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Asymmetric exchange rate effect on money demand under open economy in case of India

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Abstract

The study tries to explore the asymmetric relationship between money demand and exchange rate in case of India. The period of study is April 2004 to November 2015. For money demand both narrow (M1) as well as broad (M3) monetary aggregates have been used. In this paper, it is shown that failure to find a significant relationship between the exchange rate and the demand for money could stem from the assumption of linear dynamic adjustment process among the variables. With the help of non-linear ARDL it is found that rupee appreciation and rupee depreciation have an asymmetric effect on the demand for money in India both in the short run and the long run. The results showed that the coefficient of positive partial sum (Ln EX+) which represents rupee appreciation is significant and negative, while for negative partial sum (LnEX-) the coefficient is positive and significant The combined implication of the results is that exchange rate movement effects demand for money through the wealth effect not through the mechanism of change in expectations.

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1. Introduction

After the liberalisation of 1991, Indian economy integrated with rest of the world not only through free trade and foreign competition but also through capital movement and market-determined exchange rate. The door was opened for the foreign investor, easing the norms for international capital flows. Further due to the development of information technology and propagation of institutional investors, Indian economy experienced a surge in international capital flows. In such an integrated economy the determinants of money demand are expected to have changed. Specifically due to shifting to market-determined exchange rate system. On the recommendation of Rangarajan Committee, the liberalized exchange rate management system (LERMS) was introduced in India, directing the economy towards the market-determined system.

Money demand function is fetching considerable attention of researchers in economics. The main focus has been given to identifying the appropriate definition of money supply for policy purpose and testing the stability of money demand function. This study tries to estimate the effect of exchange rate on money demand for the period India adopted mostly market-determined exchange rate system. Some studies have ignored changes in market expectations and institutional factors taking place under fixed and floating exchange rate system.

Identifying the relevant variable is the first issue in explaining money demand. Nobel laureate Mundell (1963) advocated that along with income and interest rates, the exchange rate could certainly be a factor to influence the demand for money. The depreciation of domestic currency increases the domestic currency value of foreign assets held by domestic residents. If this is conceived as an increase in wealth, the demand for money should increase (Arango and Nadiri, 1981). However if depreciation of the domestic currency is followed by the expectation of further depreciation, they will hold more foreign currencies, and accordingly, demand for domestic currencies will decrease, i.e. what we called currency substitution effect. Therefore, depending upon the dominance of the wealth effect versus the currency substitution effect, the demand for money could move in either direction. Changes in exchange rates will change the mix of an investor's portfolio between domestic and foreign assets. Particularity for an international investor depreciation of domestic currency implies an increase in his wealth measured in terms of domestic currency. According to portfolio balance approach, to retain a fixed portion of his wealth invested domestically, the investor will sell his foreign assets and buy domestic assets (capital inflow). So domestic monetary base will increase which leads to a decrease in domestic interest rates and an increase in demand for money Logue and Willet

(1974). Expansionary monetary policy generally leads to depreciation of domestic currency with lower interest rate; the international investor requires expecting an appreciation of domestic currency to compensate for lower interest rate. An expected appreciation happen only when short-run depreciation overshoot its long-run required depreciation (Dornbusch (1976a). An expected appreciation will increase domestic money demand and put upward pressure on the interest rate.

Earlier studies fail to provide the significant impact of the exchange rate changes in the determination of demand for money due to the presumption of the symmetric adjustment process. There is little to believe that appreciation and depreciation have a symmetric effect on money demand. So in this study, we have used the nonlinear model developed by Shin et al. (2014) to check the asymmetric effect of exchange rate through the partial sum decompositions.

The rest of the paper is organized as: Section 2 contains the insights from the previous studies. Section 3 describes the data and methodological strategy followed for the study. Section 4 carries a detailed analysis of empirical results. Section 5 concludes.

2. Literature Review

Bahmani-Oskooee and Pourheydarian (1990) investigate money demand and exchange rate nexus, found a positive and significant relationship between real M1 balances and the exchange rate for Canada and the U.S. but not for Japan. Bahmani-Oskooee and Malixi (1991) found that short run effect of exchange rate depreciation could be in either direction but in the long run, it leads to a significant reduction in the demand for money in nine out of eleven developing countries. Mohammad, Baharumshah & Habibullah (2001) empirically investigated the long-run relationship between exchange rate and money demand in Malaysia. In their analysis, the exchange rate showed a positive sign when money stock is defined as M2 instead of M1.

Bahmani-Oskooee, M. and A. Gelan (2009) studied money demand for twenty African countries found that M2 demand for money is stable for almost all countries, and nominal effective exchange rate was a significant determinant of the demand for money. Sharifi Renani and Hosein (2008) showed that income and exchange rate are positively associated with M1 while inflation negatively, thus supporting the wealth effect argument. Bahmani-Oskooee and Rehman (2005) examined the money demand function for seven Asian countries including India. They found cointegration relationship when money stock is taken as M1 but not M2, hence concluded that M1 is the proper definition of money stock for monetary policy purpose. Das and Mandal (2000) has taken only the M3 aggregate of money supply and used monthly data for the period of April 1981 to March 1998 to perform cointegration analysis among money balance, industrial production, short-term interest rates, wholesale prices, share prices, and real effective exchange rates. They showed that price and short-term interest rate are super exogenous, and money demand is stable despite a change in the financial structure of the economy after the 1990s.

Studies related to India are controversial about which definition of money is more suitable, M1or M3. Some studies found cointegration and money demand stability when the money supply is narrowly defined while others found same for broadly defined money supply. Ramachandran (2004) suggested that, for the long-term, it is better to use M3 for future price indicator. Padhan, P. C. (2011) investigated the stability and long-run nature of money demand function including exchange rate and stock price for various monetary aggregates, support the existence of stable money demand function, but the exchange rate is found to be insignificant. Bahmani-Oskooee and Sahar Bahmani, (2015) found that exchange rate has an asymmetric effect on the demand for money using Nonlinear ARDL model.

3. The Model and Methodology

The standard money demand function includes a scale variable that is national output, and the interest rate is taken as opportunity cost for holding money in a well-developed financial market economy. We have taken exchange rate along with output and interest rate.

$$lnMt \ = a + bln\,Yt + clnrt + dlnEXt \ + \varepsilon t \tag{1}$$

Where M is real monetary aggregate, Y is a measure of scale variable, r is the nominal interest rate, EX is real effective exchange rate, and ε is an error term. Money demand (Mt) is identified by assuming financial market is in equilibrium. As there is no obvious way to observe money demand data so by assuming money demand is equal to money supply as common in literature, we identified money demand. We have taken exchange rate along with output and interest rate.

All variable are expressed in log form. Expected sign for income coefficient is positive and for interest rate negative. As for the sign of the coefficient of the exchange rate is concerned, it may be positive or negative depending on wealth effect or currency substitution effect. The model given above is a long run model and can be estimated by any method. Ignoring short-run dynamics from long-run model could create instability problem (Laidler, 1993, p. 175). To avoid such problem we specify equation by incorporating short-run dynamics as an error-correction model.

$$\Delta\, lnM_t = \alpha + \sum_{i=1}^{n1} \beta i \Delta lnM_{t-1} + \sum_{i=0}^{n2} \delta_i \Delta lnY_{t-i} + \sum_{i=0}^{n3} \lambda_i\, \Delta lnr_{t-1} + \sum_{i=0}^{n4} \gamma_i\, \Delta lnEX_{t-i}$$

$$+ \sigma_0\, lnM_{t-1} + \sigma_1\, lnY_{t-1} + \sigma_2\, lnr_{t-1} + \sigma_3\, lnEX_{t-1} + v_t \qquad (2)$$

Equation (2) is unrestricted error correction specification follows Pesaran *et al.*'s (2001) bounds testing approach to estimate short-run as well as long-run coefficients. It also tests for cointegration by applying an F test on the joint significance of lagged level variables in (2). The asymptotic distribution is non-standard so Pesaran *et al.*'s (2001) provide two sets of critical values one assumed all variables are to be I(0), other assumed all variables to be I(1). Since most of the macroeconomic time-series variables are either I(1) or I(0), there is no need for pre unit root testing in this method, but for preliminary examination, it has been done.

Earlier studies estimated above models by using any method, assuming that exchange rate changes have symmetric effects on the demand for money. However, upswing and downswing are not adjusted at the same pace. This paper taking this into account decompose the movement of the Ln EX into its negative (the depreciation of the rupee) and positive (the appreciation of the rupee) partial sum.

Exchange rate is decomposed as $lnEX = lnEX_0 + lnEX_t^+ + lnEX_t^-$ where $lnEX_t^+$ and $lnEX_t^-$ are the partial sum process of $lnEX$ obtained from following formulae.

$$lnEX_t^+ = \sum_{j=1}^{t} \Delta lnEX_j^+ = \sum_{j=1}^{t} \max(\Delta lnEX_j \ ,0\,) \qquad (3a)$$

$$lnEX_t^- = \sum_{j=1}^{t} \Delta lnEX_j^- = \sum_{j=1}^{t} \max(\Delta lnEX_j \ ,0\,) \qquad (3b)$$

The asymmetric cointegration is based on partial sum decompositions by equation (3a & 3b) introduce non-linearity into the model. Following Shin *et al.* (2014), $lnEX$ is replaced by $lnEX_t^+$ and $lnEX_t^-$ given in (4):

$$\Delta\, lnM_t = a + \sum_{i=1}^{n1} bi\, \Delta lnM_{t-1} + \sum_{i=0}^{n2} c_i\, \Delta lnY_{t-i} + \sum_{i=0}^{n3} d_i\, \Delta lnr_{t-1} + \sum_{i=0}^{n4} e_i\, \Delta lnEX_{t-i}^+ + \sum_{i=0}^{n5} f_i\, \Delta lnEX_{t-i}^- + \theta_0\, lnM_{t-1} + \theta_1\, lnY_{t-1} + \theta_2\, lnr_{t-1} + \theta_3\, lnEX_{t-1}^+ + \theta_4\, lnEX_{t-1}^- + \zeta_t \qquad (4)$$

From Equation (4) it can be tested whether exchange rate changes have asymmetric effects on the demand for money in the short run as well as in the long run. For testing cointegration, F-test of the joint null, H_0: $\theta_0 = \theta_1 = \theta_2 = \theta_3 = \theta_4$ is applied following 'bounds-testing' approach advanced by Pesaran *et al*. (2001).

4. Data and the Results

Money stock variables include Narrow money (M1), and Broad money (M3). For scale variable we have used the index of industrial production (Seasonally adjusted X11), the implicit yield on 91-days T-bills is taken as opportunity cost variable which is competitively determined in the auction by the RBI, and Real effective exchange rate trade based (36- country weights) is used for the exchange rate. Real money stock is calculated through deflating money supply by WPI. Monthly data is drawn from RBI "Data Bank on Indian Economy" (DBIE) and data for yield on 91-days T-bills is taken from EPW Database. The period of the study is April 2004 to November 2015, considering changing composition of the economy and mainly external sector upswing, large capital inflows and appreciation of real effective exchange rate. To get a clear picture of the data, the descriptive statistics (Table 1) and figures (1, 2, 3) showing the movement of the variables over the period are provided below.

Table 1: Descriptive Statistics

Sample: 2004M04 2015M11

	LnM1	LnM3	LnY	Lnr	LnEX+	LnEX-
Mean	4.539823	5.920202	4.990914	1.902001	1.133024	-1.135678
Median	4.622425	5.992368	5.062026	1.973250	1.152533	-1.118774
Maximum	4.928589	6.452102	5.219356	2.327209	1.629971	-0.729312
Minimum	4.041774	5.327031	4.548654	1.249644	0.692152	-1.561375
Std. Dev.	0.224934	0.326344	0.195237	0.251895	0.293481	0.269762
Skewness	-0.599533	-0.325342	-0.852140	-0.905574	0.071910	-0.142209
Kurtosis	2.440604	1.932604	2.412636	2.935330	1.687073	1.649514
Jarque-Bera	10.21233	9.115897	18.95579	19.15923	10.17603	11.11078
Probability	0.006059	0.010484	0.000077	0.000069	0.006170	0.003867
Sum	635.5752	828.8283	698.7280	266.2801	158.6234	-158.9949
Sum Sq. Dev.	7.032734	14.80357	5.298318	8.819683	11.97226	10.11522
Observations	140	140	140	140	140	140

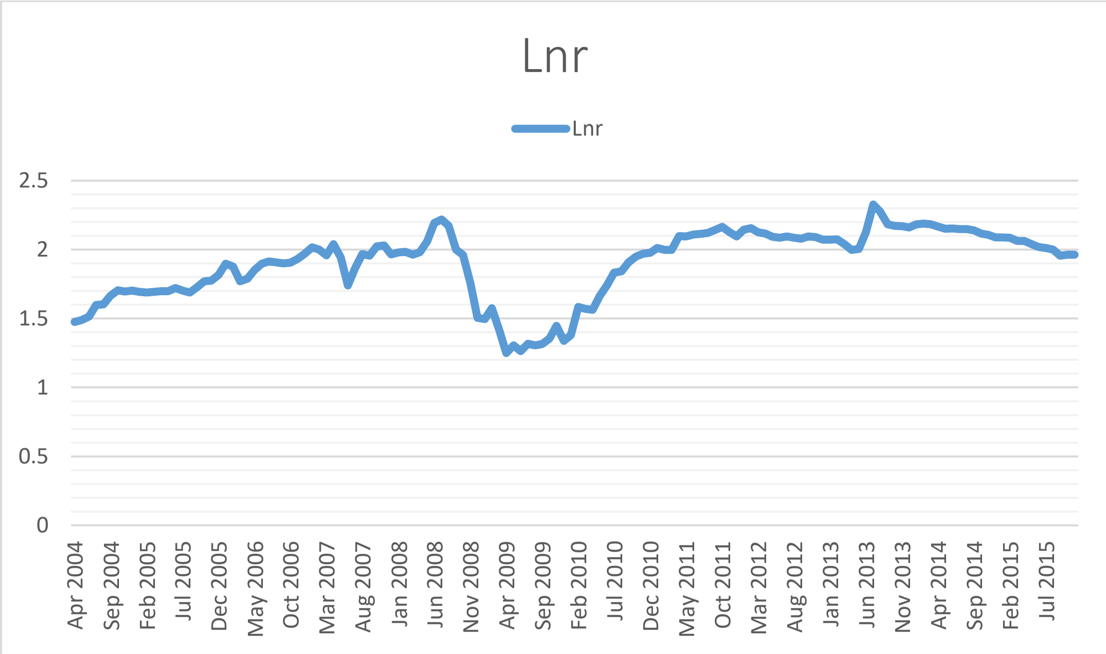

Figure 1: Interest Rate in case of India (2004M04 to 2015M11)

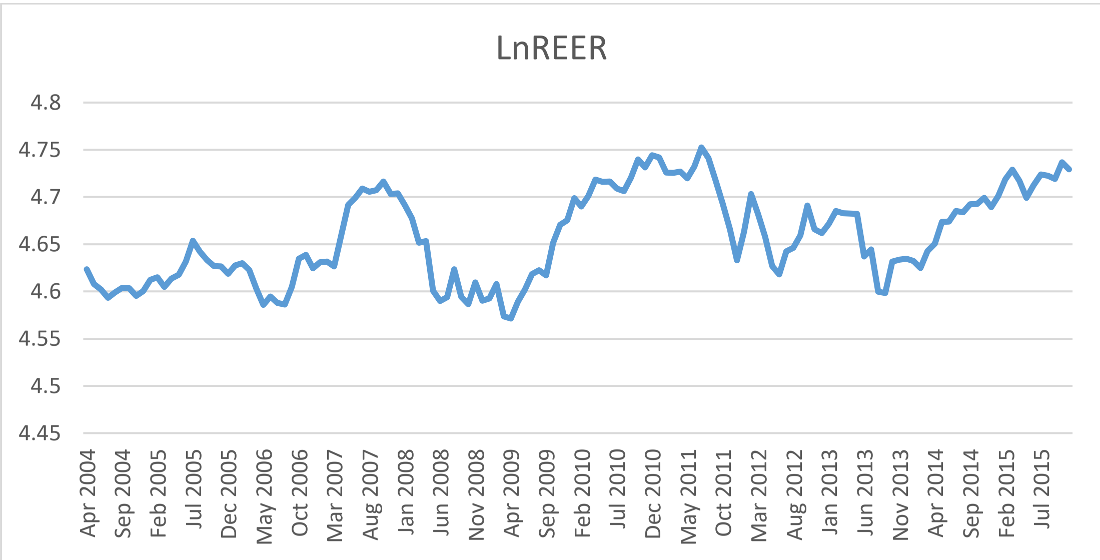

Figure 2: Real Effective Exchange Rate (2004M04 to 2011M11)

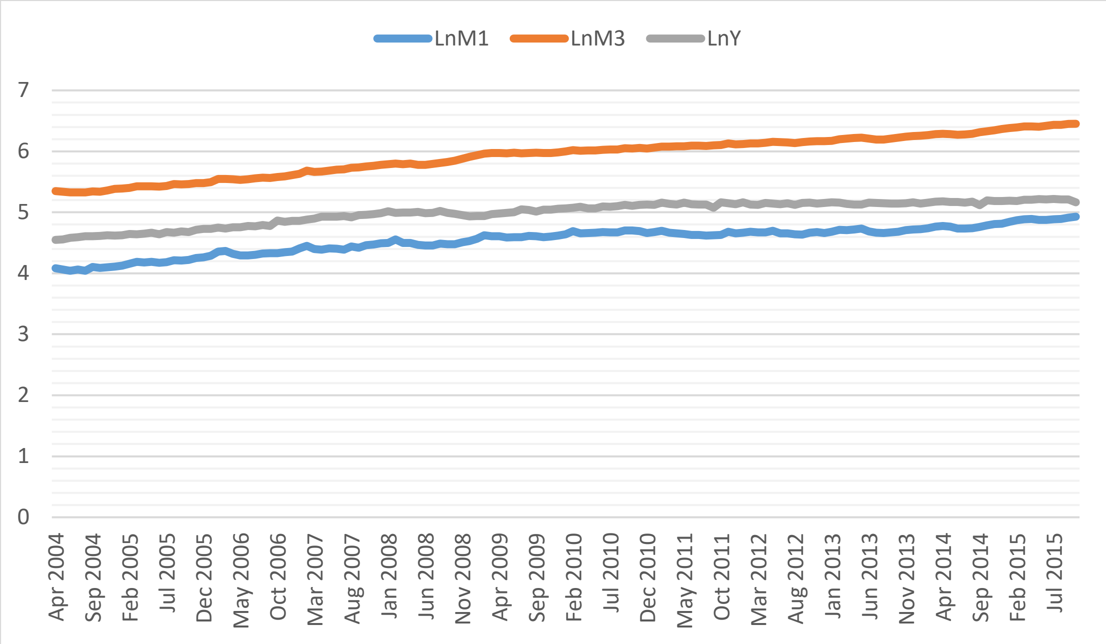

Figure 3: Output (LnY), Money Supply (M1 and M3) in case of India (2004M04 to 2015M11)

We first estimated the linear ARDL model outlined in equation (2). Optimal lag-length is selected by imposing a maximum of four lags on each first-differenced variable using Akaike's Information Criterion (AIC). The results are reported in Table 2 in three panels. Panel A reports the short-run coefficient of the model, the long-run estimates are given in Panel B and Panel C reports diagnostic tests.

Table 2: Estimates of Linear ARDL

Panel A: Short-Run Coefficients

	Lag Order						
For M1	0	1	2	**For M3**	0	1	2
ΔLnM1	-	-	-	ΔLnM3	-	0.220(0.00)	0.162(0.05)
ΔLnY	0.085(0.34)	0.2041(0.02)	-	ΔLnY	0.053(0.30)	0.025(0.66)	-0.114(0.02)
ΔLnr	-0.125(0.00)	-	-	ΔLnr	-0.075(0.00)	-	-
ΔLnEX	-0.162(0.10)	-	-	ΔLnEX	-0.012(0.61)	-	-
ECM_{t-1}	-0.147(0.00)	-	-	ECM_{t-1}	-0.29(0.00)		

Panel B: Long Run Coefficients

	LnY		Lnr		LnEX		C		Trend	
M1	0.372	(0.13)	-0.197	(0.00)	0.517	(0.11)	0.416	(0.74)	0.003	(0.00)
M3	0.577	(0.00)	-0.133	(0.00)	0.039	(0.61)	2.732	(0.00)	0.006	(0.00)

Panel C: Diagnostic Test

	F	LM-Test	BGP Test	RESET	Normal	CUSUM
M1	2.693	1.400(0.25)	1.38(0.20)	2.97(0.08)	1.20(0.54)	Stable

M3	6.082	2.018(0.12)	0.925(0.51)	2.43(0.10)	10.37(0.00)	Stable

Note: a. *p*-value is in parenthesis. "Ln" means natural log.

b. F is bounds test, The upper bound critical value of the F statistic at the usual 5% level of significance is 4.23, for k=3, from Pesaran *et al.* (2001, Table CI(iv) Case IV p.301).

c. LM is the Lagrange multiplier test for serial correlation.

d. BGP is the Breusch–Godfrey test for heteroscedasticity.

e. RESET is Ramsey's specification test. It has a $\chi 2$ distribution with only one degree of freedom.

f. The normality test is based on a test of skewness and kurtosis of residuals with $\chi 2$distribution.

Except for scale variable and exchange rate, most of the coefficients are significant. Error correction term is significant and negative, but its magnitude is small which shows that convergence is very slow. So far long-run estimates are concerned, sign expectation is satisfied for income and interest rate. However, the coefficient for income and exchange rate is insignificant which may be due to misspecification of the model. The long-run coefficients are meaningful only if cointegration is established. From Panel C, it can be seen that the F test for joint significance of lagged level variables (Bounds test) is much less than its critical value of 4.23 when M1 is taken as money demand, showing the absence of cointegration. However, there exists a limited support as ECM_{t-1} coefficient though significant has a small magnitude. Taking M3 as money demand measure shows the existence of cointegration relationship at 1% level of significance. However, once again coefficient for the exchange rate is insignificant.

Focusing on the effects of exchange rate on demand for money, based on the results so far, it may conclude that there is no significant effect for the concerned period. As mentioned before, this conclusion is based on the assumption that the adjustment happens in the linear fashion. The result might get changed if the adjustment of variables happens in asymmetric fashion. To verify that, nonlinear ARDL approach is adopted and equation (3) is estimated by imposing a maximum of four lags on each first differenced variable using AIC criterion to arrive at optimal lags. The results are reported in Table 3. The short-run results, reported in Panel A, show that the coefficient of the positive partial sum (ΔLn EX+) which represents rupee appreciation is significant and negative, while for negative partial sum ($\Delta LnEX-$) the coefficient is positive and significant at lag 1 when money demand is defined in terms of M1. And results remain same for M3, which confirms the asymmetry effects of exchange rate on the demand for money in the short run.

Considering[1] the value of error correction mechanism which gives the speed of adjustment of the variable when there is any deviation from the long run equilibrium path, the results showed

[1] The question was raised by the referee to gives some explanation about the ECM term.

that in both models it was significant and negative. It means that there is a strong long run relationship between the money demand and its determinants. In the case of Non-linear ARDL, taking M1 as the dependent variable the value of ECM_{t-1} is -0.338 and is significant at 1% level of significance. That means there is almost 34% correction to the long run equilibrium path in every period following any deviation from it in the short run. As for as M3 is concerned the value is -0.40 with 1% level of significance, that means 40% correction in each period once there is any disturbance from the equilibrium path.

Though in the Linear ARDL case ECM_{t-1} is negative and significant for both M1 and M3, the only difference is that its value is small when compared to Non-linear ARDL. That means the process of adjustment to long run equilibrium is slow in the Linear ARDL model. The main reason for the slow adjustment is that the coefficient of the exchange rate is insignificant. The intuition follows that failing to take account of the non-linearity of a variable (as exchange rate in this case) may hide the true information about the equilibrium relationship that exists between the variables.

Table 3: Non-Linear ARDL Estimates

Panel A: Short-Run Coefficients

			Lag Order				
For M1	0	1	2	**For M3**	0	1	2
ΔLnM1	-	0.158(0.05)	0.12(0.12)	ΔLnM3	-	0.182(0.01)	0.141(0.06)
ΔLnY	0.095(0.28)	0.180(0.04)	-	ΔLnY	0.057(0.23)	0.024(0.64)	-0.12(0.00)
ΔLnr	0.123(0.00)	0.041(0.17)	-	ΔLnr	-0.06(0.00)	-	-
ΔLnEX+	-0.291(0.00)	-	-	ΔLnEX+	-0.17(0.00)	-	-
ΔLnEX-	-0.019(0.91)	0.378(0.03)	-	ΔLnEX-	0.128(0.00)	-	-
ECM_{t-1}	-0.338(0.00)	-	-	ECM	-0.40(0.00)	-	-

Panel B: Long Run Coefficients

	LnY	Lnr	LnEX+	LnEX-	Constant	Trend
For M1	0.279(0.02)	-0.189(0.00)	-0.861(0.00)	0.947(0.00)	3.08(0.00)	0.02(0.00)
For M3	0.449(0.00)	-0.189(0.00)	-0.416(0.00)	0.320(0.00)	3.49(0.00)	0.01(0.00)

Panel C: Diagnostic Test

	F-stat	LM-Test	BGP Test	RESET	Normal	CUSUM
For M1	4.86	0.54(0.65)	1.11(0.35)	0.436(0.64)	1.17(0.55)	Stable
For M3	5.49	0.28(0.84)	1.18(0.30)	0.444(0.64)	5.55(0.06)	Stable

Note: a. *p*-value is in parenthesis. "Ln" means natural log.
b. F is bounds test The upper bound critical value of the F statistic at the usual 5% level of significance is, 4.23 for k=3, from Pesaran *et al.* (2001, Table CI(iv) Case IV p.301)
c. LM is the Lagrange multiplier test for serial correlation
d. BGP is the Breusch–Godfrey test for heteroscedasticity
e. RESET is Ramsey's specification test. It has a $\chi 2$ distribution with only one degree of freedom.
f. The normality test is based on a test of skewness and kurtosis of residuals with $\chi 2$distribution.

Long-run estimates are given in Panel B. The F statistic of bounds test as reported in Panel C is greater than the critical value of upper bound at 5% level of significance, indicating the presence of cointegration. It is clear that both positive partial sum $(LnEX+)$ and negative partial sum $(LnEX-)$ carries a highly significant coefficient and different sign, same as found in the short-run. It implies that when Rupee depreciates, Indian residents hold more of their domestic currency and in case of the appreciation they hold less of their domestic currency. Both coefficients are significant with opposite signs, providing supporting for the asymmetric effect in the long run. The combined implication of the results is that exchange rate movement effects demand for money through the wealth effect not through the mechanism of change in expectations. Real effective exchange rate of rupee largely appreciated due to huge capital inflows before financial crisis and that make foreign currency denominated assets less worthy, so demand for domestic money decreases. During the crisis period real effective exchange rate of rupee depreciated due to capital outflows and after that it fluctuated. The depreciation of real effective exchange rate makes foreign currency denominated assets more worthy and through wealth effect the demand for domestic money increases.

Turning to other variables, income elasticity is significant and positive bearing a coefficient less than 0.5. It may be due to decrease in demand for money for transaction purpose. The interest rate has a negative and significant coefficient as expected. Further diagnostic test shows that autocorrelation free residuals, a correctly specified nonlinear ARDL model, normally distributed errors, and stable coefficients. While the results for the CUSUM (Figure 4) shows that parameters are stable throughout the period. The CUSUMSQ (Figure 5) shows that parameters are instable for a very short period as they fall outside the critical band 0f 5%.

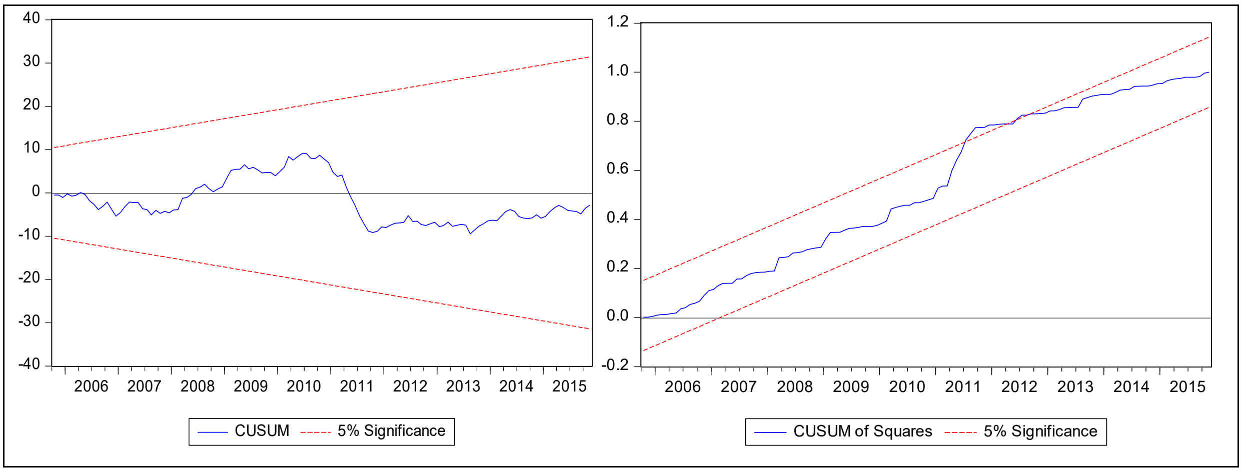

Figure 4: CUSUM and CUSUMSQ for LM1

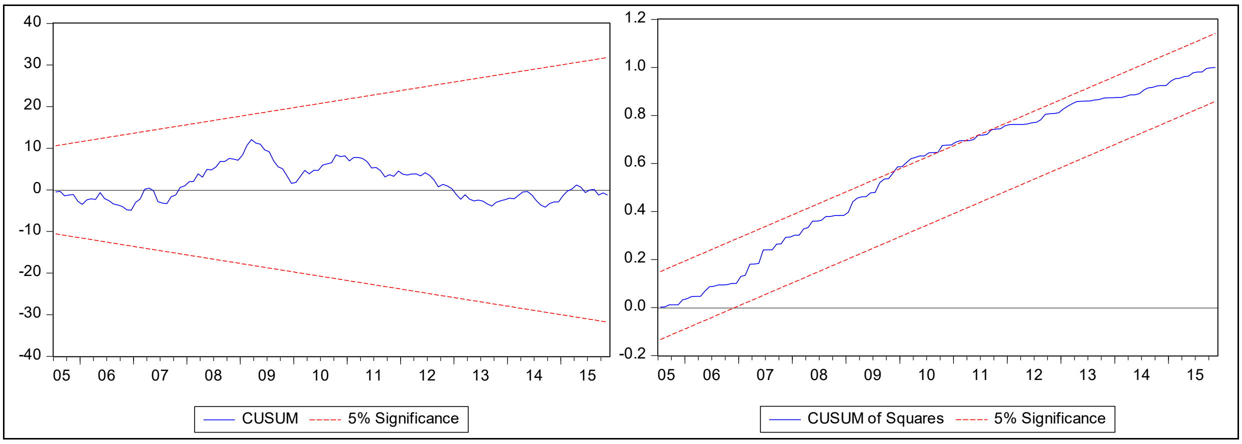

Figure 5: CUSUM and CUSUMSQ for LM3

5. Summary and Conclusion

The origin of the inclusion of the exchange rate in the model of the demand for money dates back to 1963. Robert Mundell conjectured that the demand for money could also depend on the exchange rate in addition to income and interest rate. Since then various studies have tried to examine a clear explanation for Mundell's conjecture. In this paper, it is shown that failure to find a significant relationship between the exchange rate and the demand for money could stem from the assumption of linear dynamic adjustment process among the variables. By introducing nonlinearity, using the partial sum concept, exchange rate movement could have a significant effect on the money demand. The study confirmed this by estimating the demand for money for the Indian economy. To introduce nonlinearity into the adjustment mechanism, the exchange rate is decomposed into positive partial sum (appreciation) and negative partial sum (depreciation) components. It is found that rupee appreciation and rupee depreciation have an asymmetric effect on the demand for money in India both in short run and long run. The results showed the prevalence of wealth effect whereby rupee appreciation due to huge capital inflows makes foreign currency denominated assets less worthy, so demand for domestic money decreases. Moreover, when rupee depreciates due to capital outflows, foreign currency denominated assets become more worthy and through wealth effect the demand for domestic money increases.

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