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The Empirical Verification of Money Demand in Case of India: Post-Reform Era

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Abstract

In the evident of globalised world economy and changing economic structure, the traditional policies are required to be close examination. This is true particularly in case of developing countries, like India where new economic policies have had been changing visibly since 1990s. Therefore, in the new economic policy regime one of the important building block of policy is the money demand, which needs to be examined again. Present study examines the stability issues of money demand in case of India, using quarterly data from 1996:Q2 to 2016:Q3. With the help of autoregressive distributed lag model (ARDL) or bounds testing approach of cointegration, it has been concluded that there exists stable long run relationship among variables under consideration in the post reform period.

Keywords: new economic policy, money demand, ARDL, India.

JEL Codes: E00, E4, E41, E52, G00.

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Section I

Introduction

The proper implementation of monetary policy with the help of suitable instruments, such as conventional instrument and unconventional monetary policy at the zero bound, has important implications for a number of macroeconomic issues. To gauge the performance of macroeconomic variables in any economy, monetary policy should be conducted in a way that leads to stable growth in aggregate demand. Hence, one of the important task of central bank is to keep demand from growing too rapidly, with resulting inflation, or too slowly, with resulting high unemployment and slow economic growth. But in the uncertain world what procedure should adopt by central bank to get the desirable outcome. To this end over a period of time, different nominal anchor have been announced by the central bank in various economies.

The ultimate targets that the monetary authority wants to control are macroeconomic goal variables such as, the inflation rate, unemployment rate, and growth in real gross domestic product (GDP). Rather than simply making adjustment in monetary policy instruments, central bank tries to influence these ultimate macroeconomic target variables by influencing the nominal anchor or intermediate target variables. Indian central bank, that is, the Reserve Bank of India (RBI), broadly speaking three most prevalent nominal anchor has announced, in the recent past, viz., exchange rate (the oldest one), monetary aggregates, and inflation targeting.

Focussing only upon the monetary aggregate, one of the most important variable upon which monetary aggregate was based, is the money demand. There are several issues related to money demand which matters much for monetary aggregate as a nominal anchor, and also have had an important implications for a number of macroeconomic issues. As mentioned by Goldfeld (1989), money demand relationship with its key determinants is an important building block in
macro-economic literature and is a crucial component in the conduct of monetary policy. Even in the regime of inflation targeting, well specified money demand functional form is a crucial component for an effective implementation of monetary policy—especially to trace both, the interest rate and the stock of money—in order to evaluate the impact of monetary policy upon economy. Consequently, the money demand topic has always been in the cornerstone of research.

Since the inception of reform process in India, such as, increased financial innovation, reforms in the financial sector, shifts in exchange rate policy and increased financial integration and so on, seems to contributing factors in unstable money demand function. Singh and Pandey (2010) mentioned Reddy (2002), “The monetary management in terms of framework and instruments have undergone significant changes, reflecting broadly the transition of the economy from a regulated to a liberalised and deregulated one”. Also the ongoing new cash balance management (for instance, ATM, credit cards, Paytm, emergence of new payment Apps), financial innovations, and financial liberalisations has had been expanding very rapidly not only in domestic financial markets but also in international financial markets. Therefore, the late 1980s and 1990s financial liberalisation and external shocks due to swings in capital flows, exchange rate volatility, and business cycles at global level caused to instability in the money demand functional form.

It is important to note that a clear assessment of how much money the public is likely to hold still a relevant bone of contention in the current monetary policy scenario. Under different economic situations the probable holding of money by public is a precondition for an effective monetary policy formulation of an economy. It is so because the nature and quantum of interaction between monetary and real sectors of a country is reflected by the demand for
money and its components. Importantly, as mentioned by Bharadwaj and Pandit (2010), “the relationship between stock of money and the level of output, interest rate, price level, and other important financial series such as, stock prices must be stable if it has to be of any use for policy purposes. It is only then, policy makers can effectively target the ultimate objectives like price stability, capital formation, unemployment reduction, and economic growth through intermediate variables such as, interest rates and liquidity.” Also, the growth in broad money continues to be used as an important indicator of monetary policy, although the use of broad money as an intermediate target has been de-emphasized by RBI after switching over multiple indicator approach (Singh and Pandey, 2010).

In the backdrop of the above, present study aims at certain important issues such as, estimation of money demand (narrow and broad money both), long run and short run dynamic relationship among its variables, specification of the money demand functional form, and its stability, in case of India during post reform period using dataset at quarterly frequency from 1996Q2 to 2016Q3. Further, following the present study, some important policy implications can be drawn for effective monetary policy in case of India. By applying the econometric concept of cointegration (ARDL cointegration approach), CUSUM and CUSUMQ, and Hansen instability tests, it has been found empirically that there exists long run relationship and short run dynamics among variables under consideration, in case of both narrow and broad money. Study also analyses the sensitivity of different interest rate in the money demand function which helps in setting up an effective interest rate for monetary policy. The structure of the remaining part of the paper is as follows: section 2 presents existing literature on money demand in case of developing and developed countries, and India as well. Section 3 brings out sources of database and research methodology used for empirical analysis, section 4 shows the results of analysis, and section 5 sums up the article with concluding remarks.
Section II

Literature Review

The empirical literature on money demand is available in huge quantity. A lot of research have had been done in developed and developing countries; more recently, a number of studies on emerging market economies have also been growing due to the new economic policies where India is also the witness of it. The results on money demand issues are mixed. In case of India, because of the new economic policy visibly 1990s and mixed results motivate us to work further on money demand issues. Some of the important literature on issues of money demand are as follows.

Studies Based on Developed and Developing Countries

Sekine (1998) examined the demand for broad money with respect to financial liberalization and the wealth in case of Japan for the period 1975 to 1994. Study used the cointegration technique, (such as, vector autoregressive model (VAR) and autoregressive distributed lag (ARDL) model is estimated as a general model in the single equation analysis for further confirmation of cointegration) and super exogeneity test to check the validity of the model. Then it is concluded that despite the “boom and bust” of the “bubble” economy, a stable money demand function can still be set up if one considers financial liberalization and the wealth effect, and an adequate econometric tools.

James (2005) investigated the effects of financial liberalization on the demand for money in case of Indonesia by using the quarterly time series data from 1983q1 to 2000q4. With the help of autoregressive distributed lag (ARDL) model, study concluded that included proxy for financial liberalization (i.e., linear trend) in the model plays a key role in determining money demand and its fluctuations.

correction model of money demand based on autoregressive distributed lag model (ARDL). Although industrial production is statistically insignificant for both M1 and M1A money demand but the interest rate, inflation, and the real effective exchange rate have a negative and significant impact. Further, application of CUSUM and CUSUMQ reveals that money demand is structurally stable.

Ahad (2017) examined demand for money by taking into account financial development, industrial production, income, and exchange rate in case of Pakistan for the period 1972 to 2012. Study employed Bayer-Hanck combined cointegration and Johansen cointegration for testing long run relation among variables under consideration. It is confirmed that there exists cointegration, consequently study also used VECM for short and long run causality. At last it is concluded that money demand is stable, also well explained by financial development in both long run and short run. Hence, government shall focus on financial development to control money demand.

Lai (2013) investigates the stability of money demand in case of Vietnam by using quarterly data for the period 1999Q2 to 2011Q3. The use of ARDL time series technique confirms the cointegration among variables viz., money demand, income, expected inflation, exchange rates, and gold price. Further use of CUSUM and CUSUMQ show stable money demand for M1 and M2D (without foreign currency deposits), while M2 shows temporal instability.

**Demand for Money in Case of India**

Arora (2016) analysed the money demand stability in case of India covering monthly data from 1991: M4 to 2014: M9. The use of methodology like, cointegration and vector error correction mechanism (VECM) reveals that there exists a stable money demand functional form during post-reform period in India. Study concludes that effectiveness of monetary policy can be maintained via maintaining the stability of money demand function.
Inoue and Hamori (2009) empirically analyses India’s money demand over the period of 1980 to 2007 using monthly data and the period of 1976 to 2007 using annual data. For both the dataset monthly vis a vis annually, cointegration test shows the existence of cointegrating vector among real money balances, interest rates, and output when money supply is represented by M1 and M2. Though, similar result is not found when money supply represented by M3. Hence, study concludes that in managing monetary policy by RBI, focusing M1 or M2 would be better rather than M3.

Hemachandra (2015) investigates the long run and short run relationship among M3, income level, interest rate, and exchange rate in case of India, by taking the financial year data from 1970-71 to 2013-14. The cointegration test shows the existence of long run relation among variables. Also, the stability of the long-run and short-run coefficients are analysed by CUSUM and CUSUMSQ, which shows the stable coefficients of the variables under consideration.

Rao and Singh (2006) estimated the demand for narrow money in case of India for the period 1953 to 2003. The estimates with vector auto regression (VAR) framework imply that there exists a well determined and stable money demand for the time period under consideration. Hence, the 1991 financial reforms do not affect the money demand stability.

Bharadwaj and Pandit (2010) examined the stability of money demand in case of India by using annual data with the sample period 1979 to 2006. To this end, with the help of Johansen and Juselius cointegration study shows that there exists stable relation among the variables such as, demand for real stock of broad money, exchange rate, rate of inflation, interest rate, and the level of economic activity. Consequently, it is concluded that under the new economic policy regime results are significant from the policy point of view.

In the backdrop of the above empirical literature it has been realised some important limitations, such as, most of the studies represent mixed result on money demand issues, studies
based on quarterly dataset did not calculate quarterly frequency by taking into account the concept of stock and flow variables, some of the studies did not adjust their macroeconomic series seasonally, further studies did not take care of the sensitivity of rate of interest while estimating the narrow and broad money and so on. Therefore, present study will differ by incorporating all these limitations into money demand functional form estimation.
Section III

Database and Research Methodology

This chapter describes the nature of the dataset and its sources. Also, it explains the functional form of the model and the rationale behind each and every variable and its construction under this study. Finally, chapter suggests the methodology which would be supposed to apply in this study, to verify the objective of the study empirically.

Database Description

For a better empirical analysis, the availability of a good database is a prerequisite condition. Lack of reliable dataset on macroeconomic variables is a major problem for developing countries. However, present study uses the dataset from secondary sources for empirical analysis of its objectives, that is, RBI Handbook of Statistics on Indian Economy, BSE Historical Indices and EPW Research Foundation.

Study extracts dataset for the following variables, such as, narrow money, broad money, real GDP, call money rate (CMR), 364 day Treasury bill rate, 10 year government securities, nominal effective exchange rate, and Sensex. The 364 day Treasury bill rate is extracted from EPW research foundation, Sensex dataset is taken from BSE Historical indices, and rest of the variables’ dataset are extracted from the RBI Handbook of Statistics on Indian Economy. All the dataset are extracted on monthly basis except GDP.

Then all the monthly series are converted into quarterly series. Ultimately, total number of observations are 82 covering the period from 1996:Q2 to 2016:Q3 calendar year. With due care of conversion, the concept of stock and flow of the variables have taken in account. Also, all the variables in this study, except proxies for interest rate, are considered in natural logarithmic form for some reasons such as, elasticity of each and every single variable can be derived, variables can be normalised or unit free, to avoid problem of serial correlation and
multicollinearity in the data and so on. Lastly, it is important to note that most of the above mentioned studies in the literature review did not take care of seasonality, while dealing with quarterly dataset. Present study uses the seasonally adjusted quarterly GDP data by using X-13 ARIMA.

**Model Specification**

Model 1: \[ \ln M1 = f (\ln Y, \ R, \ ln EX) \]

Model 2: \[ \ln M3 = f (\ln Y, \ R, \ ln EX, ln SP) \]

Variables in the Model 1 and Model 2 are defined as follows: \( \ln M1 \) is the natural log of narrow money, \( \ln Y \) is log of real GDP at constant price considered as proxy for real income, \( R \) stands for interest rate, \( \ln EX \) is the log of exchange rate, \( \ln M3 \) is log of broad money, and \( \ln SP \) is log of stock prices. Further, broad definition of the variables under consideration are discussed below.

**Real Narrow Money (M1):** Nominal monetary aggregate (M1) is defined as addition of the following quasi money such as, currency with the public, others’ deposits with the RBI, and demand deposits. Nominal M1 is then deflated by wholesale price index (WPI) to get real narrow money.

**Real Broad Money (M3):** Nominal monetary aggregate (M3) is defined as addition of the time deposits into narrow money definition. Again nominal broad money is deflated by WPI to obtain real broad money.

**Real Income (Y):** Gross Domestic Product (GDP) at market prices (at constant prices, base year: 2004-05) is considered as proxy for real income. Real income represents scale variable in money demand functional form.
**Interest Rate (R):** To know the better estimation of narrow and broad money model three kinds of interest rates are followed in this study, viz., call money rate (CMR), 364 day Treasury bill rate (TB-364), and 10-year government securities (G-Sec 10). CMR is considered as opportunity cost for holding real cash balance of *narrow money*. While TB-364 and G-Sec 10 are used as an opportunity cost to holding real cash balances of *broad money*. Three different interest rates are used, so as to look at the robustness of the model. Another reason to use TB-364 and G-Sec 10 in money demand estimation is that since by construction narrow money is much related to the short term interest rate i.e., weighted average overnight *Call Money Rate* (CMR), while by construction broad money deals with longer term interest rate i.e., *364 day treasury bill* and *10 year government securities*; considered in this study (as these are longer term interest rate as compare to CMR).

**Exchange Rate (ln EX):** The standard economic theory suggests that real money balances positively depend on the scale of aggregate economic activity (in this study represented by real GDP) and negatively depend on opportunity cost i.e., interest rate. However, in addition to these two variables, in 1963, Nobel Laureate, Robert Mundell (1963) proposed an idea that money demand can also depends upon the exchange rate. Though Mundell was the first to introduce this proposition but he did not give any empirical justification behind this. Since, then a lot of studies have had been done in case of developing and developed countries by incorporating exchange rate in money demand functional form. Similarly, study takes nominal effective exchange rate (NEER) into consideration as a proxy for exchange rate. NEER is considered for 36 currency Trade Based Weight (base year 2004-05).

**Stock Prices (ln SP):** Stock prices are important financial series, which helps to represent macroeconomic scenario of any country. A number of studies have considered stock market
prices to investigate its effect on the long run demand for real money balances, in case of
developing countries (for instance, Joseph et al., 2015 in case of Kenya; Hye et al., 2009 in
case of Pakistan). Since, till date none of the study considered stock prices in money demand
in case of India, so this study tries to differ over other studies by incorporating stock prices into
money demand functional form. Here, closing values of Sensex is considered as proxy for stock
prices.

The sign of the coefficient of any variable is all about the matter of empirical testing, which
has been carried out in the next section. Although, some prior expectation can be made over
here as per the economic theory, such as, scale variable (real GDP) and opportunity cost
variable (interest rate) will be positively and negatively related with real money balances
respectively. While the coefficients of exchange rate and stock prices may be positive or
negative with real money balances, which will depict either currency substitution effect or
wealth effect depending upon the sign of the coefficients.

Stationarity Test

Several stationarity tests are available for checking a time series process namely, Graphical
Method, Correlogram test, and the Unit Root test. As far as a concrete analysis is concerned,
study rely only on unit root testing. In this study two kind of unit root tests are applied such as,
the Augmented- Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests.

For an empirical analysis this study will be based on the ARDL or bounds testing approach of
cointegration. The bounds testing does not require that all variables should be integrated of
same order, even though it is important to conduct stationarity tests so that it could be
confirmed that none of the series are integrated of order two [I(2)]. Because ARDL model is
based on the assumption that none of the variables under study should follow I (2) process. If
so then the F-test will be spurious or the computed F-statistics produced by Pesaran, Shin, and
Smith (2001) and Narayan (2005) will not be valid (Pahalavani et al., 2011; Odhianbo, 2009; Adil et al., 2017)

Cointegration Test: Theoretical Accounts

The important feature that led to the development of new time series was spurious regression. To avoid the problem of spurious regression due to the non-stationarity of the variables, researchers frequently employ unit root and cointegration tests. Importantly, even if it is supposed that non-stationarity leads to spurious regression, and unit root and cointegration testing are used as a solution, yet the possibility of getting reliable inference is low. Because as mentioned by Ghouse et al. (2018), many prior specification decisions are required for unit root and cointegration, for instance, lag length, trend and structural stability, good size and power of unit root is needed in small sample and so on. Therefore, literature is still underdeveloped and econometrician couldn’t reach at one conclusion. Hence, the number of tests has been developed for cointegration till date.

Cointegration Test: ARDL Approach

In the backdrop of the above mentioned arguments study uses the recently developed cointegration technique. Pesaran et al. (2001) proposed a single equation cointegration concepts, known as autoregressive distributed lag model (ARDL or Bounds testing approach, used interchangeably). After all, it is wrong to believe that only unit root may cause for spurious regression, albeit, Granger and Newbold (1974) mentioned that missing variables are the major cause for spurious regression. Hence, to deal with these issues ARDL bounds testing approach is used, which also reflects an important insights. This test argues that by taking missing lag values into account spurious regression can be avoided. It is considered as an alternative to

ARDL bounds testing approach has several advantages over earlier concept of conventional cointegration (for instance, Engle and Granger, 1987; Johansen, 1988; Johansen and Juselius, 1990 are few among others). Some of the importance are mentioned here, viz., first, bounds test allows the cointegration relationship to be estimated by Ordinary Least Square (OLS) once the lag order of the model is identified; hence it is quite easy in procedure as compared to other methods of cointegration. Second, it can be used when the series are integrated of same order either zero or one, or even the combination of both. Third, for the presence of single cointegrating vector it provides explicit test statistics. Fourth, Pesaran and Shin (1995) reveal that by employing ordinary least square estimations (OLS) on ARDL model, asymptotically valid inference on short and long run parameters can be obtained simultaneously. Lastly, ARDL model involves just a single equation set-up, therefore it is easy for implementation and interpretation.

Present study will be looking at the existence and stability of a long run relationship among variables of money demand functional form, such as, narrow money, broad money, interest rate, real income, exchange rate, and stock prices. Note that, we will be estimating narrow (M1) and broad (M3) money both with different functional form in case of India, hence two models are defined below. Due to methodological advantages, this study is based on the bounds testing approach of cointegration. Long run relationship in the bounds test can be investigated with the help of following unrestricted error correction model (UECM):

\[
\Delta \ln M1_t = C_{01} + \sum_{i=1}^{n1} \phi_{1i} \Delta \ln M1_{t-i} + \sum_{i=0}^{n2} \phi_{2i} \Delta \ln Y_{t-i} + \sum_{i=0}^{n3} \phi_{3i} \Delta R_{t-i} + \sum_{i=0}^{n4} \phi_{4i} \Delta \ln EX_{t-i} \\
+ \beta_1 \ln M1_{t-1} + \beta_2 \ln Y_{t-1} + \beta_3 R_{t-1} + \beta_4 \ln EX_{t-1} + \varepsilon_t
\] (1)
\[ \Delta \ln M3_t = C_{03} + \sum_{i=1}^{a1} \delta_{1i}\Delta \ln M3_{t-i} + \sum_{i=0}^{a2} \delta_{2i}\Delta \ln Y_{t-i} + \sum_{i=0}^{a3} \delta_{3i}\Delta R_{t-i} + \sum_{i=0}^{a4} \delta_{4i}\Delta \ln EX_{t-i} + \sum_{i=0}^{a5} \delta_{5i}\Delta \ln SP_{t-i} + \gamma_1 \ln M3_{t-1} + \gamma_2 \ln Y_{t-1} + \gamma_3 R_{t-1} + \gamma_4 \ln EX_{t-1} + \gamma_5 \ln SP_{t-1} + \mu_t \] 

(2)

Where, \( \Delta \) is the first difference operator, all the variables in the Equations 1 and 2 are defined as earlier under the above heading “model specification”. The intercept in the Equation 1 and 2 are \( C_{01} \) and \( C_{03} \) respectively, \( t \) subscript shows time, \( \theta_{1i}, \theta_{2i}, \theta_{3i}, \) and \( \theta_{4i} \) are the coefficients of short run dynamics and \( \beta_1, \beta_2, \beta_3, \) and \( \beta_4 \) represent the coefficients of long run dynamic relationship in Equation (1) (Equation (1) represents model 1). While, \( \delta_{1i}, \delta_{2i}, \delta_{3i}, \delta_{4i}, \) and \( \delta_{5i} \) are the coefficients of short run dynamics and \( \gamma_1, \gamma_2, \gamma_3, \gamma_4, \) and \( \gamma_5 \) shows coefficients of long run dynamic relationship in the Equation (2) (Equation (2) represents model 2). Lastly, \( \varepsilon_i \) and \( \mu_t \) represent error terms, which follows white noise process.

The first step in the ARDL is to estimate equation (1) and (2) with the help of ordinary least square (OLS) method to test for the confirmation of a long run relationship among variables. The F-test is used to test whether long run relationship exists among variables through testing the significance of the lagged level of the variables. After the establishment of long run relationship, the F test reflects which variable in the system should be normalised.

In equation (1), where narrow money (lnM1) is the dependent variable, the null hypothesis of no cointegration will be \( H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0 \) against the alternative \( H_1: \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq 0 \). In equation (2), where broad money (lnM3) is dependent variable, the null hypothesis of no cointegration will be represented as \( H_0: \gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = \gamma_5 = 0 \) against the alternative hypothesis \( H_0: \gamma_1 \neq \gamma_2 \neq \gamma_3 \neq \gamma_4 \neq \gamma_5 \neq 0 \).
Pesaran et al. (2001) reports two sets of critical values, the lower critical bound and the upper critical bound. The lower critical bound assumes that variables are I(0) and the upper critical bound assumes that variables are I(1). The conclusive decision can be made regarding cointegration without knowing the order of integration of the explanatory variables, provided the computed F statistic should falls outside the critical bounds. If the computed F statistics exceeds the upper critical bound then the null hypothesis of no cointegration will be rejected, that is, it would show the existence of cointegration among variables. On the contrary, if the estimated F statistic falls below the lower critical bound, the null hypothesis of no cointegration cannot be rejected, which will posit the existence of no cointegration among variables. Apart from these two extreme conditions if F statistic falls in between lower and upper bounds, the result will be inconclusive.

If there exists a long run relationship among variables, second step is to estimate long run model for lnM1 and lnM3 with the help of following equation; due to space brevity both the models of lnM1 and lnM3 are represented in one general Equation (3). With the help of appropriate lag length this long run model will be estimated.

\[
\ln M_t = C_0 + \sum_{i=1}^{n_1} \delta_{lni} \ln M_{t-i} + \sum_{i=0}^{n_2} \delta_{Y_i} \ln Y_{t-i} + \sum_{i=0}^{n_3} \delta_{R_i} R_{t-i} + \sum_{i=0}^{n_4} \delta_{EX_i} \ln EX_{t-i} + \sum_{i=0}^{n_5} \delta_{SP_i} \ln SP_{t-i} + \mu_t \quad (3)
\]

In the third step of the bound test, we obtain the short run dynamic parameters by estimating an error correction model (ECM) associated with the long run estimates. The ECM is specified as follows; similarly due to space brevity both the models of lnM1 and lnM3 are represented in one general Equation (4).

\[
\Delta \ln M_t = C_0 + \sum_{i=1}^{n_1} \varnothing_{\Delta i} \Delta \ln M_{t-i} + \sum_{i=0}^{n_2} \varnothing_{Y_i} \Delta \ln Y_{t-i} + \sum_{i=0}^{n_3} \varnothing_{i} \Delta R_{t-i} + \sum_{i=0}^{n_4} \varnothing_{EX_i} \Delta \ln EX_{t-i} \\
+ \sum_{i=0}^{n_5} \varnothing_{SP_i} \Delta \ln SP_{t-i} + \psi ECM_{t-i} + \mu_t \quad (4)
\]
In equation (4), $\phi_{1i}, \phi_{2i}, \phi_{3i}, \phi_{4i}, \phi_{5i}$ are coefficients of the short run dynamics. ECM is the error correction term derived from the long run relationship, and $\psi$ is the coefficient of the ECM, which shows the speed of adjustment. It measures the speed with which dependent variable returns to equilibrium, in the long run over a period, due to changes in explanatory variables.

**Parameter Stability**

Parameter tests are important because only stable parameter will lead towards better policy prescription. Hansen (1992) cautions that over a period of time estimated parameter of time series may vary, hence unstable parameters can result into model misspecification; in turn model will provide bias results. Study uses the Pesaran and Pesaran (1997) and Hansen (1992) tests to check parameter stability. According to Pesaran and Pesaran (1997), for the stability of long run coefficients in the model under consideration, the short-run dynamics are essential. To this end, they suggested the estimation of error correction mechanism (ECM) as represented in Equation (4) for the Equations (1) and (2), provided the dependent variable must have the long-run relationship among variables.

**CUSUM and CUSUMQ**

After the estimation of model, to assess the parameter constancy, Pesaran and Pesaran (1997) suggested for applying the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMQ) of the recursive residuals tests (Brown et al., 1975); for examining the structural stability of the error correction models of money demand functional form. The model is estimated by ordinary least squares (OLS) and the residuals are subjected to the CUSUM and CUSUMQ.

**Hansen Instability Tests**
Hansen (1992) recommends the $L_c$ test statistics for parameter stability. He outlined a test of the null hypothesis of cointegration against the alternative of no cointegration. He mentioned that under the null hypothesis of cointegration, one should expect to see evidence of parameter stability. While, if one reject the null hypothesis of cointegration then one should see the evidence of parameter instability. He suggested (among others) use of the $L_c$ test statistic, to evaluate the stability of the parameters; $L_c$ test statistics arises from the theory of Lagrange Multiplier tests for parameter instability.

**Diagnostic Tests**

Finally, to evaluate the accuracy and predictability of the model study employs some of the common diagnostic testing. The diagnostic testing checks for serial correlation, heteroscedasticity, the functional form misspecification, and normality of the residual term. For the serial correlation study uses Breusch-Godfrey; null hypothesis of no serial correlation. Heteroscedasticity is tested with the help of Breusch-Pagan-Godfrey; null hypothesis of no heteroscedasticity. Ramsey’s RESET (regression specification error test) statistic is employed for functional form misspecification; null hypothesis is there is no misspecification in functional form. Lastly, to test whether residuals are normally distributed, study utilises the Jarque-Berra statistic; null hypothesis is residuals are normally distributed. The empirical investigation of above mentioned methodologies are discussed in the next section.
Section IV

Empirical Analysis

Unit Root Test Results

This study will be based on the autoregressive distributed lag model (ARDL), which can be implemented irrespective of the order of integration of the variables under consideration. Series may be I (0), I (1), or the mixture of both. However, series should not be integrated of order two, i.e., I (2), otherwise the computed test statistic turns out to be invalid (Ajaz et al., 2016 mentioned Ouattara, 2004). Therefore, to make sure that none of the series are I (2), study employed Augmented -Dickey-Fuller (ADF) and Phillips- Perron (PP) unit root tests.

Present study conducted unit root test by keeping in mind the nature of the series, such as, if series belongs to macroeconomic variables then there will be trend and intercept in the series. On the other hand if series belongs to financial time series then there will be no trend, although there will be doubt about the intercept. Consequently, following Ajaz et al. (2016), study adopts the Pantula principle to conduct the ADF and PP unit root tests. Noting that according to Pantula principle, test should be conducted in the following manner. Start with the estimated model which includes a constant and a trend. If null hypothesis of unit root is rejected then one can stop here. If it is not possible to reject then again start with model containing constant only. If it is possible to reject the null, then one can stop testing here, if could not be rejected then possible to continue excluding constant also. In this fashion study reports the ADF and PP test statistics.

The results of ADF and PP tests are mentioned in Table 1 below, which shows that all the variables are non-stationary at level except CMR, TB 364, and G-Sec 10, but became stationary after first difference implies that all variables are integrated of order one except CMR and TB-364, G-Sec 10.
## Table 1. Unit Root Test Results (ADF and PP)

<table>
<thead>
<tr>
<th>Variables</th>
<th>ADF Statistics [LL]</th>
<th>PP Statistics {BW}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level</td>
<td>First Difference</td>
</tr>
<tr>
<td></td>
<td>(0.97)</td>
<td>(0.05)</td>
</tr>
<tr>
<td></td>
<td>(0.97)</td>
<td>(0.00)</td>
</tr>
<tr>
<td></td>
<td>(0.13)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>CMR</td>
<td>-4.982 [0]</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.99)</td>
<td>(0.00)</td>
</tr>
<tr>
<td></td>
<td>(0.86)</td>
<td>(0.01)</td>
</tr>
<tr>
<td>TB 364</td>
<td>-3.016 [0]</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(0.04)</td>
<td></td>
</tr>
<tr>
<td>G – Sec10</td>
<td>-1.992 [0]</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(0.05)</td>
<td></td>
</tr>
</tbody>
</table>

**Source:** Calculated by authors.

**Note:** LL is lag length; Values in parenthesis are probability value; and BW stands for Bandwidth.

### Results of Cointegration by ARDL Test for Equation (1); Narrow Money Case (M1)

After conducting the unit root tests, the next step is to perform ARDL bounds test to examine the long run relationship among real money balances, such as, lnM1 & lnM3, and their determinants. Before estimating cointegration, appropriate lag length is the precondition. To this end, since we deal with quarterly dataset so we adopted general-to-specific approach. The preferred specification is chosen by starting with max \( p = \max q = 4 \) and dropped all insignificant lags (Ajaz et al., 2016).
After setting appropriate lag length (3 lags from AIC in case of Equation (1) and 3 lags from SBC in case of Equation (2)), linear ARDL is estimated. Table 2 represents the result of Equation (1), where dependent variable is lnM1.

In Panel A, short run coefficients are shown and all the coefficients are significant. Also, they are carrying their expected sign as per the theory, discussed in the model specification part. In short run exchange rate (NEER = dollar/rupee) being a positive in sign and significant in magnitude at lag order (0) shows the currency substitution effect in case of India, under study period. This result is similar to the findings of Oskooee and Behmani (2015) in case of Iran.

Turning to the long run normalized coefficients in Panel B, all the coefficients of the variables are significant and getting expected sign as per the theory. But the long run relation among variables under consideration will be meaningful only if cointegration is established. From panel C, it is shown that the $F$ test for joint significance of lagged level variables (bounds test) is higher than its critical value of 4.412 when lnM1 is considered as dependent variable. This implies the existence of cointegration among variables under study for Equation (1). Importantly, to establish a cointegration, two criteria should be fulfilled, firstly, there should be long run relationship, which is proved by $F$ test. Secondly, error correction term should be significant. Here, coefficient of ECM is -0.658 and significant also, which shows the speed of adjustment. Thus, it shows that in the long run with the speed of 65% per quarter the dependent variable will return to equilibrium due to a change in explanatory variables, which shows quick convergence. Thus, ECM term further strengthen the results obtained in the ARDL model of cointegration, means narrow money is affected by income, interest rate, and exchange rate.

Thus, after satisfying both the condition of equilibrium, it is concluded that there exists long run relationship, in Equation (1), among variables for the time period under consideration. To look at the robustness of the model various diagnostic tests are conducted, which are reported
in Panel C. The results show that estimated Equation (1) does not contain serial correlation, heteroscedasticity, functional form misspecification, and also errors are normally distributed.

To assess the parameter constancy the CUSUM and CUSUMQ tests are plotted. Graph 1 and 2 plot the result of ECM, whose functional form is depicted in Equation (4). This equation is estimated by OLS and the residuals are subjected to the CUSUM and CUSUMQ tests. The estimation of Equation (4) gives the ECM term whose coefficient is highly significant and negative, i.e. (-0.65), which confirms the existence of a stable long run relationship among variables. Therefore, similar outcome of parameter stability is also shown by graphical representation. The results of Graph 1 and 2 depict the absence of any instability of the coefficients because the plot of CUSUM and CUSUMQ statistics are within 5% critical bounds of parameter stability.

Lastly, in order to have concrete test statistics rather than the graph for parameter constancy, study employs Hansen (1992) instability test. The result of Hansen’s $Lc$ test statistics for the long run Equation (1) is reported in Table 3. The probability value is greater than even 20%, hence study fails to reject null hypothesis of parameter stability. Thus, we find the strong evidence in favour of parameter stability.

In the backdrop of the above discussion it has been concluded that narrow money (M1) is stable in case of India over the period from 1996Q2 to 2016Q3, particularly after economic reform period.
Table 2: Full Information Estimate of Linear ARDL Equation (1), Dependent Variable lnM1

Panel A: Short-Run Coefficient Estimates

<table>
<thead>
<tr>
<th>Variables</th>
<th>Lag Order</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Δ ln M1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Δ ln Y</td>
<td></td>
<td>0.884</td>
<td>(0.00)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Δ CMR</td>
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<td>-0.005</td>
<td>(0.06)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Δ ln EX</td>
<td></td>
<td>0.529</td>
<td>0.044</td>
<td>-0.353</td>
<td>(0.01)</td>
</tr>
</tbody>
</table>

Panel B: Long-Run Coefficient Estimates

<table>
<thead>
<tr>
<th>Constant</th>
<th>Ln Y</th>
<th>CMR</th>
<th>Ln EX</th>
</tr>
</thead>
<tbody>
<tr>
<td>-10.269</td>
<td>1.344</td>
<td>-0.007</td>
<td>0.603</td>
</tr>
<tr>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.04)</td>
<td>(0.00)</td>
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</tbody>
</table>

Panel C: Diagnostic Statistics

<table>
<thead>
<tr>
<th>F</th>
<th>ECM</th>
<th>BG-LM</th>
<th>RESET</th>
<th>Normality</th>
<th>CUSUM</th>
<th>CUSUMQ</th>
<th>Adj. R²</th>
<th>BPG</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.412</td>
<td>-0.658</td>
<td>0.235</td>
<td>0.005</td>
<td>9.116</td>
<td>Stable</td>
<td>Stable</td>
<td>0.993</td>
<td>10.367</td>
</tr>
<tr>
<td>(0.00)</td>
<td>(0.97)</td>
<td>(0.89)</td>
<td>(0.01)</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Calculated by authors
Note: a. Selected Model: ARDL (1, 0, 0, 3)
b. Values in parenthesis are probability values. Ln stands for natural logarithm. Δ stands for first difference operator.
c. F is the bounds test, the lower and upper bound critical values of the F statistic at the usual 5% level of significance are 3.23 and 4.35 respectively. These values came from Pesaran et al. (2001, Table CI (iii) - Case III, p. 300).
d. BG-LM is the Breusch Godfrey Serial Correlation Lagrange Multiplier test.
e. RESET is the Ramsey’s regression specification error test.
f. Normality is based on the Jarque - Bera test.
g. BPG is Breusch-Pagan-Godfrey test for heteroscedasticity.
Table 3. Hansen Test for Parameter Stability for Equation (1)

Dependent Variable: Narrow Money (lnM1)

<table>
<thead>
<tr>
<th>Tests</th>
<th>Test Statistic</th>
<th>Probability Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Lc$</td>
<td>0.029558</td>
<td>&gt; 0.20</td>
</tr>
</tbody>
</table>

Source: Calculated by authors

Results of Cointegration by ARDL Test for Equation (2); Broad Money Case (M3)

This session estimates Model 2 whose functional form in the ARDL approach is defined in Equation (2). Note that Equation (2) differs from the Equation (1) not only in terms of dependent variable but also in terms of explanatory variable. In Equation (2) one additional explanatory variable is added, i.e., Stock Prices. Being a significant financial variable, present study incorporates this. Some studies which have done so in case of developing countries are Joseph et al. (2015) in case of Kenya; Hye et al. (2009) in case of Pakistan. Hence, we are here trying to estimate money demand with stock prices as well in case of India. Also noting that, this study differs from others on this ground because most of the studies estimated money demand functional form in the recent past in case of India without stock prices. However, after
setting up appropriate lag length, linear ARDL bounds test is estimated for Equation (2). Result of the Equation (2) is documented in Table 4, where dependent variable is \( \ln M3 \).

In Panel A, short run coefficients are shown and all the coefficients are significant except interest rate. Here, weighted call money rate (CMR) is represented as proxy for interest rate. Also, they are carrying their expected sign as per the theory except interest rate, which is carrying positive sign. In short run exchange rate being a positive and significant in magnitude at lag order zero shows the *currency substitution effect* in case of India, under study period. At last, in short run analysis, stock prices carry a negative and significant coefficient which supports the *currency substitution effect* in case of India over the sample period.

Turning to the long run coefficients represented in Panel B, all the coefficients of the variables are significant and getting expected sign as per the theory, except interest rate (CMR) whose coefficient again shows positive relation with broad money. Also, stock prices and exchange rate are consistent in their sign in short and long run both. Still in the long run, exchange rate and stock prices both are depicting *currency substitution effect*.

However, the long run relationship among variables will be meaningful only if cointegration is established. From panel C, it is shown that the F test, which is equal to 1.344, for joint significance of lagged level variables is less than its lower critical value of 2.86, when \( \ln M3 \) is considered as dependent variable. This implies the existence of no cointegration among variables for Equation (2). Since two criteria should be fulfilled for having cointegration, such as, *firstly*, long run relationship among variables should be there, which can be proved by F test. *Secondly*, error correction term should be significant. Here, coefficient of ECM is -0.225 and significant, which shows the speed of adjustment. Thus, it shows that in the long run with the speed of 22.5% per quarter the dependent variable will return to equilibrium due to a change in explanatory variable, which shows slow convergence as compare to narrow money.
Thus, it is evident that only second condition of cointegration is satisfied for Equation (2) while first condition of F-test is violated hence, it can be concluded that there exists no long run relationship among variables for the time period under consideration, in case of Equation (2).

At last, to look at the robustness of the estimated Equation (2) various diagnostic tests have been conducted, which are reported in Panel C. Results show that estimated Equation (2) does not contain serial correlation, heteroscedasticity, functional form misspecification, and also errors are normally distributed.

Now the question arises what are the possible reasons due to which Equation (2) does not show cointegration among variables. There could be three possible reasons, which study wants to highlight. First reason may be related to interest rate; importantly it is a common mistake, this is what the present study observed in literature review, in case of developed and developing countries. Notice that Equation (1) deals with the narrow money and the proxy for interest rate is considered as CMR, which is short term interest rate, and it is appropriate to take CMR into consideration while estimating narrow money. Because the nature of narrow money by construction is somehow link with short term interest rate rather than long term. As far as Equation (2) is concerned, here study incorporated CMR again as a proxy for interest rate, which should not have been the case. Because by construction, broad money is more appropriate with long term interest rate. Hence, to estimate Equation (2), one should take longer interest rate as compare to CMR while estimating broad money. Therefore, this study re-estimate Equation (2) by taking into account the longer interest rate as compare to CMR. Now we have taken 364 day Treasury bill and 10 year government security as proxy for longer interest rate and then estimated Equation (2). The outcome of the estimation is discussed in the next heading.
Second possible reason behind not getting long run relationship could be financial liberalisation. The financial liberalisation encompasses both financial innovation and institutional or regulatory changes (James, 2005). Since early 1990s, the ongoing new cash balance management (for instance, ATM, credit cards, Paytm, emergence of new payment Apps), financial innovations, and financial liberalisations has had been expanding very rapidly not only in domestic financial markets but also in international financial markets. Further, move towards a flexible exchange rate regime and globalisation of capital markets have led to make serious doubt about the stability and reliability of the conventional money demand functional form. There are some study which has raised this issue on national and international level (for instance, Singh and Pandey, 2010). Even some of the studies re-estimated money demand after incorporating financial innovation term as one of the important explanatory variable (Arrau, 1993 in case of Chile and Mexico; James, 2005 in case of Indonesia). Hence, there is a need to reconsider money demand functional form after taking into account financial innovation in case of India also; where the entire new policy regime has had been changing visibly since the early 1990s and somewhat implicitly since the late 1970s.

Third possible reason could be model misspecification. This is more common flaw which is found in most of the macroeconomic models. Model misspecification deals with the issue of linearity or non-linearity of the underlying functional form. If underlying macroeconomic model is non-linear in nature and someone estimates this model with methodology which is based on linear in nature then result will be misleading. Therefore, one should take care of all these issues while estimating money demand functional form.
Table 4: Full Information Estimate of Linear ARDL Equation (2), Dependent Variable \( \ln M3 \)

Panel A: Short-Run Coefficient Estimates

<table>
<thead>
<tr>
<th>Variables</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \Delta \ln M3 )</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln Y )</td>
<td>0.440</td>
<td>(0.00)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta CMR )</td>
<td>0.002</td>
<td>(0.30)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln EX )</td>
<td>0.098</td>
<td>(0.04)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln SP )</td>
<td>-0.040</td>
<td>(0.02)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Panel B: Long-Run Coefficient Estimates

<table>
<thead>
<tr>
<th>Constant</th>
<th>( \ln Y )</th>
<th>( CMR )</th>
<th>( \ln EX )</th>
<th>( \ln SP )</th>
</tr>
</thead>
<tbody>
<tr>
<td>-12.177</td>
<td>1.954</td>
<td>0.007</td>
<td>0.437</td>
<td>-0.178</td>
</tr>
<tr>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.36)</td>
<td>(0.03)</td>
<td>(0.00)</td>
</tr>
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</table>

Panel C: Diagnostic Statistics

<table>
<thead>
<tr>
<th>( F )</th>
<th>( ECM )</th>
<th>( BG-LM )</th>
<th>( RESET )</th>
<th>( Normality )</th>
<th>( Adj. R^2 )</th>
<th>( BPG )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.344</td>
<td>-0.225</td>
<td>5.496</td>
<td>-0.015</td>
<td>6.143</td>
<td>0.998</td>
<td>2.686</td>
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<tr>
<td>(0.00)</td>
<td>(0.14)</td>
<td>(0.31)</td>
<td>(0.05)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Calculated by authors

Note: a. Selected Model: ARDL (1, 0, 0, 0, 0)
b. Values in parenthesis are probability values. \( \ln \) stands for natural logarithm. \( \Delta \) stands for first difference operator.
c. \( F \) is the bounds test, the lower and upper bound critical values of the \( F \) statistic at the usual 5% level of significance are 2.86 and 4.01 respectively. These values came from Pesaran et al. (2001, Table CI (iii) - Case III, p. 300).
d. \( BG-LM \) is the Breusch Godfrey Serial Correlation Lagrange Multiplier test.
e. \( RESET \) is the Ramsey’s regression specification error test.
f. \( Normality \) is based on the Jarque - Berra test.
g. \( BPG \) is Breusch-Pagan-Godfrey test for heteroscedasticity.
**Estimation of Equation (2) by considering 364 Day Treasury bill in the Money Demand Functional Form with Linear ARDL Bounds testing Approach.**

In this session study performs linear ARDL bounds test to re-examine the long run relationship among variables considered in Equation (2), by replacing CMR with the 364 Day Treasury bill. Now, the specification of Equation (2) for this session has become as such, real money balances, i.e., broad money (lnM3) treated as dependent variable, and explanatory variables are income (i.e., real GDP), long term interest rate (i.e., 364 Day Treasury bill rate), exchange rate (NEER), and stock prices (Sensex Closing Value).

After setting up appropriate lag length by considering general to specific approach (5 lags from AIC is utilized for re-estimation of Equation (2)), linear ARDL is employed. Table 5 represents the result of Equation (2), where dependent variable is lnM3.

In Panel A, short run coefficients are shown, the coefficient of broad money is significant at lag four. Here, GDP and NEER show expected sign but both are insignificant. Although, the 364 Day Treasury bill rate (at both the lag zero and one) and stock prices (at lag three) show significant and expected sign as per the theory, discussed under model specification heading.

Turning to the long run normalized coefficients in Panel B, coefficient of all the variables are insignificant except GDP. Although the sign of coefficient is as per the theory and consistent as well, both in short and long run. It is important to note that some of the short and long run coefficients are insignificant, may be because of employing linear ARDL method in re-estimation of Equation (2). Therefore, one can evaluate the insignificant values of the variables by estimating again Equation (2) with the help of non-linear ARDL method, developed by Shin et al., (2014).
However, the long run relation among variables under consideration will be meaningful only if cointegration is established. From panel C, it is shown that the $F$ test for joint significance of lagged level variables’ (bounds test) value is 3.178. Noting that this value falls in between the critical lower bound value (i.e., 2.86) and the upper critical bound value (i.e., 4.01), which shows that the cointegration test becomes inconclusive. In the case of inconclusive result, following Kremers et al. (1992) and Banerjee et al. (1998), the error correction term (ECM) will be useful to establish cointegration. Here, the coefficient of $ECM$ is $-0.324$ and significant also at 1% level of significance. Having found a highly significant and negative sign of the coefficient of ECM, the error correction term shows the existence of long run relationship among variables. However, the speed of adjustment to obtain equilibrium in the event of shock(s) to the system is 32.4 percent per quarter, which is less than the speed of adjustment found in Equation (1). The result of the ECM also reflects that all the chosen explanatory variables with lags significantly causes the changes in the broad money in the long run.

To gauge the adequacy of the specification of the model, various diagnostic and stability tests have been conducted, which are reported in Panel C. It has been shown that estimated result does not contain serial correlation, heteroscedasticity, functional form misspecification, and also errors are normally distributed.
**Table 5:** Full Information Estimate of modified Equation (2) by Linear ARDL, Dependent Variable lnM3

### Panel A: Short-Run Coefficient Estimates

<table>
<thead>
<tr>
<th>Variables</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
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<tbody>
<tr>
<td>(\Delta \text{Ln M3})</td>
<td>-</td>
<td>-0.062</td>
<td>-0.110</td>
<td>-0.163</td>
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<tr>
<td></td>
<td></td>
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<td>(0.36)</td>
<td>(0.16)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>(\Delta \text{Ln Y})</td>
<td>0.231</td>
<td>-</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>(0.27)</td>
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<td></td>
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</tr>
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<td>(\Delta \text{TB364})</td>
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<td>-0.006</td>
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<tr>
<td></td>
<td></td>
<td>(0.05)</td>
<td>(0.05)</td>
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</tr>
<tr>
<td>(\Delta \text{Ln EX})</td>
<td>0.070</td>
<td>-</td>
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<td>(0.23)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(\Delta \text{Ln SP})</td>
<td>-0.003</td>
<td>0.035</td>
<td>0.001</td>
<td>-0.041</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>(0.91)</td>
<td>(0.36)</td>
<td>(0.98)</td>
<td>(0.09)</td>
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</table>

### Panel B: Long-Run Coefficient Estimates

<table>
<thead>
<tr>
<th></th>
<th>Constant</th>
<th>Ln Y</th>
<th>TB364</th>
<th>Ln EX</th>
<th>Ln SP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-9.374</td>
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<td>-0.005</td>
<td>0.216</td>
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<tr>
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<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.52)</td>
<td>(0.22)</td>
<td>(0.42)</td>
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</table>

### Panel C: Diagnostic Statistics

<table>
<thead>
<tr>
<th></th>
<th>(F)</th>
<th>(ECM)</th>
<th>(BG-LM)</th>
<th>(BPG)</th>
<th>Normality</th>
<th>Adj. R2</th>
<th>CUSUM</th>
<th>CUSUMQ</th>
<th>RESET</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.178</td>
<td>-0.324</td>
<td>0.492</td>
<td>14.495</td>
<td>4.092</td>
<td>0.999</td>
<td>Stable</td>
<td>Stable</td>
<td>-0.023</td>
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<td>(0.00)</td>
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<td></td>
<td></td>
<td></td>
<td>(0.12)</td>
</tr>
</tbody>
</table>

**Source:** Calculated by authors  
**Note:**  
a. Selected Model: ARDL (5, 1, 2, 0, 4)  
b. Values in parenthesis are probability values. Ln stands for natural logarithm. \(\Delta\) stands for first difference operator.  
c. \(F\) is the bounds test, the lower and upper bound critical values of the \(F\) statistic at the usual 5% level of significance are 2.86 and 4.01 respectively. These values came from Pesaran et al. (2001, Table CI (iii) - Case III, p. 300).  
d. \(BG-LM\) is the Breusch Godfrey Serial Correlation Lagrange Multiplier test.  
e. \(RESET\) is the Ramsey’s regression specification error test.  
f. **Normality** is based on the Jarque - Berra test.  
g. \(BPG\) is Breusch-Pagan-Godfrey test for heteroscedasticity.
As prescribed by Pesaran and Pesaran (1997), the stability of the short run and long run coefficients have been checked through the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMQ) test given by Brown et al. (1975). The CUSUM and CUSUMQ statistics are updated recursively and plotted against the break points. The plot of CUSUM and CUSUMQ are depicted in Graph 3 and 4 respectively. The plots of the statistics stay within the critical bounds of 5% level of significance, hence the null hypothesis of all coefficients under Equation (2) is stable, cannot be rejected. Therefore, estimation of Equation (2) with 364 Day Treasury bill is stable for the sample period and variables under consideration.

Hence, it has been concluded by present study that broad money (M3) is stable in case of India over the period of 1996Q2 to 2016Q3 (particularly after economic reform period), when 364 Day Treasury bill rate is considered as proxy for interest rate instead of CMR.
Estimation of Equation (2) by considering secondary market’s 10 year government securities (G-Sec 10) in the Money Demand Functional Form with Linear ARDL Bounds testing Approach

In this session study carries out linear ARDL bounds test to re-examine long run relationship among variables considered in Equation (2), by replacing CMR with the 10 year government securities. Now, the functional form specification of Equation (2) for this session has become as such, real money balances (lnM3) depicts dependent variable, while explanatory variables are income (that is, real GDP), long term interest rate (i.e., G-Sec10), exchange rate (NEER), and stock prices (Sensex closing value).

After setting up of appropriate lag length through general to specific criterion (5 lags from AIC criterion is utilized), linear form of the ARDL method is employed to estimate the Equation (2). Results are presented in Table 6.
### Table 6: Full Information Estimate of Linear ARDL modified Equation (2), Dependent Variable lnM3

**Panel A: Short-Run Coefficient Estimates**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Lag Order</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>∆ Ln M3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>∆ Ln Y</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>∆ G-Sec10</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>∆ Ln EX</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>∆ Ln SP</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Panel B: Long-Run Coefficient Estimates**

<table>
<thead>
<tr>
<th>Constant</th>
<th>Ln Y</th>
<th>G-Sec10</th>
<th>Ln EX</th>
<th>Ln SP</th>
</tr>
</thead>
<tbody>
<tr>
<td>-4.715</td>
<td>1.177</td>
<td>-0.028</td>
<td>-0.145</td>
<td>0.104</td>
</tr>
<tr>
<td>(0.04)</td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.43)</td>
<td>(0.26)</td>
</tr>
</tbody>
</table>

**Panel C: Diagnostic Statistics**

<table>
<thead>
<tr>
<th>F</th>
<th>ECM</th>
<th>BG-LM</th>
<th>BPG</th>
<th>Normality</th>
<th>Adj. R2</th>
<th>CUSUM</th>
<th>CUSUMQ</th>
<th>RESET</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.314</td>
<td>-0.314</td>
<td>3.012</td>
<td>11.227</td>
<td>2.132</td>
<td>0.999</td>
<td>Stable</td>
<td>Stable</td>
<td>-0.023</td>
</tr>
<tr>
<td>(0.00)</td>
<td>(0.22)</td>
<td>(0.84)</td>
<td>(0.34)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.18)</td>
</tr>
</tbody>
</table>

**Source:** Calculated by authors

**Note:**

a. Selected Model: ARDL (5, 1, 1, 2, 4)
b. Values in parenthesis are probability values. Ln stands for natural logarithm. ∆ stands for first difference operator.
c. F is the bounds test, the lower and upper bound critical values of the F statistic at the usual 5% level of significance are 2.86 and 4.01 respectively. These values came from Pesaran et al. (2001, Table CI (iii) - Case III, p. 300).
d. BG-LM is the Breusch Godfrey Serial Correlation Lagrange Multiplier test.
e. RESET is the Ramsey’s regression specification error test.
f. Normality is based on the Jarque - Bera test.
g. BPG is Breusch-Pagan-Godfrey test for heteroscedasticity.
Panel A shows short run coefficients of the model. The broad money coefficient is significant at fourth lag length. Importantly, all the short run coefficients of this model are significant (except real GDP) and greater in magnitude as compare to coefficients of Equation (2) in the last session, where 364 Day Treasury bill was treated as opportunity cost. Specifically, the coefficients of G-Sec 10 is greater and negative (that is, -0.011) in magnitude as compare to 364 Day Treasury bill (that is, -0.006). Consequently, it is evident that estimation of broad money with longer term interest rate (G-Sec 10) gives better result as compare to short term interest rate (like, CMR, 364 Day Treasury bill). Further all the coefficients show the expected sign as per the economic theory.

Panel B shows the long run coefficients, which are greater in magnitude as compare to the coefficients of Equation (2) in the last session. Again the sign of the coefficients are as per economic theory. Here, the coefficients of real GDP and G-Sec 10 are significant while exchange rate and stock prices are insignificant. The possible reason behind this may be the
application of linear ARDL. Here, once again non-linearity may play a significant role in estimation.

The long run coefficients would be meaningful, if cointegration exists. Panel C shows the bounds and diagnostic test statistics. The F test (bounds test) for joint significance of lagged level variables is equal to 5.314. Noting that this value is greater in magnitude as compare to the F test value, while we estimated Equation (2) with CMR (the F-test value was 1.344) and 364 Day Treasury bill (F-test value was 3.178). The F equal to 5.314 is greater than the upper critical bound value (i.e., 4.01 at 5 percent level of significance), which shows the existence of cointegration among variables. The coefficient of ECM is -0.314, which satisfies all three condition, i.e., less than one, negative, and it is significant also. The desirable ECM further strengthen the long run equilibrium association ship amongst variables. Here it shows 31.4 percent per quarter adjustment in the long run, provided if any short mismatch is there.

Lastly, adequacy of the re-estimation of Equation (2) is judged by various diagnostic tests, which are depicted in Panel C. Diagnostic tests confirm that result is free from serial correlation, heteroscedasticity, functional form misspecification, and also shows the normal distribution of error term.

After estimating Equation (2), as per the prescription of Pesaran and Pesaran (1997), stability of the short and long run coefficients are evaluated by using CUSUM and CUSUMQ; given by Brown et al. (1975). Graph number 5 and 6 depict the plot of CUSUM and CUSUMQ respectively. The plots are within the 5% critical bands, hence null hypothesis of stable coefficients under Equation (2), while G-Sec 10 is considered as opportunity cost, cannot be rejected.

In the backdrop of the above rationale it can be concluded that in case of India, broad money (M3) is stable over a time period from 1996Q2 to 2016Q3; provided the time period,
specification of money demand functional form, and econometric technique under consideration. Furthermore, results are more robust when G-Sec 10 is considered as a proxy for interest rate rather than the CMR or 364 Day Treasury bill rate.
Section V
Summary and Concluding Remarks

The nature and magnitude of interaction between the monetary and real sectors of any country is reflected by money demand and its components. Clearly, the interaction between stock of money and its explanatory components such as, level of income, interest rate, exchange rate, and other major economic or financial series must be stable if one uses it for policy prescription. Only then ultimate objective of any economy like price stability, capital formation, employment generation, and economic development and so on, can be achieved with the help of intermediate variables like interest rate and monetary aggregates.

The issue of money demand functional form stability is of crucial importance to both the design as well as effectiveness of monetary policy. Hence, considerable attention is paid on the empirical verification of its stability, in case of developed and developing economies. In the recent past, particularly after the ‘Report of the Expert Committee to Revise and Strengthen the Monetary Policy Framework’ (Chairman: Dr. Urjit R. Patel) in 2014, the issue of money demand stability has been linked with inflation as a policy target. As Rangarajan (1999) argues, “If one were to deny the existence of a reasonable stable demand function for money, there will be little scope for monetary policy to play any role in inflation management”.

In the backdrop of the above rationale, present study tries to reopen the considerable issues with reference to money demand such as, its functional form, stability, log run relationship among variables and so on. Consequently, this study empirically verified the money demand functional form and its stability in case of India by considering quarterly data from 1996Q2 to 2016Q3. The analysis of present study differs with other studies in case of India with regards to explanatory variables, methodological details, frequency of the database, and the sample period.
Different money stock such as, narrow money (M1) and broad money (M3) are estimated with different functional form, with the help of linear autoregressive distributed lag model (ARDL) bounds testing approach developed by Pesaran et al. (2001). Apart from the number of advantages of this technique, it is also the most recent in the time series literature to deal with cointegration concept. The possible outcome of estimation of M1 and M3, their limitations, policy prescription, and the scope of carrying further research are as follows.

In case of estimation of M1, it is found that there exists long run cointegration among variables by obtaining significant F- test and error correction mechanism (ECM). Also, Hansen (1992) instability, CUSUM and CUSUMQ tests are applied to test the stability issues for M1 and found that narrow money is stable over the time period under study.

While estimation of broad money (M3) by considering CMR as opportunity cost, study shows that there exists no cointegration, the F- test value is less than the lower critical bound, although the ECM is significant. Having found no cointegration among variables in case of M3, we could not derive any policy prescription but study suggests some interesting issues behind not getting cointegration among variables, such as,

First issue is, linking the short term interest rate while measuring broad money, which should not have been the case, because by construction M3 is more related with the longer term interest rate rather than short term interest rate. Therefore, present study re-estimated money demand functional form by taking into account longer term interest rate such as, 364 Day Treasury bill rate and 10 year government securities. Ultimately with the help of F-test and various diagnostic tests, it has been concluded that there exists long run relationship among variables, also this functional form is stable over the time period under study.

Second issue may be related with the recent financial innovation and financial liberalisation in the early 1990s. Hence, possible suggestion is one should estimate money demand functional
form after incorporating the proxy for financial innovation. As it has had been done in case of some developed and developing countries’ cases (*for instance*, James, 2005 in case of Indonesia, Baba et al, 1992 in case of U.S.). Interestingly, they find stable money demand function. Hence, one can estimate money demand functional form after incorporating proxy for financial innovation term and then robustness of the results can be seen.

*Third possible reason* for not getting cointegration may be because study utilises linear form of ARDL while estimating broad money. As it is the common mistake in the literature with which we came out. Most of the time, relation is non-linear in nature and we estimate it with linear model. Therefore, we get misleading results. Hence, to overcome on this issue, one can estimate Equation (2) again by considering the non-linear form of autoregressive distributed lag model (NARDL) proposed by Shin et al., (2014).

In the backdrop of the above rationale, it has been concluded that there exists cointegration and stable money demand functional form in case of both narrow money *vis a vis* broad money, *albeit* broad money is more vulnerable to external shocks, in case of India over the period of 1996Q2 to 2016Q3. Hence, with due care one should aptly go for either of the two money stock options for effective implementation of monetary policy.
Literature Cited:


Arora, N., & Osatieraghi, A. (2016). Does India have a stable demand for money function after reforms? A macroeconometric analysis. *Прикладная эконометрика*, (4 (44)).


