“Evidence from a New Currency Equivalent Monetary Aggregate for India”

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Abstract

This paper empirically examines the properties of a new weighted monetary aggregate, Currency equivalent monetary aggregate (CEMA) for India using the components of a broad monetary aggregate NM3 recommended by the working group on Money Supply, Analytics and Methodology of Compilation, Reserve Bank of India (RBI, 1998). The empirical properties of this aggregate *via* a money demand function are compared with its simple sum counterpart NM3. The results suggest the superiority of the CEMA over NM3.

Keywords: monetary aggregate, money demand, cointegration.
JEL Classification: E40, E41, E51.

Introduction

Simple sum monetary aggregates practiced by all central banks today have little basis in economic aggregation and index number theories. The basic limitation of the simple sum scheme lies in its improper accounting for substitution effects whenever there is a fluctuation in the relative prices of different monetary components. These monetary components are treated as perfect substitutes in the simple sum scheme and are assigned equal weights. Such an aggregation is likely to result in either an overestimation or an underestimation of the quantity of money in an economy. Since monetary policy is related to the behavior of indices of the quantity, price and velocity of money, such aggregates to be useful must be theoretically meaningful and empirically measurable. Recent developments in monetary aggregation theory and their empirical applications for a large number of countries have proved the superiority of a class of aggregates called economic monetary aggregates in general and Divisia monetary aggregates in particular. Barnett (1980) suggested the Divisia monetary indices that successfully circumvent the problems underlying the simple sum scheme. The Divisia aggregates internalize pure substitution effects occurring due to a relative price change in financial innovation. The empirical superiority of these aggregates compared to their simple sum counterparts was proved in Barnett (1982) and Barnett, Offenbacher and Spindt (1984). Though the recent developments by Barnett and others heavily draw upon aggregation theory and index number theory, the problems with simple sum aggregation have been recognized since long. For example Friedman and Scwartz (1970) said, "This [simple summation] procedure is a very special case of the more general approach. In brief, the general approach consists of regarding each asset as a joint product having different degrees of moneyness and 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 per dollar of aggregate value. The procedure we have followed implies that all weights are either zero or unity. The more general approach has been experimented with only occasionally. We conjecture that this approach deserves and will get much attention than it has so far received."

Irving Fisher (1922) wrote long back with regard to simple sum or the arithmetic average index 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."

The traditional simple sum aggregates at a broader level (for example M3 or NM3 in India), capture both monetary and non-monetary services of the components since they view distant substitutes of money as perfect substitutes. This leads to a difference in the Central banks' published money and the economists' concept of money. Therefore there is a need to construct an economic monetary aggregate that captures all monetary assets' contributions to the monetary services flow in an economy. Barnett and Serletis (2000) discuss the issue of such aggregation to arrive at a Divisia monetary services index[1]

[1] The discrete time Divisia monetary index is defined as $\log M^D_t$ - $\log M^D_{t-1} = \sum_{i=1}^{n} s^*_{i\,t} (\log x_{i\,t} - \log x_{i\,,\,t-1})$, where the growth rate of the aggregate is the weighted average of the growth rates of the component monetary assets with the Divisia weights being defined as the expenditure shares averaged over the two periods of the change, $s^*_{i\,t} = 0.5(s_{i\,t} + s_{i\,,\,t-1})$ for i =1,…n, where $s_{i\,t} = \pi_{it}x_{it}/\Sigma\pi_{jt}x_{jt}$ is the expenditure share of asset i during period t, and π_{it} is the user cost of asset i, derived as in Barnett (1978), $\pi_{it} = (R_t - r_{it})/(1+R_t)$. π_{it} is the opportunity cost of holding the ith asset.

measuring the flow of monetary services both theoretically and empirically. The empirical evidence for various countries in favour of such aggregates are found today (see for example, Belongia and Binner (Ed.), Money, Measurement and Computation (2006)). In line with this research Rotemberg, Driscoll and Poterba (1995) derived 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* and called it the currency equivalent monetary aggregate (CEMA). The CEMA represents the stock of currency that would be required by households to obtain the liquidity services 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. Thus, CEMA is a measure of total money stock in the economy.

This paper empirically examines the properties of a CEMA for India using the components of NM3 recommended by the working group on Money Supply, Analytics and Methodology of Compilation, Reserve Bank of India (RBI), 1998. This working group was constituted to examine the efficacy of the existing monetary aggregates in the advent of financial innovation in different dimensions. For example, since the 1980s, and especially in the 1990s financial liberalization and innovations led to blurring of boundaries between banks and non-banks in the process of financial intermediation. Increased substitutability of financial assets resulted in expanded portfolio choices for an individual. With increasing number of interest-bearing assets or near monies such portfolios became sensitive to movements in returns of these assets. In light of this development one may suspect the feasibility of using the conventional simple sum aggregates as instruments or intermediate variables for monetary policy. Even the use of such aggregates as indicators of underlying monetary developments may be questioned. The new monetary and liquidity aggregates recommended by the working group, though simple sum in design, have included financial assets considered "to be good substitutes for money in a functional sense, or at least, are related to underlying conditions of aggregate demand" (RBI Bulletin, 2000). The present study therefore attempts to construct a weighted money stock measure, CEMA, and examine its performance to see the feasibility of targeting the same in an era of financial innovation when simple sum schemes do not make any sense theoretically, as structural economic variables. Since there is no study in the Indian context, the present study intends to fill the gap by using the components and measures recommended by the working group (RBI, 1998) to construct a CEMA.

The rest of the paper is divided into three sections. Section 1 briefly discusses the theoretical foundation underlying CEMA due to Rotemberg et al. (1995) and also reviews some international evidence on CEMA. The recommendations of RBI's third working group on compilation of NM3 and other data used in the study are discussed in Section 2 where results pertaining to empirical properties of the aggregates are also presented. Concluding remarks are offered in the last section.

1. CEMA: theory and empirical evidence

CEMA is defined by Rotemberg et al. (1995) as,

$$\text{CEMA}_t = \sum_i \left[(r_t^b - r_t^{\,i})/r_t^{\,b}\right] m_t^i, \tag{1}$$

where r_t^b is the rate of return on a benchmark asset with no liquidity services, $r_t^{\,i}$ is the rate of return on the *i*th monetary asset and $(r_t^b - r_t^{\,i}) / r_t^{\,b}$ is the weight assigned to the ith asset. Thus the aggregate captures the total liquidity services in the economy. The original derivation of the aggregate can be found in Rotemberg et al. (1995). Though the derivation considered the level of liquidity held by a person represented by CEMA_t in 1, the sum of CEMAs held by all individuals is the expression 1 applied to aggregate asset holdings. The important property of CEMA is its adaptability to changes in financial environment. Newly introduced interest bearing assets can be added to the aggregate since assets are added with weights between 0 and 1, with higher interest yielding assets being assigned lower weights. Thus CEMA like the simple sum money, measures the stock of monetary assets whereas the Divisia money measures the flow of monetary services. 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.

Rotemberg (1995) empirically examined the performance of CEMA in relation to macroeconomic variables, on US monetary components. Assets like currency, demand deposits, traveler checks, savings accounts at commercial banks, other checkable deposits, money market accounts at commercial banks, money market instruments at thrift institutions were considered. Results from Granger causality and cointegration tests proved superiority of CEMA over its simple sum counterparts in predicting output movement. Further results from a vector autoregression showed that monetary impulses raised prices permanently; raised output and lowered unemployment temporarily.

A study by Serletis and Koustas (2001) examined the long-run question of money's influence on output growth by employing different monetary aggregates including Divisia and CEMA. They could find CEMA to be neutral in the long run.

In the Indian context Acharya and Kamaiah (1998) constructed a CEMA over four assets, namely currency, demand deposits, time deposits and post office deposits for the monthly sample 1985:04 to 1996:09 and compared it with its simple sum counterpart M4 (compiled in line with the recommendations of the second working group on money supply, RBI, 1977). The currency equivalent aggregate dominated M4 in information content and money demand stability tests. Overall the empirical performance of CEMA was found to be better than M4.

2. New money measures, data and empirical findings

A working group was set up by the Reserve Bank of India on December 3, 1997 under the chairmanship of Dr. Y.V. Reddy to examine the efficacy of existing monetary aggregates. The basic objective was to "examine the adequacy of the existing money stock measures for appropriately reflecting liquidity in the economic system and in this context, consider the possibility of including any other financial asset(s)". Among the other objectives the group also aimed at compiling and disseminating monetary statistics on international standards. The major departure in the working group recommendation was compilation of monetary aggregates on a residency basis, i.e., excluding non-resident repatriable foreign currency fixed liabilities (Foreign Currency Non-Resident (Banks) [FCNRB] and for example Resurgent India Bonds [RIBs] type deposits). Further it was also felt necessary to consider the importance of non-depository financial corporations in a set of liquidity aggregates. But the liquidity aggregates were made distinct from the new set of proposed monetary aggregates. The manual on Monetary and Financial Statistics (MFS) of the International Monetary Fund (IMF) also served as a benchmark and accordingly the following monetary and liquidity aggregates were recommended.

NM_3 = Currency with the Public + Aggregate deposits of residents [Demand deposits + Time Deposits of residents (certificate of deposits + other short-term time deposits + long-term time deposits] + "Other" Deposits with RBI + call/term funding from financial institutions.

$L_1 = NM_3$ + *Post Office Deposits*.

$L_2 = L_1$ + *Term Deposits with FIs + Term Borrowings by FIs + CDs issued by FIs*.

$L_3 = L_2$+ *Public Deposits with NBFCs*.

In this study we use the components of NM_3 to construct CEMA on monthly observations spanning over 1999:03 to 2005:05. For the own rates of returns of these components, we have used an implicit rate for demand deposits following Klein (1974), own rate of return for certificate of deposits, 30 days to 1 year rate on time deposits for other short-term time deposits, 1 year and above rate on time deposits for long-term time deposits, and call money rate for call/term funding from financial institutions. The benchmark rate should ideally be a rate on a completely illiquid asset. Since it's difficult to have such an asset in the real world, we have chosen the benchmark rate as the maximum from a range of rates like UTI dividend rate, 15 years return on govt. of India securities, etc. To avoid negative values of the difference between benchmark rate and some own rates of return we have added a constant to the benchmark rate. Using these rates in calculation of weights for different assets a CEMA is calculated following equation 1.

2.1. Descriptive statistics and data properties. The descriptive statistics and simple correlations between growth rates (in log nominal and log real terms) of monetary aggregates and real variables like index of industrial production (IIP), wholesale price index (WPI) and consumer price index (CPI) are presented below.

Table 1. Descriptive statistics

	LNM3	LCEMA	LIIP	LWPI	LRNM3	LRCEMA
Mean	14.1987	13.8985	5.1682	5.108	13.6911	13.3908
St. dev.	.26579	.29286	.11093	.08637	.18279	.20994

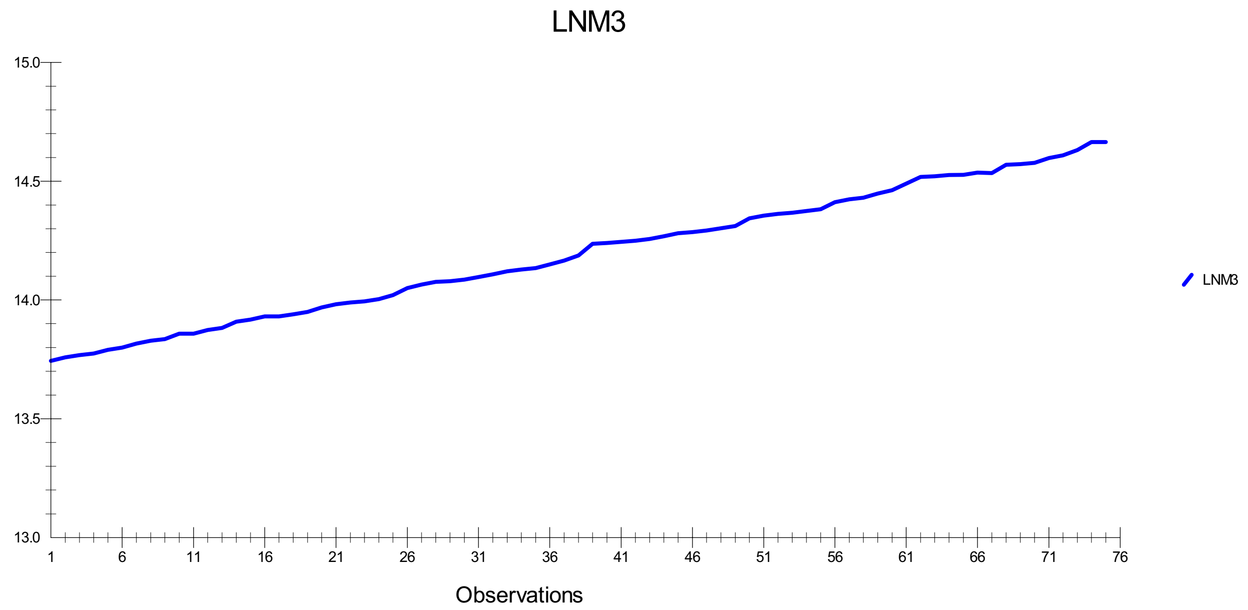
Note: L denotes "log", and R denotes "real".

Table 2. Correlation matrix

	LNM3	LCEMA	LRCEMA	LRNM3
LIIP	.91849	.92431	.92224	.91603
LWPI	.99021	.98553	–	–
LCPI	.99124	.98708	–	–

Note: L denotes "log".

The standard deviations of nominal and real CEMA are lower than that of nominal and real simple sum NM3. CEMA and NM3 are highly correlated in log levels. CEMA bears a higher correlation with IIP, but lower correlations with WPI and CPI compared to NM3, in log levels. The correlation between NM3 and CEMA in log differences is 0.59120 compared to that of 0.99576 in log levels. The same is evident in the following plots. It's therefore necessary to test further the characteristics of these aggregates in a standart money demand function.



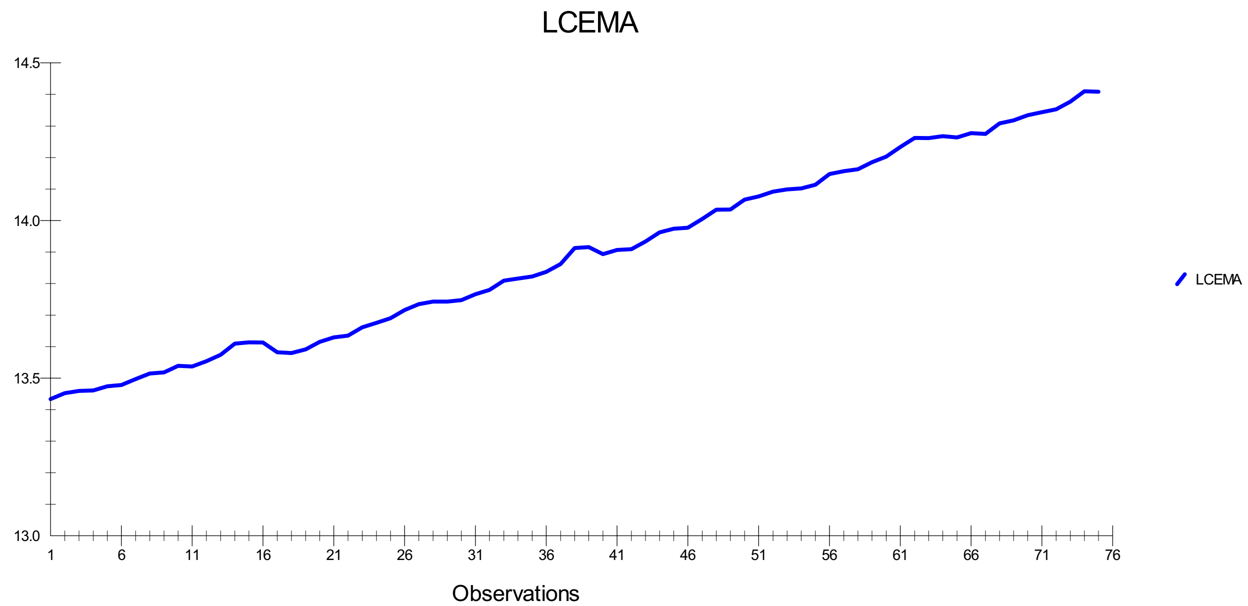


Fig. 1. NM3 and CEMA

2.2. Stationarity properties. In this section a unit root test developed by Kwiakowski et al. (1992, KPSS hereafter) is employed to check if the monetary aggregates and real variables are stationary. The KPSS test for unit roots uses stationarity as the null hypothesis. KPSS (1992) derive their test by starting with the model

$$Y_t = \beta' D_t + \mu_t + u_t\ ,\ u_t \sim I(0), \tag{2}$$

$$\mu_t = \mu_{t-1} + \varepsilon_t\ ,\ \varepsilon_t \sim N(0,\ \sigma_\varepsilon^2), \tag{3}$$

where D_t stands for deterministic components. The hypotheses to be tested are

H_0: $\sigma_\varepsilon^2 = 0 \Rightarrow Y_t \sim I(0)$,

H_1: $\sigma_\varepsilon^2 > 0 \Rightarrow Y_t \sim I(1)$,

The KPSS test statistics, the Lagrange Multiplier (LM) statistics for testing $\sigma_\varepsilon^2 = 0$ is

$$(T^{-2} \sum_{t=1}^{T} \hat{St}^{\,2}) \,/\, \hat{\partial}^{\,2} \tag{4}$$

$\hat{s}_t = \sum_{j=1}^{t} \hat{u}_j$, where $\hat{u}_t$ is the residual of a regression of Y_t on D_t . $\hat{\partial}^{\,2}$ is a consistent estimate of the long-run variance of u_t using $\hat{u}_t$. The stationarity test is a one-sided right tailed test so that one rejects the null of stationarity at the 100.α% level if the KPSS test statistic is greater than the 100(1-α)% quantile from the appropriate asymptotic distribution. The results of the test are presented in the table below.

Table 3. KPSS unit root test results

Without trend (lag = 2) With trend (lag = 2)							
Lrnm3	2.59***	Dlrnm3	0.05	Lrnm3	0.14*	Dlrnm3	0.03
Lrcema	2.55***	Dlrcema	0.11	Lrcema	0.29***	Dlrcema	0.04
Liip	2.30***	Dliip	0.06	Liip	0.18**	Dliip	0.03
Call	1.93***	Dcall	0.02	Call	0.11	Dcall	0.03
Lwpi	2.52***	Dlwpi	0.05	Lwpi	0.23***	Dlwpi	0.50
Lcpi	2.56***	Dlcpi	0.05	Lcpi	0.04	Dlcpi	0.03
Lnm3	2.59***	Dlnm3	0.04	Lnm3	0.12	Dlnm3	0.02
Lcema	2.55***	Dlcema	0.11	Lcema	0.39***	Dlcema	0.03

Notes: l and r denote log and real respectively. ***, ** and * indicate 1%, 5% and 10% levels of significance respectively.

The null of stationarity is rejected for all the variables in log level without trend. The same is rejected with trend for all excepting call, lcpi and lnm3.

2.3. Estimating demand for money. Here, we employ the ARDL bounds test procedure proposed by Pesaran et al. (1996) and Pesaran and Shin (1998). The test yields asymptotically efficient long-run estimates irrespective of the order of integration (i.e., I (0) or I (1)) of the variables. Accordingly, to test for cointegration among a Monetary aggregate (M), Index of Indastrial Production (IIP), and Call Money Rate (CALL), we need to first estimate the following unrestricted error correction model:

$$\Delta \log M_t = aX_t + \sum_{i=1}^{2} b_i \Delta \log M_{t-i} + \sum_{i=1}^{2} d_i \Delta \log \Pi\mathrm{P}_{t-i} + \\ + \sum_{i=1}^{2} e_i \Delta \log CALL_{t-i} + \delta_1 \log M_{t-1} + \delta_2 \log \Pi\mathrm{P}_{t-1} + \\ + \delta_3 CALL_{t-1} + u_t , \tag{5}$$

where X_t is a vector of deterministic variables (intercept and trend in this case), M is a monetary aggregate in real terms, b_i, d_i and e_i are the short-run dynamic coefficients, δs are the long-run multipliers, and u_t is the white noise error. Rejecting the null hypothesis $\delta_1 = \delta_2 = \delta_3 = 0$ indicates that there exists long-run relationship among M, IIP, and $CALL$ irrespective of their integration properties. We use the critical bounds available in Pesaran et al. (1996) for testing the null, as the asymptotic distribution of Wald or F-statistics is non-standard. The critical bound (F-statistics) for 10% significance level in the case of two regressors with constant and a linear trend is 4.205-5.109. One can reject the null $\delta_1 = \delta_2 = \delta_3 = 0$ if the calculated F exceeds the upper bound and then a long-run relationship among the variables is confirmed. If the calculated F is less than the lower bound one cannot reject $\delta_1 = \delta_2 = \delta_3 = 0$ and there is no long-run relationship. Finally, if the calculated F lies between the lower and upper bounds the inference is inconclusive. Table 4 reports the F statistics for the monetary aggregates.

Table 4. F-statistics for inferring cointegration

Money	NM_3	CEMA
F-statistics	10.04	6.61

The calculated F-values are found to be greater than the upper bound in all the cases and therefore a long-run money demand relationship is confirmed for both NM3 and CEMA.

Now we estimate the long-run coefficients and the corresponding error correction terms for NM3 and CEMA in the money demand relationship of the following an auto regressive distributed lag (ARDL) form:

$$\log M_t = a_0 + a_1 t + \sum_{i=1}^{p} \varphi_i \log M_{t-i} + \sum_{i=1}^{q} \theta_i \log \Pi P_{t-i} + \\ + \sum_{i=1}^{r} \psi_i CALL_{t-i} + v_t . \tag{6}$$

The results are reported in Table 5.

Table 5. Long-run coefficients and error correction terms

	Monetary aggregate	
Regressors	NM3	CEMA
iip	0.19 (0.25)	0.67 (0.02)
Call	-0.005 (0.08)	-0.01 (0.09)
Constant	12.50 (0.00)	9.82 (0.00)
Trend	0.006 (0.00)	0.005 (0.00)
Error correction$_{t-1}$	-0.25 (0.00)	-0.19 (0.00)

Notes: The ARDL order for NM3 and CEMA money demand equations are (2,1,3) and (1,1,1) respectively. The lag orders are chosen by the R bar square criterion using Microfit 4.0.

All the long-run coefficients as well as the error correction terms bear theoretically expected signs. The scale variable IIP is significant for CEMA and the elasticity is of a higher magnitude compared to that of

NM3. But the scale variable is not significant for NM3. The opportunity cost variable CALL is also found significant for both NM3 and CEMA. The error correction terms bear the expected signs in all the equations, and are also found statistically significant. The statistical significance of the error correction term thus indicates short-run adjustment taking place in the money demand equations of a reasonable magnitude.

Concluding remarks

In this paper an attempt has been made to construct a new weighted monetary aggregate (CEMA) of the Rotemberg et al. (1995) type. The study uses the components of the new simple sum money definition of the RBI, NM3 for aggregation purpose. The empirical performance of this aggregate is compared with its simple sum counterpart NM3 by employing a money demand function. The money demand function is estimated using the ARDL approach to cointegartion. The weighted monetary aggregate, CEMA is found to dominate the simple sum one in terms of expected properties in a money demand equation.

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