Does Financial Innovation Disturb the Money Demand Stability?

Masudul Hasan Adil[1]

Abstract

Traditional money demand functions are often criticised for persistent over prediction, implausible parameter estimates, highly serially correlated errors and unstable money demand. This study argues that some of those problems might have emerged for not factoring in financial innovation into money demand function. This study estimates money demand in case of India during -the post-reform period from 1996: Q2 to 2016: Q3. The money demand function is estimated with the help of linear ARDL approach to cointegration developed by Pesaran et al. (2001) after employing various proxies for financial innovation. In conclusion, the study finds that there is a stable long-run relationship among variables such as real money balances, scale variable and opportunity cost variable. In a nutshell, the study provides an assessment of the relative importance of the financial innovation variables in money demand equation, which shows that financial innovation plays a very significant role in the money demand specification and its stability.

Keywords: ARDL, CUSUM and CUSUMQ, co-integration, financial innovation, India, money demand function

JEL Classification: E41; E44; E42; E52; O16; O53

[1] Masudul Hasan Adil, Research Scholar, Mumbai School of Economics and Public-Policy (Autonomous), University of Mumbai, Mumbai-400098, India. Email id: adilmasood.alig@gmail.com.

1. Introduction

The demand for money function has been a subject of empirical scrutiny because of its importance in monetary policy effectiveness, seigniorage, inflation and other important aspects of macroeconomic policy. A lot of criticism is made in the literature for the empirical approaches of money demand used for policy assessment. Significant research is done on whether demand for money function is stable and predictable. This issue was raised after a series of findings displayed that money demand was unstable in a number of countries during the 1970s (for instance Goldfeld 1976 and Roley 1985 in the case of U.S. and Darrat 1986 in the case of four Latin American countries). Apart from the stability problems, traditional specification of money demand usually derives parameter estimates that are not economically plausible and error terms are subject to serial correlation problem. Consequently, this problem turns into persistent over prediction of money demand or 'missing money' episodes. As mentioned by Siklos (1993), the traditional specification of demand for money does not cointegrate in case of several industrial countries, which ultimately suggests misspecification of money demand.[2] Importantly, these problems are more severe in countries where inflationary episodes are high.

Often, close scrutiny of raw data would reveal shifts or continuous movements in the real money balances. This phenomenon is unrelated to the behaviour of explanatory variables used in the literature. Usually, these shifts are found in the direction of real money holding the balance of the firms as well as households. In literature, the shifts or continuous movement in the real money balances attributed to financial liberalisation**.**[3] Financial innovation can be either a new product or a new process for supplying an already existing product or market arrangements (Lewis and Mizen, 2000). Product innovation is the emergence of new product in the market such as money market mutual funds, money market accounts and sweep accounts among others. While process innovation is associated with making changes or improvements in the already existing products like facilitating transactions through automated teller machines, point of sale terminals and electronic funds transfer, etc. Arnaboldi and Rossignoli (2015) quote the European Central Bank (ECB 2003) definition: "financial innovation is primarily a product and organisational innovation, which

---

[2] Countries included in this sample are Canada, Norway, Sweden, the United Kingdom and the United States. Cointegration was witnessed only in case of the United States data, which supports the finding of Hoffman and Rasche (1991).

[3] In the present study, financial liberalization is broadly defined to encompass financial innovations and institutional/regulatory changes (James, 2005).

allows cost or risk reduction for banks and/or a service improvement for the financial industry as a whole." In brief, financial liberalisation takes care of all those improvements in the financial sector that are alternative to currency and demand deposits. Thus, the dramatic increase in money demand was observed in the economies that undertook financial innovations. In several European countries, a permanent increase in money demand was witnessed (Grilli, 1989), which Grilli cited as a possible rationale for the improvements in the banking system. A similar result was found by Ochs and Rush (1983) for currency in case of the US.

The traditional specification of money demand equation does not fully encompass the financial market developments (Gurley and Shaw, 1960; Tobin, 1965; Bordo and Jonung, 1990). It is pertinent that financial innovations not be considered as part of a stationary error term because these innovations have led to permanent shifts in the real money balances. In addition to the above, there are several other causes for the shifts in the velocity of real money balances, which are more relevant to structurally unstable economies. For instance, in many emerging economies, the practice of conducting transactions in a foreign currency, i.e. currency substitution leads to increase in the velocity of domestic money stock that often appear to be irreversible in nature (Arrau, 1995 quoted Guidotti and Rodriguez, 1992).

In the backdrop of the above discussion, the aim of this study is to explore the ways in which permanent shifts in the demand for money function can be modeled. This study explores the issue in the context of India by using the quarterly data for the period 1996: Q2 to 2016: Q3. This subject is quite relevant for India as in the early 1990s India's financial sector underwent significant reforms leading to financial liberalisation. These changes dismantled the administered interest rates, unified dual exchange rates through a market-based exchange rate system and in a phased manner introduced convertibility on current account (Ramachandran, 2004). It is obvious that financial liberalisations must have affected the demand for money. Therefore, this empirical study explores the mechanism of how financial liberalisation and its process might have affected the demand for real money balances.

The empirical estimation of the model is done by introducing a proxy for financial liberalisation as an additional explanatory variable while estimating the demand for money function. As quoted by James (2005) there are several ways to incorporate the proxy for financial liberalisation in the money demand equation. Such as by including dummy variables (Friedman & Schwartz, 1983), a time trend (Arrau et al., 1995; Dekle & Pradhan, 1999;

Moore, Porter & Small, 1990), institutionally-related variables (Akhtar, 1983; Bordo & Jonung 1981, 1987, 1990; Klovland, 1983; Siklos, 1993), or by adjusting monetary indices (Binner, Gazley, Chen & Chie, 2004). Present study focusses on first three approaches to incorporate proxy for financial innovation as an explanatory variable in the money demand function, such as deterministic time trend, institutional variables (money market instruments, for instance certificate of deposits [CDs] and commercial paper [CPs]) and dummy variables (one for cards and another for mobile banking). The rationale behind using a deterministic time trend is that it does not require to incorporate all possible financial innovation, rather it is used in general to capture financial innovation. Further, details on particular financial innovation, i.e. institutional variables and dummy variables, are discussed in section 4.

In a nutshell, achieving true money demand function is an important aspect of monetary policy. Therefore, it is necessary to incorporate these financial liberalisations into money demand equation. Several studies have been done on the stability issues of money demand in case of advanced economies after incorporating proxy for financial liberalisation. Similarly, the present study tries to look at the stability of money demand function in an emerging economy, like India, after incorporating financial innovation component.

This study has five sections. Section 2 presents the literature based on advanced and emerging economies. It discusses how traditional long-run money demand function was misspecified in various countries, particularly after the 1970s. Section 3 presents the data source and variables' description used in this study. It discusses the autoregressive distributed lag (ARDL) model or bounds testing approach to co-integration, developed by Pesaran et al. (2001). The CUSUM and CUSUMQ tests, developed by Brown et al. (1975) are also discussed to check the stability of the parameter. Further, different functional forms are discussed to give an alternative approach to modeling financial innovation in the same section. Section 4 presents the empirical findings. Finally, Section 5 presents a summary and concluding remarks in the light of current monetary policy scenario.

2. Literature Review

Until the 1970s, several countries witnessed a stable relationship among the stock of real money balances, income level and opportunity cost variables. As mentioned by Laidler (1977), "voluminous research during the post-war period is a witness of the stable money demand function." However, circumstances had changed after the late 1970s. A number of studies (Artis and Lewis, 1976; Goldfeld, 1976; and Hacche, 1974 and others) raised their doubt on the stability of money demand function. Even in the case of the UK and the US, studies questioned the existence of stable money demand due to difficulty in modeling the money market. In fact, the UK and the US were not the only exceptions, similar problems were realised by several other countries as the period since the mid-1970s was characterised by unusual economic scenarios such as recession, supply shocks, high and volatile inflation and so on. Further, the same period was also characterised by substantial institutional changes that attributed to the financial liberalisation. Consequently, several changes took place in the financial market such as authorisation to commercial banks to open interest-bearing checkable deposits and growth of negotiable order of withdrawals (NOW, US), etc. These very changes removed the distinction between interest-bearing and non-interest bearing deposits. Further, the concentration account and zero balance account led firms to look out at their deposit balances more carefully (Simpson and Porter, 1980).

In the backdrop of the above changes in the financial market, it was firmly believed that instability in the money demand function may be attributed to the non-inclusion of these financial innovations in the money demand equation. Therefore, the financial system deepening and widening all over the world has raised the question on the stability of money demand function. In this regard, a study was done by Baba et al. (1992) in the case of the US data is a pioneer. It examined money demand specification differently, which was uniformly successful over periods of known difficulty in the money demand. Their study concluded that contrary to the prevailing view that money demand is unstable, there is good evidence for the existence of a stable, cointegrating money demand function, based on theory, with an error-correction specification.

As a result, in the conventional money demand equation, several shortcomings were realised during this period. Sophisticated econometric techniques, several financial deregulations, institutional changes and newly emerged dataset led the researchers to think over reformulation of money demand function in terms of sophisticated examination of dynamics, functional forms specification and use of the better econometric technique. In this backdrop, the present study examines some of the important literature on the stability of money demand after the emergence of financial innovation and institutional/regulatory changes.

Dekle and Pradhan (1999) estimated long-run money demand in four ASEAN countries[4]. The study utilised simple linear time trends and time dummy variables approach to capture financial innovation and concluded that money demand equations are cointegrated. Baba, Hendry and Starr (1992) estimated the US M1 demand functions, which earlier were supposed to be unstable, regularly "breaking down", over 1960-1988 (for instance missing money, great velocity decline, *M1-explosion*). The alternative specifications, which are estimated in dynamic error-correction form, explain the earlier "breakdowns", showing the model's distinctive features that are important in accounting for the data.

Yu and Gan (2009) investigate the dynamic relationship between money demand and financial innovation in the case of ASEAN-5 by utilising monthly time span from 1987: M1 to 2007: M4. The Engle-Granger two-step cointegration technique (1987) and ECM conclude that there exists a long-run relationship among variables, particularly after financial innovation. Kumar and Webber (2013) investigate the demand for M1 in the case of Australia and New Zealand over the period 1960-2009. Results state that M1 was unstable over the period 1984-1998 for both the countries, although tests for stability are not rejected thereafter. Mwanzia, Ndanshau and Luvanda (2017) investigate the effect of stock market prices on money demand in Kenya by using quarterly data for the period 1996: Q1 to 2011: Q2. Their study supports the wealth effect argument and stable money demand in Kenya despite the flourishing financial innovations in the Kenyan financial system.

Hossain (2007) estimated M1 for Indonesia in an open economy using annual data from 1970 to2005. The CUSUM and CUSUMQ of residuals' tests suggest that M1 is stable, despite the financial reforms and innovations since the early 1990s in Indonesia. Siddiki (2000) estimated M2 in case of Bangladesh using annual data from 1975 to 1995. The ARDL test suggested a cointegrating and stable long-run relationship among real per capita broad money demand, real per capita income, domestic interest rates and unofficial exchange rate premiums despite the changes in financial and exchange rate policies between 1975 and 1995. Arrau, Gregorio, Reinhart and Wickham (1995) examine money demand by utilising quarterly data for different time periods for ten developing countries[5]. They mention that after

[4] The countries in this sample include Indonesia, Malaysia, Singapore and Thailand. In all four economies the estimated real broad money equations are found to be stable (cointegrated) after incorporating time trend.

[5] The countries in this sample include Argentina, Brazil, Chile, India, Israel, Korea, Malaysia, Mexico, Morocco and Nigeria. Of these, cointegration was found in the money demand function in case of Argentina, Brazil, Chile, India, Israel, Korea, Malaysia and Mexico after incorporating proxy for financial innovation (that is deterministic time trend and stochastic trend).

considering different proxies for financial innovation, money demand and its fluctuations are explained well.

Ibrahim (2001) analyses the role of financial factors in the behaviour of M1 and M2 by covering period 1977:1 to 1998:8, in Malaysia. Focussing on changes in M1 and M2 attributed to financial innovations, the study concludes that stable M1 and M2 can be found. Hossain and Arwatchanakarn (2017) investigate the stability of the money demand using quarterly data for the period 1999:Q1-2014: Q4, in Thailand. The ARDL results provide a cointegrating relationship, which confirms that the existence of money growth-inflation relationship is based on a stable narrow money-demand equation. Das and Mandal (2000) investigate the stability of the long-run money demand for M3 in India for the period 1981-1998. Despite the large shocks due to financial liberalisation during the 1990s, the study finds stable long-run demand for M3. Rao and Singh (2006) estimate M1 in India for the period 1953-2003. The estimates with vector autoregression (VAR) framework imply that there exists stable M1. Hence, the 1991 financial reforms do not affect money demand stability.

According to the above literature, there exists a stable money demand function after incorporating a proxy for financial innovation in the money demand equation. In the case of India, after economic reform of the 1990s, a lot of financial innovation had happened that influenced the stability of money demand, which prompted the researchers to investigate the stability of money demand in India. The effect of economic reforms on the stability of money demand was mixed. A majority of the studies support the view that money demand is stable even after economic reforms (for instance Adil et al., 2018; Arora, 2016; Padhan, 2011 and Bharadwaj & Pandit, 2010). Contrary to this, some studies support to unstable money demand after reform (for instance Inoue and Hamori, 2009; Singh and Pandey, 2010; and Aggarwal 2016). Importantly, the existence of unstable money demand is evident in India, but hardly anyone attempts to look at the stable money demand after capturing financial innovation as an explanatory variable in the money demand equation. Henceforth, this study tries to check whether money demand function is stable after incorporating financial innovation in the money demand function. Thus, examining the money demand issue in this fashion would add value to the available literature on money demand.

3. Dataset and Research Methodology

The data

This study has used a dataset from secondary sources such as *RBI Handbook of Statistics on Indian Economy*, *BSE Historical Indices* and *EPW Research Foundation* for an empirical analysis of its objectives. The study has extracted dataset for the following variables-— narrow money (M1), broad money (M3), real GDP, call money rate (CMR), 10 year government securities (G-Sec 10), nominal effective exchange rate (NEER), certificate of deposit (CD), commercial paper (CP) and Sensex. The CD and CP data were 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.*

This study has used quarterly dataset rather than monthly. Because increasing the sample size by increasing the sampling frequency as opposed to using data over a long period of time is not appropriate for testing long-run relationships between economic time series (Siklos, 1993 quoted; Hendry, 1986; and Perron, 1989). Therefore, all series are monthly except GDP, then monthly series are converted into quarterly frequency. Ultimately, this left us with 82 observations for the period from 1996: Q2 to 2016: Q3. The present study has taken dataset from 1996: Q2 because the quarterly data on GDP is available on RBI website since 1996: Q2. Further, we converted all the variables under consideration, except proxy for opportunity cost variables, into natural logarithmic form in order to ensure the accuracy and robustness in the estimations. The study has also used the seasonally adjusted dataset by employing X-13 ARIMA.

Model Specification and Variables' Description

The econometric specification of the money demand function defined in this study is based on a log-linearised version of a conventional long-run theoretical money demand function (see for instance Goldfeld, 1989). Apart from the financial innovation, which is the main concern of the present study, some additional variables are also utilised such as exchange rate and stock prices. The functional form with respective money stocks is mentioned below.

Model 1: $\ln M1 = f(\ln Y, \; R, \; \ln EX, FI)$

Model 2: $\ln M3 = f(\ln Y, \; R, \; \ln EX, \ln SP, FI)$

Variables in the Model 1 and Model 2 are defined as follows: *lnM1* is the log of narrow money, *lnY* is log of real GDP at constant price, *R* stands for interest rate, *lnEX* is the log of exchange rate, *lnM3* is log of broad money, *lnSP* is log of stock prices and *FI* stands for financial innovation. Further, the broad definition of the variables under study is discussed below.

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

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

Real Income (Y): Gross Domestic Product (GDP) at market prices (at constant prices) is considered as a proxy for real income. Real income represents a scale variable in the money demand function.

Interest Rate (R): To have a robust estimation of M1 and M3, two kinds of interest rates are used in this study, *viz.* call money rate (CMR) and 10-year government securities (G-Sec 10). CMR is considered as the opportunity cost for holding real cash balances of *narrow money (M1)*, while G-Sec 10 is used as the opportunity cost for holding real cash balances of *broad money (M3)*. The reason to use G-Sec 10 apart from CMR in money demand estimation is that since by construction M1 is more likely to link with short term interest rate, i.e. weighted average overnight *Call Money Rate* (CMR), while by construction M3 is more likely to deal with long term interest rate, i.e. *G-Sec10*.

Exchange Rate (ln EX): In addition to scale and opportunity cost variables, Robert Mundell (1963) proposed an idea that money demand can also depend upon the exchange rate. Mundell was the first to introduce this proposition, although he did not give any empirical justification. After that several studies incorporated exchange rate in money demand function. Similarly, this study takes the nominal effective exchange rate (NEER) as a proxy for the exchange rate. NEER is considered for 36 currency Trade-Based Weight (the base year 2004-05).

Stock Prices (ln SP): Stock prices are important financial series that help in representing the macroeconomic scenario of a country. Studies have also considered stock prices to investigate its effect on long-run demand for real money balances (*for instance* Mwanzia *et al.*, 2017 in case of Kenya; Hye *et al.*, 2009 in case of Pakistan). In India, according to the authors, none of the studies considered stock prices in money demand. Therefore, this study has factored in stock prices into money demand function. It has considered closing values of Sensex as a proxy for stock prices.

Financial innovation (FI): Present study captures the financial innovation through three different ways— deterministic time trend approach, institutionally-related variable approach and dummy variable approach. *Firstly*, simple time trend is used to capture financial innovations that measure the mean rate at which new cash management techniques (i.e. financial innovation) have an effect on real money balances, assuming technological change is exogenous to the financial sector. The inclusion of time trend in money demand estimation merely assumes that the implementation of new technologies or practices leads to a decline in real money balances smoothly over a period of time. *Secondly*, the institutionally-related variable is considered for financial innovation. Under these two important proxies related to money market instruments such as CDs and CPs are considered to capture variables related to institutions. *Thirdly*, dummy variables are utilised as a proxy to capture financial innovation. In the case of India, two important breakthroughs are considered that is cards and mobile banking. As per the data available on the RBI website, the cards become more prevalent after the 2004: Q2 and mobile banking after 2011: Q2. Consequently, one (0, 1) dummy variable is included to capture the effects of cards on money demand.[6] And one (0, 1) dummy variable is utilised for mobile banking.

The sign of coefficients is all about the matter of empirical investigation. However, some prior expectation can be made as per the economic theory such as scale variable (real GDP) and opportunity cost variable (interest rate) as positively and negatively related with money stocks, respectively. The coefficients of the exchange rate and stock prices may have a positive or negative relationship with money stocks, which will depict either currency substitution effect or wealth effect depending upon the sign of the coefficients. Lastly, as mentioned by Dekle and Pradhan (1999), financial innovation may be positive or negative in sign, depending upon either institutional and technological advancement (depicts negative sign) or increasing monetisation of the economy and financial deepening (depicts positive sign).

Cointegration Test: ARDL Approach

[6] Here, cards consist of credit cards and debit cards and their usage at ATMs and POS.

The aim of this study is to examine the short-and long-run dynamic relationship between money demand and financial reforms and its stability among variables under the money demand equation. To this end, the study utilises cointegration concepts. Pesaran *et al.* (2001) propose a single equation cointegration concepts known as autoregressive distributed lag (ARDL or bounds testing, used interchangeably) approach to cointegration. The use of ARDL implies that by taking missing lag values into account, spurious regression can be avoided. Because of its advantages, ARDL is considered as an alternative to the Engle-Granger (EG, 1987), Engle-Yoo (EY, 1987), and Johansen Juselius (JJ, 1990) cointegration concepts. Some of the pertinent benefits of ARDL are as follows: first, the ARDL approach does not require prior information about the order of integration of variables, whereas it is pre-requisite in EG cointegration analysis; second, the EG may suffer from endogeneity problem while it is not the case with ARDL; third, in ARDL the short-and long-run components of the model can be estimated simultaneously, removing problems associated with omitted variables and serial correlation; and lastly, ARDL gives the unbiased and efficient estimates of the variables because it avoids the problems that might come in the presence of serial correlation and endogeneity (Siddiki, 2000).

This study estimates M1 and M3 money stocks but with different functional form in the case of India. Therefore, two models are defined below. The Long-run relationship in the bounds testing approach can be investigated with the help of following unrestricted error correction model (UECM):

$$\Delta \ln M1_t = C_{01} + \sum_{i=1}^{n1} \phi_{1i} \Delta \ln M1_{t-i} + \sum_{i=0}^{n2} \phi_{2i} \Delta \ln Y_{t-i} + \sum_{i=0}^{n3} \phi_{3i} \Delta R_{t-i} + \sum_{i=0}^{n4} \phi_{4i} \Delta \ln EX_{t-i}$$
$$+ \sum_{i=0}^{n5} \phi_{5i} \Delta \ln FI_{t-i} + \beta_1 \ln M1_{t-1} + \beta_2 \ln Y_{t-1} + \beta_3 R_{t-1} + \beta_4 \ln EX_{t-1} + \beta_5 \ln FI_{t-1} + \varepsilon_t \qquad (1)$$

$$\Delta \ln M3_t = C_{03} + \sum_{i=1}^{n1} \delta_{1i} \Delta \ln M3_{t-i} + \sum_{i=0}^{n2} \delta_{2i} \Delta \ln Y_{t-i} + \sum_{i=0}^{n3} \delta_{3i} \Delta R_{t-i} + \sum_{i=0}^{n4} \delta_{4i} \Delta \ln EX_{t-i} + \sum_{i=0}^{n5} \delta_{5i} \Delta \ln SP_{t-i}$$
$$+ \sum_{i=0}^{n6} \delta_{6i} \Delta \ln FI_{t-i} + \gamma_1 \ln M3_{t-1} + \gamma_2 \ln Y_{t-1} + \gamma_3 R_{t-1} + \gamma_4 \ln EX_{t-1} + \gamma_5 \ln SP_{t-1} + \gamma_6 \ln FI_{t-1} + \mu_t \qquad (2)$$

Where, Δ is the first difference operator, all variables in Equations (1) and (2) are defined as earlier under the heading "*model specification*". The intercept in Equation (1) and (2) are C_{01} and C_{03} respectively, *t* subscript shows time, $\emptyset_{1i}, \emptyset_{2i}, \emptyset_{3i}, \emptyset_{4i}$ and $\emptyset_{5i}$ 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 $\delta_{1i}, \delta_{2i}, \delta_{3i}, \delta_{4i}, \delta_{5i}$ $and\ \delta_{6i}$ are coefficients of short-run dynamics and $\gamma_1, \gamma_2, \gamma_3, \gamma_4, \gamma_5\ and\ \gamma_6$ shows coefficients of long-run dynamic relationship in the Equation 2 (Equation 2 represents Model 2). Lastly, ε_t and μ_t represent error terms, which follow the white noise process.

To confirm a long-run relationship among variables, the *first step* in ARDL is to estimate Equation 1 and 2 with the help of ordinary least square (OLS). The F-test is used to test whether long-run relationship exists among the variables through testing the significance of the lagged level of variables. In Equation 1, the null hypothesis of no cointegration is $H_{0:}$ $\beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$, against alternative $H_1: \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq 0$. In Equation (2), the null hypothesis of no cointegration is depicted as $H_{0:}$ $\gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = \gamma_5 = 0$, against alternative hypothesis $H_{0:}$ $\gamma_1 \neq \gamma_2 \neq \gamma_3 \neq \gamma_4 \neq \gamma_5 \neq 0$. Pesaran et al. (2001) report two sets of critical values, lower critical bound and upper critical bound. The conclusion is drawn with the help of F-test. If the computed F-test exceeds the upper critical bound, the null hypothesis of no cointegration is rejected. Conversely, if estimated F-test falls below the lower critical bound, the null hypothesis of no cointegration cannot be rejected. Additionally, if F-test falls in between lower and upper bounds, the result is inconclusive.

If a long-run relationship exists, -the *second step* estimates the long-run model for lnM1 and lnM3 with the help of Equation 3 (to save space both the models for *lnM1* and *lnM3* are examined in one general Equation). This model is estimated with the help of appropriate lag length.

$$\ln M_t = C_0 + \sum_{i=1}^{n1} \delta_{1i} \ln M_{t-i} + \sum_{i=0}^{n2} \delta_{2i} \ln Y_{t-i} + \sum_{i=0}^{n3} \delta_{3i} R_{t-i} + \sum_{i=0}^{n4} \delta_{4i} \ln EX_{t-i} + \sum_{i=0}^{n5} \delta_{5i} \ln SP_{t-i} + \sum_{i=0}^{n6} \delta_{6i} \ln FI_{t-i} + \mu_t \quad (3)$$

In the *third step* of the bounds test, we obtain short-run dynamic parameters by estimating an error correction model (ECM) associated with long-run estimates. ECM is specified as follows: both models for *lnM1* and *lnM3* are represented in one general Equation (4).

$$\Delta lnM_t = C_0 + \sum_{i=1}^{n1} \varnothing_{1i} \Delta \ln M_{t-i} + \sum_{i=0}^{n2} \varnothing_{2i} \Delta lnY_{t-i} + \sum_{i=0}^{n3} \varnothing_{3i} \Delta R_{t-i} + \sum_{i=0}^{n4} \varnothing_{4i} \Delta lnEX_{t-i} + \sum_{i=0}^{n5} \varnothing_{5i} \Delta \ln SP_{t-i} + \sum_{i=0}^{n6} \varnothing_{6i} \Delta \ln FI_{t-i} + \psi ECM_{t-1} + \mu_t \quad (4)$$

In equation 4, $\varnothing_{1i,} \varnothing_{2i,} \varnothing_{3i,} \varnothing_{4i,} \varnothing_{5i} \, and \, \varnothing_{6i}$ are coefficients of short-run dynamics. ECM is the error correction term derived from the long-run relationship, and ψ is the coefficient of 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 essential because only stable parameter may lead to better policy prescription. Hansen (1992) cautions that over a period estimated parameter of time series may vary, hence unstable parameters can result in model misspecification. This may lead to biased results. The study utilises the Pesaran and Pesaran (1997) test to check parameter stability. According to Pesaran and Pesaran (1997), for the stability of long-run coefficients in the model, the short-run dynamics is essential. To this end, they suggest estimation of ECM in Equations 1 and 2 as per Equation 4, provided dependent variable have a long-run relationship among variables.

CUSUM and CUSUMQ

After the estimation of the model, to assess the parameter constancy, Pesaran and Pesaran (1997) suggest applying the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMQ) of recursive residuals tests (Brown *et al*., 1975) for examining the structural stability of ECM of the money demand equation. The model is estimated by OLS and residuals are subject to the CUSUM and CUSUMQ tests.

Diagnostic Tests

Finally, to gauge the accuracy and predictability of the model, the study employs diagnostic tests. Diagnostic testing checks for serial correlation by employing Breusch-Godfrey (BG), heteroscedasticity by using Breusch-Pagan-Godfrey (BPG), the functional form misspecification is tested with Ramsey's RESET (regression specification error test) and normality of the residual term is checked with Jarque-Berra statistic. The empirical investigation of the above-mentioned methodologies is discussed in the next section.

4. Empirical Analysis

This study examines the money demand function after incorporating different proxies for financial innovation. There are various ways to capture financial innovation in the money demand equation. This study focusses on the deterministic time trend, institutionally related variables and dummy variable approaches. By doing so, it provides an assessment of the relative importance of these three proxies of financial innovation and evaluates the robustness of the results. To this end, the study has used linear ARDL technique for cointegration, and CUSUM and CUSUMQ test to check money demand stability. But before the cointegration analysis, it is prerequisite to look at the order of integration of series for the application of ARDL.

Unit Root Test Results

The ARDL approach to cointegration can be implemented irrespective of the order of integration of variables. Series may be integrated of order zero, i.e. I (0), integrated of order one, i.e. I (1) or a mixture of both. However, series should not be integrated of order two, i.e. I (2), otherwise computed test statistic turns out to be invalid (Adil *et al*., 2017). Therefore, to make sure that none of the series are I (2), the study employs two kinds of unit root tests: the augmented Dickey-Fuller (ADF) by Dickey and Fuller (1981) and Phillips-Perron (P-P) by Phillips and Perron (1988). Results are mentioned in Table 1 below, which shows that all variables are non-stationary at level except CMR, CD, CP and G-Sec 10, but all become stationary after first difference. It implies that all variables are I (1), except CMR, CD, CP and G-Sec 10 which are I (0), which fulfills the criteria to apply ARDL.

Table 1. Unit Root Test Results (ADF and PP)

Variables	ADF Statistics [LL]		PP Statistics {BW}	
	Level	First Difference	Level	First Difference
ln M1	0.216 [4]	-2.878 [3]	0.114 {19}	-20.154 {60}
	(0.97)	(0.05)	(0.97)	(0.00)
ln SP	1.485 [1]	-6.370 [0]	1.698 {1}	-6.294 {3}
	(0.97)	(0.00)	(0.98)	(0.00)
ln EX	-1.487 [0]	-7.933 [0]	-1.422 {1}	-7.952 {2}
	(0.13)	(0.00)	(0.14)	(0.00)
CMR	-4.982 [0]	-	-5.064 {3}	-

	(0.00)		(0.00)	
ln Y	0.615 [0]	-9.089 [0]	0.712 {4}	-9.147 {4}
	(0.99)	(0.00)	(0.99)	(0.00)
ln M3	-0.599 [4]	-3.729 [3]	-1.438 {80}	-11.019 {13}
	(0.86)	(0.01)	(0.56)	(0.00)
G –Sec10	-1.992 [0]	-	-1.992 {0}	-
	(0.05)		(0.05)	
C D	-3.015 [1]	-	-3.640 {1}	-
	(0.04)		(0.01)	
C P	-4.067 [0]	-	-4.062 {3}	-
	(0.00)		(0.00)	

Source: Calculated by authors.
Note: LL is lag length; Values in parenthesis are probability value; and BW stands for Bandwidth.

(A) Financial Innovation as a Deterministic Time Trend Approach

The application of a deterministic time trend approach to capture financial innovation is quite common in literature on money demand. For instance, Arrau et al. (1995) in case of ten developing countries, James (2005) in case of Indonesia, Dekle and Pradhan (1999) in case of ASEAN countries utilised deterministic time trend. Importantly, all of them reached the same conclusion that financial innovation does play an important role in determining money demand and its stability. Following the same rationale, this study chooses a deterministic time trend to examine short-and long-run dynamics of money demand function and its stability issues in case of India over a period 1996: Q2 to 2016: Q3.

(i) Results of Cointegration by ARDL Approach for Equation (1) with Deterministic Time Trend; Narrow Money Case (M1)

Table 2: Full Information Estimate of Linear ARDL Equation (1), Dependent Variable lnM1

Panel A: Short-Run Coefficient Estimates

	Lag Order				
Variables	0	1	2	3	4
Δ *Ln M1*	-	-0.560	-0.438	-0.470	
		(0.00)	(0.00)	(0.00)	
Δ *Ln Y*	0.308	-0.142	0.207	0.387	
	(0.27)	(0.70)	(0.57)	(0.17)	
Δ *CMR*	0.003	0.004	0.005	-0.006	
	(0.23)	(0.08)	(0.05)	(0.01)	
Δ *Ln EX*	0.010				
	(0.00)				
Δ *t*	0.010				

(0.00)

Panel B: Long -Run Coefficient Estimates

Constant	*Ln Y*	*CMR*	*Ln EX*	*t*
16.387	-3.027	0.002	2.673	0.078
(0.35)	(0.23)	(0.95)	(0.01)	(0.09)

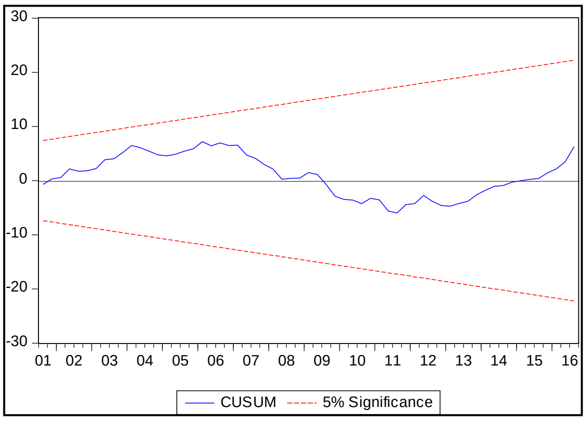
Panel C: Diagnostic Statistics

F	*ECM*	*Adj. R2*	*Normality*	*BG-LM*	*BPG*	*RESET*	*CUSUM*	*CUSUMQ*
4.269	-0.125	0.995	3.444	5.034	18.070	1.364	Stable	Stable
	(0.05)		(0.18)	(0.08)	(0.32)	(0.25)		

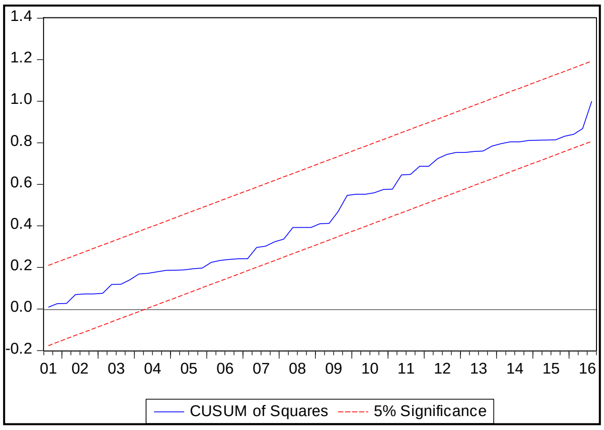
Source: Calculated by Authors

Notes: (a) Selected Model: ARDL (4, 4, 0, 4) (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 critical bounds values of the F statistic at 10% level of significance are 2.45 and 3.52 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 Ramsey's regression specification error test. (f) *Normality* is based on the Jarque - Berra test. (g) *BPG* is Breusch-Pagan-Godfrey test for heteroscedasticity.

Graph 1. Plot of CUSUM for Equation (1)



Graph 2. Plot of CUSUMQ for Equation (1)



Source: Calculated by Authors

After testing unit root, the next step is to perform the ARDL bounds test to examine the long-run relationship among real money balances, such as *lnM1* & *lnM3*, and their determinants. Before the estimation of cointegration, the appropriate lag length is required. To this end, we adopt the general-to-specific approach. Following Ajaz *et al.* (2016), the preferred specification is chosen by starting with max p = max q = 4. After setting up the appropriate lag length, linear ARDL is estimated. Table 2 represents the estimated result for Equation 1, where the dependent variable is real narrow money (*lnM1*).

Panel A shows short-run coefficients of the estimated model for *lnM1*. The coefficients estimate of the short-run interest rate is reasonable and correctly signed up to third lag. The coefficient of real GDP is insignificant but carrying its expected sign as per economic theory. In short-run, an exchange rate (NEER = Trade Weighted Average of 36 currency basket per Rupee or dollar/rupee used interchangeably) being positive in sign and significant in magnitude at lag order (0) shows the *currency substitution effect* in case of India under study period. Result supports the findings of Bahmani-Oskooee and Bahmani (2015) in the case of Iran. Importantly, focusing on our main concern that is deterministic time trend (*t*). As argued by Dekle and Pradhan (1999), financial innovation may change the velocity of real money balances in either direction. Hence, the coefficient of *t* can have either a positive or negative sign. In this study analysis, the coefficient of *t* reflects a positive effect of financial innovation on *lnM1* of about 4% per year in the short-run. The rationale behind the positive relation between *t* and *lnM1* is discussed in the latter part of the study. In comparison to our analysis, Dekle and Pradhan (1999) examined the impact of financial liberalisation on money demand by using annual data from 1974 to1995 in case of ASEAN-4 countries that is Indonesia, Malaysia, Singapore and Thailand. Their study reported a positive effect of 7.4% per year in Indonesia and a positive effect of 1.4% per year in the case of Thailand.

Turning to the long-run normalized coefficients in Panel B, coefficients estimate of the long-run real GDP and CMR are neither reasonable nor correctly signed. However, the coefficient of the exchange rate is significant and signed as per expectation. Also, it is consistent with the results found in short-run, meaning that in long-run also it is supporting the currency substitution effect. Focussing on the coefficient of *t*, it is significant and consistent with the estimate found in the short-run analysis. In long-run, the coefficient of *t* indicates a positive effect of financial innovation of *lnM1* of about 31.2% per annum. Comparatively, in long-run also our findings support the result of Dekle and Pradhan (1999) analysis.

Now let’s turn to the rationale behind the positive relationship between *t* and *lnM1* in the short-and long-run analysis. The rationale behind the positive coefficient of *t* is quite evident as noted by Bordo and Jonung (1987) and Melnick (1995). In many developing countries the velocity of money may fall over time because of increasing monetization (departure from barter trade) of an economy or financial deepening. Our analysis supports their findings. As is evident, after the economic reforms of the 1990s, Indian economy became more inclined towards monetisation with economic growth and higher day to day transaction of *M1*. Consequently, the decline of the velocity of *M1* in the current analysis is justified. However, the short-and long-run relationship among variables is meaningful only if cointegration is established.

It can be seen in panel C that the *F* test, i.e. equal to 4.269, for joint significance of lagged level variables is higher than its critical value of 3.52. This implies the existence of cointegration among variables under study for Equation 1. Importantly, to establish a cointegration, two criteria must be fulfilled. *Firstly*, there should be a long-run relationship among the variables, which is shown by *F* test. *Secondly*, the ECM should be significant. Here, the coefficient of *ECM* is -0.125 and significant, which shows that in long-run with the speed of 12.5% per quarter the dependent variable will return to equilibrium due to any disturbance in the explanatory variables. Thus, *ECM* term further strengthens the results obtained by F-statistics. After satisfying both the conditions of equilibrium, it is concluded that there exists a long-run relationship among the variables for Equation 1. To look at the robustness of the model, various diagnostic tests were conducted, which are reported in Panel C. The results show that Equation 1 does not contain serial correlation, heteroscedasticity and functional form misspecification. Besides, errors are normally distributed. To assess the parameter constancy of the model, CUSUM and CUSUMQ tests were plotted. Results, as shown in Graph 1 and 2, depict the absence of any instability of coefficients as the plot of CUSUM and CUSUMQ statistics are within 5% critical bounds of parameter stability.

In the backdrop of the above discussion, it is concluded that real narrow money balance (M1) is stable after incorporating deterministic time trend ([*t*] used as a proxy for financial innovation) in case of India over the post-reform period from 1996: Q2 to 2016: Q3.

(ii) Results of Cointegration by ARDL Approach for Equation 2 with Deterministic Time Trend; Broad Money Case (M3)

Table 3: Full Information Estimate of Linear ARDL Equation 2, Dependent Variable lnM3

Panel A: Short-Run Coefficient Estimates

	Lag Order				
Variables	0	1	2	3	4
Δ *Ln Y*	0.184 (0.06)	-			

Δ *G-Sec10*	-0.010	-0.012
	(0.28)	(0.03)
Δ *Ln EX*	0.109	-
	(0.04)	
Δ *t*	0.005	-
	(0.08)	

Panel B: Long -Run Coefficient Estimates

Constant	*Ln Y*	*G-Sec10*	*Ln EX*	*t*
-1.711	0.600	-0.001	0.354	0.017
(0.52)	(0.09)	(0.91)	(0.00)	(0.01)

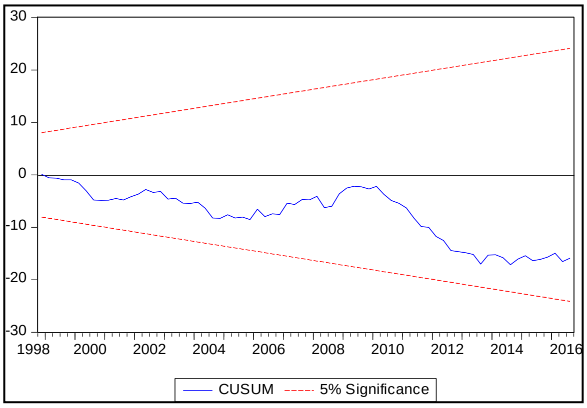
Panel C: Diagnostic Statistics

F	*ECM*	*Adj. R2*	*Normality*	*BG-LM*	*BPG*	*RESET*	*CUSUM*	*CUSUMQ*
3.843	-0.306	0.999	2.619	2.462	10.629	1.027	Stable	Stable
	(0.00)		(0.27)	(0.29)	(0.16)	(0.31)		

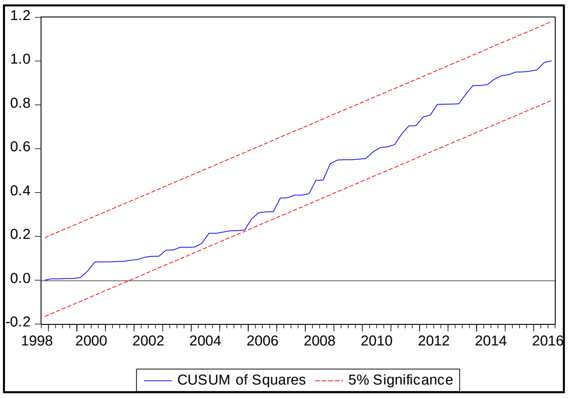
Source: Calculated by Authors

Notes: (a) Selected Model: ARDL (1, 0, 2, 0) (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 critical bounds values of the F statistic at 10% level of significance are 2.45 and 3.52 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 Ramsey's regression specification error test. (f) *Normality* is based on the Jarque - Berra test. (g) *BPG* is Breusch-Pagan-Godfrey test for heteroscedasticity.

Graph 3. Plot of CUSUM for Equation 2



Graph 4. Plot of CUSUMQ for Equation 2



Source: Calculated by Authors

Demand for broad real money balances (M3) is estimated after taking into account the deterministic time trend (*t*). After setting up the appropriate lag length, linear ARDL technique is utilized for Equation 2. Results of the estimated Equation 2 are documented in Table 3, where the dependent variable is *lnM3*.

Panel A shows short-run coefficients of the M3 model. All the coefficients estimate of variables under study are quite reasonable and correctly signed as per economic theory. The coefficient of the exchange rate (NEER = dollar/rupee) being positive and significant in magnitude at lag order (0) shows the *currency substitution effect* in India, under the study period. The result supports the findings of Bahmani-Oskooee and Bahmani (2015) in the case of Iran. Importantly, focusing on the issue of financial innovation, the coefficient of *t* reflects a positive effect of financial innovation on *lnM3* of about 2% per year, in the short-run. In comparison to our analysis of *lnM3,* James (2005) examined the impact of financial liberalisation on monetary aggregate M2 (broad money) by using quarterly data from 1983: Q1 to 2000: Q4, in case of Indonesia. His study depicts a positive effect of the technological development on M2 by about 3.2% per year in Indonesia.

Turning to the long-run coefficients in Panel B, all coefficients estimates of explanatory variables, except G-Sec10, are significant and signed as per economic theory. The coefficient of G-Sec10 is insignificant but the sign is as per expectation. The coefficient of the exchange rate being significant and signed as per economic theory supports currency substitution effect. Thus, it is consistent in the short-and long-run. Focussing on the coefficient of *t*, it is significant and consistent with the estimate found in the short-run. In the long-run also the coefficient of *t* indicates a positive effect of financial innovation on *lnM3* by about 6.8% per year. In the long-run, our finding supports the result of James (2005) in the case of Indonesia. Note that the sign of the *t* coefficient is positive, which is similar to the sign found in the *lnM1* model. Therefore, the rationale behind the positive coefficient of *t* may be understood by following the discussion made in case of the *lnM1* model. However, the long-run relationship among variables will be meaningful only if cointegration is established.

In panel C, it is seen that the *F* test, i.e. equal to 3.843, for joint significance of lagged level variables is higher than its critical value of 3.52. This implies the existence of cointegration among variables under consideration for Equation 2. Also, the coefficient of *ECM* is -0.306 and significant. It shows that in long-run the speed of 30.6% per quarter the response variable (*lnM3*) will return to equilibrium due to any disturbance in its explanatory variables. Thus, *ECM* term further strengthens the results obtained by F-test for co-integration. Thus, based on the result of *F-test* and *ECM,* it is concluded that there exists a long-run relationship among variables of Equation 2. To gauge the robustness of the model, various diagnostic tests were conducted, which are reported in Panel C. The results show that estimated Equation 2 does not contain serial correlation, heteroscedasticity, functional form misspecification and also errors are normally distributed. To assess the parameter constancy of the model, CUSUM and CUSUMQ tests were plotted. Results of Graph 3 and 4 depict the absence of any instability of coefficients. As the plot of CUSUM and CUSUMQ statistics were within the 5% critical bounds of parameter stability, it was concluded that *lnM3* was stable after incorporating deterministic time trend ([*t*] used as a proxy for financial innovation) in case of India over the post-reform period from 1996: Q2 to 2016: Q3.

In a nutshell, based on the empirical findings, it was concluded that both the real money stock (M1 and M3) are stable. Nevertheless, the present study argued that the deterministic time trend is a less precise proxy for financial innovation. As *t* increases, the real money stock, that is M1 and M3, also increase over time due to the economic expansion. In effect, both show positive co-movements between them. If *t* is used as a proxy for financial innovation, it encompasses all the developments of financial innovation in general. Therefore, in order to have more concrete impact of a particular financial innovation in money demand, one should rely on other proxies for financial innovation, such as institutionally related variables (for instance Bordo and Jonung,1990) and dummy variables (for instance Dekle and Pradhan, 1999), which serve the purpose better.

Therefore, in order to check the robustness of the results, this study tests the impact of financial innovation on money demand by utilising other proxies such as institutionally-related variables and dummy variables. Results for other proxies for financial innovation are mentioned in the *Appendix*. Based on *F-test* and *ECM*, the result showed that there is a long- and short-run dynamic relationship among variables considered under the money demand equation (M1 and M3 both). Also, with the help of CUSUM and CUSUMQ tests, it was shown that estimated models are stable. Thus, institutionally related variables and dummy variables have a predictable impact on real money balances, as per economic theory. The increase in financial innovation or reforms, which increase the number of banks, spur institutional and technological advances (debit cards, credit cards, mobile banking, electronic transfers and cash machines), —make it easier to convert money substitutes into money. Consequently, the use of sophisticated technological appliances that make cash management practices more convenient, positively influence an individual's demand for real money balances. In turn, people feel that the use of payment technology is a more convenient way to make purchases than using cash. Hence, financial innovation reduces the quantity of money that people choose to hold. And this is what we get when we use institutionally related variables, that is money market instruments (CDs and CPs) and dummy variables (dummies for cards and mobile banking). The results for both proxies are mentioned in the *Appendix*.

Importantly, the coefficients of scale variable (i.e., real GDP) is greater than unity in most of the models. This kind of coefficients is similar to the coefficients found in the study made by Dekle and Pradhan (1999). They mentioned that greater than unity coefficients of scale variable are possible. It is so because technological progress may have changed the relationship between nominal money and prices. Also, it may be possible because of changes in the financial markets and money-holding behaviour among private sector agents. Despite the inclusion of financial innovation, the coefficient of scale variable is still greater than unity. Therefore, this puzzle remains to be resolved.

In the backdrop of the relationship between financial innovation and money demand, this study suggests that financial innovation is an important determinant of real money balances (M1 and M3) and ensures a stable money demand function. The study has used three proxies for financial innovation, but the more accurate proxies through which the relationship between money demand and specific financial innovation was known are institutionally related variables and dummy variables. The policy implication of stable money demand is discussed in the next section.

5. Summary and Concluding Remarks

It is believed that the transmission mechanism for monetary and fiscal policy in a variety of economic models depends on the stability and predictability of the demand for money, and that policy assessment requires knowledge about the parameters that characterize this important macroeconomic relationship (Arrau et al., 1995). In spite of this, empirical research on money demand suggests that the traditional way of modeling the demand for money has lacunas such as persistent over prediction, implausible parameter estimates, highly serially correlated errors and instable money demand. Consequently, the traditional way of money demand estimation leads to misspecification of the money demand function. This argument supports the finding of Siklos (1993). He mentioned that the traditional specification of money demand in a number of industrial countries failed to cointegrate, suggesting fundamental misspecification in the money demand function.

Very often inspection of raw data shows a shift or movement in the holding of real money balances when there is a permanent increase in its velocity. There have been given a number of justifications behind this, such as changes in the transaction technology, financial liberalisation, financial innovation and deregulation are few among others. These financial markets developments are difficult to capture by traditional money demand specification (Gurley and Shaw, 1960; Tobin, 1965; Bordo and Jonung, 1990).

In the analysis of this study, it is postulated that the failure of finding stable money demand function and its determinants could be the result of ignoring the role of financial innovation. Financial innovation is an important explanatory variable in money demand function. This study analyses the process that could be used for its estimation. In the empirical analysis, financial innovation is modeled for a deterministic time trend approach, institutionally related variables approach and dummy variable approach, in order to check the robustness of the model. The empirical findings depict stable money demand with respect to different proxies of financial innovation. Nevertheless, it is argued that the deterministic time trend is a less precise proxy for financial innovation. Hence, to have an impact of specific kind of financial innovation on real money balances one should rely on other proxies like institutionally related variables and dummy variables.

Thus, despite the use of scale and opportunity cost variables, the study incorporated financial innovation as an explanatory variable in the money demand function and revisited the traditional specification of money demand. The empirical estimation was done in the case of India for the post-reform period by utilising quarterly data from 1996: Q2 to 2016: Q3. Based on linear ARDL approach to cointegration developed by Pesaran et al., the study findings suggested a short-and long-run dynamics among the study variables. Further, the stability of money demand equations was also tested by utilising the CUSUM and CUSUMQ tests developed by Brown et al. (1975). It showed that both the real money balances (M1 and M3) were stable in case of India for the provided time period, research methodology and variables.

In the backdrop of these empirical findings, the study suggests financial innovation while modeling money demand. The study supports the existing literature on the demand for money in case of advanced and emerging economies, which suggests that improvement in money demand stability is importantly determined by financial innovation and/or institutional changes, for instance estimation of Arrau et al. (1995) in a sample of ten developing countries, James (2005) in case of Indonesia, Dekle and Pradhan (1999) in case of ASEAN countries, Siklos (1993) in case of U.S., U.K., Canada, Sweden and Norway. In a nutshell, capturing financial innovation in the money demand equation resulted in an improvement over the standard specifications in terms of yielding more plausible values for the parameters of the money demand function and its stability.

Having established a stable money demand function in the case of India, the following policy implications may be drawn. The Reserve Bank of India (RBI) may target monetary aggregates as an intermediate target in order to achieve ultimate macroeconomic goals, i.e. flexible inflation targeting. This policy implication coincides with the monetary policy strategy of the European Central Bank (ECB). As mentioned by Pospisil (2017), price stability is being a major concern, the Governing Council of the ECB has decided to accord broad monetary aggregate M3 prominent importance in the Euro system's monetary policy strategy by announcing a reference value for its annual growth rate. Consequently, the ECB analyses, along with other economic indicators, the development of monetary aggregates.

References

Arrau, P., De Gregorio, J., Reinhart, C. M., & Wickham, P. (1995). The demand for money in developing countries: assessing the role of financial innovation. *Journal of development economics*, *46*(2), 317-340.

Adil, M. H., Ganaie, A. A., & Kamaiah, B. (2017). Wagner's Hypothesis: An Empirical Verification. *IIM Kozhikode Society & Management Review*, *6*(1), 1-12.

Adil, Masudul Hasan and Haider, Salman and Hatekar, Neeraj, The Empirical Verification of Money Demand in Case of India: Post-Reform Era (June 3, 2018). Available at SSRN: https://ssrn.com/abstract=3189672 or http://dx.doi.org/10.2139/ssrn.3189672

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

Akhtar, M. A. (1983). *Financial innovations and their implications for monetary policy: an international perspective*. Basel, Switzerland: Bank for International Settlements.

Artis, M. J., & Lewis, M. K. (1976). The demand for money in the United Kingdom: 1963–1973. *The Manchester School*, *44*(2), 147-181.

Arnaboldi, F., & Rossignoli, B. (2015). Financial innovation in banking. In *Bank Risk, Governance and Regulation* (pp. 127-162). Palgrave Macmillan, London.

Aggarwal, S. (2016). Determinants of money demand for India in presence of structural break: An empirical analysis. *Business and Economic Horizons*, *12*(4), 173.

Ajaz, T., Nain, M. Z., & Kamaiah, B. (2016). Inflation and openness in India: an asymmetric approach. *Macroeconomics and Finance in Emerging Market Economies*, *9*(2), 190-203.

Bahmani-Oskooee, M., & Bahmani, S. (2015). Nonlinear ARDL approach and the demand for money in Iran. *Economics Bulletin*, *35*(1), 381-391.

Baba, Y., Hendry, D. F., & Starr, R. M. (1992). The demand for M1 in the USA, 1960–1988. *The Review of Economic Studies*, *59*(1), 25-61.

Bordo, M. & Jonung L. (1990). The long-run behaviour of income velocity: The institutional approach revisited. *Journal of Policy Modelling* 12, 165-197.

Bordo, M. D., & Jonung, L. (1981). The long-run behavior of the income velocity of money in five advanced countries, 1870–1975: An institutional approach. *Economic Inquiry*, *19*(1), 96-116.

Bordo, M. D., & Jonung, L. (1987). *The long-run behavior of the velocity of circulation: The international evidence*. Cambridge University Press.

Binner, J. M., Gazely, A. M., Chen, S. H., & Chie, B. T. (2004). Financial Innovation and Divisia Money in Taiwan: Comparative Evidence from Neural Network and Vector Error-Correction Forecasting Models. *Contemporary Economic Policy*, *22*(2), 213-224.

Brown, R. L., Durbin, J., & Evans, J. M. (1975). Techniques for testing the constancy of regression relationships over time. *Journal of the Royal Statistical Society. Series B (Methodological)*, 149-192.

Bhaskara Rao, B., & Singh, R. (2006). Demand for money in India: 1953–2003. *Applied Economics*, *38*(11), 1319-1326.

Das, S., & Mandal, K. (2000). Modelling money demand in India: Testing weak, strong & super exogeneity. *Indian Economic Review*, 1-19.

Dekle, R., & Pradhan, M. (1999). Financial liberalization and money demand in the ASEAN countries. *International Journal of Finance & Economics*, *4*(3), 205-215.

Dickey, D. A., & Fuller, W. A. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica: Journal of the Econometric Society*, 1057-1072.

Darrat, A. F., (1986). Monetization and stability of money demand in developing countries: The Latin American case, Savings and Development 10, 59-72.

Engle, R. F., & Granger, C. W. (1987). Co-integration and error correction: representation, estimation, and testing. *Econometrica: journal of the Econometric Society*, 251-276.

Engle, R. F., & Yoo, B. S. (1987). Forecasting and testing in co-integrated systems. *Journal of econometrics*, *35*(1), 143-159.

Friedman, M., & Schwartz, A. J. (1983). Monetary Trends in the United States and the United Kingdom: Their Relations to Income, Prices, and Interest Rates 1867-1975. University of Chicago Press.

Goldfeld, S. M., Fand, D. I., & Brainard, W. C. (1976). The case of the missing money. *Brookings papers on economic activity*, *1976*(3), 683-739.

Goldfeld, S. M. (1989). Demand for money: empirical studies. In *Money* (pp. 131-143). Palgrave Macmillan, London.

Gurley, J. G., & Shaw, E. S. (1960). Money in a Theory of Finance. *The Brookings Institution, Washington, DC* (No. 332.4/G97m).

Grilli, V. (1989). Seigniorage in Europe, in: M. De Cecco and A. Giovannimi, eds., A European central bank? (Cambridge University Press, Cambridge, UK).

Guidotti, P. E., & Rodriguez, C. A. (1992). Dollarization in Latin America: Gresham's law in reverse?. *Staff Papers*, *39*(3), 518-544.

Hossain, A. A., & Arwatchanakarn, P. (2017). Does Money Have a Role in Monetary Policy for Price Stability under Inflation Targeting in Thailand?. *Journal of Asian Economics*, *53*, 37-55.

Hossain, A. A. (2007). The narrow money demand behaviour in Indonesia, 1970-2005. *ASEAN Economic Bulletin*, 320-338.

Hendry, D. F. (1986). Econometric modelling with cointegrated variables: an overview. *Oxford bulletin of economics and statistics*, *48*(3), 201-212.

Hye, Q. M. A., Wasti, S. K. A., Khatoon, N., & Imran, K. (2009). Relationship between stock prices, exchange rate and demand for money in Pakistan. *Middle Eastern Finance and Economics*, *3*, 89-96.

Hansen, B. E. (1992). Tests for Parameter Stability in Regressions with I (1) Processes. *Journal of Business and Economic Statistics*, 10(3), 321-335.

Hoffman D. & Rasche R. (1991). Long-run income and interest elasticities of money demand in the United States, *Review of Economics and Statistics*, *73*, 665-674.

Hacche, G. (1974). The demand for money in the United Kingdom: Experience since 1971. *Bank of England Quarterly Bulletin*, *14*(3), 284-305.

Ibrhim, M. H. (2001). Financial factors and the empirical behaviour of money demand: a case study of Malaysia. *International Economic Journal*, *15*(3), 55-72.

Inoue, T., & Hamori, S. (2009). An empirical analysis of the money demand function in India. *Economics Bulletin*, *29*(2), 1224-1245.

Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration—with applications to the demand for money. *Oxford Bulletin of Economics and statistics*, *52*(2), 169-210.

James, G. A. (2005). Money demand and financial liberalization in Indonesia. *Journal of Asian Economics*, *16*(5), 817-829.

Kumar, S., & Webber, D. J. (2013). Australasian money demand stability: application of structural break tests. *Applied Economics*, *45*(8), 1011-1025.

Klovland, J. T. (1983). The demand for money in secular perspective: The case of Norway, 1867–1980. *European Economic Review*, *22*(2), 193-218.

Lewis, M. K., & Mizen, P. D. (2000). Monetary economics. *OUP Catalogue*.

Laidler, D. (1977). The demand for money: theory and evidence. *Dum-Don Valley*, *New York*.

Moore, G. R., Porter, R. D., & Small, D. H. (1990). Modeling the Disaggregated Demands for M2 and M1: The US Experience in the 1980s. *Board of Governors of the Federal Reserve System (US) Proceedings*, 21-112.

Mwanzia, J. K., Ndanshau, M. O., & Luvanda, E. (2017). The Effect of Stock Prices on Demand for Money: The Case of Kenya. *Tanzania Economic Review*, *5*(1-2).

Muralikrishna Bharadwaj, B., & Pandit, V. (2010). Policy reforms and stability of the money demand function in India. *Margin: The Journal of Applied Economic Research*, *4*(1), 25-47.

Melnick, R. (1995). Financial services, cointegration, and the demand for money in Israel. *Journal of Money, Credit and Banking*, *27*(1), 140-153.

Ochs, J., & Rush, M. (1983). The Persistence of Interest-Rate Effects on the Demand for Currency: Note. *Journal of Money, Credit and Banking*, *15*(4), 499-505.

Perron, P. (1989). Testing for a random walk: A simulation experiment of power when the sampling interval is varied. In *Advances in econometrics and modelling* (pp. 47-68). Springer, Dordrecht.

Phillips, P. C., & Perron, P. (1988). Testing for a unit root in time series regression. *Biometrika*, *75*(2), 335-346.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of applied econometrics*, *16*(3), 289-326.

Pesaran, M. H., & Pesaran, B. (1997). *Working with Microfit 4.0: interactive econometric analysis;[Windows version]*. Oxford University Press.

Padhan, P. C. (2011). Stability of demand for money in India: Evidence from monetary and liquidity aggregates. *International Journal of Economics and Finance*, *3*(1), 271.

Pospisil, R. (2017). The Monetary Aggregates and Current Objectives of European Central Bank. *Studia Prawno-Ekonomiczne*, *105*, 341-363.

Roley, V. V. (1985). Money demand predictability, Journal of Money, Credit and Banking 17, 611-641.

Ramachandran, M. (2004). Do broad money, output, and prices stand for a stable relationship in India?. *Journal of Policy Modeling*, *26*(8-9), 983-1001.

Siklos, P. L. (1993). Income velocity and institutional change: Some new time series evidence, 1870-1986. *Journal of Money, Credit and Banking*, *25*(3), 377-392.

Siddiki, J. U. (2000). Demand for money in Bangladesh: a cointegration analysis. *Applied Economics*, *32*(15), 1977-1984.

Simpson, T. D., & Porter, R. D. (1980, October). Some issues involving the definition and interpretation of the monetary aggregates. In *Federal Reserve Bank of Boston Conference Series* (Vol. 23, pp. 161-234).
Singh, P., & Pandey, M. K. (2010). Financial Innovation and Stability of Money Demand Function in Post–reform period in India. *Economics Bulletin*, *30*(4), 2895-2905.

Tobin, J. (1965). The monetary interpretation of history. *The American Economic Review*, *55*(3), 464-485.

Yu, H., & Gan, P. T. (2009). An empirical analysis of the money demand function in ASEAN-5. *International Research Journal of Finance and Economics*, Issue 33 (2009).

Appendix: Section 4. Empirical Analysis

(B) Financial Innovation as an Institutionally Related Variable (Commercial Paper [CD] and Certificate of Deposit [CP]) Approach

(i) Results of Cointegration by ARDL Approach for Equation (1) with Institutionally Related Variable (CD); Narrow Money Case (M1)

Table 4: Full Information Estimate of Linear ARDL Equation (1), Dependent Variable lnM1

Panel A: Short-Run Coefficient Estimates

	Lag Order				
Variables	0	1	2	3	4
Δ *Ln M1*	-	-0.229 (0.01)	-0.206 (0.02)	-0.154 (0.07)	0.527 (0.00)
Δ *Ln Y*	0.213 (0.00)				
Δ *C D*	-0.006 (0.00)				
Δ *Ln EX*	0.187 (0.03)				

Panel B: Long -Run Coefficient Estimates

Constant	*Ln Y*	*C D*	*Ln EX*
-12.000	1.247	-0.032	1.099
(0.00)	(0.00)	(0.02)	(0.00)

Panel C: Diagnostic Statistics

F	*ECM*	*Adj. R2*	*Normality*	*BG-LM*	*BPG*	*RESET*	*CUSUM*	*CUSUMQ*
3.875	-0.170	0.994	1.947	0.431	4.103	1.917	Stable	Stable
	(0.00)		(0.38)	(0.81)	(0.85)	(0.17)		

Source: Calculated by Authors
Notes: (a) Selected Model: ARDL (5, 0, 0, 0) (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 critical bounds values of the F statistic at 10% level of significance are 2.72 and 3.77 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 Ramsey's regression specification error test. (f) *Normality* is based on the Jarque - Berra test. (g) *BPG* is Breusch-Pagan-Godfrey test for heteroscedasticity.

(ii) Results of Cointegration by ARDL Approach for Equation (2) with Institutionally Related Variable (CD); Broad Money Case (M3)

Table 5: Full Information Estimate of Linear ARDL Equation (2), Dependent Variable lnM3

Panel A: Short-Run Coefficient Estimates

			Lag Order		
Variables	0	1	2	3	4
Δ *Ln M3*	-	-0.205			
		(0.09)			
Δ *Ln Y*	0.314				
	(0.04)				
Δ *C D*	0.003				
	(0.09)				
Δ *Ln EX*	0.311				
	(0.01)				
Δ *Ln SP*	-0.038				
	(0.03)				

Panel B: Long -Run Coefficient Estimates

Constant	*Ln Y*	*C D*	*Ln EX*	*Ln SP*
-14.330	2.187	0.020	0.608	-0.263
(0.00)	(0.00)	(0.32)	(0.14)	(0.05)

Panel C: Diagnostic Statistics

F	*ECM*	*Adj. R^2*	*Normality*	*BG-LM*	*BPG*	*RESET*	*CUSUM*	*CUSUMQ*
1.223	-0.143	0.998	11.186	0.227	10.703	-0.024	Stable	Stable
	(0.09)		(0.00)	(0.89)	(0.15)	(0.12)		

Source: Calculated by Authors

Notes: (a) Selected Model: ARDL (2, 0, 0, 0, 1) (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 critical bounds values of the F statistic at 10% level of significance are 2.45 and 3.52 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 Ramsey's regression specification error test. (f) *Normality* is based on the Jarque - Berra test. (g) *BPG* is Breusch-Pagan-Godfrey test for heteroscedasticity.

(iii) Results of Cointegration by ARDL Approach for Equation (1) with Institutionally Related Variable (CP); Narrow Money Case (M1)

Table 6: Full Information Estimate of Linear ARDL Equation (1), Dependent Variable lnM1

Panel A: Short-Run Coefficient Estimates

	Lag Order				
Variables	0	1	2	3	4
Δ *Ln M1*	-	-0.219	-0.192	-0.131	0.529
		(0.02)	(0.03)	(0.15)	(0.00)
Δ *Ln Y*	0.231				
	(0.00)				
Δ *C P*	-0.005				
	(0.00)				
Δ *Ln EX*	0.195				
	(0.02)				

Panel B: Long -Run Coefficient Estimates

Constant	*Ln Y*	*C P*	*Ln EX*
-12.299	1.285	-0.028	1.086
(0.00)	(0.00)	(0.02)	(0.00)

Panel C: Diagnostic Statistics

F	*ECM*	*Adj. R2*	*Normality*	*BG-LM*	*BPG*	*RESET*	*CUSUM*	*CUSUMQ*
3.886	-0.180	0.994	1.829	0.508	4.795	3.352	Stable	Stable
	(0.00)		(0.40)	(0.78)	(0.78)	(0.07)		

Source: Calculated by Authors

Notes: (a) Selected Model: ARDL (5, 0, 0, 0). (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 critical bounds values of the F statistic at 10% level of significance are 2.72 and 3.77 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 Ramsey's regression specification error test. (f) *Normality* is based on the Jarque - Berra test. (g) *BPG* is Breusch-Pagan-Godfrey test for heteroscedasticity.

(iv) Results of Cointegration by ARDL Approach for Equation (2) with Institutionally Related Variable (CP); Broad Money Case (M3)

Table 7: Full Information Estimate of Linear ARDL Equation (2), Dependent Variable lnM3

Panel A: Short-Run Coefficient Estimates

	Lag Order				
Variables	0	1	2	3	4
Δ *Ln M3*	-	-0.196			
		(0.10)			
Δ *Ln Y*	0.311				
	(0.04)				
Δ *C P*	0.003				
	(0.07)				
Δ *Ln EX*	0.310				
	(0.01)				
Δ *Ln SP*	-0.035				
	(0.04)				

Panel B: Long -Run Coefficient Estimates

Constant	*Ln Y*	*C P*	*Ln EX*	*Ln SP*
-13.868	2.117	0.020	0.597	-0.241
(0.00)	(0.00)	(0.27)	(0.11)	(0.03)

Panel C: Diagnostic Statistics

F	*ECM*	*Adj.* R^2	*Normality*	*BG-LM*	*BPG*	*RESET*	*CUSUM*	*CUSUMQ*
1.524	-0.147	0.998	11.148	0.174	10.318	-0.025	Stable	Stable
	(0.07)		(0.00)	(0.92)	(0.17)	(0.11)		

Source: Calculated by Authors

Notes: (a) Selected Model: ARDL (2, 0, 0, 0, 1) (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 critical bounds values of the F statistic at 10% level of significance are 2.45 and 3.52 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 Ramsey's regression specification error test. (f) *Normality* is based on the Jarque - Berra test. (g) *BPG* is Breusch-Pagan-Godfrey test for heteroscedasticity.

(C) Financial Innovation as a Dummy Variable Approach

(i) Results of Cointegration by ARDL Approach for Equation (1) with Dummy Variables (Cards and Mobile Banking); Narrow Money Case (M1)

Table 8: Full Information Estimate of Linear ARDL Equation (1), Dependent Variable lnM1

Panel A: Short-Run Coefficient Estimates

	Lag Order				
Variables	0	1	2	3	4
Δ *Ln Y*	0.885				
	(0.00)				
Δ *C P*	-0.004				
	(0.09)				
Δ *Ln EX*	0.365	0.148	-0.351		

	(0.10)	(0.52)	(0.00)
Δ *Dum Cards*	-0.038	-0.065	
	(0.02)	(0.00)	
Δ *Dum MB*	-0.055		
	(0.03)		

Panel B: Long -Run Coefficient Estimates

Constant	*Ln Y*	*C P*	*Ln EX*	*Dum Cards*	*Dum MB*
-8.299	1.288	-0.005	0.282	0.030	-0.080
(0.00)	(0.00)	(0.10)	(0.10)	(0.30)	(0.03)

Panel C: Diagnostic Statistics

F	*ECM*	*Adj. R2*	*Normality*	*BG-LM*	*BPG*	*RESET*	*CUSUM*	*CUSUMQ*
3.356	-0.687	0.995	9.755	0.030	11.123	0.639	Stable	Stable
	(0.00)		(0.01)	(0.99)	(0.43)	(0.43)		

Source: Calculated by Authors

Notes: (a) Selected Model: ARDL (5, 0, 0, 0). (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 critical bounds values of the F statistic at 10% level of significance are 2.26 and 3.35 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 Ramsey's regression specification error test. (f) *Normality* is based on the Jarque - Berra test. (g) *BPG* is Breusch-Pagan-Godfrey test for heteroscedasticity.

(ii) *Results of Cointegration by ARDL Approach for Equation (2) with Dummy Variables (Cards and Mobile Banking); Broad Money Case (M3)*

Table 9: Full Information Estimate of Linear ARDL Equation (2), Dependent Variable lnM3

Panel A: Short-Run Coefficient Estimates

	Lag Order				
Variables	0	1	2	3	4
Δ *Ln M3*	-	0.157	0.203		
		(0.17)	(0.08)		
Δ *Ln Y*	-0.134	-0.498			
	(0.50)	(0.09)			
Δ *G-Sec10*	-0.011				
	(0.00)				
Δ *Ln EX*	0.306				
	(0.00)				
Δ *Dum Cards*	-0.068				
	(0.00)				
Δ *Dum MB*	-0.042				
	(0.01)				

Panel B: Long -Run Coefficient Estimates

Constant	*Ln Y*	*G-Sec10*	*Ln EX*	*Dum Cards*	*Dum MB*

-6.813		1.513	-0.020	-0.157		-0.040		-0.079
(0.00)		(0.00)	(0.00)	(0.20)		(0.01)		(0.01)

Panel C: Diagnostic Statistics

F	*ECM*	*Adj. R2*	*Normality*	*BG-LM*	*BPG*	*RESET*	*CUSUM*	*CUSUMQ*
4.834	-0.543	0.999	0.627	0.558	20.651	2.149	Stable	Stable
	(0.00)		(0.73)	(0.76)	(0.48)	(0.15)		

Source: Calculated by Authors

Notes: (a) Selected Model: ARDL (5, 0, 0, 0). (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 critical bounds values of the F statistic at 10% level of significance are 2.26 and 3.35 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 Ramsey's regression specification error test. (f) *Normality* is based on the Jarque - Berra test. (g) *BPG* is Breusch-Pagan-Godfrey test for heteroscedasticity.