An Empirical Investigation of India's Money Demand Function: An ARDL Approach

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Abstract

The present research paper tries to investigate the stability of India's money demand function using the variables such as broad money, income, interest rate, price level, foreign exchange reserve, and exchange rate between 1990 and 2020 through an ARDL model. The finding has two fold (1) the ARDL bound test for cointegration and (2) the long-run and short-run ARDL models, including the error correction term (ECT). The outcome of the ARDL-bound test proved the existence of long-run relationship among the variables. In addition, the long-run ARDL model revealed that all variables have a statistically significant impact on broad money (M3). In addition, the error correction term (ECT) is 0.64, which suggests that short-term disturbances are resolved with a speed of 64 percent within a year. Finally, the diagnostic outcomes of the study indicated that the data used in this study satisfied the assumptions of classical linear regression model while, the stability tests (CUSUM and CUSUMSQ) provided evidence in support of the validity of the model. Overall, the research findings suggest that policymakers and the RBI can estimate output gaps and inflationary expectations using broad money (M3) as an indicator or information variable in the inflation-targeting strategy in India.

Keywords: Money Demand, ADF test, bound test, ARDL Model.

1. Introduction

Demand for money is the subject of much theoretical and practical study because it serves as an essential component of the macroeconomic policy framework (Barnett et al., 1992).Stability is the most frequently investigated aspect of money demand. A stable money demand refers to the observation that money holdings in the real world can be explained by functional relationships with a limited number of factors, reaching statistically significant levels that are generally accepted (Laidler, 1982).Many macroeconomic variables, such as the interest rate, price level, savings, investment, imports, exports, GDP, etc., may have a significant influence on money demand (Padhan, 2016). These relationships will enable the Reserve bank to develop an adequate money demand function and to conduct and establish an appropriate monetary policy in order to

achieve the desired economic growth and price stability. The Reserve Bank is able to achieve its monetary policy objectives and foster economic development due to its ongoing money demand function (Nag et al., 1993). This is important, especially in light of the external shocks to the monetary system that erupted during the global financial crisis of 2008–2009 (Sugema, 2012; Nezky, 2013). The long-term relationship between broad money and its determinants and stable money demand has always been at the forefront of monetary policy debates, and it has gained currency due to growing financial integration. So far, both theoretical and empirical methods have been intricate and multidirectional. This problem is exceedingly extensive and comprehensive within the context of India. M1 and M3 are the two most important policy-relevant indicators (RBI, 1998). Actually, the era before 1969, when many post offices also served as banks, is most analogous to the advent of the M2 and M4. However, with the expansion of the banking network in both rural and urban regions, this function became less prominent. Further, in recent times, there has been a gradual transition towards a more digitized and cashless economy in India (Garg and Panchal, 2017). Government programs that encourage digital transactions have made a major impact on the money demand function. There has been a dramatic increase in the use of electronic payment systems, such as mobile wallets, internet banking, and others, which is changing the way people keep and transfer money. In this context, the present study delves into the examination of the stability of India's broad money (M3).

2. Literature Review

Bhattacharya (1995) examined the India's money demand function between 1950 and 1980 using M1, M2, and M3 measures of the money supply. He found that long-term interest rate respond more quickly than the short-term interest rate. Pradhan and Subramanian (1997); Das and Mandal(2000) analyze the money demand function in India. Their study found that money demand (M3) was stable over the study period. Ramachandran (2004) investigated the consistency of money demand (M3), price, and output in India using the ECM and co-integration approach. His study showed a stable correlation between M3 and real income. Noer and Achsani (2010) investigated the consistency of money demand in Indonesia between 1990: (Q1) and 2008 (Q3). They concluded that income is positively associated with money demand whereas; interest rate is negatively related to money demand (M3). Ben-Salha and Jaidi (2014) used ARDL to examine the factors affecting money demand in Tunisia. Their findings showed that interest rate and investment affects money demand in the short-run whereas, Consumer Price Index and interest rate influence the money demand in long-rum. Pawan (2014) investigated the consistency and stability of India’s money demand. He found that only broad money remained stable during the study period.Azeem and Ayub (2014) conducted a study to investigate money demand, interest rate, and investment using ARDL Model. The study reached to the conclusion that demand for money and the investment found to be a statistically significant and positive.Nchor and Adamec (2016) analyzed the variables that affected Ghana's real money between 1990 and 2014.The outcomes reveled that interest rate has a short-term impact on money demand whereas GDP has a long-term impact. Adil et al., (2022) evaluated the stability of India's money demand function using ARDL and impulse response function from the period of 1996:Q2 to 2016:Q3. They reached to the conclusion that both M1 and M3 found to be stable.Barnett et al., (2022) examined the stability of demand for money in the European Union, India, the United Kingdom, the United States, Poland, and Israel. They found that broad money (M3) is more stable than narrow money (M1).

Several study endeavors have aimed to investigate the objective of attaining financial stability. Nevertheless, there is a noticeable absence of current research that focuses on this specific aspect, particularly in relation to the money demand function in India within the framework of an open economy. In light of this

research gap, the current study seeks to examine the dynamics of the money demand function after the liberalization of the Indian economy.

3. Data and Methodology

The purpose of this study is to examine the stability of money demand function in India after the implementation of the New Economic Reforms from 1990 to 2020 using broad money, income, interest rate, price, foreign reserve, and exchange rate. The information regarding broad money, income, interest rate, and foreign reserves is taken from the Handbook of Statistics on the Indian Economy for the years 2021–22, published by the Reserve Bank of India. Similarly, data on price level and exchange rate are extracted from the World Development Indicator, provided by the World Bank. The hypothesized long-term relationships among the selected variables are as follows:

$$\boldsymbol{LN(M3) = \beta_o + \beta_1(Y) - \beta_2(R) + \beta_3(P) + \beta_4(FR) + \beta_5(ER) + \varepsilon_t}1$$

Where M3 = broad money measured as M3 in case of India, Y = income measured by real GNP, R = Government Securities, P = general price level measured by whole sale price index, FR = stock of foreign reserves and ER = Exchange Rate, measured as domestic currency units (Rupees)per unit of foreign currency (US dollar).

3.1*Model Specification*

Once the data has been identified and gathered, a crucial step involves establishing the stationarity order of the chosen variables. To accomplish this, the study utilized the Augmented Dickey-Fuller test, as proposed by Dickey and Fuller (1979). Based on the mixed order of stationarity obtained from the ADF test, the study attempts to use the ARDL model (Pesaran and Shin,1995); Pesaran (1997); and Pesaran et al.(2001) for further econometric analysis using the following long-run equation:

$$\begin{aligned}\Delta \boldsymbol{LN(M3)_t} = \boldsymbol{\beta_0} + \sum_{i=1}^{p} \boldsymbol{\beta_{1i}}\, \Delta \boldsymbol{LN(M3)_{t-1}} + \sum_{i=0}^{p} \boldsymbol{\beta_{2i}}\, \Delta \boldsymbol{LN(Y)_{t-1}} + \sum_{i=0}^{p} \boldsymbol{\beta_{3i}}\, \Delta \boldsymbol{(R)_{t-1}} + \sum_{i=0}^{p} \boldsymbol{\beta_{4i}}\, \Delta \boldsymbol{LN(P)_{t-1}} \\ + \sum_{i=0}^{p} \boldsymbol{\beta_{5i}}\, \Delta \boldsymbol{(FR)_{t-1}} + \sum_{i=0}^{p} \boldsymbol{\beta_{6i}}\, \Delta \boldsymbol{(ER)_{t-1}} + \boldsymbol{\theta_1 LN(M3)_{t-1}} + \boldsymbol{\theta_2 LN(Y)_{t-1}} \\ + \boldsymbol{\theta_3 (R)_{t-1}} + \boldsymbol{\theta_4 LN(P)_{t-1}} + \boldsymbol{\theta_5 LN(FR)_{t-1}} + \boldsymbol{\theta_6 LN(ER)_{t-1}} + \boldsymbol{\epsilon_t}2\end{aligned}$$

To examine the presence of co-integration or a long-run relationship among the variables, we conducted a bound test. In the bound test, we set up a null hypothesis where the long-run coefficients are all equal to zero, suggesting no co-integration. If the null hypothesis is rejected, it implies the existence of a long-run relationship among the variables. This analysis provides insights into the interdependencies and dynamics among the variables over an extended period.

Null hypothesis: $\boldsymbol{H_0: \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = 0}$

Alternative hypothesis: $\boldsymbol{H_i: \delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq \delta_5 \neq \delta_6 \neq 0}$

The existence of cointegration is determined by the joint significance of F statistics, which are evaluated against two sets of critical values corresponding to different significance levels. If the computed value of the F statistics exceeds the upper bound critical value, it suggests the presence of cointegration among the variables. On the other hand, if the F statistics value falls below the lower bound critical value, it indicates no cointegration among the variables. In cases where the F statistics value lies between the upper and lower bounds of the critical values, the result regarding cointegration is inconclusive. To select the lag length in our analysis we followed Akaike Information Criterion (AIC). Once we establish the presence of cointegration, we formulate the Error Correction Model (ECM), which captures the short-run dynamics with long-run adjustment in the following manner.

$$\Delta LN(M3)_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i}\, \Delta LN(M3)_{t-1} + \sum_{i=0}^{p} \beta_{2i}\, \Delta LN(Y)_{t-1} + \sum_{i=0}^{p} \beta_{3i}\, \Delta LN(R)_{t-1} + \sum_{i=0}^{p} \beta_{4i}\, \Delta LN(P)_{t-1} + \sum_{i=0}^{p} \beta_{5i}\, \Delta(FR)_{t-1} + \sum_{i=0}^{p} \beta_{5i}\, \Delta(ER)_{t-1} + \lambda ECT_{t-1} + e_t \quad (3)$$

(Where Δ represents the first operator of differentiation, β_0 is intercept, ϵ_t is Error of Chance, the variables namely; M3, Y, R, P, FR and ER are already defined, the expression with summation signs (β_{i1} -β_{i6}) indicates the model's short-run coefficients, whereas ($\theta_1 - \theta_6$) represent the long-run coefficients).

3.2 *Diagnostic and Stability Test*

In order to assess the validity of our model, we conducted some diagnostic tests. The Jarque-Bera test was employed to examine the normality of residuals. To investigate serial correlation, we used the Breusch-Godfrey LM test. In order to test for Heteroskedasticity, a Breusch Pagan test is performed; to assess the presence of specification errors, we employed the Ramsey RESET test. For testing towards model stability CUSUM and CUSUMSQ were used (Brown et al., 1975).

4. Result and Discussion

Table: 1 Unit Root Test

Variables	t-statistics	Prob. Values	Order of Integration
LN(M3)	-4.078415	0.0036	**I(0)**
LN(Y)	-3.798067	0.0307	**I(1)**
R	-5.656132	0.0001	**I(1)**
LN(P)	-4.313970	0.0020	**I(0)**
LN(FR)	-2.442970	0.0166	**I(1)**
LN(ER)	-3.628717	0.0111	**I(0)**

Source: Author Calculations

The statistical information of equation 1 is represented in Table 1, which clearly indicates that money demand (M3), price level(P), and exchange rate (ER) are stationary at level whereas income (Y), interest rate (R), and foreign reserve (FR) are stationary at their first differences. Thus, they are integrated in the mixed order of integration at a 5 percent (0.05) level of significance.

Table: 2
Lag Selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	75.73179	NA	3.29e-10	-4.809089	-4.526200	-4.720492
1	300.7753	341.4453	7.58e-16	-17.84657	**-15.86635***	-17.22639
2	353.0051	**57.63283***	**3.52e-16***	**-18.96587***	-15.28831	**-17.81410***

Source: Author Calculations

The VAR lag order selection criterion in table 2 determined the selection of the lag length. At the 5% significance level, four lag selection criteria out of five suggest that the optimal lag length is 2. Therefore, further econometric analysis was done with the help of lag 2.

Table: 3
ARDL Bounds Test

Level of Significance	Lower Bound I(0)	Upper Bound I(1)	F-statistic	Conclusion
10 %	2.26	3.35	**15.32**	Cointegration Exists
5 %	2.62	3.79		
2.5 %	2.96	4.18		
1 %	3.41	4.68		

Source: Author Calculations

The ARDL bound test is used to find long-run relationships among variables. The estimated F-statistic value is 15.32, which is more than the upper and lower bounds at the 1%, 5%, and 10% significance levels. This means that money demand (M3) is cointegrated with income (Y),interest rate (R), and Price level (P), foreign reserve (FR), and exchange rate (ER).

Table: 4
Summary Statistics for Equation 2

Variable	Coefficient	Std. Error	t-Statistics	Prob.
LN(Y)	0.557699	0.041297	13.50457	**0.0000**
R	-0.093318	0.035116	-2.657398	**0.0209**
LN(P)	0.508581	0.253552	2.005825	**0.0680**
LN(FR)	0.382814	0.054664	7.003041	**0.0000**
LN(ER)	0.421784	0.178967	2.356769	**0.0363**

Source: Author Calculations

Table 4 displays the empirical findings of equation 3. The outcomes suggest that income, interest rate, price level, foreign reserve, and exchange rate exhibit statistically significant with correct sign. Moreover, the income coefficient indicates that a 1% rise in income results in a 56% increase in money demand. The positive association between income and money demand shows that, money serves as a store of value, and its demand may exhibit a greater than proportional increase in income level (Hossain, 2012). The negative and statistically significant impacts of interest rate on money demand provided empirical support of Keynes' theory of speculative demand for money (Liliana et al., 2019). Keynes argued that if bond prices (or interest rate) were predicted to decline in the future, individuals would sell bonds to prevent capital losses. In this circumstance, cash is preferable to bonds. As a result, when interest rates are low, liquidity is preferred; when interest rates are high, bonds are preferred. The speculative demand for money changes inversely with the interest rate (Appelt, 2016; Sanyal, 2019).Moreover, the notable and statistically significant (at a 10% significance level) correlation between the price level and money demand demonstrates that a rise in the price level leads to a raised demand for money within the economy. This outcome aligns with established economic theory.The outcome of the favorable effect foreign reserve may protect an economy against the negative consequences of a fluctuating exchange rate it may reduce swings in the domestic currency's value (Fukuda and Kon, 2012). Hence, an increase in FR may contribute to a rise in the credibility of the domestic currency, which may result in a rise in money demand (Jindal, 2016). Lastly, the outcome of the positive effect of exchange rate might lead to currency growth of foreign financial assets; hence increasing the need for cash reserves (Serena and Sousa, 2017).

Table: 5
Summary Statistics for Equation 3

Variable	Coefficient	Std. Error	t-Statistics	Prob.
D(LNY)	-0.125894	0.053708	-2.344060	0.0371
D(R)	-0.018498	0.007937	-2.330715	**0.0380**
D(LNP)	0.525096	0.132120	3.974393	**0.0018**
D(LNFR)	0.056327	0.014364	3.921251	**0.0020**
D(LNER)	0.224166	0.064645	3.467663	**0.0047**
CointEq (-1)	**-0.636557**	0.055778	-11.41239	**0.0000**
R-Squared				**0.95**
Adjusted R -Squared				**0.91**

Source: Author Calculations

After determining the long-term coefficient, the details of the short-term ARDL model, including the ECT, are shown in Table 5. All variables are statistically significant with correct sign except income (Y). The negative impact of income (Y) on broad money (M3) in the short run might be the cause of the exogenous shocks in the economy during the study period such as global financial crisis (2008–2009) demonetization of Indian rupees (2016), and COVID-19 pandemic. However, the negative value of the error correction term (ECT) determines the rate at which the variables readjust and revert to the original equilibrium level. Thus, the value of ECT is -0.64. This demonstrates that short-term disturbances are quickly rectified within a year.

Table: 6
Diagnostic Test

Test Name	P-Value	Result
Breusch-Godfrey LM	0.40	No serial correlation
Breusch-Pagan-Godfrey	0.34	No heteroscedasticity
Ramsey RESET	0.18	No specification error
Jarque- Bera	0.15	Normally distributed residuals

Source: Author Calculations

The findings of the diagnostic test are represented in Table 6. The Breusch-Godfrey Lagrange Multiplier (LM) test demonstrated that the model is free from serial correlation. The Breusch-Pagan test results suggested that the model is homoscedastic rather than heteroscedastic. Further the Ramsey RESET probability value demonstrated that the model is free from the specification error. The residuals from the model were found to follow a normal distribution, as confirmed by the Jarque-Bera test.

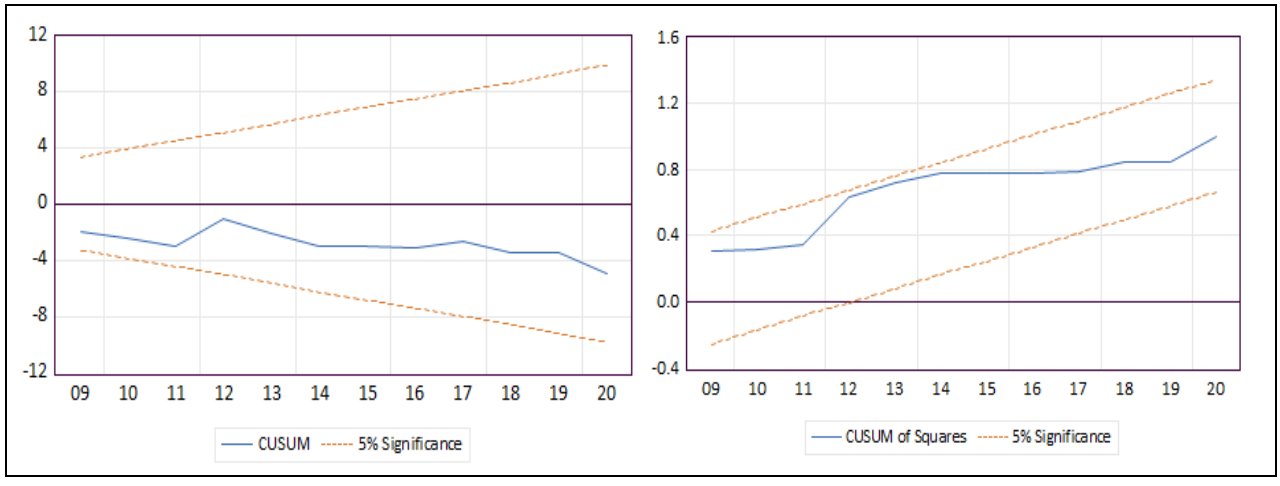

Figure: 1 Stability Test

In terms of stability, the graph of the cumulative sum (CUSUM) and cumulative sum of square (CUSUMSQ) lies within the 5% critical boundaries, indicating the stability of the model.

5. Conclusion

Using annual time series data from 1990 to 2020, the aim of this study is to examine the stability of India's money demand (M3). Dickey-Fuller test has been computed for order of stationarity. Moreover, the empirical analysis of ADF test indicates that the variables, namely broad money (M3), income(Y), interest rate (R), price level (P), foreign reserve(FR), and exchange rate (ER) have stationarity in the mixed order of integration, i.e., I (0) and I (1). The outcome of ARDL bound observed that variables are cointegrated, implying that they have a long-run relationship. The empirical results of the long-run ARDL model showed that income, price level, foreign reserve, and exchange ratehave positive as well as significant impact on money demand whereas interest rate has a negative and significant impact. Further, the short run ARDL results showed that all variables are statistically significant with correct sign except income. However, the error correction term (ECT) is -0.64. The negative value of ECT demonstrates that the short-term disturbances are quickly rectified within a year. The diagnostic tests confirmed the assumption of classical linear regression.Finally, CUSUM and CUSUMSQ confirm the overall stability of the model. In conclusion, the empirical analysis of the money demand (M3) in India holds significant relevance for policymakers, economists, and researchers. By unraveling the intricate relationship between economic variables and money demand, it contributes to a deeper understanding of the Indian monetary dynamics and offers valuable insights for designing effective monetary policy frameworks.

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