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THEORETICAL AND EMPIRICAL ISSUES IN MONETARY AGGREGATION

1.1. Introduction

The purpose of monetary policy is to achieve certain goals such as sustainable output and employment, price stability and financial stability etc. Monetary authorities often try to achieve these goals through manipulating certain variables known as instruments. However, effective implementation of monetary policy is often constrained by the limited knowledge of the structure of the macroeconomy as well as the way it works. In this context, monetary authorities have to depend on theoretical paradigms concerning the structure of economy in the conduct of monetary policy. However, there are different and competing theoretical paradigms or models that are considered to be appropriate representation of the economy in the literature. In this respect, policy makers have to choose from a wide range of models for an effective implementation of the policy. The choice of a particular variable as a target, instrument or indicator in turn depends on the specific model or models followed by the monetary authority in the policy formulations.

The use of monetary aggregates among other instruments as policy variable continues to be a matter of discussion in both theoretical and empirical literature. Monetary aggregates have been widely used as intermediate targets during monetarist
experiment in many of the central banks in the 70’s and 80’s. According to monetarists, money played an important and direct role in the transmission mechanism. However, financial innovations and sophistication of financial markets in the early 80’s led to weakening of the relationship between money and economic activity. Empirical evidence against the stability of money demand also led to de-emphasize the role of money in the policy formulation (Friedman and Kuttner 1992; and Estrella and Mishkin 1996).

The emergence of New Keynesian models around this time also justified the shift of focus from monetary aggregates to interest rate in the policy deliberations. The policy makers began to use interest rates as instruments in line with certain pre-specified targets for those variables that appear as arguments in the objective function. In this respect, the interest rate rule proposed by Taylor (1993) became more popular in policy settings although it was not explicitly announced by many central banks. However, integration of financial markets and continued innovations had implications to the term structure of interest rate relationships, which are important in the transmission mechanism under New Keynesian models. Consequently, instability of Taylor type monetary policy rules especially during subprime crisis period as documented by Barnett and Chauvet (2011b) became a major issue in the policy deliberations. Thus due to unreliability of traditional interest rate targeting, many central banks recently began to depend on unconventional monetary policy tools such as quantitative and credit easing.

In this context, many authors have been arguing that monetary aggregates may have additional information and there are some transmission channels where money does play an important role (Nelson 2002). In fact, some central banks still continue to observe developments in the monetary aggregates in the policy formulations (e.g. two pillar approach followed by European Central Bank). Recently Barnett (2012) also observed that “focusing solely on interest rates, while ignoring monetary aggregates, ignores the product produced by the central bank. The relevancy of that product to public understanding of monetary policy is independent of whether or not the central bank itself targets or otherwise uses measurements of that product in conducting its monetary policy.”
However, official statistics on monetary aggregates are constructed using simple sum aggregation procedure. Such constructs of monetary aggregates i.e. arithmetic sum of a spectrum of monetary assets, produces aggregation bias. The use of simple sum aggregates can be justified only if the component assets are perfect substitutes. This aggregation procedure was suitable when the assets included in the monetary totals were interest free assets. Development of financial markets and innovation in the modern banking made it possible to use a wide spectrum of assets, which yield explicit interest rate, for transaction purposes. Thus most of the monetary candidates, such as fixed deposits of various maturities that yield explicit monetary return, cannot be treated as perfect substitutes. Therefore, simple sum aggregates suffer from aggregation bias and the magnitude of bias tends to be larger with higher level of aggregation. In this respect, as Barnett and Chauvet (2009, 2011b) observed many paradoxes that appeared during last 20 years can be attributed to the use of simple sum aggregates. The problems that arise due to such measurement errors in the monetary aggregate are collectively called as “Barnett Critique”\(^1\). The essence of Barnett Critique can be summarised as follows: “The assumptions implicit in the data construction procedures must be consistent with the assumptions made in producing the models within which the data are nested. Unless the theory is internally consistent, the data and its applications are incoherent. Without that coherence between aggregator function structure and the econometric models within which the aggregates are embedded, stable structures can appear to be unstable” (Barnett and Chauvet 2011b).

1.2. Monetary Aggregates: A Brief Review of Literature

Development of a coherent theoretical framework for the construction monetary aggregates consistent with economic theory and index number theory was first developed by Barnett (1980). But, the literature on the concept and measurement of money has a long tradition. Money was usually identified with the quantities of precious metals or paper money during sixteenth and eighteenth centuries. However, with the advent of modern banking system new forms of means of payment came into existence (Friedman and Schwartz 1970). This complicated the definition of money and its quantification. Subsequently, many studies attempted to deal with questions

\(^{1}\) The term ‘Barnett critique’ was first used by Chrystal and MacDonald (1994)
such as ‘what to be considered as money?’ or ‘what criteria to be followed in the
definition of money?’ In this respect, the literature on the definition of money can be
broadly classified into two i) a priori functional approach and ii) empirical approach
to the definition of money. However as assets included in the monetary totals became
imperfect substitutes, issues like quantifying ‘moneyness’ of monetary assets and
methods to properly aggregate these assets became prominent in the literature.
Consequently, there are a lot of studies that attempted to measure the ‘moneyness’ of
monetary assets and construct monetary aggregates using aggregation theory and
index number theory. The following section briefly introduces the literature pertaining
definition and measurement of money.

1.2.1. A Priori Approaches

Under a priori functional approach, money is identified with an asset or a
collection of assets that are consistent with relevant functional and institutional
attributes of money. However, a priori approach could not provide a unique measure
of the concept of money. First of all, there was lack of consensus on the functions that
has to be emphasised in the definition of money. Accordingly there were different
groupings of assets that are labelled as money, as there were different conceptual
definitions. Even those who accented the role of money as a medium of exchange
could not bring out a unique measure. For instance, Clower (1971) emphasising the
medium of exchange function argued that the commodities that act as means of
payment in the absence of Walrasian auctioneer- coordinator can be regarded as
money. Accordingly, he considered currency, demand deposits and trade credit as
money. However, Shackle (1971) criticised the inclusion of trade credit in the
definition of money and favoured a definition which defines money as a means of
simultaneous payment. According to him trade credit doses not complete the
transactions but merely postpone the payment. Thus he defined money that includes
currency and transaction deposits along with time deposits.

Pesek and Saving (1967) while emphasising the medium of exchange function
in definition of the money argued that it must be the net wealth of the public. In his
view interest bearing assets cannot be treated as money. While, Newlyn (1964)
indicated that “assets can be uniquely identified as money (medium of exchange) if, in
financing payments, they are neutral; that is to say, the aggregate of the class of assets to which they belong remains the same and there is no re-percussion in the market for loans.” From another point of view, Friedman and Schwartz (1963) favoured a definition that emphasised the store of value function of money. According to him money is temporary abode of purchasing power and included currency, demand deposits and time deposits of the public held by commercial banks in their aggregate. But his approach was criticised for including only time deposits and excluding other assets that act as temporary abode of purchasing power (Tobin 1965).

Likewise, the views of Gurley and Shaw (1955) and Radcliffe committee (1959) stressed on liquidity as an attribute of money. The essence of their argument is that monetary authorities try to influence the total demand by manipulating the liquidity demanded by the economic agents. Thus, they argued that proper definition of money should consider the liabilities of nonbank financial intermediates as they are close substitutes of currency. But Friedman and Schwartz (1970) were critical about the precise definition of the concept of liquidity and also the “statistical totals used to approximate the concept have varied widely in composition”.

In summary, *a priori approach* couldn’t bring forth either a coherent and consistent theoretical framework or a proper methodology to quantify the concept called money. There were considerable ambiguities in the theoretical concept of money as well the composition of assets attached to the pre defined theoretical concept. In this context, some argued that the search for a proper definition of money and its measurement requires empirical considerations. Accordingly there are various approaches in the literature that try to define and indentify the money employing certain empirical criteria.

1.2.2. Empirical Approaches

Criticising the *a priori* approaches Friedman and Schwartz (1970) observed that “The definition of money is to be sought for not on grounds of principle but on grounds of usefulness in organizing our knowledge of economic relationships.” One such criterion for identifying monetary aggregates was proposed by Friedman and Meiselman (1963). They identified the monetary assets based on dual criteria of
correlation. Accordingly the aggregate which have highest correlation with income is defined as money. The aggregate so defined should have highest correlation with income than with the components included in that aggregate. Kaufman (1969), Hullet (1971) and Schadrack (1974) applied the dual criteria to identify monetary aggregates with some modifications.

Another approach that tried to define money empirically considered the stability of money demand functions as a criterion. Under this approach as argued by Friedman and Schwartz (1970) money is equated with an aggregate if its real value has a relatively stable relation with a small number of variables such as wealth, income, interest rates or rate of change in prices. However, the procedure to identify monetary aggregates using stability of money demand functions often failed to give conclusive results. The aggregates that satisfy the stability criterion varied across time for any country or across countries. Moreover evidence for shifts in the money demand functions since early 80s made the stability of money demand function criteria less attractive.

One of the major flaws in both the dual criteria of correlation and stable demand for money criterion is that the identification of money in this manner is circular in argument. Both these criteria define money that gives stable and robust relation with output, then using it to substantiate the prior view which is methodologically unsound (Mason 1976). Similarly, these criteria more or less were concerned about identifying assets that can be called as money. The monetary totals proposed by these criteria contained assets with varying degrees of ‘moneyness’. Thus, issues like what formula should be followed in arriving at a particular aggregate that measure the ‘moneyness’ of each asset was not addressed reasonably. The aggregates are often constructed by simply summing the quantities of monetary assets disregarding varying degrees of ‘moneyness’ contained in the assets.²

² Barnett (1990) observes that Friedman was aware of the pitfalls in using simple sum aggregation procedure in the monetary aggregation (See Friedman and Schwartz 1970; and Friedman and Meiselman 1965 foot note 3), but they couldn’t give a satisfactory solution to the problem of aggregation.
1.2.3. ‘Moneyness’ of Monetary Assets

Some of the earlier attempts to appropriately measure the ‘moneyness’ of assets can be found in Timberlake and Fortson (1967), and Laumas (1968) who extended the correlation analysis of Friedman and Meiselman (1963). An aggregate derived along these lines as in Laumas (1969) is however criticised for the same reasons as in the case of Dual criteria of correlation. In addition, an aggregate produced through this method assumes linear aggregator function implying perfect substitution between the components (Barnett 1990).

Another application of dual criteria of correlation for monetary aggregation was developed by Koot (1975). He derived weights by employing factor analysis method to a number of financial assets. The first two factors are then extracted relating first factor to money and second to near money. The appropriate money is then defined by applying dual criteria of correlation and the factor score of assets, assuming that it reflects ‘moneyness’ of that asset and is used to compute a weighted monetary aggregate. But monetary aggregate arrived by using this method could not provide a consistent measure. Moreover, lack of a coherent theoretical framework makes it less attractive.

Similarly, some studies attempted to define the ‘moneyness’ of financial assets based on the observations of Gurley and Shaw (1955) and Radcliffe committee (1959). The empirical studies that tried to measure the degree of substitutability between various assets along this line followed two different approaches. Some studies used the cross interest elasticity estimates from a demand function for currency and demand deposits on income and rates of return on one or more near-money assets as a measure of substitutability (See Feige and Pearce 1977 for a detailed discussion).

Alternatively, some studies used micro theoretic foundations to measure the substitutability of monetary assets. Under this approach the consumer is assumed to choose the aggregate of monetary services that maximise their utility. Pioneering work in this line was done by Chetty (1969) who estimated a CES (Constant elasticity of substitution) utility function subject to a two period budget constraint. The
elasticity of substitution estimated from this constrained optimisation is used to derive
the appropriate weights of monetary assets. The quantity of money is then arrived by
aggregating the quantities of monetary assets multiplied by their respective weights.
Chetty’s work was seminal in many respect, for instance, he was first to recognise the
role of micro economic aggregation theory to monetary aggregates (Barnett 1990).

Following Chetty’s methodology a number of studies empirically examined
the substitutability of financial assets with certain extensions and modifications (e.g.
Moroney and Wilbratte 1976; Boughton 1981; and Husted and Rush 1984). Particularly,
Donovan (1978) modified Chetty’s procedure to make it more consistent
with consumer demand theory. He modelled consumer preference in an indirect utility
framework. Further, he observed that monetary assets included in the utility function
yields certain monetary services and are durable in nature. Thus, the relevant prices in
the budget constraint must be the rental prices of monetary assets i.e. prices of the
service flows yielded by them. Besides, monetary aggregates constructed following
Chetty (1969) depend on unknown parameters. Failure to arrive at non- parametric
approximations and ambiguities regarding price of money limited the use of such
aggregates.

1.2.4. Monetary Aggregates as Aggregation Theoretic Index Numbers

The above mentioned studies that attempted to measure the ‘moneyness’ of
monetary assets could not bring forth a coherent theoretical framework and a sound
methodology to construct the monetary aggregates. Existence of various potential
weighing schemes based on these approaches left many issues in monetary
aggregation unresolved. However, some of these issues can be addressed by the
application of aggregation theory and index number theory to monetary aggregation.

According to aggregation theory economic aggregates are embedded in the
economic structure and can be related through a function (known as aggregator
function) of its components. In this context, the constructs of aggregate implied by the
economic theory can be obtained given the form of the aggregator function and
quantities of component assets. However such economic aggregates depend on the
unknown parameters which have to be estimated. Non-parametric approximations of aggregator function require applications of Index number theory (Barnett 1980, 1987).

In this respect, Barnett (1978, 1980) was first to apply aggregation theory and index number theory to monetary aggregation. He derived a monetary aggregator function from a neoclassical framework. Monetary aggregates so specified approximates the optimum quantity of monetary assets demanded by a representative economic agent. A brief discussion on the derivation of monetary aggregates consistent with behaviour of a representative economic agent following Barnett, Fisher, and Serletis (1992) is given below.

Consider a derived utility function containing monetary assets that characterise the preference of a representative agent such as $V = u(c, f(m), l)$, where $c$ is a vector of goods and services, $l$ is leisure time, $m$ is a vector of monetary assets and $f(l)$ defines the monetary aggregation function. Note that sub-utility function $f(l)$ over monetary assets exits due to the assumption of weakly separable utility function in monetary services. The representative economic agent’s decision problem is to maximise the utility function subject to a budget constraint. Since the monetary assets are assumed to be weakly separable, the consumers decision problem can be formulated as a two stage optimisation problem. In the first stage the total expenditure is allocated among consumer goods, monetary services and leisure. In the second stage the allocation of expenditure (which is decided in the first stage) is done within each category. Accordingly the optimisation problem with respect to monetary services may be expressed as

$$\text{Max } f(m) \quad \text{subject to } y = \pi ' m, \quad (1.1)$$

where $y$ is the total expenditure on monetary services and $\pi$ is a vector of user costs of monetary asset. The user cost of monetary asset is formerly derived by Barnett (1978, 1980) measures the opportunity cost of holding monetary asset relative to a benchmark asset. The aggregate can be acquired by solving the decision problem in equation 1.1. Accordingly, the monetary aggregate ($M$) can be equated to the utility associated with the optimum quantities of monetary assets ($m^*$) chosen by the representative agent i.e. $M=f(m^*)$. 
Thus, appropriate monetary aggregates should reflect the preference of economic agent as characterised by the monetary aggregator function. In this respect, Barnett (1980) showed aggregator function implied by simple sum aggregation or linear aggregation function requires highly restricted assumptions regarding the preference of the economic agent. In the case of simple sum aggregates the underlying aggregator function assumes that components are perfect one-for-one substitutes which is highly unrealistic. Such aggregates fail to internalise the substitution effects that arise due to changes in the relative price of monetary assets. Since the components in the monetary aggregates are imperfect substitutes an appropriate functional form must be nonlinear in nature. Besides, as Barnett (1980) observed, monetary aggregates so specified also require parameterised econometric specification of such aggregator functions. Dependence on unknown parameter of aggregator function makes the aggregates obtained by aggregation theory less attractive to official communications. Alternatively, non parametric approximations of aggregator functions can be obtained by applying index number that depends on price and quantities unlike economic aggregate that depends on quantities and unknown parameters.

In this context, Diewert (1976) identified a class of index number that exactly track the economic aggregator function known as “superlative index number”. Such index numbers are capable of tracking the exact aggregator function up to third order reminder term. He showed that Fishers ideal index which approximates homogenous quadratic aggregator function and the Divisia index which approximates the homogenous translog aggregator function can be considered as superlative index numbers. Subsequently, Barnett (1980) related the monetary aggregation and index number theory and showed that exact monetary aggregator functions can be tracked by Divisia index in continuous time and Tornqvist-Theil approximation in discrete time. The growth rate of Divisia index so defined equals the weighted average of growth rate of components. The weight of each component is measured as the share of its expenditure on total expenditure on monetary services. For discrete time Divisia

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3 Barnett (1980) suggested the use Fishers ideal index and Divisia index for monetary aggregates and both aggregate were identical. But Divisia index is often preferred since it is found to be exact for nonhomothetic translog aggregator function (Barnett 1990).
index weight is calculated as each component’s between-period average expenditure share.

Subsequent research on Divisia index has proposed some useful extensions to the theory on monetary aggregation. For instance, the preceding discussion on theory and development of Divisia index mainly focused on consumer demand function. There is an analogous aggregator function for a representative nonfinancial firm developed by Barnett (1987, 1990). Similarly, Divisia index can be extended by incorporating risk (Barnett, Liu, and Jensen 1997; and Barnett and Wu 2005) and multilateral aggregation (Barnett 2007) are the recent developments in the literature. For a collection of theoretical and empirical literature related to monetary aggregation can be found in Barnett and Serletis (2000), Belongia and Binner (2000), and Barnett and Chauvet (2011a).

Another monetary aggregate, known as the currency equivalent (CE) index, with desirable properties of micro theoretic foundation was proposed by Hutt (1963) and subsequently developed by Rotenberg (1991) and Rotenberg, Driscoll, and Poterba (1995). They derived the CE index aggregate from representative consumer’s intertemporal utility framework. Weights of the CE aggregate are obtained by solving the optimization problem subject to a budget constraint. The weights so derived can be interpreted as marginal utility of components included in the aggregate. The CE index considered to be a special case of Divisia index and it measures the flow of monetary services assuming the aggregator function to be quasi linear in currency whose rate of interest is zero in addition to assumptions that underlie discrete time Divisia index (Anderson, Jones, and Nesmith 1997).

In addition, Barnett observed that CE aggregate can be considered as a stock measure of money that measures the share of discounted monetary services provided by an aggregate (Barnett 1991). Following Barnett’s interpretation of CE aggregates as economic stock of money, Kelly (2011) argued that CE aggregates can be considered as aggregation theoretic measure of narrowly defined money. Thus, CE aggregates isolates the portion of each asset that serve like currency. Empirical studies have documented the properties of CE aggregates and compared its performance relative to simple sum and other weighted monetary aggregates (see for e.g.
Rotemberg, Driscoll, and Poterba 1995; Serletis and Molik 1993; Serletis and Koustas 2001; Kelly 2009; and Kelly, Barnett, and Keating 2011). However, there is further scope in exploring the properties of CE aggregates considering its theoretical foundations.

1.3. Monetary Aggregates: Current Practices

Official agencies responsible for generating monetary aggregates have not yet properly utilised the advancements in monetary aggregation theory for generating the relevant monetary statistics. The aggregates produced by the official agencies follow simple sum aggregation procedure to aggregate the components selected following certain criteria such as degree of liquidity, size and denomination, maturity of deposits, type of money issuers etc (International Monetary Fund 2008). However a few national banks such as Bank of Israel, National Bank of Poland, Bank of England and Federal Reserve Bank of St. Louis publish divisia index.⁴ Unpopularity of aggregation theoretic monetary aggregates such as Divisia and CE index considering the documented evidence of theoretical and empirical superiority of such aggregates is a matter of concern.

1.3.1. Evolution of Official Definitions of Monetary Aggregates in India

Statistics on monetary aggregates for India are compiled and disseminated by Reserve Bank of India. In this respect RBI follows the recommendations of the working groups set up to review the measures of money supply periodically. So far RBI constituted three working groups viz. the First Working Group on Money Supply (FWG) (1961), the Second Working Group (SWG) (1977) and the “Working Group on Money Supply: Analytics and Methodology of Compilation” (Chairman: Dr. Y.V. Reddy) (1998).

The first working group emphasising the role of money as a liquid asset and medium of exchange and defined money supply in a narrow sense comprising currency with public (CU), net demand deposits with banks (DD), and other deposits

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⁴ Advance in Monetary and financial measurement website (http://www.centerforfinancialstability.org/amfm_int.php) maintained by Centre for Financial stability provides data on Divisia monetary aggregates of various countries. It also gives collection of relevant literature pertaining to a number of countries.
with RBI (OD). The FWG also recommended a border measure named as aggregate monetary resources adding time deposits with the banking system to the money supply mentioned above. The SWG widened the scope of the monetary aggregates and suggested four different measures of money namely, M1, M2, M3, M4. The classification was done in such a way that the narrower measures composed of more liquid assets than boarder measures. The aggregates and its components as recommended by SWG are given below:

\[ M1 = \text{currency with public + demand deposits with the banking system i.e. commercial banks, state co-operative banks, central co-operative banks and primary cooperative banks + other deposits with RBI} \]

\[ M2 = M1 + \text{saving deposits with post office savings banks} \]

\[ M3 = M1 + \text{time deposits with the banking system} \]

\[ M4 = M1 + \text{all deposits with post office savings banks excluding National Saving Certificates (NSC).} \]

Subsequently, the Third Working Group (TWG) reviewed the measures of money in the context of developments in the Indian financial sector since 1990’s. While reviewing the existing measure of monetary aggregates, the TWG attempted to ensure the methodology of compilation of monetary aggregates on par with international standards. To this end the suggestions in Manual on Monetary and Financial Statistics published by International Monetary Fund have been considered. The group opined that “money as a statistical construct reflects i) assets with monetary characteristics, or ii) specific liquid liabilities of a particular set of financial intermediaries.” In this respect the TWG observed that liquidity provided by non banking financial intermediaries especially since 1990’s have to be included in the constructs of money. Accordingly they have included a wide range of assets having monetary characteristics in the definitions of money. Thus, the TWG recommended four measures of monetary aggregate and three measures of liquidity aggregates. The Liquidity aggregates included financial assets that are considered to be the substitutes of broad money which are the liabilities of Non- banking financial intermediaries. Similarly the TWG introduced residency concept in the definition of monetary
aggregate and excluded repatriable foreign currency fixed deposits by non-residents. The details of recommended measures of monetary aggregates and liquidity aggregates by TWG are as follows

Monetary aggregates

\[ M_0 = \text{Currency in circulation} + \text{bankers’ deposits with RBI} + \text{other deposits with RBI} \]

\[ M_1 = \text{Currency with public} + \text{demand deposits with the banking system} + \text{other deposits with RBI} \]

\[ M_2 = M_1 + \text{time liability portion of savings deposits with the banking system} + \text{certificates of deposit issued by banks} + \text{term deposits (excluding non resident foreign currency deposits) with a contractual maturity up to and including one year with the banking system} \]

\[ M_3 = M_2 + \text{term deposits (excluding non resident foreign currency deposits) with a contractual maturity up to and including one year with the banking system} + \text{call borrowings from ‘Non- Depository’ financial corporations by the banking system} \]

Liquidity aggregates

\[ L_1 = M_3 + \text{all deposits with post office savings bank except NSC} \]

\[ L_2 = L_1 + \text{term deposits with Term Lending Institutions and Refinancing Institutions (FIs)} + \text{term borrowing by FIs and Certificates of Deposits issued by FIs} \]

\[ L_3 = L_2 + \text{public deposits of non banking financial companies} \]

It is evident that RBI like all other central banks is yet to incorporate the advancements in the monetary aggregation theory in the construction monetary aggregates. In this respect, current statistics on monetary aggregates, mentioned above
are produced using simple sum index. The TWG did not favour the compilation weighted monetary aggregates. The TWG observed that there are practical difficulties in using weighted monetary aggregates as targets. But as Barnett (2012) observed the increasing financial instrument complexity requires quality data on monetary aggregates and that would help minimise the errors in the policy making.

There are a few studies that have attempted to empirically define and construct meaningful monetary aggregates in the Indian context. Some studies tried to empirically define the monetary aggregates applying Friedman- Meiselman dual criteria, Factor analytic technique and canonical correlation analysis etc. (Shergill 1980; Kamaian and Bhole 1982; Kamaiah and Subrahmanyam 1983; and Ramachandran and Kamaiah 1991). Similarly some studies have attempted to construct aggregation theoretic monetary aggregates in the Indian context ( see Kannan 1989; Jadav 1989; Subrahmanyam and Swami 1991; Ramachandran 1994, 1995, 1998; Acharya 1998; Jha and Longjam 1998; Acharya and Kamaiah 2001; Acharya and Gopalaswamy 2007; and Ramachandran, Das, and Bhoi 2010). Empirical evidence, however, was not convincingly favourable to weighed monetary aggregates. It is often attributed to constant relative price of monetary assets included in the aggregate prior to liberalization and the unavailability of reliable data on quantities of monetary assets and interest rates. Recent empirical studies that reported evidence in favour of weighted monetary aggregates corroborates this argument (Acharya and Kamaiah 2001; Acharya and Gopalaswamy 2007; and Ramachandran, Das, and Bhoi 2010). In this context it is worthwhile to review the relevance of aggregation theoretic measures in the Indian context.

1.4. Scope and Relevance of the Study

Indian financial system has witnessed significant changes since early 1990’s. A package of measures were initiated to reform the financial system in order to make it more efficient and competent by lessening the financial repression. The administrated interest rate regime was dismantled progressively and the statutory reserve requirements of banking institutions were reduced. Besides, a series measures were taken to strengthen the institutional set up of banking and other financial sector. The process did increase the interlinkages between various financial segments and it
increased the size, depth and activities of financial sector in India (Mohan 2006). The significant changes in the structure of financial environment, growing number of substitutes for monetary assets and changes in the payment technology are likely to have significant implications for the characteristics of monetary assets included in monetary aggregates. Similarly, with a market oriented financial system and deregulated interest rate regime we can no longer assume the relative prices of various assets to be constant. In this context, simple sum aggregation procedure would be inappropriate since it fails to capture the changes in the characteristics of monetary assets.

There were attempts to construct aggregation theoretic monetary aggregates using Indian data. However only a few studies have tried to construct CE aggregates using Indian data (Acharya and Kamaiah 1998; and Acharya and Gopalaswamy 2007). The empirical evidence was supportive of CE aggregates in the Indian context. Availability of reliable data at highly disaggregated level since the recommendation of Third Working Group makes it ideal to re-explore the potential use of aggregation theoretic monetary aggregates, especially at higher level of aggregation. In this context, this study constructs CE aggregates and examines its properties.

Specifically, the thesis examines the usefulness of CE aggregates as a leading indicator of inflation in Indian context. Sweeping changes in the economic environment of developing countries that marked a transition towards market oriented economies in the late 80’s drastically altered the conduct of monetary policy. Increased vibrancy of financial markets along with financial innovations makes the arguments for theoretically meaningful measures of money stock in the policy discourse more relevant than ever. Against these backgrounds, there is a need to reexamine the relevance of weighted monetary aggregates in the context of changing financial environment. India being a fairly liberalized economy since early 1990s and as a leading economy among developing countries stands as the best choice for examine the relative importance of weighted monetary aggregates as compared to simple sum aggregates.

The Reserve Bank of India follows ‘multiple indicators’ approach since April 1998. Under multiple indicator approach, a number of variables put in use to draw
guidance for the conduct of monetary policy. In this context, the growth rate of money continues to play a dominant role as an indicator if not as an intermediate target. To this end, the RBI, like many other central banks, largely depends on the M3 money stock which is constructed using the simple sum procedure. In this context, this study examines the potential use of CE aggregate as leading indicator of inflation in India. There is no study focusing exclusively on the relevance of such aggregates in the current monetary policy settings wherein monetary aggregates are used as indicators rather than as targets. Previous studies in the Indian context tried to examine the properties of CE aggregates vis-a-vis simple sum aggregates in terms of their information content, stability of their demand functions etc(Acharya and Kamaiah 1998; and Acharya and Gopalaswamy 2007). Hence, the present study exclusively focuses on the superiority of CE aggregates as a predictor of inflation as the Reserve Bank of India has a forward looking approach and inflation continues to be a dominant concern.

This study also attempts to model inflation dynamics using p-star approach developed by Hallman, Porter, and Small (1991). P-star approach is based on Quantity theory of money and it links the short run dynamics of actual inflation to the determinants of long run equilibrium price. Under this approach the long run equilibrium price (p*) is determined by current money supply, potential income and the equilibrium velocity. Under P-star model the actual price is assumed to adjust to the deviations from its long run equilibrium, In other words P-star model predicts whether inflation will rise, fall or unchanged as actual prices are below, above or at their equilibrium. Empirically this can be estimated as a reduced form equation that relates short-term changes in inflation to price gap which is defined as deviations actual price from its equilibrium level.

Previous studies that estimated P star model found supporting evidence for a number of countries [Germany (Toèdtter and Reimers 1994) and other OECD countries (Hoeller and Poret 1991). Middle east (Tawadros 2007) to cite a few]. Some studies also attempted to estimate P-star model using weighted monetary aggregates (Reimers 2002) and (Mäki-Frânti 2007). However, only few studies have done in the context of developing countries. In the Indian context, Nachane and Lakshmi (2002) estimated the P* model using both annual and quarterly data for the
period 1955 to 1990. They found supporting evidence for monetarist explanation of inflation as velocity gap models performed better compared to output gap model. However evidence for poor performance of output gap models in their study may be attributed to use of unreliable data on output at quarterly frequencies. In this context, use of aggregation theoretic aggregates while estimating P-star may provide useful insights into the inflation dynamics. This study tries to estimate P-star model based on both simple sum and CE monetary aggregates for India.

1.5. Objectives

- Construct currency equivalent monetary aggregates using broader range of available monetary and financial assets;
- Examine and document the properties and stylised facts of currency equivalent monetary aggregates;
- Evaluate the performance of currency equivalent aggregates over simple sum aggregates as leading indicator of inflation;
- Examine and compare dynamics of inflation using alternative measures of money.

1.6. Data and Methodology

The empirical analysis was carried out using monthly and quarterly for the period from April 1993 to June 2009. There are two reasons to choose this sample: (i) availability of consistent time series data on the components of new monetary aggregates as recommended by Third Working Group on Money Supply (1998); and (ii) this period covers the liberalized financial regime.

We construct, three monetary aggregates namely, M1, M2, and M3 and one liquidity aggregate L1 following the recommendations of third working group on money supply. The details of components included in the aggregates mentioned above are given in Appendix A. Simple sum aggregates of these measures are constructed by summing the quantities of monetary assets at four nested levels of aggregation. Similarly, CE monetary aggregates for these four measures of are constructed following the methodology of Rotemberg, Driscoll, and Poterba (1995).
Details of quantities of monetary assets and corresponding interest rate proxies used to produce the monetary aggregates are given in Appendix A. The data on quantities of monetary assets were seasonally adjusted prior to computing monetary aggregates. The data are collected from various issues of Handbook of Statistics on Indian Economy and other publications of the Reserve Bank of India. Interest rate on time deposits and benchmark prime lending rate of SBI are obtained from Sate Bank of India.

Selection of an appropriate benchmark interest rate is very crucial in the estimation of CE aggregates. Theoretically it is a rate on benchmark asset that provides no liquidity services and is used to transfer wealth from one period to another. Thus, benchmark asset cannot be traded in the secondary market. In practice, it is either proxied by the rate of return on a least liquid asset/long maturity assets or maximum rate of return among a range of assets. Following Barnett and Spindt (1982) the benchmark rate of interest \( R_t \) is chosen as the maximum rate among a set of market rates such as prime lending rate (PLR) of State Bank of India (SBI), yield on long-term government securities \( r_{gs} \) and the rates of return on components of the broadest aggregate (i.e. L1) which is specified as

\[
R_t = \text{Max}\{r_{it}, (i = 1, 2, 3, \ldots n), r_{gs}, BPLR_t\}
\] (1.2)

The properties and performance of simple sum and CE aggregates are documented using conventional statistical methods, such as correlation analysis, scatter plots, information content tests etc. Correlation between inflation rate and annual growth rates of monetary aggregates (both contemporaneous and lagged) are used to assess the strength of relationship between inflation and money growth. Line graphs and scatter plots are used to examine the velocity behaviour of both simple sum and CE aggregates. The contemporaneous, lagged and leading cyclical co-movements are measured by cross correlation coefficients between cyclical component of money and cyclical component of real output (proxied by IIP at monthly frequencies and GDP at Quarterly frequencies). For monthly data up to 6 months lead and lag of H P filtered cyclical series of real IIP and for quarterly estimates up to four quarter leads and lags of H P filtered cyclical series of real GDP are considered. Similarly, Information content tests following Tinsely, Spindt and
Friar (1980) and Mills (1983) are used to assess the information contained in monetary aggregates about inflation and output growth.

The performance of CE aggregates in predicting inflation vis-à-vis simple sum aggregates are examined using bivariate cointegrating system following the methodology of Ribba (2003). As a first step, time series properties of annual inflation rate ($\pi$) and annual growth rate of monetary aggregates ($m$) are examined using standard unit root tests, namely, the Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) unit root tests. If the variables are found to be integrated of order one, the cointegration between the variables is tested using Johanesn cointegration test. If cointegration is established among the variables then error correction model is estimated and the unidirectional causality is tested by imposing restrictions on speed of adjustment parameters. Impulse response functions and decomposition of forecast error variance are also used to evaluate the performance of aggregates.

P- Star model of inflation dynamics was estimated using quarterly data form 1997 Q1 to 2009 Q2. H-P filter was used to obtain equilibrium velocity and potential output series. The P star model containing both velocity gap and output gap was estimated. In order to assess the performance of alternative monetary aggregates the model was estimated using measures of velocity gap from simple sum and CE monetary aggregates. The forecasting ability of models was examined using both in-sample and out of sample forecast. In-sample forecasts allow us to investigate the forecasting performance of the models estimated for the whole available sample period. Out of sample forecasting performance was carried out by estimating each model recursively, beginning with the period 1997 Q1 to 2007 Q1, and introducing successively a new quarter at each recursion. The one period ahead forecast, made at each stage are then noted and compared with the corresponding actual observation. In order to evaluate the forecasting performance of models this study used root mean square error (RMSE) and mean absolute error (MAE) criteria.

1.7. Organisation of the Study

The thesis is organised into five chapters. Chapter 1 discusses the issues, objectives and methodology. Chapter 2 provides the theoretical foundation of CE
Monetary Aggregates, discuss the issues involved in the construction of CE aggregates in India and evaluate the use of CE aggregates based on some stylised facts. Chapter 3 examines the role of CE aggregates vis-a-vis simple sum aggregates as leading indicators of Inflation. Chapter 4 examines the dynamics of inflation using P-star model using both CE and simple sum aggregates. The fifth chapter provides the summary of empirical findings and draws useful policy inference based on the empirical results.

1.8. Limitations

1. As this study focuses on the construction of aggregation theoretic monetary aggregates, the availability of consistent time series on monetary components and their respective interest rates are very crucial. In this regard, this study used data on monetary components as recommended by Third Working Group (1998). The data on monetary components was available only from April 1993. This considerably limited the sample size. Besides, due to unavailability of data on short-term and long term time deposits for the period prior to March 1999, this study generated data on these series by using a ratio of 55/45 as given in the report of Third Working Group (1998). Availability of quality data on such components would give better estimates of CE aggregates in future.

2. Even though the study constructs monetary aggregates over the components as recommend by Third working Group (1998), it excludes call/term borrowings by financial institutions and certificate of deposits issued by commercial banks. The component was excluded because CE aggregates is highly sensitive to interest rate changes and abnormal spikes in the interest rate series will affect the construction of CE aggregates. In this regard, interest rate on these was extremely high and volatile during sample period.

3. Similarly, this study ignored the possible dynamics of output in predicting inflation due to non availability of data on output at monthly frequencies and unreliability of index of industrial production as a proxy for output in Indian context.

4. The Quarterly data on GDP was available only from 1996 Q2. This constrains the empirical evidence from P-star model to a considerable extent.