Stability of Demand for Money in India: Evidence from Monetary and Liquidity Aggregates

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Abstract

The determinants and stability of money demand functions, as per new definitions of monetary aggregates, has been analyzed in this paper. Quarterly Data from 1996Q2 to 2009Q2, for various monetary aggregates, interest rates, exchange rates, stock prices and GDP is in use. The cointegration tests, error correction mechanism, Granger causality and CUSUM tests has been applied for empirical analysis. The estimated results disclose the existence long-run and short-run relationship among the variables. Unidirectional Granger causality found from GDP and Stock Prices to monetary, new monetary as well as liquidity aggregates. Also similar result repeated from interest rates to money demand functions. The CUSUM and CUSUMQ tests support the existence of stability of each money demand functions. All the three variables, except exchange rate, affect the money demand of both types of specification.

Keywords: Monetary, New monetary, Liquidity aggregates, Cointegration, Stability tests, Causal tests

1. Introduction

Stability of demand for money is vital for choosing the appropriate instruments and intermediate targets of monetary policy. Essentially, it's a prerequisite for use of monetary aggregate as an intermediate target. Money demand stability implies that the quantity of money can be predictable related to various macroeconomics variables (Judd and Scadding (1982) and Friedman (1987)). In fact various macroeconomic variables such as, fiscal policy, interest rates, exchange rate, stock market, consumption expenditure, savings, investment, Import, export, etc can significantly affect the money demand. Understanding such linkages will facilitate the central bank to design the appropriate money demand function and, thus accordingly formulate and implement the appropriate monetary policy to achieve the desired objective of price stability with growth.

The issue of determinants and stability of money demand function in a transition economy has received budding interest among academician and policy makers. Stability of money demand functions is essential for stable economic growth. Several empirical studies examining the money demand function across economies are found in the macro-monetary literature. Some of the prominent studies are, Tobin (1958), Chow (1966), Goldfeld (1973), Judd and Scadding (1982), Roley (1985), McCallum and GoodFriend(1987), Laidler (1990), Goldfeld and Sichel(1990), Taylor (1991) and many more . These studies made significant contributions towards determinants and stability of money demand function. More empirical studies found across economies recently e.g. Hafer and Jansen (1991), Miller (1991), McNown and Wallace (1992) and Mehra (1993) for the USA. The paper of Lütkepohl and Wolters (1999), Coenen and Vega (2001), Brand and Cassola (2000), Holtemöller (2004b) discusses for Euro area. Arize and Shwiff (1993), Miyao (1996) and Bahmani-Oskooee (2001) examined the demand for money in the context of Japan. The studies of Drake and Chrystal (1994) for the UK; Haug and Lucas (1996) for Canada; Lim (1993) for Australia, whereas Orden and Fisher (1993) for New Zealand; Brissimis and Leventakis (1981), Bahami-Oskooee and Economiodu (2005) among few for Greece; Hsing(2007) for Croatia are pioneering in the field of demand for money. No unanimous results found in terms of specification, determinants and stability of money demand function. For example, Taylor (1991) recognized that for a high inflationary country, inflation expectation was the main determinant of money demand function than the low inflationary country.

Various aspect of money demand functions have been extensively studied in Indian context. The earlier studies of Biswas (1962), Singh (1970), Avadhani (1971), Gupta (1970, 71), Ahluwalia (1979) widely differs regarding income and interest rate as the determinant of money demand. Vasudevan (1977), Arif (1996), provides useful survey of some of the earlier studies. Applying various statistical and econometric techniques Deadman and Ghatak (1981), Sampath and Hussian (1981), Bhole (1985) and Rangarajan (1988), Nag and Upadhyay (1993) focused attention on the choice of monetary aggregates as dependent variable. Jadav (1994) established the long-run real income elasticity of broad money and semi elasticity with respect to own real rate of return. Recently Joshi and Saggar (1995), Arif (1996), Mohanty and Mitra (1999), Das and Mandal (2000) found stability of money demand functions. On the other hand, Bhoi (1995), Pradhan and Subramanian (2003) observed that financial deregulation and liberalization in the 1990s affect the empirical stability of broad money. The real GDP significantly affects money demand not interest rates, Kulkarni and Erickson (2000), thus supporting monetarists' argument of no role of interest rate in money demand. Padhan (2006), examined the money demand (M1, M3) function under liquidity adjustment facility and found that money demand functions are sensitive to real income, interest rates and to some extent exchange rates.

In India, the monetary policy formulation and implementation, which was entirely governed by the policies of Reserve Bank of India (RBI) during pre 1990's has become market driven in the post 1990's scenario. However, last two decade the economy is witnessed by several socio-economic-political crises, e.g. spill over effect of Asian Financial turmoil of 1997, Indo-Pak Kargil War, the devaluation of rupees against US dollar, US sub prime crisis spill over effect, global recession, the stock market crash, spiral increase in inflation, general elections, internal rebellion of various activists groups and many more. This has complicated the task for RBI to conduct and implement monetary policy in a challenging environment and cope up with the pace of transition from an administered system to a market based process. Choosing the appropriate intermediate target, instruments and operating procedures of monetary policy has become tedious. Since mid 80's monetary target is still the intermediate target of monetary policy even though RBI has adopted multiple indicator approach ever since mid 90's. An effective and transparent monetary policy requires a strong relationship between output, income, prices, interest rates etc. and other macroeconomic variables. Therefore such transitions and challenges raise concerns over the determinants and stability of the money demand.

To summaries, most of these studies applied either narrow money (M_1) or broad money (M_3) as measures of monetary aggregates and mixed evidence found on stability. Recently, RBI working group on money supply (1998) came up with alternative monetary aggregates such as L_1, L_2, L_3, NM_1, NM_2, and NM_3 (Note 1). Although, broad money (M_3) is widely used for policy analysis, other monetary aggregates are quite relevant for the economy, as they provide unique information. To our mind, none of the study considered such empirical specification of money demand functions. There is also paucity of study to examine the impact of factors such as stock price, exchange rates in affecting money demand functions. Instead of using proxy variable (IIP) the study uses actual quarterly GDP data for income and two different interest rates (call money rate i.e. market determined interest rate and 91Day Treasury bill rate i.e. policy rate). In view of this, the objective of the paper is to study determinants and stability of money demand applying various monetary (old and new) and liquidity aggregates in this context of India.

The rest of the paper is divided into following sections. The Section 2 specifies model specification and methods of estimation of money demand function. Section 3 discusses the empirical results and section 4 concludes.

2. Model Specifications and Methods of Estimation

While formulating the demand for money we have started with the traditional quantity theory of money expressed as MV = Py (Note 2). As suggested by Friedman (1987) including various determinants of money demand the QTM, a simple money demand function, can be stated as $(M/P)^d = f(y, r, E, S)$, where M is money stock, P is general price level, V is velocity of circulation of money, y is real income, r is interest rate, E is exchange rate, S is stock price. The exchange rate and stock price is included as additional determinants of demand for money. The rationality is that foreign exchange and stocks constitutes a part of portfolio of economic agents. Depreciation in exchange rate may result in further depreciation of the currency, which will force individuals to hold money as foreign currency to avoid possible losses. Similarly, expectations of currency depreciations may reduce money demand either due to substitution effect or wealth effect, Arango and Nadiari (1981). On the other hand stock price could be another variable affecting money demand functions possibly due to wealth effect and substitution effect Friedman (1988). For example, any increase in stock price might increase the nominal wealth; as returns on investment increases. This might induce people to hold more money and hence demand for money balances increases. Similarly, as stock price increases people might reshuffle the portfolio and prefer to hold large chunk of other attractive and lucrative equities in the portfolios. It indicates that net affect of stock price could be either +ve or –ve. Thus the demand for real money balances as a function of real income, interest rate, real stock price, real exchange rate can be specified as (Note 3)

$$(M/P)_t^d = \beta_0 + \beta_1 (Y/p)_t + \beta_2 r_t + \beta_3 E_t + \beta_4 S_t + \varepsilon_t \quad ---- \qquad (1)$$

Where, M is nominal money supply at time t., P is the price level(WPI), Y is nominal income, r_t is short term interest rate and E_t is the real exchange rate, S_t is the real stock price at time t. In the equation, $(M/P)_t^d$ represents the real money balance and $(Y/p)_t$ is the real income at time t. Theoretically, demand for money is directly related with real income and indirectly with interest rates. But the sign of the exchange rate and stock price in uncertain. So by convention, the values of the coefficient of income (β_1) should be positive and interest rate (β_2) is negative but for exchange rate (β_3) and stock price (β_4) it could be either negative or positive. It calls for empirical estimation of money demand functions and tests its stability.

The equation (1) can be estimated by multiple linear regression models, although regression model does not explain the dynamic relationship among the specified variables. The relationship could also be spurious. The cointegration test of Johansen-Juselius (1990) possibly avoids the problem by allowing feedback relationship and provides the long-run equilibrium relationship among variables.

The equation 1 can be expressed as a vector of variables, where each variable might be dynamically interrelated. Their long-run and short-run equilibrium relationship can be examined using cointegration and error correction model respectively. Technically speaking the money demand equation can be considered as a cointegrating equation. The estimation of Johansen –Juselius cointegration equation is based on Vector auto regression model estimated through maximum likelihood estimation procedure (Note 4). Johansen (1988, 1991), Johansen's-Juselius (1990, 1992) methodology is design to determine the number of cointegrating vector in the VAR system. The methods specify two test statistics in order to test the number of cointegrating vectors. Those are λ max (the maximum eigen value statistics) and λ trace statistics. The first step of testing cointegration is to tests whether the series are

stationary or not i.e. I (1) or I (0). Then apply the cointegration for non-stationary series i.e the series at levels if the variables are I (1). We can test the integration of the series by applying Phillips –Peron, PP (1988) and KPSS (1992) tests. Once the series are cointegrated they follow equilibrium pattern in the long run. However, in the short-run they might depart from each other resulting in dis-equilibrium. This can be explained through corresponding error correction model by including stationary residuals from the cointegrating vectors and include its one period lagged values (ECt-1) in an error correction model.
The ECM can be specified as,

$$\Delta M_t = \beta 0 + \sum_{j=1}^{n} \beta_{1j} \Delta M_{t-j} + \sum_{j=0}^{n} \beta_{2j} \Delta y_{t-j} + \sum_{j=0}^{n} \beta_{3j} \Delta r_{t-j} + \sum_{j=0}^{n} \beta_{4j} \Delta E_{t-j} + \sum_{j=0}^{n} \beta_{5j} \Delta S_{t-j} + \lambda EC_{t-1} + u_t \text{.................(2)}$$

Where, λ is the coefficient of error correction term. It denotes the speed of convergence towards equilibrium and provides the direction of equilibrium. The expected sign of the coefficient is negative. It means if the model is out of equilibrium, then demand for real money balance come forward from below to restore the equilibrium in the next period. If λ is not statistically significant, implying that the coefficient is equivalent to zero, hence the dependent variable adjusts to the changes in independent variables in the same period during short run.
We have applied the Granger causality tests to evaluate the temporal causality. Granger causality test says that if the variables are cointegrated then there exists a necessarily causal relationship among them at least in one direction. The causality can be tested using F statistics. Under the null hypothesis of no causality (e.g. from Y to X), if calculated F statistics is greater than critical F statistics with appropriate degrees of freedom and significance level, then reject the null hypothesis against alternative hypothesis.
Finally, we have applied CUSUM and CUSUMQ tests, proposed by Brown et. al. (1975) to tests the stability of the long-run and short-run coefficients. If the plot of CUSUM or CUSUMQ stays with in the 5% significance level, then the coefficients estimates are said to be stable (Note 5).

3. Data and Empirical Analysis

3.1 Data

Various alternative definitions of monetary aggregates such as narrow money (M1), broad money (M3) and liquidity aggregates L_1, L_2, new monetary aggregates (NM_3) is applied for empirical analysis(Note 6).
Weighted average call money rate (henceforth CMR) Mumbai and 91 Day Treasury bill rate (henceforth TBR) are considered for interest rates and Real effective exchange rate (reert) trade based (36- country weights) is for exchange rate. For stock price, CNXNifty is considered. Real income is measured by GDP at constant price. The empirical analysis is carried out applying quarterly data from 1996 Q2 to 2009 Q2. The period has been chosen based on availability of the quarterly data; collected from the Handbook of Statistics on Indian Economy. The quarterly data for CMR and TBR which is not available are extrapolated from monthly data. The real values are generated by deflating the nominal variable with the wholesale price index (WPI). After estimating the variable in real term, all the variables are expressed by natural logarithms.

3.2 Descriptive Statistics and Correlations

Preliminary understating of data structure can be analyzed through descriptive statistics and correlations coefficients. The results of summary statistics for all variables expressed in natural logarithms are given in table 1. The results reveal that except 91 day Treasury bill rate (TBR) and CNXNifty other variables follow normal distribution as represented by JB test and corresponding probability values. The null hypothesis of normal distribution for both the variables is rejected at 1% and 10 % significance level. Since the sample size is very small i.e. 53 only, so such type of conclusion is irrelevant. Skewness and Kurtosis support the same conclusion, whose value for a normal distribution are 0 and 3 respectively. Except TBR and CNXNifty other variables are normally distributed. When the variable is normally distributed, it does not follow random walk process and hence become easy to establish the relationship between such variables.
The variability of various monetary aggregates is similar. The coefficient of variations is lowest for TBR indicating that it's less volatile. The correlation coefficient of GDP and Stock price with money aggregates are highly correlated. Interest rate is moderately correlated with the monetary aggregates. Informally, the money demand functions are highly correlated with the income, interest rate and stock market. The sign of the correlation coefficient are obtained as per expectations. Although correlation coefficient between exchange rate and monetary aggregates are very less, it does not provide cause and effect relationship between variables. The demand function can be estimated through regression analysis.

3.3 Regression Analysis

The money demand equation 1 can be estimated through multiple linear regression model. We have estimated 10 different regression equations for 5 different alternative combinations of monetary aggregates using 2 types of interest rates separately. It's because the model suffers from multicollinearity problem as the correlation coefficient between CMR and TBR is very high i.e 0.858 and VIF is 3.788. The results are reported in table 2. The regression model is estimated with Newey-West HAC standard error and covariance with lag truncation equal to 3 to avoid the possibility of unknown heteroscedasticity and autocorrelation problem. The regression results using CMR and TBR separately are reported in panel A and B respectively. In both the panel, income and interest rates significantly affect money demand function irrespective of model specification. The coefficients of income are statistically significant at 1% significance level applying t test. Except for M_3 (which is significant at 5% significance level) in panel A, the coefficient of interest rate are statistically significant at 1% significance level. The results are consistent with Keynesian theory of demand for money as the sign of the coefficient; real income and interest rate are consistent and statistically significant. On the other hand, coefficient of stock price is statistically significant at 1% significance level only for M_1 money demand function and none other. But exchange rate is not statistically significant in either case. Hence both the variables do not statistically significantly affect money demand. The obtained coefficients are elasticity of money with respect to respective variables. For example the income elasticity of M_3 is equal to 1.32, i.e. more elastic. The regression results are robust due to high R^2, Significant F statistics, no autocorrelation and no heteroscedasticity problem. Of course, the limitation is that multiple regression model does not explain dynamic relationship among variables. The cointegration techniques e.g. Johansen-Juselius (1990) applied here can overcome such problem (Note 7).

3.4 Stationary of the Series

If any linear combination of two or more non-stationary series is stationary then the series are said to be cointegrated. The application of cointegration needs prior checking of stationary properties. Phillips-Perron (PP, 1988) and Kwiatkowsk, Phillips, Schmidt, and Shin (KPSS, 1992) unit root tests are applied. The former test addresses the issue of possible serial correlation in the regression model and tests the hypothesis. The later is a confirmatory test. The results are reported in table 3 at level and first difference of the variables. The models are estimated including a constant (C) and with constant & trend (C & T) term in the regression equations separately. For PP and KPSS tests the brackets represent the bandwidth of Newey- West using Bartlett kernel. For PP tests p values are in the parenthesis.

The PP tests assume the null hypothesis of unit root against the alternative of stationary. On the other hand KPSS is a confirmatory test, which assumes the null hypothesis of stationary against the alternative of non-stationary. For all variables at level the null hypothesis is accepted. However, for the variables at first difference, we reject the null hypothesis of unit root at 1% significance level for by both the PP and KPSS test of alternative model specification. Thus variables are stationary at first difference and non-stationary at level. Hence we can apply cointegration tests at level data.

3.5 Cointegration Results

The next step is to apply the multivariate cointegration test of Johansen (1988, 1991) and Johansen's-Juselius (1990, 1992), estimated through maximum likelihood estimation procedure. Two tests statistics such as λ trace and λ maximum eigen value is used to determine the number of cointegration vector. For n variable cases if at least one (r=1) cointegrating vector is present, it is sufficient to conclude that the variables are cointegrated. The number of cointegrating vector is estimated through VAR model for which it is necessary to specify the number of lag length in the autoregressive process. We have started with 1 lag and maximum of 8 is taken in the process. The lag length of 4 is chosen based on Akaike Information Criteria, Schwarz Bayesian Criteria and log likelihood ratio tests, which is theoretically and practically justified. The robustness of the model has also been checked using ARCH, LM, JB, Heteroscedasticity tests (Note 8).

Once optimal lag length is determined then next step is to apply cointegration test. The obtained results are reported in table 4. Panel A specify the cointegration equation with constant term, whereas panel B specify model with the linear deterministic trend term. In both the cases, we have estimated 10 cointegrating equations with two different interest rates. In panel A , irrespective of money demand specification with any interest rates, the null hypothesis of zero cointegrating vector (r=0) is rejected against the alternative of at least one cointegrating vector at 5% significance level. The same result is repeated in panel B also. For both the model we found minimum one cointegrating vector. Further, testing more number of cointegrating vectors, we might obtain different results, as shown in the table. This is evident from both trace and eigen value statistics. For example, the null hypothesis of r=2 cointegrating vector is rejected and alternative of 3 cointegrating vector is accepted for M_1 money demand function with constant term. Similarly for NM_3 money demand function with trend, the null hypothesis of r=1 cointegrating vector is rejected at 5% significance level and alternative of r> 2 is accepted. The result strongly supports the presence of one cointegrating vector for both the demand functions. Therefore, we can conclude that cointegration exists between variables and hence in the long-run they are related.

3.6 Error Correction Mechanism

If the variables are cointegrated, it need not necessarily mean that in the short-run they are always in equilibrium. This departure from the equilibrium relationship in the short-run is explained through error correction term. The error correction term is obtained from the residuals terms of cointegrating equations and plugged into the cointegrating equation with lagged term in first difference. The specified error correction model 2 is estimated using OLS methods. The results are reported in table 6. The details of ECM results are not provided here except the coefficient of Error correction term due to space consumption and may be available upon request. It means except M_3 money demand equation the sign of coefficient of error correction term is negative which is as per expectations. It implies that the specified money demand function adjust from below to restore the equilibrium in the immediate next period. Since other coefficients are statistically insignificant, implying that they are equivalent to zero. So the money demand function reacts to the changes in independent variables with the same period to restore equilibrium. However, if ECM term is negative, then monetary aggregates comes from above to restore equilibrium. The result indicates that all the variables are related in the short run and therefore the short-run causality can be explained through Granger causality tests.

3.7 Granger Causality Tests

The bivariate Granger causality test is applied for testing causality. According to Engel-Granger (1987), if the variables are cointegrated, then they are necessarily causally related at least in one direction. Granger causality applied for stationary series only, so we have estimated this for variables with first difference. The bivariate Granger causality tests results are reported in table 6. Accordingly the null hypothesis of GDP does not Granger cause monetary aggregates have been rejected for all types of money demand functions at various significance level, as reported by F statistics and corresponding P values. It implies that real income Granger causes money demand but not the reverse except for L2. Except L2 unidirectional causality found from real income to real money balances. Bi-directional relationships exist for real income and real L2 money balance. There is also unidirectional causality from real money to both the interest rates. It implies that call money rate reacts (also TBR) for any change in money demand not the reverse. Unidirectional causality found from stock price to money demand functions as the null hypothesis is rejected at various significance level. No causal relationship notices in either direction between exchange rate and real money balances. The result is consistent with regression results, also justified as per the magnitude and sign of coefficients are concerned.

3.8 Stability Tests

Once variables are cointegrated and causal relationship established, then stability of the demand for money can be tested applying CUSUM and CUSUMQ tests. From cointegrating equation we can obtain residuals. Considering the coefficients of residual with one period lagged term, we estimate an error correction model (with appropriate lagged term, here it is 4) and then apply both CUSUM and CUSUMQ test on the residual of error correction term. The equation 2 specifies ECM and can be estimated by OLS method. Then apply the CUSUM and CUSUMQ tests on the residual. If graphical plot of the CUSUM and CUSUMQ stays within 5% significance level, then coefficient estimators are said to be stable. The estimated result for each money demand specification with both CMR and TBR are represented in both Panel A and B respectively. From fig 1 it is clear that graphical plot of the CUSUM and CUSUMQ stays with in critical band of 5% for M_1, L_1, and L_2 demand for money. It indicates that the demand for money is stable. However although CUSUMQ tests for M_3 and NM_3 money demand are slightly out side the band (during mid 2006 to 2007) most of the cumulative sum of recursive residual squares are with in 5% confidence limit. It indicates that both M_3 and NM_3 demand for money is also relatively stable.

3.9 Money Demand Functions

The estimated money demand functions through regression analysis are reported in table 2. The estimated demand functions suggest existence of a stable relationship between real money balances with real income, real interest rate, and to some extent real exchange rate and stock price. From the equations we can find the elasticity of demand for real money balances. The income elasticity of demand with respect to M_1, M_3, L_1, L_2 and NM_3 is 1.014, 1.32, 1.39, 1.387, and 1.397 respectively. The positive sign is consistent with the theory because as income increases the demand for money increases. The interest (CMR) elasticity of money demand with respect is M_1, M_3, L_1, L_2 and NM_3 is -0,118, -0.127, -0.143,-0.140 and -0.145 respectively, which is also consistent with theory. The elasticity of money demand for M_1, M_3, L_1, L_2 and NM_3 with respect to exchange rate is 0.006, 0.188, 0.284, 0.288 and 0.173 respectively. Similarly the elasticity of money demand for M_1, M_3, L_1, L_2 and NM_3 with respect to stock price is 0.165, 0.038, 0.046, 0.046 and 0.083 respectively. Elasticity of money demand with respect to real income is elastic but inelastic for interest rate, exchange rate and stock price. The results are consistent with theories of demand for money.

4. Conclusion

The paper started with a discussions on the specification, estimation and stability of the demand for money with respect to various monetary (old and new) and liquidity aggregates. The money demand function specified including exchange rate and stock price in addition to income and interest rates. For empirical testing of the same it uses quarterly data. All the series expressed in natural logarithms are stationary at first difference. The cointegration result shows the presence of more than one cointegrating vector for all types of money demand functions, supporting the long-run equilibrium relationship among variables. Similarly ECM also supports the short-run dynamic properties of money demand functions. Unidirectional causality found from GDP and Stock Prices to monetary, new monetary and liquidity aggregates through Granger causality test. Similarly unidirectional causality is also noticed from interest rates to money demand functions. The CUSUM and CUSUMQ tests show that all the alternative specification of money demand functions is stable. The paper also concludes that except exchange rate, all the other variables significantly affect the money demand function.

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Notes

Note 1. M1 = Currency with the Public + Demand Deposits with the Banking System + 'Other' Deposits with the RBI.

M2=M1 + Savings Deposits of Post office Savings Bank

M3 = M2 + Term Deposits of residents with a contractual maturity of over one year with the Banking System + Call/Term borrowings from 'Non-depository' Financial Corporations by the Banking System

NM2 = currency and residents' short-term bank deposits which would stand in between narrow money (M1) (which includes only the non-interest bearing monetary liabilities of the banking sector) and broad money (M3) (an all encompassing measure that includes long-term time deposits). NM3= Currency with the public + Demand Deposits with Banks + Time Deposits with Banks- FCNR (b) and RIB deposits + 'Other' Deposits with RBI +Other borrowings by Banks.

L1= M3 + all Post Office Deposits with the Post Office Savings Banks(Excluding National Savings Certificate)

L2= L1+ Term Deposits with FIs + Term Borrowing by FIs + CDs issued by FIs
L3= L2 + Public Deposits with NBFCs
Note 2.According to the standard text books, real income determines the demand for money in the classical sense as money is demanded for transaction purpose, whereas for Keynesian it is real income and interest rate as people demand money for transaction, precautionary and speculative purpose. On the other hand, Friedman has given a list of factors affecting money demand such as stock, bonds, etc. which generated wealth. Similar exchange rate also determines the demand for money because of substitution as well as wealth effect.
Note 3. According to Rangarajan (1985),it is possible to build into such a formulation the lagged impact of the factors that influence the money holding
Note 4. Since this is widely applied technique, we are not discussing the details of it. Once can refer a stranded text book on Time series Econometrics. In our earlier version of the paper Padhan (2006) we have discuses about this procedure elaborately.
Note 5. The significance level is portrayed by two straight lines whose equations are given in Brown et.al (1975)
Note 6. NM2 and L2 are not considered due to lack of required data.
Note 7. Gonzalo (1994) analyzed the statistical performance of three cointegration tests such as, Engel-Granger, the Stock and Watson tests, and Johansen's test and found that Johansen's is found to be superiors to the other tests under consideration.
Note 8. The results can be obtained from the author upon request.

Table 1. Descriptive Statistics and Correlations

Descriptive Statistics	M_1	M_3	L_1	L_2	NM_3	GDP	CMR	TBR	REERT	CNXNifty
Mean	3.45	3.990	4.002	4.004	3.977	5.541	0.813	0.820	1.994	0.999
Std. Dev.	0.149	0.176	0.180	0.179	0.185	0.116	0.134	0.146	0.0161	0.178
Skewness	0.270	0.066	0.054	0.054	0.115	0.149	0.206	-1.419	-0.662	0.702
Kurtosis	1.827	2.003	1.915	1.922	1.928	2.093	2.929	7.994	3.389	2.411
Jarque-Bera	3.680	2.232	2.624	2.590	2.655	2.012	0.388	72.875	4.202	5.126
P Values	0.159	0.328	0.269	0.274	0.265	0.366	0.824	0.000	0.122	0.077
Coeff. Variation	0.043	0.043	0.045	0.045	0.046	0.022	0.165	0.002	0.008	0.178
Correlations										
M_1	1.000	0.991	0.992	0.992	0.995	0.963	-0.344	-0.499	0.135	0.797
M_3	0.991	1.000	0.999	0.999	0.999	0.959	-0.355	-0.526	0.120	0.730
L_1	0.992	0.999	1.000	1.000	0.999	0.963	-0.364	-0.532	0.130	0.736
L_2	0.992	0.999	1.000	1.000	0.999	0.963	-0.363	-0.532	0.131	0.737
NM_3	0.995	0.999	0.999	0.999	1.000	0.961	-0.358	-0.524	0.126	0.748
GDP	0.963	0.959	0.963	0.963	0.961	1.000	-0.281	-0.468	0.095	0.753
CMR	-0.344	-0.355	-0.364	-0.363	-0.358	-0.281	1.000	0.858	-0.070	-0.090
TBR	-0.499	-0.526	-0.532	-0.532	-0.524	-0.468	0.858	1.000	0.028	-0.144
REERTB	0.135	0.120	0.130	0.131	0.126	0.095	-0.070	0.028	1.000	0.263
CNXNifty	0.797	0.730	0.736	0.737	0.748	0.753	-0.090	-0.144	0.263	1.000

Table 2. Regression Results: (Newey West HAC Standard Error and Covariance (lag truncation=3))

Dep.Var	Panel A: Independent Variables					Panel B Independent Variables				
	C	GDP	CMR	REERT	CNXNifty	C	GDP	TBR	REERT	CNXNifty
M_1	-2.25* (-4.33) (0.000)	1.014* (17.01) (0.000)	-0.12* (-3.94) (0.000)	0.006 (0.030) (0.976)	0.1649* (4.700) (0.000)	-2.08* (-3.53) (0.00)	0.953* (12.63) (0.000)	-0.12* (-2.92) (0.005	0.0874 (0.375) (0.709)	0.186* (4.673) (0.000)
	R^2=0.949 Adj R^2=0.945 DW=1.158 F=224.645 P=0.000					R^2=0.946, Adj R^2=0.945, DW=1.58, F=226.15 P=0.000				
M_3	-3.93* (-4.73) (0.000)	1.32* (14.11) (0.000)	-0.13** (-2.63) (0.011)	0.188 (0.656)) (0.515)	0.0383 (0.737) (0.464)	-3.70* (-4.68) (0.000	1.298* (12.11) (0.000)	-0.14** (-3.02) (0.004)	0.275 (0.908) (0.368)	0.065 (1.222) (0.228)
	R^2=0.929 Adj R^2=0.922 DW=1.497 F=156.136 P=0.000					R^2=0.930, Adj R^2=0.92 DW= 1.49, F=159.43 P=0.000				
L_1	-4.24* (-5.44) (0.000	1.39* (14.57) (0.000)	-0.14* (3.033) (0.004)	0.284 (1.127) (0.265)	0.046 (0.981) (0.333	-4.01* (-4.94) (0.000	1.318* (12.10) (0.000)	-0.16* (-2.911) (0.005)	0.038 (1.323) (0.192)	0.075 (1.465) (0.149)
	R^2=0.938 Adj R^2=0.933 DW=1.604 F=183.21 P=0.000					R^2=0.939 Adj R^2=0.934 DW= 1.59, F=186.74 P=0.000				
L_2	-4.194 (-5.41) (0.000)	1.387 (-2.99) (0.000)	-0.140 (-2.99) (0.004)	0.288 (0.684) (0.497)	0.0459 (0.784) (0.437)	-3.94* (-4.96) (0.00)	1.308* (12.07) (0.000)	-0.16* (-2.93) (0.005)	0.384 (1.343) (0.186)	0.073 (1.469) (0.148)
	R^2=0.938 Adj R^2=0.933 DW= 1.599 F=182.014 P=0.000					R^2=0.939, Adj R^2=0.934 DW= 1.59 F=186.028 P=0.000				
NM_3	-4.07* (-5.17) (0.000)	1.397* (14.52) (0.000)	-0.14* (-3.05) (0.004)	0.173 (0.623) (0.536)	0.083 (1.664) (0.103)	-3.84* (-4.80) (0.00)	1.316* (11.86) (0.000)	-0.14* (-2.90) (0.006)	0.272 (0.887) (0.379)	0.111** (2.076) (0.043
	R^2=0.938 Adj R^2=0.931 DW=1.548 F=175.469 P=0.000					R^2=0.9386Adj R^2=0.934 DW= 1.55 F=178.150 P=0.000				

*, **, ** Denotes 1%,5% and 10% significance level respectively. Obtained 't' statistics and p values are given the parenthesis respectively.

Table 3. Unit Root Tests

Variable	PP Test Level		PP Test First Difference		KPSS Test Level		KPSS Test First Difference	
	C	C & T	C	C & T	C	C & T	C	C & T
M_1	2.770 (14) (1.00)	-2.98 (18) (0.148)	-9.279 (17) (0.000) *	-13.46 (15) (0.000) *	0.980 (5)	0.231 (13)	0.421 (05) *	0.137 (14) *
M_3	1.364 (12) (0.999)	-1.138 (7) (0.912)	-3.946 (80) (0.000) *	-5.951(21) (0.000) *	0.989 (5)	0.123 (5)	0.246 (10) *	0.131 (12) *
L_1	1.623 (19) (0.999)	-3.12 (10) (0.113)	-9.269 (25) (0.000) *	-9.541(24) (0.000) *	0.994 (5)	0.144 (3)	0.283 (20) *	0.173 (19) *
L_2	1.582 (19) (0.999)	-3.101 (9) (0.117)	-9.366 (26) (0.000)	-9.461(24) (0.000)	0.994 (5)	0.148 (3)	0.278 (20) *	0.108 (19) *
NM_3	4.544 (44) (1.000)	-1.62 (12) (0.771)	-7.451 (50) (0.000) *	-7.45 (50) (0.000) *	0.991 (5)	0.187 (8)	0.407 (46) *	0.500(81) *
GDP	-0.789 (12) (0.814)	-6.33 (25) (0.000) *	-17.68 (11) (0.000) *	-16.88 (11) (0.000)	0.983 (5)	0.500 (52)	0.372 (11) *	0.636 (11) *
CMR	-3.478 (1) (0.013)	-3.765 (1) (0.007)	-11.44(18) (0.000) *	-12.06 (20) (0.000) *	0.407 (4)	0.102 (4)	0.097 (9) *	0.095 (9) *
TBR	-0.939 (1) (0.707)	-1.633 (1) (0.766)	-3.806 (0) (0.005) *	-3.584 (1) (0.04) *	0.344 (5)	0.096 (4)	0.177 (1) *	0.132 (1) *
REERT	-2.218 (2) (0.203)	-1.973 (2) (0.602)	-5.332 (1) (0.000) *	-5.661 (1) (0.000) *	0.162 (4)	0.948 (4)	0.163 (1) *	0.086 (0) *
CNXNIFTY	-0.962 (1) (0.759)	-2.02(0) (0.577)	-5.004 (3) (0.001) *	-4.91 (15) (0.0009) *	0.642 (3)	0.174 (5)	0.9395 (2) *	0.062 (2) *

*, **, ** Denotes 1%,5% and 10% significance level respectively stands for with constants and C & T for with constant and trend. For PP tests and KPSS the brackets represent the bandwidth Newey- West using Bartlett kernel. For PP tests p values in the parenthesis. The critical values for KPSS LM statistics is at level with constant term is at 1%, 5%, 10% significance level are 0.739, 0.463 and 0.347 respectively and for constant and trend term it is 0.216, 0.146 and 0.119. Similar

Table 4. Johansen Juselius Cointegration Tests

Cointg. Equation	Hypothesis: Trace Stat.	Hypothesis: Max Stat.	Panel A (with Constant)				Panel B (With Trend)			
			λ Trace Stat.	P value	λ Max Stat.	P Value	λ Trace Stat.	p Value	λ Max Stat.	p Value
M_1, GDP, CMR, REERT, CNXNifty	Ho:r=0, H_1:r>0	Ho:r=0, H_1:r=1	127.530*	0.000	50.327*	0.000	141.624*	0.000	46.544*	0.005
	Ho:r≤1,H_1:r>1	Ho:r=1,H_1:r=2	17.003*	0.001	41.319*	0.000	93.250*	0.000	44.764	0.071
	Ho:r≤2, H_1:r>2	Ho:r=2, H_1:r=3	95.684*	0.044	18.162	0.171	50.946*	0.006	23.915	0.088
	Ho:r≤3, H_1:r>3	Ho:r=3, H_1:r=4	17.321	0.114	146.7	0.078	23.041	0.053	15.171	0.154
M_1, GDP, TBR, REERT, CNXNifty	Ho:r=0, H_1:r>0	Ho:r=0, H_1:r=1	141.230*	0.000	61.795*	0.000	155.957*	0.000	66.025*	0.000
	Ho:r≤1,H_1:r>1	Ho:r=1,H_1:r=2	79.435*	0.000	42.244*	0.000	89.938*	0.001	43.927*	0.001
	Ho:r≤2, H_1:r>2	Ho:r=2, H_1:r=3	32.191*	0.030	19.302	0.132	46.008*	0.003	21.401*	0.021
	Ho:r≤3, H_1:r>3	Ho:r=3, H_1:r=4	18.086	0.097	13.396	0.140	25.547*	0.035	14.023	0.251
	Ho:r≤4, H_1:r>4	Ho:r=4, H_1:r=5	4.492	0.344	4.492	0.344	12.543*	0.024	11.523*	0.002
M_3, GDP, CMR, REERT, CNXNifty	Ho:r=0, H_1:r>0	Ho:r=0, H_1:r=1	105.580*	0.000	37.776*	0.002	130.037*	0.000	42.981*	0.014
	Ho:r≤1,H_1:r>1	Ho:r=1,H_1:r=2	67.784*	0.001	31.312*	0.021	87.875*	0.000	32.907*	0.040
	Ho:r≤2, H_1:r>2	Ho:r=2, H_1:r=3	36.272*	0.038	16.759	0.244	34.909*	0.002	29.409*	0.016
	Ho:r≤3, H_1:r>3	Ho:r=3, H_1:r=4	19.42	0.063	14.171	0.091	25.507	0.054	14.119	0.246
M_3, GDP, TBR , REERT, CNXNifty	Ho:r=0, H_1:r>0	Ho:r=0, H_1:r=1	170.182*	0.000	81.628*	0.000	124.004*	0.000	44.367*	0.002
	Ho:r≤1,H_1:r>1	Ho:r=1,H_1:r=2	88.956*	0.000	35.866*	0.005	79.052*	0.000	35.812*	0.003
	Ho:r≤2, H_1:r>2	Ho:r=2, H_1:r=3	33.089*	0.000	28.118*	0.007	43.844*	0.007	25.231*	0.025
	Ho:r≤3, H_1:r>3	Ho:r=3, H_1:r=4	24.970*	0.010	18.374*	0.019	20.610*	0.007	18.069*	0.011
	Ho:r≤4, H_1:r>4	Ho:r=4, H_1:r=5	6.446	0.959	6.446	0.159	2.541	0.119	2.541	0.119
L_1, GDP, CMR, REERT, CNXNifty	Ho:r=0, H_1:r>0	Ho:r=0, H_1:r=1	136.924*	0.000	61.426	0.000*	136.973*	0.000	61.428*	0.000
	Ho:r≤1,H_1:r>1	Ho:r=1,H_1:r=2	75.493*	0.000	31.846*	0.018	75.495*	0.02	31.848*	0.018
	Ho:r≤2, H_1:r>2	Ho:r=2, H_1:r=3	43.646*	0.022	19.721	0.110	43.646*	0.005	19.721	0.110
	Ho:r≤3, H_1:r>3	Ho:r=3, H_1:r=4	23.923	0.075	13.861	0.101	23.925*	0.015	13.860	0.101
	Ho:r≤4, H_1:r>4	Ho:r=4, H_1:r=5	4.004	0.067	9.064	0.054	10.064	0.136	10.004	0.135
L_1, GDP, TBR, REERT, CNXNifty	Ho:r=0, H_1:r>0	Ho:r=0, H_1:r=1	100.386*	0.000	36.734*	0.024	114.820*	0.000	44.478*	0.008
	Ho:r≤1,H_1:r>1	Ho:r=1,H_1:r=2	63.832*	0.005	28.872*	0.050	70.340*	0.012	32.788*	0.041
	Ho:r≤2, H_1:r>2	Ho:r=2, H_1:r=3	35.275*	0.049	20.931	0.075	32.337	0.181	16.820	0.473
	Ho:r≤3, H_1:r>3	Ho:r=3, H_1:r=4	14.804	0.769	8.354	0.806	21.237	0.190	16.216	0.240
L_2, GDP, CMR, REERT, CNXNifty	Ho:r=0, H_1:r>0	Ho:r=0, H_1:r=1	92.701*	0.002	33.479*	0.041	113.839*	0.000	40.183*	0.030
	Ho:r≤1,H_1:r>1	Ho:r=1,H_1:r=2	59.221*	0.016	29.0146*	0.043	73.638	0.076	32.186*	0.045
	Ho:r≤2, H_1:r>2	Ho:r=2, H_1:r=3	30.057	0.161	13.341	0.472	211.472	0.069	22.165	0.141
L_2, GDP, TBR, REERT, CNXNifty	Ho:r=0, H_1:r>0	Ho:r=0, H_1:r=1	99.293*	0.004	36.04*	0.035	114.894*	0.002	44.863*	0.000
	Ho:r≤1,H_1:r>1	Ho:r=1,H_1:r=2	63.184*	0.006	22.590*	0.050	70.030*	0.014	31.863	0.537
	Ho:r≤2, H_1:r>2	Ho:r=2, H_1:r=3	35.593	0.545	20.456	0.080	38.167	0.138	17.903	0.384
	Ho:r≤3, H_1:r>3	Ho:r=3, H_1:r=4	15.156	0.212	8.753	0.054	20.167	0.213	13.519	0.288
NM_3, GDP, CMR, REERT, CNXNifty	Ho:r=0, H_1:r>0	Ho:r=0, H_1:r=1	104.860*	0.001	41.669*	0.006	24.384*	0.000	45.677*	0.006
	Ho:r≤1,H_1:r>1	Ho:r=1,H_1:r=2	62.190*	0.036	26.631*	0.046	78.708*	0.001	29.686	0.097
	Ho:r≤2, H_1:r>2	Ho:r=2, H_1:r=3	36.209*	0.036	17.681	0.185	49.012*	0.011	24.521	0.073
	Ho:r≤3, H_1:r>3	Ho:r=3, H_1:r=4	18.829	0.077	13.348	0.125	24.550	0.728	13.257	0.307
NM_3, GDP, TBR, REERT, CNXNifty	Ho:r=0, H_1:r>0	Ho:r=0, H_1:r=1	131.128*	0.000	64.994*	0.000	110.277*	0.000	40.246*	0.027
	Ho:r≤1,H_1:r>1	Ho:r=1,H_1:r=2	66.134*	0.003	27.743*	0.048	70.0264*	0.001	27.013*	0.012
	Ho:r≤2, H_1:r>2	Ho:r=2, H_1:r=3	38.381	0.022	24.201	0.027	32.953*	0.004	23.323	0.024
	Ho:r≤3, H_1:r>3	Ho:r=3, H_1:r=4	14.179	0.277	9.086	0.425	14.629	0.067	12.142	0.105

*, **, ** Denotes 1%,5% and 10% significance level respectively. Critical Values are used from Osterwald-Lenum (1992).

Table 5. Error Correction Models:

ECM Equations	Interest rate Variables	Coefficient of ECM(-1)	T Statistics	P values
M_1	CMR	-0.405	-0.973	0.342
M_1	TBR	-0.182	-0.377	0.709
M_3	CMR	0.003	0.008	0.993
M_3	TBR	0.377	0.791	0.438
L_1	CMR	-0.083	-0.404	0.647
L_1	TBR	-1.173	-1.77	0.162
L_2	CMR	-0.855	-1.216	0.237
L_2	TBR	-0.289	-0.625	0.538
NM3	CMR	-0.342	-0.797	0.434
NM_3	TBR	-0.002	-0.009	0.996

*, **, ** Denotes 1%,5% and 10% significance level respectively.

Table 6. Granger Causality Tests

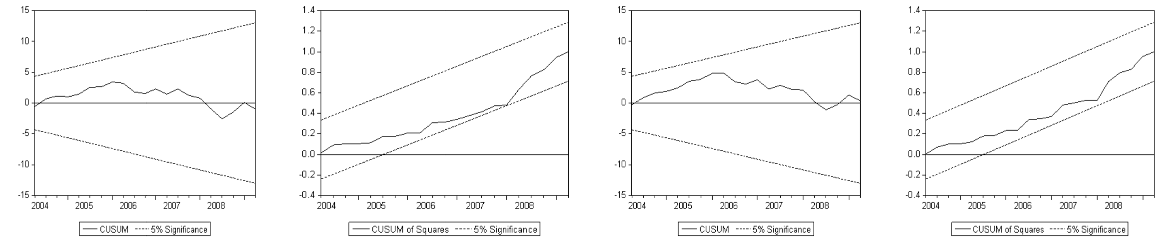
Hypothesis e. g. H_0: Y does not Granger cause X. ; H_1: Y Granger cause X , Lag=4:

Direction of Causality (Y→X)	F Statistics	P value	Causality Exists	Direction of Causality (Y→X)	F Statistics	P Value	Causality Exists
RGDP→ M_1	2.53***	0.055	Y	L_1→TBR	4.243*	0.006	Y
M_1→GDP	1.211	0.322	N	EERTB→ L_1	0.838	0.510	N
CMR→M_1	1.894	0.131	N	L_1→REERTB	0.251	0.907	N
M_1 →CMR	5.457*	0.001	Y	CNXNIFTY→L_1	2.397***	0.067	Y
TBR→ M_1	1.872	0.135	N	L_1→-CNXNIFTY	0.792	0.537	N
M_1-TBR	4.835**	0.003	Y	GDP→ L_2	8.247*	0.000	Y
REERTB→ M_1	0.510	0.729	N	L_2→ GDP	2.272**	0.079	Y
M_1 → REERTB	0.077	0.989	N	CMR→ L_2	0.966	0.437	N
CNXNIFTY-→ M_1	5.037*	0.002	Y	L_2 →CMR	3.340**	0.019	Y
M_1 → CNXNIFTY	3.152**	0.024	Y	TBR → L_2	1.526	0.213	N
GDP → M_3	2.361***	0.070	Y	L_2→ TBR	4.121*	0.007	Y
M_3→GDP	1.579	0.199	N	REERTB → L_2	0.950	0.445	N
CMR→– M_3	1.390	0.255	N	L_2 →REERTB	0.284	0.887	N
M_3 →CMR	5.171*	0.002	Y	CNXNIFTY→ L_2	2.353***	0.071	Y
TBR→ M_3	0.842	0.5073	N	L_2→CNXNIFTY	0.803	0.531	N
M_3→TBR	5.229*	0.002	Y	GDP → NM_3	3.335**	0.019	Y
REERTB→ M_3	0.486	0.746	N	NM_3 → GDP	1.508	0.219	N
M_3 →REERTB	0.138	0.967	N	CMR → NM_3	1.220	0.318	N
CNXNIFTY → M_3	2.419***	0.065	Y	NM_3 →CMR	5.611*	0.001	Y
M_3→CNXNIFTY	1.863	0.136	N	TBR →NM_3	0.544	0.704	N
DP→L_1	8.271*	0.000	Y	NM_3→ TBR	5.462*	0.001	Y
L_1→ GDP	2.276**	0.078	Y	REERTB→- NM_3	0.591	0.671	N
CMR→ L_1	0.899	0.474	N	NM_3 → REERTB	0.042	0.996	N
L_1 - CMR	3.396**	0.018	Y	CNXNIFTY →NM_3	2.401***	0.066	Y
TBR → L_1	1.267	0.299	N	NM_3→ CNXNIFTY	2.035	0.108	N

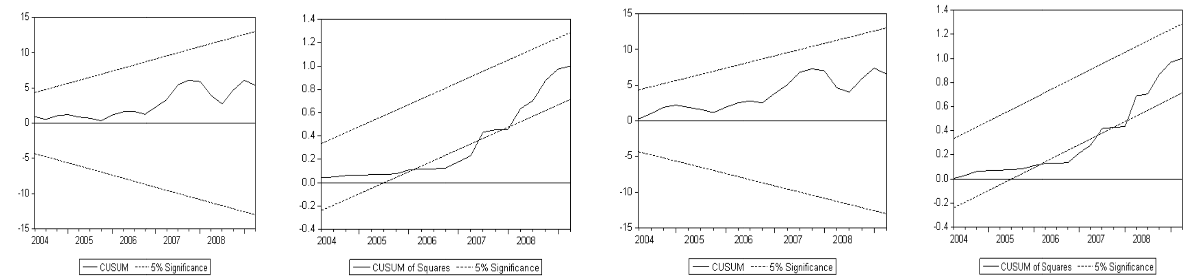
*, **, ** Denotes 1%,5% and 10% significance level respectively. Y for Yes , N for No

Panel A: with CMR **Panel B: with TBR**

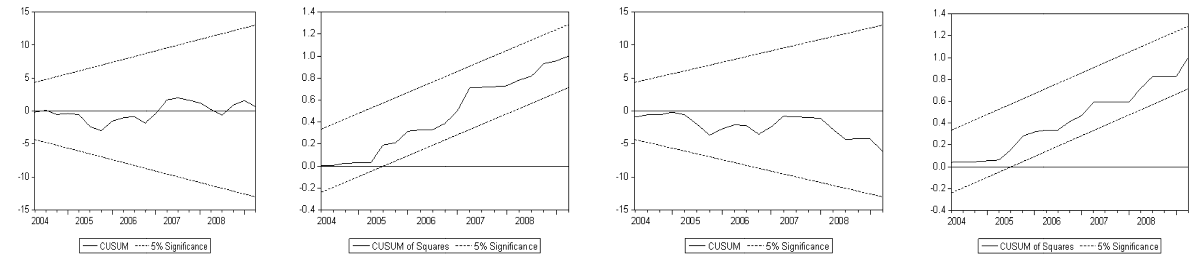
1. M_1



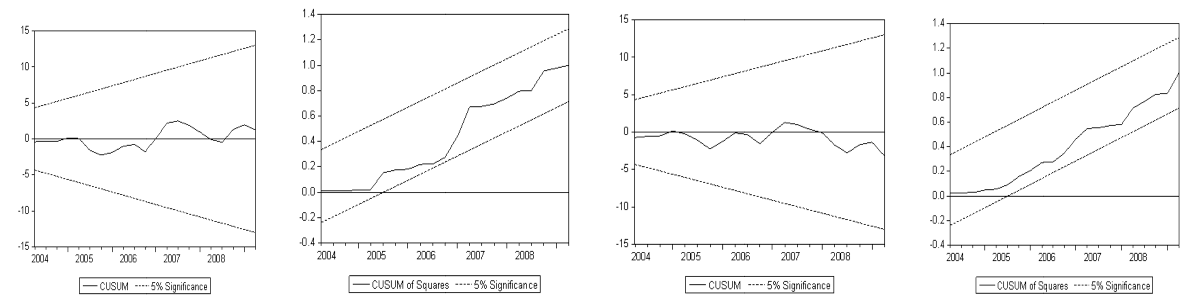
2. M_3



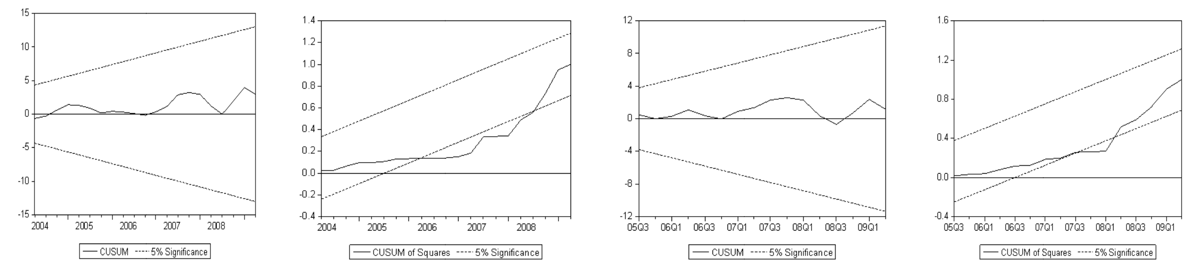
3. L_1



4. L_2



5. NM_3



The straight line represent critical bound at 5% significance level

Figure 1. CUSUM and CUSUMQ Test: Plot of cumulative sum of and square of recursive residual