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An Analysis of the Demand for Money in Bangladesh: Partial Adjustment and Vector Error Correction (VEC) Approach

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Abstract: This paper examines the determinants of demand for money in Bangladesh using yearly data from 1975-2016. Partial adjustment model and vector error correction model have been used to examine the nature of short run and long run determinants and short run dynamics. Impulse Response Analysis has been performed by giving a shock to real per capita GDP, inflation, real interest rate, degree of monetization and real exchange rate to visualize the duration of their effects on the real narrow money (M1) and real broad money (M2) in Bangladesh. The results of partial adjustment model in the study suggest that only real M1 follows partial adjustment mechanism. Real per capita GDP and degree of monetization have positive effects on money demand in Bangladesh whereas real exchange rate has negative effect on money demand in Bangladesh which implies that the currency substitution effect is less than the asset substitution effect. The Johansen-Juselius procedure is applied to test the co integration relationship between variables and it is followed by the VEC (Vector Error Correction) regression model. The empirical results of the study trace a long-run equilibrium relationship in the variables for real narrow money in Bangladesh.

Keywords: Money Demand; Determinants of Money Demand; Bangladesh; Narrow Money (M1); Broad Money (M2) ; Partial Adjustment Model; Co Integration ;Vector Error Correction; Impulse Response Function

1. Introduction

The demand for money is important for the formulation and conduct of dynamic monetary and fiscal policy. Good understanding of the money demand equation and its structure are crucial to work out current and future macroeconomic policies. Thus great amount of researches have been carried out over the years on money demand equation and its structures. Now-a-days understanding of the demand for money is viewed as a pivotal concept to the theory of monetary economics.

However, the determinants of various factors that affect the long run demand for money as well as short run dynamic adjustment of actual money balances to the desired level still remains inconclusive as there have been continuous monetary innovation and financial market integration (Ahmed et al. 2005). Hence, it is imperative to analyze the demand for money for different countries.

The objectives of the study are as follows:

- To estimate both the narrow money and the broad money demand functions for Bangladesh using the most recent data within the framework of partial adjustment model including exchange rate, degree of monetization, real per capita GDP, real interest rate and inflation rate to test whether or not these variables significantly affect the demand for money.
- To develop an error correction model and to test the hypothesis that the error correction term significantly affects the short-run dynamics (rate of change of demand for money).
- To perform Impulse Response Analysis by giving a shock to real per capita GDP, inflation, real interest rate, degree of monetization and real exchange rate to visualize the duration of their effects on the real M1 and M2 in Bangladesh

2. Literature Review

A number of researchers conducted studies on money demand function in different countries. Ahmed (1997) investigated the determinants of demand for money in Bangladesh using annual observations for the period of 1974-95. His analysis showed that real per capita GDP, degree of monetization and real exchange rate have positive effects on money demand in Bangladesh while conflicting evidence was found regarding the role of interest rate in Bangladesh.

Tillers (2004) conducted an econometric analysis on the demand for broad money in Latvia. His study suggested a stable relationship of money demand. Tillers (2004) study also found that the demand for money in Latvia is characterized by relatively high income elasticity which is typical for the economy in a monetary expansion phase.

Ahmed et al. (2005) investigated the long-run equilibrium money demand relationship as well as short -run dynamics, i.e. stability and the speed of adjustment to the long- run equilibrium in the context of Bangladesh for both the broad money and the narrow money categories. The empirical evidence demonstrated that a single co integrating vector describes the long-run equilibrium money demand relationship for both the broad money and narrow money (M1 and M2) categories in the country. Their study also found that there exists a statistically significant long-run equilibrium money demand relationship among real money balances of various types, real income and respective nominal interest rates.

Champika et al. (2013) conducted a study on the long run money demand function for Sri Lanka using error correction version of autoregressive distributed lag (ARDL) approach while giving special attention to the effect of international financial crisis on money demand. Findings of the paper emphasized that M1 money demand in Sri Lanka is highly co-integrated with the real income; real exchange rate and short term domestic and foreign interest rates. It is also found that short-run causality (in Granger sense) runs from both foreign interest rate and financial crisis variable to M1, emphasizing that both variables have a significant impact on money demand in Sri Lanka in the short-run. However, they also found that financial crisis did not show significance in the long-run as was expected. To the end, in their study, the overall test results show that Sri Lanka was able to maintain a stable money demand function despite the economic uncertainty arises due to international financial crisis.

3. Methodology

3.1. General Model of Money Demand

Following the work of Ahmed (1997), a money demand function for Bangladesh can be specified as follows:

$$lrm = f(lrpci\ ,ldom\ ,rer,\ infla,\ rintr)$$

where lrm denotes the logarithm of real M1 or M2, lrpci is the logarithm of real per capita GDP, which proxies the level of economic activity, infla is the rate of inflation measured by the rate of change of Consumer Price Index, rintr is the real rate of interest which is equal to the differences between nominal rate of interest and inflation rate, idom is the logarithm of degree of monetization and rer is the real exchange rate which is equal to the differences between nominal exchange rate and inflation rate. Here exchange rate is defined as Taka per US dollar.

In this formulation, the coefficients of lrpci and Idom are expected to be positive and the coefficients of rintr and infa are expected to be negative. Sign of the coefficient of rer is indeterminate. Because when exchange rate changes, it leads to currency substitution which has a positive impact on the money demand. On the other hand, it leads to asset substitution which has a negative impact on money demand. The net effect can be positive or negative depending on the relative strength of the two effects. This is essentially an empirical issue which will be tested in this paper.

3.2 Partial Adjustment Model

Partial Adjustment Model (PAM) introduces a mechanism for the adjustment of the actual stock of real cash balances to its desired level in order to separate the long run equilibrium demand for money from its short run demand. This mechanism assumes that:

$$logm_t = logm_{t-1} = b(logm_t^* - log\ m_{t-1}) \quad \text{---(1)}$$

where M* is the desired stock of real money balances, m is the actual stock of money balances and b is the adjustment coefficient which is expected to be between 0 and 1.

The equation indicates that the actual change is a fraction of the desired change. Following the partial adjustment mechanism, the short run money demand function can be specified as follows:

$$lrm_t = \alpha_0 + \alpha_1\ lrpci_t + \alpha_2\ ldom_t + \alpha_3\ rer_t + \alpha_4\ infla_t + \alpha_5\ rintr_t + \alpha_6\ lrpci_{t-1} + e_t \quad \text{---(2)}$$

The long run equilibrium demand function for money can be obtained from the short run money demand function by equating m_t to m_{t-1} in (2). Accordingly the long run demand function takes the following form:

$$lrm_t = \beta_0 + \beta_1\ lrpci_t + \beta_2\ ldom_t + \beta_3\ rer_t + \beta_4\ infla_t + \beta_5\ rintr_t + e_t \quad \text{---(3)}$$

where $\beta_i = \alpha_i / (1-\alpha_6)$ for i= 0….5

The adjustment coefficient, b, in equation (1) is actually 1- a_6. Once the short run function (2) is estimated, the estimate of the adjustment coefficient, 1- a_6, can be computed and the long run function can be easily derived.

3.3. Co integration Approach to Demand for Money

The methodology developed in the previous section, though a popular one, is subject to some drawbacks. For example it takes just one-period lagged value of dependent variable to capture the complex short run dynamics. Moreover, most macroeconomic time series data are non stationary. If the series are non stationary, inference drawn from them might be misleading. To overcome these difficulties co integration-based error correction modeling is developed. Unit root tests can be used to test for stationarity of any given time series (Ahmed 1997). Co integration method will be applied after that to see whether the variables are integrated with each other. If it is found that the variables are co integrated, then the study will proceed to run the vector error correction model.

3.4. Unit Root Test

Stationarity of a series is an important phenomenon. If x and y series are non-stationary random process (integrated), then modeling the x and y relationship as a simple OLS relationship as in equation below will only generate a spurious regression.

$$Y_t = \alpha + \beta X_t + \varepsilon_t \quad \text{--- (4)}$$

Time series stationarity is the statistical characteristics of a series such as mean and variance over time. If both are constant over time, then the series is said to be a stationary process (i.e. it is not a random walk/has no unit root), otherwise, the series is described as being a non-stationary process (i.e. a random walk/has unit root). Differencing a series using differencing operations produces other sets of observations such as the first differenced values, the second differenced values and so on

$$x\ level \qquad x_t$$

$$x\ 1st\ differenced\ value \qquad x_{t-1}$$

$$x\ 2nd\ differenced\ value \qquad x_t - x_{t-1} \quad \text{--- (5)}$$

If a series is stationary without any differencing it is designated as I(0) , or integrated of order 0. On the other hand, a series that has stationary first differences is designated I(I), or integrated of order one (1). Augmented Dickey Fuller test (Dickey and Fuller, 1979) have been used in this study to test the stationarity of the variables.

3.5. Johansen and Juselius Cointegration Test

Johansen and Juselius (1988) Produces two tests to determine the number of co integration vectors: the Maximum Eigen value test and the Trace test. The maximum Eigen value statistic tests the null hypothesis of r co integrating relations against the alternative of r+1 conuetrating relations for r=0,1,2..n-1. This test statistics are computed as:

$$LR_{max}\left(\frac{r}{n+1}\right) = -T * \log(1 - \lambda\hat{}) \quad \text{---(6)}$$

Where λ is the Maximum Eigenvalue and T is the sample size. Trace statistics investigate the null hypotheis of r cointegrating relations against the alternative of n cointegrating ralations, where n is the number of variables in the system for r= 0,1,2…n-1. Its equation is computed according to the formula:

$$LR_{tr}\left(\frac{r}{n+1}\right) = -T * \sum_{i=r+1}^{n} \log(1 - \lambda\hat{}_i) \quad \text{---(7)}$$

In some cases Trace and Maximum Eigen value statistics may yield different results and (Alexander,2001) indicates that in this case the results of trace test should be preferred.

3.6. Vector Error Correction Model (VECM)

According to Adhikary (2012) in the presence of one or more co integrating vectors, VEC model will be applied in the study as outlined in Granger (1988).

$$\Delta lrm_t = \alpha + \lambda e_{t-1} + \sum_{i=1}^{n} bi\, \Delta lrm_{t-i} + \sum_{i=1}^{m} ci\, \Delta lrpci_{t-i} + \sum_{i=1}^{o} di\, \Delta ldom_{t-i} + \sum_{i=1}^{p} ei\, \Delta rer_{t-i} + \sum_{i=1}^{q} fi\, \Delta infla_{t-i} + \sum_{i=1}^{r} gi\, \Delta rintr_{t-i} + \varepsilon_t\ ) \quad \text{---(8)}$$

where lrm denotes the logarithm of real M1 or M2, lrpci is the logarithm of real per capita GDP, which proxies the level of economic activity, infla is the rate of inflation measured by the rate of change of Consumer Price Index, rintr is the real rate of interest which is equal to the differences between nominal rate of interest and inflation rate, idom is the logarithm of degree of monetization and rer is the real exchange rate which is equal to the differences between nominal exchange rate and inflation rate. Exchange rate is defined as Takas per US dollar.

Notably, in this specification, the parameter (λ) of the lagged error correction term (e_{t-1}) indicates the long run relationship in the variables being studied, and also the speed of adjustment from the short run to long run equilibrium state. The appropriate lag length of the variables has been selected through different information criteria such as FPE, AIC, HQIC and SBIC (Akaike,1969; Brooks, 2008). Notably, the parameter of the error correction term needs to be negative and statistically significant in terms of its associated t value to confirm long -run equilibrium relationship in the variables.

Impulse Response Analysis has been performed in this analysis by giving a shock of one standard deviation (+-2 S.E innovations) to real per capita GDP, inflation, real interest rate, degree of monetization and real exchange rate to visualize the duration of their effects on the real M1 and M2 in Bangladesh.

4. The Data

The data used in this study are taken from the World Bank and Bangladesh Bank (Appendix). Annual observations comprising the period 1975-2016 has been used to estimate the model. Income variable used in this study is per capita GDP. Real GDP is computed by deflating the nominal GDP by the Consumer Price Index (1990=100). The Consumer Price Index (CPI) is used because it is a good indicator of the movement of prices (Crocket and Evans, 1980). Real per capita GDP is obtained by dividing the real GDP by the total population. The bank rate (discount rate), an average of the monthly bank rate published by Bangladesh Bank, is used for the nominal interest rate variable. Saqib and Ahmed (1986) found that the bank rate is highly correlated with time deposit rate and call money rate (correlation coefficients are .91 and .96 respectively) in Pakistan (including former East Pakistan). The real interest rate is computed from the formula $rintr_t = intr_t - infla_t$, where $intr_t$ is the nominal interest rate, $infla_t$ the inflation rate, which is given by $[(CPI_t\text{-}CPI_{t-1})/CPI_{t-1}]$. The degree of monetization is measured by the ratio of M2 to GDP.

Two definitions of money are: the narrow money and the broad money. The narrow money, denoted Ml, includes currency outside the banking system plus demand deposits. The broad money, denoted M2, includes time and saving deposits besides Ml. The opportunity costs variables are in levels rather than logarithms since the formulation provides practical advantages (Eder, 1995).

5. Empirical Result and Discussion

Empirical results will be discussed in this section. The econometrics program STATA was used to compute numerical results in this section.

5.1. Partial Adjustment Model

The partial adjustment model, which was introduced by Goldfeld (1973), has become a standard framework for modeling the money demand function. Later a vast number of researchers such as Arango and Nadiri (198l), Gujarati (1988), Mcgibany et al (1995) applied this framework in their empirical studies. In the present study, partial adjustment models were estimated for the real narrow money (Table-1) and the real broad money (Table-2). This estimated model gives the short run money demand function. A long run money demand function is also computed from the estimated short run function as discussed in the previous sections.

Table 1: Estimates of Short Run Real Narrow Money

Dependent Variable: Log of Real Narrow Money (M1), **Number of Obs**= 39, **F(6,32)** = 624.53, **Prob>F**=0.0000, **R-Squared**= 0.9915, **Adj R-Squared**= 0.9899, **Root MSE**= 0.06629

Variable	Coef.	Std. Err	T	P>|t|	[95 % Conf. Interval]	
*lrpci	2.846	0.448	6.36	0.000	1.935	3.758
*ldom	0.358	0.079	4.55	0.000	0.198	0.519
*rer	-0.014	0.004	-3.51	0.001	-0.022	-0.006
Infla	0.006	0.009	0.63	0.534	-0.013	0.0248
Rintr	-0.003	0.010	-0.29	0.774	-0.022	0.017
**difrm1	0.354	0.149	2.38	0.023	0.051	0.657
Constant	4.113	2.420	1.70	0.099	-0.818	9.045

Note: * Significant at 1% confidence interval; ** Significant at 5% confidence interval;***Significant at 10% confidence interval

From the table 1, it is observed that log of real per capita income affects positively and significantly the demand for narrow money as expected. Its coefficient denotes the short run elasticity which is 2.846. It indicates that a 1% increase in the degree of monetization increases the demand for money by less than 1% in the short run. The degree of monetization is another significant factor which affects the demand for narrow money positively. Its coefficient also denotes short run elasticity. The value is less than 1 which indicates that a 1% increase in the degree of monetization increases the demand for money by less than 1% in the short run.

The negative coefficient for exchange rate indicates that in case of Bangladesh, currency substitution is less than the asset substitution in the short run. According to Ahmed (1997), change in exchange rate has two effects- financial asset substitution effect which is negative, and currency substitution effect which is positive on the demand for money. When exchange rate increases, Taka, the unit of currency in Bangladesh, becomes cheaper compared with other international currencies and people (who have portfolio baskets of international currencies) are expected to substitute more Taka for foreign currencies. Thus it leads to currency substitution which has a positive impact on the demand for money. On the other hand, when exchange rate increases, Taka loses its value. Note that exchange rate is defined as so many Takas for a US dollar. As a result, people are likely to substitute certain financial assets such as stocks and bonds for Taka. This is asset substitution which has a negative impact on the demand for money. The net effect can be positive or negative depending on the relative strengths of the two effects. Since exchange rate has a negative coefficient, it indicates that in the case of Bangladesh, the net effect is negative. It also implies that the currency substitution effect is less than the asset substitution effect.

This study did not find real interest rate and inflation as significant variable to affect short run narrow money demand in Bangladesh.

The R^2 value indicates that the overall goodness of fit of the model is excellent. The variables included in the model explain 99 percent of the variation in log real narrow money in Bangladesh.

The regression results for real broad money are shown in Table-2 below.

Table 2: Estimates of Short run Real Broad Money

Dependent Variable: Log of Real Narrow Money (M2), **Number of Obs**= 39, **F(6,32)** = 1735.56, **Prob>F**=0.0000, **R-Squared**= 0.9969, **Adj R-Squared**= 0.9964, **Root MSE**= 0.06014						
	Coef.	**Std. Err**	**T**	**P>|t|**	**[95 % Conf. Interval]**	
***lrpci**	2.631	0.407	6.44	0.000	1.799	3.463
***ldom**	1.287	0.072	17.99	0.000	1.140	1.432
***rer**	-0.016	0.004	-4.28	0.000	-0.023	-0.008
Infla	0.011	0.008	1.37	0.180	-0.005	0.027
Rintr	0.023	0.009	2.74	0.010	0.006	0.041
***difrm2**	-0.524	0.165	-3.18	0.003	-0.860	-0.188
Constant	3.643	2.209	1.65	0.109	-0.856	8.141

Note: * Significant at 1% confidence interval; ** Significant at 5% confidence interval;***Significant at 10% confidence interval

From Table-2, it is observed that the R^2 value indicates that the overall goodness of fit of the model is excellent. The variables included in the model explain 99 percent of the variation in log real broad money in Bangladesh. Log of real per capita GDP and log of degree of monetization have significant positive effects on the demand for broad money. Short run broad money demand elasticity with respect to per capita GDP is greater than 1 (elastic) which indicates that money is a luxury good in Bangladesh. This study did not find real interest rate and inflation as significant variable to affect short run broad money demand in Bangladesh.

The coefficient of exchange rate is negative and significant for broad money. The sign of this coefficient suggests that the currency substitution is less than asset substitution in Bangladesh, a result similar to the case of narrow money.

The long run money demand functions for real narrow money and the real broad money can be derived from the corresponding partial adjustment model as discussed earlier. For real narrow money the adjustment coefficient is 0.65. It means that real narrow money follows the partial adjustment mechanism. Now, dividing each coefficients of the short run function (from Table-1) by 0.65, yields the following long run money demand function for real narrow money:

$$\mathbf{lrm_t = 6.32 + 4.37\ lrpci_t + 0.551\ ldom_t - 0.022\ rer_t + 0.009\ infla_t - 0.005\ rintr_t + e_t}$$

Here the long run income elasticity is 4.37 which mean that a 1% increase in real per capita GDP will increase real narrow money demand approximately by 4.37 % in the long run. Similarly, the coefficient of the degree of monetization also denotes long run elasticity. This elasticity is 0.551 which indicates that for a 1% increase in the degree of monetization, real narrow money demand will increase 0.551% in the long run. Similarly, here the coefficients of interest rate, exchange rate and inflation rate show their respective long run impacts as these coefficients belong to the long run money demand function. The magnitudes and signs of these coefficients suggest that the long run impacts are almost similar to their corresponding short run impacts.

On the other hand, for the real broad money, the coefficient of the lagged term is -0.524 (Table-2). It means adjustment coefficient is 1.524. Since the value of adjustment coefficient lies between 0 and 1, it does not support the hypothesis that broad money demand also follows a partial adjustment mechanism.

5.2. Co integration Approach

According to Ahmed (1997), one of the implicit assumptions in the partial adjustment model was that all the variables used in the money demand model are stationary. If the time series used in the model are non stationary, it might give a spurious regression. Long run relationship can be found among variables that are co integrated. According to Hendry and Ericsson (1991) an econometric model must, in the first place, be consistent with economic theory. They argue that if economic theory suggests that a long run relationship exists among economic variables, then it is possible to discover such a relationship among variables with a regression model using the co integration approach. Another important reason for testing co integration is that if two variables are co integrated, an OLS regression yields a consistent estimate of the true coefficient (Engle and Granger, 1987). A co integrated relationship can be found among variables that are integrated of the same order. For that reason, before carrying out co integration tests, unit root tests should be conducted to ascertain the order of integration of the time series involved.

5.3. Unit Root Test

Table-3 displays the result of unit root test of the variables. Augmented Dickey Fuller (ADF) unit root test was used in this respect.

Table 3: Dickey-Fuller Unit Root Test Result

Variable	Level	First Difference
lrm1	I(0)	I(1)
lrm2	I(0)	I(1)
Lrpci	I(0)	I(1)
Ldom	I(0)	I(1)
Rer	I(0)	I(1)
Infla	I(0)	I(1)
Rintr	I(0)	I(1)

Result of the unit root test shows that all variables contain unit root at level. But when first difference of the variable are used, it is found that the variables are stationary.

5.3. Co integration Result

Table-4 and Table-5 summarizes the results of the Johansen co integration test. Hypothesis of Johansen co integration test is:

Null Hypothesis (H_0): No Co integration among variables

Alternative Hypothesis (H_1): Co integration among variables

Table 4: Johansen Cointegration test (Real M1)

Trend= Constant, Sample = 1979-2016, **Number of Obs** = 38 ; lags = 4					
Max Rank	**Parms**	**LL**	**Eigen value**	**Trace statistic**	**5% Critical value**
0	114	100.49	-	211.31	94.15
1	125	157.57	0.95	97.14	68.52
2	134	177.63	0.67	57.04	47.21
3	141	193.66	0.58	24.96	29.68
4	146	202.63	0.39	7.04*	15.41
5	149	205.15	0.13	1.99	3.76
6	150	206.15	0.05	-	-

Table 5: Johansen Co integration test (Real M2)

Trend= Constant, Sample = 1979-2016, **Number of Obs** = 38 ; **lags** = 4					
Max Rank	**Parms**	**LL**	**Eigen value**	**Trace statistic**	**5% Critical value**
0	114	148.69	-	185.97	94.15
1	125	188.93	0.89	105.48	68.52
2	134	206.10	0.61	71.14	47.21
3	141	221.81	0.58	39.74	29.68
4	146	233.04	0.46	17.28	15.41
5	149	241.61	0.37	0.12*	3.76
6	150	241.68	0.00	-	-

The trace test yields one co integrating equation at the 5% level of significance. Thus, it is concluded that the both the series are co integrated (Real M1 and Real M2), and a long run equilibrium relationship exists among them. As a result, the study proceeds to run the vector error correction model as outlined in the previous sections.

5.4. Vector Error Correction Model

Table 6 portrays the result of the vector error correction model for real narrow money in Bangladesh.

Table 6: Vector Error Correction Model for Real M1

Vector Error – Correction Model					
Sample: 1979 – 2016 ; Log likelihood = 157.5799 ; Det (sigma_ml) = 6.36e ; No. of obs = 36 ; AIC = -1.809993; HQIC = 0.81 ; SBIC = 3.69					
Equation	**Parms**	**RMSE**	**R-sq**	**Chi2**	**p>chi2**
D_lrm1	20	0.07	0.78	58.43	0.00
D_lrpci	20	0.01	0.95	330.08	0.00
D_ldom	20	0.05	0.82	74.21	0.00
D_rer	20	2.09	0.84	87.47	0.00
D_infla	20	3.10	0.67	33.11	0.0328
D_rintr	20	3.05	0.68	33.96	0.0264

D_lrm1	Coef.	Std.Error	Z	P>|z|	95% conf. interval	
_cel L1	-.13	0.43	-0.31	0.76	-.97	.70
Lrm1						
LD.	-.004	.39	-0.01	0.99	-.77	.76
L2D.	-.20	.39	-0.53	0.59	-.99	.57
L3D.	-.69	.29	-2.34	0.01	-1.28	-.11
Lrpci						
LD.	.50	3.03	0.17	0.86	-5.44	6.45
L2D.	3.23	2.13	1.52	0.12	-.93	7.41
L3D.	2.35	1.36	1.72	0.085	0.32	5.03
Ldom						
LD.	-.04	.30	-0.16	0.86	-.63	.54
L2D.	-.11	.32	-0.35	0.72	-.75	.52
L3D.	.29	.22	1.33	0.18	-.14	.74
Rer						
LD.	.00	.02	0.02	0.98	-.04	.04
L2D.	.00	.03	0.13	0.90	-.05	.06
L3D.	-.02	.02	-1.05	0.29	-.07	.02
Infla						
LD.	-.02	.02	-1.12	0.26	-.07	.02
L2D.	-.01	.03	-0.40	0.68	-.07	.05
L3D.	.00	.03	0.13	0.89	-.06	.07
Rintr						
LD.	-.02	.02	-0.96	0.33	-.07	.02
L2D.	-.01	.03	-0.43	0.66	-.08	.05
L3D.	.00	.03	0.16	0.871	-.64	.07

Johansen Normalization Restriction Imposed						
beta	Coef.	Std. Error	Z	p>|z|	96% Conf. Interval	
_cel						
Lrm1	1	.	.	.	.	.
Lrpci	-7.68	.30	-25.11	0.00	-8.28	-7.08
Ldom	.09	.03	2.60	0.00	.02	.16
Rer	.06	.00	20.76	0.00	.05	.06
Infla	-.04	.00	-13.62	0.00	-.05	-.03
Rintr	-.06	.00	-16.35	0.00	-.07	-.05
_cons	22.11	.	.	.	.	.

From the result, it is revealed that a long run equilibrium relationship exists among variables for real M1.

This has been observed by the parameter (λ) of the error correction term e_{t-1}, which is negative as expected. From the Table -6 and using speed of adjustment formula [Speed of Adjustment= ln(0.5)/ ln(1+ λ), it is found that equilibrium will be restored in 4.86 years.

From the result, it is found that there is no significant short run impact of the variables on the demand for real narrow money (p value greater then .05).

However, all the variables have significant long run significant impact on the demand for real narrow money. From the table we can see that degree of monetization and real exchange rate have positive long run impact on the demand for real narrow money while real per capita GDP, inflation and real interest rate have significant negative long run impact on demand for real narrow money in Bangladesh. For the result of the impact of real per capita GDP on real narrow money, it is found that the result is a bit contradictory. In the partial adjustment model it was found positive while here in error correction model it is found negative. Also it was found in the partial adjustment model that real exchange rate have negative impact while in this error correction model it is found positive meaning that currency substitution is more than asset substitution in Bangladesh.

Table 7 shows the result of the vector error correction model for real broad money in Bangladesh.

Table 5: Vector Error Correction Model for Real M2

Vector Error – Correction Model					
Sample: 1979 – 2016 ; Log likelihood = 188.93 ; Det (sigma_ml) = 1.11e-12 ; No. of obs = 36 ; AIC = -3.55; HQIC = -1.63 ; SBIC = 1.94					
Equation	**Parms**	**RMSE**	**R-sq**	**Chi2**	**p>chi2**
D_lrm1	20	0.05	0.86	103.45	0.00
D_lrpci	20	0.01	0.93	226.15	0.00
D_ldom	20	0.04	0.88	123.61	0.00
D_rer	20	2.01	0.85	95.41	0.00
D_infla	20	2.70	0.75	48.65	0.00
D_rintr	20	2.72	0.74	46.95	0.00

D_lrm2	**Coef.**	**Std.Error**	**Z**	**P>|z|**	**95% conf. interval**	
_cel L2	-.49	0.43	-0.31	0.76	-.97	.70
Lrm2						
LD.	-.09	.39	-0.01	0.99	-.77	.76
L2D.	-.93	.39	-0.53	0.59	-.99	.57
L3D.	-.31	.29	-2.34	0.01	-1.28	-.11
Lrpci						
LD.	1.78	3.03	0.17	0.86	-5.44	6.45
L2D.	3.09	2.13	1.52	0.12	-.93	7.41
L3D.	1.00	1.36	1.72	0.085	0.32	5.03
Ldom						
LD.	.46	.60	0.76	0.44	-.73	1.65
L2D.	.83	.51	1.64	0.10	-.16	1.83
L3D.	.42	.30	1.38	0.16	-.17	1.03
Rer						
LD.	-.00	.00	-0.82	0.41	-.02	.01
L2D.	-.02	.01	-1.47	0.14	-.05	.00
L3D.	-.00	.01	-0.13	0.89	-.03	.02
Infla						
LD.	-.04	.01	-2.26	0.02	-.07	-.00
L2D.	-.03	.02	1.73	0.08	-.00	.07
L3D.	.02	.01	1.47	0.14	-.00	.06
Rintr						
LD.	-.03	.01	-2.02	0.04	-.07	-.00
L2D.	.03	.02	1.96	0.05	-.00	.07
L3D.	.02	.01	1.30	0.19	-.01	.05

Johansen Normalization Restriction Imposed						
beta	**Coef.**	**Std. Error**	**Z**	**p>|z|**	**96% Conf. Interval**	
_cel						
Lrm2	1	.	.	.	.	.
Lrpci	-3.45	.44	-7.85	0.00	-4.32	-2.59
Ldom	-1.25	.04	-26.11	0.00	-1.34	-1.15
Rer	.02	.00	6.06	0.00	.01	.03
Infla	.01	.00	3.56	0.00	-.00	.02
Rintr	-.00	.00	-0.34	0.73	-.01	.00
_cons	.63	.	.	.	.	.

From the result, it is revealed that a long run equilibrium relationship does not exist among variables for real M2. This has been observed by the positive parameter (0.49)(λ) of the error correction term e_{t-1}, which was supposed to be negative to exist a long run equilibrium relationship. However, this study has found that there is significant negative short run impact of inflation and real interest rate on the demand of real broad money in Bangladesh. This result matches with the expected result.

5.5. Autocorrelation Test

Table 7 and 8 presents autocorrelation test (for real M1 and real M2 respectively) for the model used in the study. Hypothesis for the test is:

Null Hypothesis H_0: No Autocorrelation at lag order

Alternative Hypothesis H_1: Autocorrelation at lag order

Table 7: Lagrange Multiplier Test (real M1)

Lag	chi2	Df	Prob >Chi2
1	28.2866	36	0.81683
2	36.6672	36	0.43774

Table 8: Lagrange Multiplier Test (real M2)

Lag	chi2	Df	Prob >Chi2
1	22.4831	36	0.96169
2	45.8244	36	0.12638

Results show that null hypothesis is accepted (p value greater than .05) at lag order in the cases which means that there is no autocorrelation problem in the model.

5.6. Impulse Response

Figure 1 and 2 reports impulse responses. From figure 1, it is observed that for initial shock in real per capita GDP, real M1 will increase up to the 3rd year. After that it will somehow be stabilized. In the 6th year it will have a sharp increase while from the 7th year real narrow money will have a sharp decline. In case of initial shock in degree of monetization, real exchange rate and inflation, real narrow money will show a declining trend whereas in case of initial shock in real interest rate, real narrow money will have upward trend. In the figure 2, it is seen that for an initial shock in the real per capita GDP, degree of monetization, real exchange rate, inflation and real interest rate, real broad money will have mixed responses, i.e. in some years it will increase whereas in some years it will decline.

Figure 1: Impulse Response for real M1

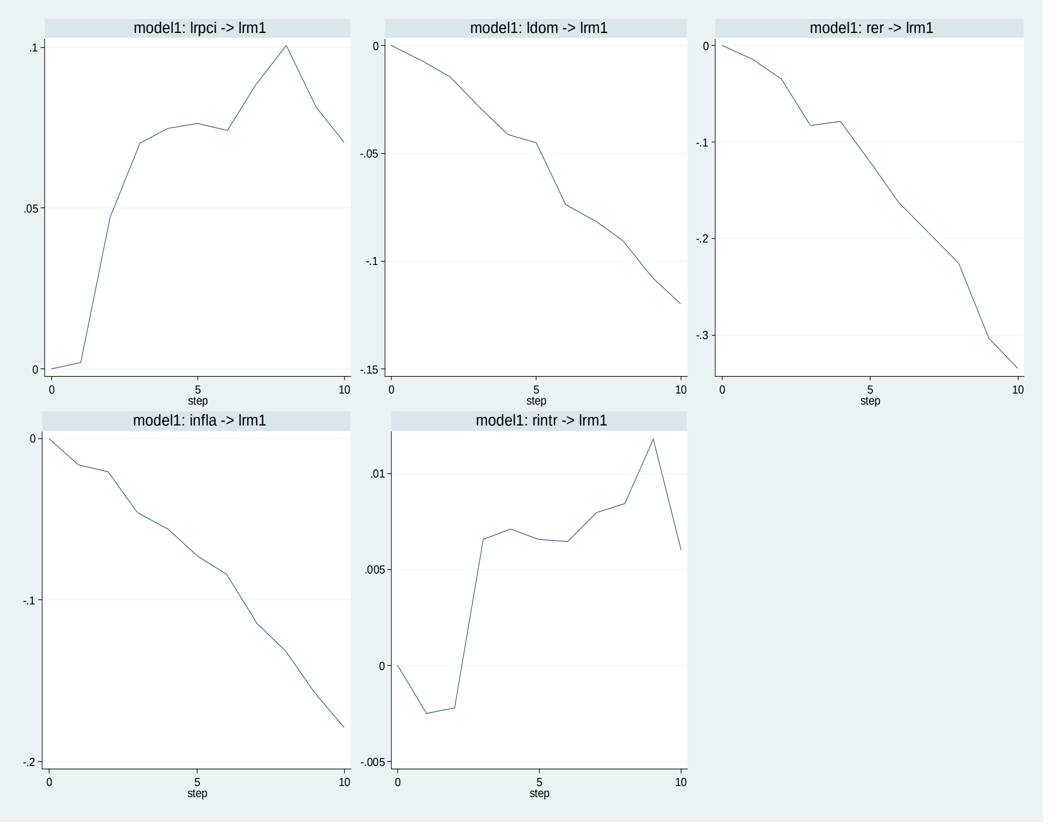
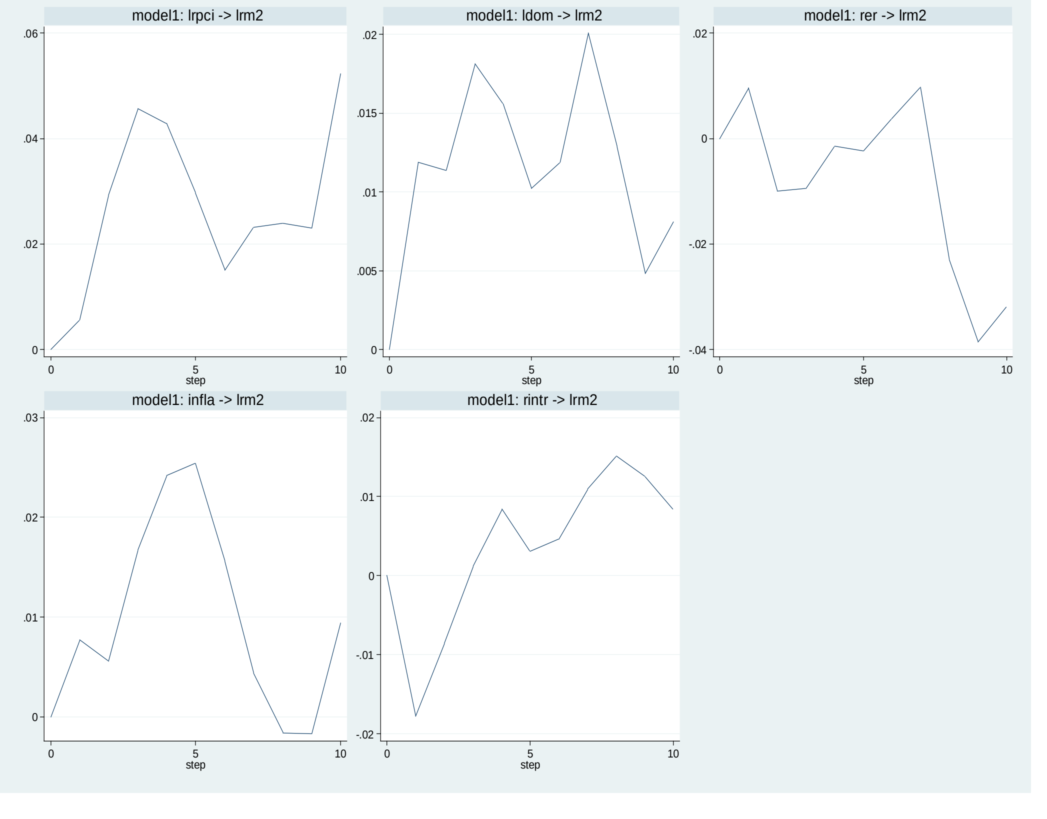


Figure 2: Impulse response for real M2



6. Conclusion

The main purpose of the study is to specify and estimate both the narrow money and the broad money demand function in Bangladesh including some non-traditional scale and explanatory variables. Partial adjustment model and error correction model are applied to investigate the nature of short run and long run determinants and short run dynamics. Both real narrow money and real broad money are used for comparison. Impulse Response Analysis has been performed by giving a shock to real per capita GDP, inflation, real interest rate, degree of monetization and real exchange rate to visualize the duration of their effects on the real M1 and M2 in Bangladesh. The results of partial adjustment model in the study suggest that only real narrow money follows a partial adjustment mechanism. Real per capita GDP and degree of monetization have positive effects on money demand in Bangladesh whereas real exchange rate has negative effect on money demand in Bangladesh which implies that the currency substitution effect is less than the asset substitution effect.

The Johansen-Juselius procedure is applied to test the co integration relationship between variables followed by the VEC (Vector Error Correction) regression model. The empirical results trace a long-run equilibrium relationship in the variables for real narrow money. It was found that the degree of monetization and real exchange rate have positive long run impact on the demand for real narrow money while real per capita GDP, inflation and real interest rate have significant negative long run impact on demand for real narrow money in Bangladesh. For the result of the impact of real per capita GDP on real narrow money, it is found that the result is a bit contradictory. In the partial adjustment model it was found positive while in the error correction model it is found negative. Also it was found in the partial adjustment model that real exchange rate have negative impact while in this error correction model it is found positive meaning that currency substitution is more than asset substitution in Bangladesh.

Money demand function shows the economy's capacity to absorb money supply, thus if the supply of money is greater than demand for money, the economy will experience inflationary pressure. Similarly, if the money supply is less than the demand for money, an economy is likely to experience deflationary pressure. Thus necessary steps have to be taken considering result of this study by concerned authority for maintaining equilibrium in the economy.

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