1990 as a kink is observed in the plot around that period

The long run equlibrium relations underlying the demand for money functions is studied by employing the Johansen-Juselius multivariate cointegration tests As a prerequisite for the cointegration test KPSS unit root tests are conducted to confirm that all variables under consideration are non-stationary Table 5 5 presents the unit root test results

Table 5.5
KPSS Unit Root Test Statistics

WITHOUT TREND				WITH TREND				
Variables	**k=1**	**k=2**	**k=3**	**k=4**	**k=1**	**k=2**	**k=3**	**k=4**
lrm4	6 808	4 589	3 476	2 808	0 862	0 604	0 473	0 392
lrcema	6 359	4 294	3 258	2 635	1 026	0 070	0 538	0 438
liip	6 587	4 452	3 378	2 731	0 491	0 359	0 291	0 248
callr	0 517	0 396	0 330	0 284	0 391	0 300	0 251	0 217
Δlrm4	0 137	0 153	0 181	0 217	0 057	0 064	0 076	0 094
Δlrcema	0 291	0 306	0 326	0 348	0 104	0 111	0 120	0 130
Δliip	0 061	0 068	0 080	0 091	0 047	0 052	0 061	0 069
Δcallr	0 015	0 021	0 029	0 036	0 012	0 016	0 023	0 029

Note Here k refers to lag length, Δ denotes variables in first differences "l" and "r" refer to "log" and "real" respectively The 5% critical values are 0 463 without trend and 0 146 with trend

The test statistics in the above table show that all the statistics are significant enough to reject the null hypothesis of stationarity both without and with trend The upper half of the table shows statistics for variables in levels and the lower half for variables in first differences Statistics for first differences, show that calculated values are below the critical values for both with trend and without trend Hence it is inferred that all the variables are non-stationary and integrated of order one(that is I(1))

Having confirmed the non-stationarity of the variables, the J-J cointegration tests have been carried out for both the demand for money specifications. The statistics (Trace and λ max) are summarized in the table 5 6

Table 5.6

J-J Cointegration Test for Money Demand Stability

System	Null	Trace	λ max	Cointegrating Vctors
lrm4, liip, callr	r=o	79 2642*	45 6772*	[1 00 1 06 -0 01]
	r≤1	33 5870*	26 3317*	[1 00 1 12 -0 005
	r≤2	7 2553	7 2553	
lrcema, liip, callr	r=o	49 0102*	28 8503*	[1 00 0 81 -0 038]
	r≤1	20 1599*	12 6618*	[1 00 1 02 -0 0006]
	r≤2	7 4981	7 4981	

Note * denotes significant at 5% level "l" and "r" refer to "log" and "real" respectively

Both Trace and λ max statistics reject the null of one cointegrating vector against existence of two cointegrating vectors for both the specifications, therby implying the systems to be stable The cointegrating vectors bear theoretically expected signs The lag for the test has been chosen according to the Akaike's information criterion

5.4. Concluding Remarks

From the above results it may be concluded that the Currency equivalent monetary aggregate performs as good as the simple sum monetary aggregate To be specific the aggregate(CEMA) dominates its sum counterpart in the information content test and money demand stability test. The J-test results are mixed in anature However, the new aggregate needs further study both theoretically and empirically before it could be used as an intermediate target in the conduct of monetary policy

CHAPTER - VI

SUMMARY AND IMPLICATIONS

Developments in economic aggregation theory and statistical index number theory have, of late, influenced monetary economists to look at the issue of an appropriate money stock measure as a fundamental problem of aggregation The main architect of this new school of thought is William A Barnett whose established theoretical results are popularly known as the microeconomic monetary aggregates He suggests adoption of Divisia monetary services indices at the central bank level instead of conventional simple sum aggregates The research efforts from various countries and the resultant evidences from some countries in support of these aggregates have enthused Barnett to conclude that "Under no circumstances should the simple sum monetary aggregates be used to measure either the flow or stock , except perhaps in investigating the distant economic past, when money maybe did not yield interest The simple sum monetary aggregates are an anachronism"(1991, pp 238-239) The decade long campaign by Barnett and his collaborators for these indices are based on strong theoretical foundations However, results across countries have been sensitive to the existing financial environment institutional set up, structure of financial services supply, and payments technology A Bank of England study conducted in the recent past pointed out that, "A Divisia measure of money appears to have some leading indicator properties for predicting both nominal output and inflation. . . a case can clearly be made for including Divisia in the range of indicators analyzed by the authorities when forming their judgments on monetary conditions"(Fisher, Hudson and Pradhan, 1993, p.63).

In view of the above, the present study tries to explore the feasibility of empirical implementation of such aggregates in the Indian context for two reasons. First, for the last several years the Indian monetary policy has veered around monetary targeting. The *raison daitre* has been well documented in the literature. It has also been pointed out in the annual report of the Reserve Bank of India 1996-97 that "As an alternative to monetary targeting, interest rates are often considered as an intermediate target in developed economies where interest rates play an important role in equilibrating markets. The various segments of the financial markets are closely integrated in developed economies, with interest rates in various markets mutually influencing one another. This is not the case in India yet, even though the beginning of such an integration of markets is discernible in recent years. With the demand function for money reasonably stable, the quantity of money plays an important role in determining prices in India. Under these circumstances it is better to target money than interest rates"(pp. 136-137). Second, the Indian financial environment has been experiencing financial innovations in terms of (i) introduction of new money market instruments like Certificates of deposits, Commercial papers, Money Market Mutual Funds etc., (ii) changes in payments technology by way of introducing Automated teller machines and use of credit cards etc..

The present study applies Barnett's(1982) three step procedure to optimal monetary aggregates to Indian data to search for some optimal monetary groupings and studies the relative performance of Divisia versus Simple sum monetary aggregates. The first step of this three step procedure warrants empirical application of a rigorous theoretical criterion known as weak separability to ensure that a set of monetary components chosen for aggregation form a weakly separable block. In the second stage one has to choose a statistically good index number (for example the Divisia index or the Fisher Ideal index of Diewert's superlative class) to construct what may be known as economic monetary aggregates. The third stage involves evaluation of these aggregates' performance with respect to the real macro economic variables such as gross domestic product, prices etc ,

To fulfill the first step of Barnett's three step procedure, the present study applies Varian's(1983) nonparametric test for the first time in the Indian context Though in the previous studies parametric tests have also been employed, we use the nonparametric tests due to two main reasons *viz* , (i) the parametric approach involves specification of a particular functional form and estimation of parameters which may result in parameters that are not robust, (ii) there is less scope for aggregation error when we use separable groupings obtained from this test since the nonparametric tests ensure rationalisation of a well behaved utility function over the data set On the other hand results from a parametric separability test may be deceptive because the functional form may not be consistent with all the neoclassical consumer behaviour axioms leaving thereby scope for aggregation error

The results show that the annual sample 1970-1996 and the monthly sample 1985 04 1996 09 rationalize well behaved utility functions Subsequently, six groupings are discovered for annual data as theoretically admissible groups known as weakly separable groups For monthly data the test yields only two separable groups On the whole the separability evidences are inclined towards broader aggregates The official money supply measures M3 and M4 as compiled by the RBI are found to be theoretically admissible groups, both for annual and monthly specifications whereas M2 emerges as a separable group for annual specification only Experimenting with a new asset called Certificate of deposit for which data is availble also yields some encouraging separable groupings. Using these separable groups, both Divisia and Simple sum aggregates are constructed The performance of these aggregates are evaluated in terms of information content test, non-nested hypothesis testing and stability of demand for money functions

The results of the above tests for annual data are mixed in nature The information content test shows slight dominance of Divisia aggregates over their sum counterparts whereas the J-test results are mixed in nature However, the Divisia money demand is found to be stable except in two cases (Divisia aggregates) namely DM2 and DM7 All simple sum money demand relationships, however, are found to be stable

The monthly results give a clear edge to the Divisia aggregates over their simple sum counterparts in all the tests Especially, the CUSUM square plots indicate structural breaks for simple sum monetary aggregates around the year 1991 whereas no such break is observed in the Divisia money demand relationships This change in the simple sum money demand may be attributed to financial innovations taking place in the Indian money market during the past few years The stability of Divisia money demand may be due to the ability of the aggregate to capture the entire liquidity services available in the economy and also to account for the substitution effects due to compositional shifts in the financial portfolio

The long run equilibrium relationships underlying the monthly money demand relationships are studied by employing the Johansen-Juselius multivariate cointegration procedure The test results in terms of the Trace statistics and λ max statistics reject the null hypothesis of zero cointegrating vectors against the alternative of one or more cointegrating vectors This implies that there is a long run equilibrium relationship between real money balances, interest rate(user cost aggregate in case of Divisia aggregates) and real income

Results of extended Divisia and sum aggregates with CU, DD and CD (as an additional candidate of money) show money demand to be stable for Divisia specifications and unstable for sum specifications In terms of information content, however, sum aggregates are found to be better performers These extended sets are based on the separability results obtained in chapter three They do not include time deposits as the data on time deposits published by the RBI include certificate of deposit

In addition to the Divisia aggregates as discussed above the present study also endeavoures examination of a realtively new aggregation theoretic aggregate called as the Currency equivalent monetary aggregate(CEMA) by considering the same four assets *viz* , CU, DD, TD, PD for the sample 1985 04 1996 09 CEMA represents the stock of currency that would be required by the households to obtain the liquidity services that they get from a broad spectrum of financial assets Currency is assigned a weight of one in the construction of this aggregate and the weight assigned to other assets is smaller depending upon their rate of return The higher the rate of return *viz* , the higher the investment services provided by the asset, the lower the weight assigned to it This aggregate represents the total monetary capital stock of an economy and has a preference theoretic foundation as has been proved by Rotemberg *et al*(1995) The Divisia monetary services indices on the other hand measure the flow of transaction services in the economy Our experimentation with this new aggregate results in a stable money demand function for this aggregate, as clearly indicated by the CUSUM square plots whereas that of the simple sum equivalent of this aggregate is unstable around the year 1991 CEMA also performs better in the J-test and the information content test.

Though there is no doubt about the theoretical superiority of the new monetary aggregates, empirically they have not been able to outperform their simple sum counterparts *in toto*. However, in some of the tests like money demand stability the superiority of the new monetary aggregates is clearly established

In light of the above discussion some suggestions may be given in the Indian context The Reserve Bank of India has recently set up a working group to judge the appropriateness of the existing money stock measures in view of the ensuing finacial sector reforms One of the objectives of the working group is to examine the adequacy of the present measures in reflecting liquidity in the economic system and to consider the feasibility of possible inclusion of some additional financial assets in the exsting money stock measures The evidences of the present study encourage addition of some of the potential candidates of money to the existing money stock measures At the same time retaining the practice of simple sum measures may lead to bad measurement It is therefore suggested that a proper data base be developed with corresponding interest rates earned on the assets to construct Divisia monetary indices The indicator properties of the Divisia aggregates can then be studied and these aggregates can be monitored along with the simple sum counterparts in order to see the plausibility of their implementation as intermediate targets in the conduct of monetary policy

APPENDIX - A

METHODS USED IN THE STUDY

A.1. CUSUM Square Test (BDE) for model stability

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

$$Y_t = X_t \beta_t + u_t, \qquad t = 1, 2, \ldots, n$$

where Y_t is (t x 1) vector of observations on the dependent variable X_t is (t x k) matrix of observations on k independent variables, β_t is (k x 1) vector of parameters, and u_t is (t x 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:

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

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

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

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

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

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

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

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

$S_t = 1 \quad$ if $t = n$

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

$$E(S_t) \cong (t+k) / (n-k)$$

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.2. KPSS Unit Root Test:

This test, due to Kwiatkowski et al (1992) provides a test statistics under the null hypothesis of stationarity 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, $S_t = \sum_{t=1}^{T} e_t$, e_t being the residual from a regression of 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)

A.3. Joahnsen and Juselius (JJ) Procedure:

Until recently, the empirical works involving the estimation of cointegrating vectors employed the single-equation error-correction technique proposed by Engle and Granger (1987) 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) propounded a method(which was later refined by Johansen and Juselius (1990)), that allowed for the testing of more than one cointegrating vector

The Johansen test for cointegration begins by considering the unrestricted reduced form of a system of variables which, by assumption, can be represented as a finite order vector Autoregressive model(VAR)

$$Y_t = \mu + A(L)\, Y_{t-1} + U_t \qquad \text{(A 1)}$$

where $Y_t = [Y_{1t} \quad Y_{nt}]^T$ T being the transpose, $A(L) = \sum_{i=1}^{k} A_i L^i$, $E(U_t U_t^T) - \sum$

The key requirement for this methodology is that none of the variables in the system be integrated of order zero This approach also assumes that the disturbances of the model, U_t are distributed normally.

Equation (A 1) can be presented in the form of an equivalent vector error correction model(VECM) from as the following

$$\Delta Y_t = \mu + B(L)\,\Delta Y_{t-1} + \Pi Y_{t-k} + U_t \qquad (A.2)$$

If there is no cointegration among the set of n variables included in Y, then the rank of Π is zero In this case equation (A 2) becomes a simple VAR in first differences On the other hand, if the rank of Π is n, there are n linearly independent combinations of Y_t that are I(0) Since any linear combination of I(0) variables must also be I(0), this means that the n variables in Y_t must themselves be I(0), and it is appropriate to estimate an unrestricted VAR in levels, in equation(A 1) (though it may be rewritten in error-correction form as in equation A 2)

In the case where, some but probably fewer than n, stationary linear combinations exist means that there are cross-equation restrictions among the coefficients of A(L) in equation(A 1) The advantage of representing eqn (A 1) in VECM form is that in equation (A 2), all of the cross-equation restrictions are concentrated in the matrix Π In the Johansen approach, the number of such restrictions is determined by, first estimating Π without restrictions from equations (2) and then determining the rank of Π The restrictions on Π are then imposed and a restricted VECM is estimated

In practice, this process is achieved in two steps First ΔY_t and Y_{t-k} are each regressed on a constant and lagged ΔY, yielding residuals

$$R0_t = \Delta Y_t - \hat{a} - \hat{b}(L)\,\Delta Y_{t-1} \qquad (A.3)$$

$$Rk_t = Y_{t-k} - \hat{c} - \hat{d}(L)\,\Delta Y_{t-1} \qquad (A.4)$$

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The ordinary least squares(OLS) estimate of Π from equation (A.2), with no restriction on the rank of Π, would then be obtained by regressing $R0_t$ on Rk_t

Π can always be recoded in a variety of ways, as

$$\Pi = \alpha \beta \qquad \text{where } \alpha, \beta \text{ are } n \times n$$

However, under the hypothesis that Π is of reduced rank, the dimensions of α and β can be reduced to $n \times r$, $r < n$. The Johansen procedure involves choosing the first coloumn of β as the maximum likelihood estimate of the linear combination of Rk_t, (that is, $\beta_1 Rk_t$) that is most correlated with $R0_t$. The second column of β is the linear combination, orthogonal to β_1, which has the next highest correlation, and so on. A representation of the VECM which is equivalent to equation (A.2) is then given by

$$\Delta Y_t = \mu + B(L)\, \Delta Y_{t-1} + \alpha\, ECM_{t-k} \qquad \text{(A.5)}$$

where $ECM_{t-k} = \beta Y_{t-k}$ $\qquad \beta = [\beta_1 \quad \beta_n]^T$

Johansen and Juselius(1988) provide two test statistics, known as the trace and λ-max statistics, to determine the rank of the matrix Π. If for example the tests indicate that two cointegrating vectors exist, maximum likelihood estimates of those vectors are given by the first two columns of β and the VECM(equation(A.2)), is given under the restriction of two cointegrating vectors by

$$\Delta Y_t = \mu + B(L)\, \Delta Y_{t-1} + \alpha_1\, ECM1_{t-k} + \alpha_2\, ECM2_{t-k} \qquad \text{(A.6)}$$

where $ECM_i = \beta_i\, Y_{t-k}$ $\qquad i=1,2$

All the variables in (A 6) are now stationary and inference on any of the parameters in (A 6) can proceed using asymptotically valid standard distribution theory The coefficients α_1 and α_2 represent the effects of the stationary linear combinations ECM1 and ECM2 on the system and are referred to as loadings (in a single equation approach, they are frequently referred to as "speeds of adjustment")

It should be noted that no structural interpretation can be placed on the error-correction terms without making further identifying assumptions However, in the present case , if there were only one cointegrating vector in the system, and if it is included in the financial aggregate, one might wish to interpret it as a "long run" demand function If more than one cointegration vector exists among the data, any structural interpretation is difficult to place on it, though examining the effect of each cointegrating vector on future changes of the variables in the system may provide indirect evidences to the nature of the relationship that has been identified

A.4. Tests for Non-nested Hypotheses(The Davidson-Mackinnon J-Test)

Let us consider the problem of testing two hypotheses

$$H_0 \quad y = \beta x + u_0 \qquad u_0 \sim IN(0 \ \sigma_0^2) \qquad (A\ 7)$$

$$H_1 \quad y = \gamma z + u_1 \qquad u_1 \sim IN(0, \sigma_1^2) \qquad (A\ 8)$$

The hypotheses are called non nested since the explanatory variables under one of the hypotheses are not a subset of the explanatory variables in the other

H_0 being the maintained hypothesis, the test procedure for testing H_0 against H_1 is as follows

Equation (A 8) is estimated by OLS and the predicted value of y is obtained as $\hat{y}_1 = \hat{\gamma} z$. Then the regression equation

$$y = \beta x + \alpha \hat{y}_1 + u \qquad \text{(A 9)}$$

is estimated to test the hypothesis that $\alpha = 0$ If the hypothesis is rejected, then H_0 is rejected by H_1 If the hypothesis is not rejected, then H_0 is not rejected by H_1

Similarly testing H_1 against H_0 starts with estimating equation (A 7) by OLS and generating the predicted value of y *viz*,

$$\hat{y}_0 = \hat{\beta} x$$

Then the regression equation,

$$y = \gamma z + \delta \hat{y}_0 + v \qquad \text{(A 10)}$$

is estimated to test the hypothesis $\delta = 0$ If the hypothesis is rejected then H_1 is rejected by H_0 and *vice versa*

As suggested by Davidson and Mackinnon the models given above H_0 and H_1 can be combined into a single model *viz*,

$$y = (1-\alpha)\ \beta x + \alpha(\gamma z) + u \qquad \text{(A 11)}$$

where one has to test $\alpha = 0$ versus $\alpha = 1$. As it is difficult to estimate β, γ, and α from this model we get the estimates of $(1-\alpha)\ \beta$ and $\alpha\gamma$. As shown by Davidson-Mackinnon one can substitute $\hat{y}_1 = \hat{\gamma} z$ for γz in equation (A.11) and then test $\alpha = 0$ They also show that under H_0, $\hat{\alpha}$ from (A.9) is asymptotically N(0 1) Because α and β are estimated jointly they call it the J-test It is to be noted here that the J-test is one degree of freedom tests irrespective of the number of explanatory variables in H_0 and H_1

APPENDIX - B

DESCRIPTION AND SOURCES OF DATA

Time series data on all the variables used in the empirical analysis are from 1970-1996 for the annual sample and from 1985 04 to 1996 09 for the monthly sample For the extended sub sample 1994 04 1996 07, an additional asset called the certificate of deposit is included in the analysis All the monetary variables are measured in crores of rupees at current prices The monthly data have been deseasonalised by using the additive seasonal adjustment procedure

B.1. Monetary Assets

Four financial assets viz , currency with the public(CU), net demand deposits with all commercial and co-operative banks(DD), net time deposits with all commercial and co-operative banks(TD) and post office savings bank deposits(PD) have been considered for both annual and monthly analysis A new asset called certificate of deposit is also included in the analysis for the sample 1994 04 1996 07 The sample size has been constrained by the availability of data

B.2. Interest rate variables

B.2.1. Own rate of return

Regarding rate of return on individual assets, currency being the most liquid amongst all assets, the rate of return on it is assumed to be zero For demand deposits, an implicit competitive rate is constructed using Klein's (1974) methodology. The formula employed for constructing this rate is

$$r_{DD} = r_T \, [\, 1 - (\, BR / DD \,)\,]$$

where r_{DD} is the implicit rate on demand deposits, r_T is 91 day treasuring bill rate and BR is bank reserve held against demand deposits, 12 month deposit rate is used as a proxy for time deposit rate In case of postal savings deposits, the rate of interest per annum on post office savings bank accounts with limits of investment lying between a minimum of Rs 20/- and a maximum of Rs 50,000, is used In the absence of such a rate commercial bank 3 months savings deposit rate is used For certificate of deposit, its own rate of return is used

B.2.2. Bench mark rate

Theoretically R, the benchmark rate should be the rate on a particular asset which is completely illiquid and does not provide any monetary service The rate on human capital may serve the purpose since it does not render any monetary service in a world where there is no slavery system However, due to difficulties associated with the availability of such an asset, the present study proxies R by taking the rate of return on the highest yielding asset in period t and calculates user costs for each asset in that particular time period In the absence of any direct measurement of a benchmark rate one can only construct proxy measures, which need not be rate of return on only one asset Thus, rates of return like long term government bond yield rate , company deposit rate yield on private debentures and UTI dividend rates have served this purpose for different time periods in the study. The highest available rate from among these rates in a particular year is considered as the benchmark for that year

B.3. Income Measure

For annual data gross domestic product at factor cost and for monthly data index of industrial production have been used as income measure The series on index of industrial production has 1980-81 as its base

B.4. Prices

The whole sale price index(WPI) (with base=1980-81) has been chosen as a measure of prices

B.5. Scale and Opportunity cost variables

Real gross domestic product(gross domestic product deflated by WPI) for annual data and index of industrial production for monthly data have been chosen as "scale" variables in money demand tests The weighted average of call money rates is used as the opportunity cost variable in simple sum money demand functions whereas the respective Divisia user cost aggregates have been used as opportunity cost variables in Divisia money demand functions

SOURCES OF DATA

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