



Munich Personal RePEc Archive

# **Empirical Approaches to the Post-Keynesian Theory of Demand for Money: An Error Correction Model of Bangladesh**

Kundu, Nobinkhor and Mollah, Muhammad Musharuf  
Hossain

Department of Economics, Comilla University, Bangladesh., School  
of Business Studies, Southeast University, Bangladesh

12 August 2014

Online at <https://mpra.ub.uni-muenchen.de/65727/>  
MPRA Paper No. 65727, posted 22 Jul 2015 12:39 UTC

## **Empirical Approaches to the Post-Keynesian Theory of Demand for Money: An Error Correction Model of Bangladesh**

**Nobinkhor Kundu\***  
**Muhammad Musharuf Hossain Mollah<sup>♦</sup>**

The demand for money is crucial important tool of monetary policy to deal with the macroeconomic problems and to prescribe appropriate policy of the economy. This paper investigate to empirically explore the long-run equilibrium for demand for real money balance as well as short-run dynamics in the context of monetary policy in Bangladesh. Using time-series annual data for the period 1981 to 2012 and applying the methods of cointegration and error-correction, the study find a single cointegrating equation showing long-run stable relationship between demand for money and explanatory variables in the model. The study also finds convergence of short-run dynamics towards statistically significant long-run equilibrium and concludes that the results have important implications for the conduct of monetary policy in Bangladesh.

*JEL Classification:* E41, C22, C52

*Keywords:* Demand for Money, Cointegration, Bangladesh

### **1. Introduction**

The demand for money is one of the most important components of the transmission mechanism of monetary policy on the macroeconomic views. A stable money demand function is a condition in the conduct of monetary policy as it enables a policy-driven change in monetary aggregates to have predictable influences on output, interest rate, price and ultimately exchange rate. The analysis of the demand for money plays an important role in the decision-making process of central banks which has been working on a demand-for money analysis intensively. Empirical studies have been conducted in both developed and developing countries to evaluate the determinants and the stability of the demand for money function for various monetary aggregates.

---

\* Assistant Professor, Department of Economics, Comilla University, Comilla-3503, Bangladesh. Phone: +88-01911662226, Email: nobinkundu@yahoo.com

<sup>♦</sup> Assistant Professor of Marketing, School of Business Studies, Southeast University, Dhaka-1213, Bangladesh. Cell: +88-01716200047, Email: mhmr@yaho.com. I wish to thank an anonymous referee for helpful comments on an earlier draft. However, the usual disclaimer applies.

For developed countries, Friedman (1959), Chow (1966) and Goldfeld (1973) found that permanent income to be the superior scale variable over measured current income even for developing countries. The stable and predictable money demand functions in developed countries are in most cases supported by well managed data set and institutional settings. The scenery is almost opposite in developing countries. The choice of the scale variable, current income as measured by real GDP (gross domestic product) is due to the empirical findings of Adekunle (1968), that is, income and price expectations are static in Least Develop Countries (LDCs). It might not be inappropriate that the demand for real balances should be related to current income and current rate of inflation, thus we use nominal GDP measure as a proxy for current income and current inflation rate as a proxy for expected inflation rate.

Taslim (1984) introduced expected inflation rate as a measure of opportunity cost of holding money instead of using nominal interest rate that was significant. He criticized using of nominal interest rate as an explanatory variable as it was determined by institutional settings rather than market forces. Conversely, for a developing country with immature capital market and institutionally regulated interest rates, it has been argued that the use of inflation (expected) over interest rates as a measure of the alternative cost of holding money is more apposite. Consequently, it would not be inappropriate that the demand for real balances depend on current income in Bangladesh.

Ahmed (1977) found coefficients that were statistically significant at respectable levels and of the expected signs. He concluded that there existed a stable money demand function in Bangladesh. Murti and Murti (1978) focused on the appropriate functional form of the Demand for Money in Bangladesh using the generalized Box-Cox Transformations. The results found by them were similar to those of Ahmed's results as they adopted the whole data set of Ahmed and estimated the same variables and functions.

Hossain (1992) studied the stability of money demand function in Bangladesh. Using both Chow and CUSUM and CUSUMS'Q test, and he found a stable broad money function while he identified the instability of narrow money demand function, which might have been caused by financial reforms in Bangladesh since the early 1980s. Islam (2000) who employed sophisticated econometric techniques, Johansen-Juselius Co-integration tests, in estimation of money demand function in Bangladesh using quarterly data. Hossain (2006) over again was investigated dynamic money demand behaviour by applying the methods of cointegration and error-correction and using annual data. Islam and Hossain both have been employed by the cointegration and error-correction techniques. They found a stable single co-integrating vector exists in the long-run equilibrium money demand relationship in Bangladesh.

This paper briefly reviews explains relevant empirical issues in modeling and estimating money demand function for Bangladesh and provide some additional perspectives not covered in other reviews. The main purpose of research study is to empirically explore 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 Bangladesh for real money balance, real income, interest rate, inflation rate and exchange rate.

The remainder of this paper is organised as follows. Theoretical foundation is presented in section-II. Section III describes the econometric methodology used for the present study as well as the data. Section IV is analytical framework for the analytical analysis. Section-V presents the results of the empirical analysis of the augmented model. Finally, summary and conclusions are presented in Section VI.

## 2. Theoretical Foundation

In the long term, there are few basic approaches and theoretical concepts based on different methodological view points. According to *classical economics*, all markets are in equilibrium and always a full employment. The *Quantity theory* emphasized a direct and proportional relationship between money and price level.

This relationship was developed in classical equilibrium framework by *two alternative* but equivalent expressions: One is “*Equation of exchange*” – associated with Irving Fischer’s (1911) equation:  $MV = PT$ , where M is the quantity of money in circulation, V is “transactions velocity of circulation of money”, T is the volume of transactions and P is the price level.

And other is “*Cambridge approach or cash balance approach*” - associated with the Cambridge University economists, especially A.C. Pigou (1917). Cambridge economists pointed out the role of wealth and the interest rate in determining the demand for money. According to Milton Friedman (1956), among of *modern monetarists*, Stability of development of the demand for money depends on the overall wealth of society in various forms (money, bonds, securities, material and human resources) as well as on the taste and preferences of holders of the wealth and refreshed the traditional quantitative money theory in the Cambridge version.

In a *Keynesian economy*, Keynes adopted the *transactional motive* from the monetarist approach of the Cambridge school and considered the fact that a part of the demand for money is associated with transactions related to income developments. The speculative demand for money is what Keynes called as “liquidity preference.” Formal, Keynes (1936) approach can be written as follows:

$$M_d = L_1(Y) + L_2(i)$$

Where  $M_d$  is demand for money,  $L_1$  expresses the transactional and precautionary motive,  $L_2$  expresses the speculative motive of liquidity preference,  $Y$  is nominal GDP and  $i$  is the interest rate (Keynes, 1936).

The *Neo-Keynesian* interpretation of the money demand is based on Keynes’s principles. Thus, the demand for money can be expressed as follows:

$$M_{da} = kY \text{ and } M_{ds} = \alpha - \beta i, \text{ Thus } M_d = L(Y, i)$$

Where  $M_{da}$  is demand for active balances,  $M_{ds}$  is speculative demand for money,  $k$  is the share of active balances in GDP,  $L$  is the “liquidity preference function”,  $\alpha$  and  $\beta$  are parameters. This approach was developed by Baumol (1952) and Tobin (1956) to an approach based on the possession of money as inventory, where the transactional motive of liquidity preference is well-known formula:

$$M_d/P = \sqrt{cY/2i}$$

Where  $M_d/P$  is demand for real balances,  $c$  is transactional costs,  $Y$  is real GDP and  $i$  is the interest rate. The Bauman-Tobin model assumption of cost stability in a transaction ( $c$  – parameter) is not realistic in the long run.

The *Post-Keynesian* economics differs from neo-Keynesian especially in the inclusion of the *financial motive* in the demand for money. In this approach, the demand for money is usually expressed in nominal terms. For transformation to the real demand for money form, it is necessary to consider inflation. Arestis Philip (1988) approach to the demand for money in a *small open economy* can be expressed using the following equation:

$$M_d = K(Y_r)^a (P^e)^{-b} (CR)^{-c} (ER^e)^{-d} \mu$$

Where  $M_d$  is real money balances,  $K$  is the Cambridge coefficient function,  $Y_r$  is real GDP,  $P^e$  is the expected rate of inflation,  $CR$  is an estimated variable for credit limitations,  $ER^e$  is the expected appreciation or depreciation rate of the currency,  $\mu$  is a non-systematic component and  $a$ ,  $b$ ,  $c$ , and  $d$  are elasticity values.

### 3. Econometric Model And Data

#### 3.1 Empirical Methodology

We have used demand for money model specified by Arestis Philip (1988) to estimate the demand for money in a *small open economy*.

In general, the empirical estimation of demand for money or real cash balances function for Bangladesh can be expressed using the following equation:

$$M^*/P^* = \alpha_0 Y_t^{\beta_1} I_t^{\beta_2} P_t^{\beta_3} R_t^{\beta_4} e^{\mu_t} \quad (1)$$

Where  $M^*$  denote the *desired* stock of nominal money balance,  $P^*$  is the price level used to convert nominal money balance to real money balance  $M^*(=M^*/P^*)$ ,  $Y$  is aggregate real national income as scale variable,  $I$  is the long-term nominal interest rate (%) as opportunity cost variable, the rate of inflation ( $P$ ) as measured by consumer price index, and  $R$  is the exchange rate as ratio of Bangladesh Taka and U.S. Dollar respectively. In natural log (ln) linear function of the form,

$$\ln M_t = \alpha_0 + \beta_1 \ln Y_t + \beta_2 \ln I_t + \beta_3 \ln P_t + \beta_4 \ln R_t + \mu_t \quad (2)$$

Empirical analysis in terms of first differencing to induce stationarity has recently been questioned by Engle, R. and C. W. J. Granger, (1987) in their article “Co-Integration and Error Correction: Representation, Estimation and Testing”. They argue that the traditional approach of first differencing to induce stationarity disregards potentially important equilibrium relationships among the levels of the series to which the hypotheses of economic theory are usually taken to apply.

The behavioral assumptions require that  $\beta_1 > 0$ ,  $\beta_2 < 0$ ,  $\beta_3 < 0$ ,  $\beta_4 < 0$  and that the  $\mu_t$  sequence is stationary, so that any deviations from long-run money market equilibrium are temporary in nature.

$$\mu_t = \ln M_t - \alpha_0 - \beta_1 \ln Y_t - \beta_2 \ln I_t - \beta_3 \ln P_t - \beta_4 \ln R_t \quad (3)$$

that is stationary.

We have argued that real money balances, real income, nominal deposit rate, inflation rate and exchange rate are most likely integrated of order one, so that their changes are stationary. However, stationarity in  $\mu_t$  would establish (3) as a plausible long-run relationship, with the short-run dynamics incorporated in  $\mu_t$ , usually referred to as the *equilibrium error*. Then the integrated variables  $M_t, Y_t, I_t, P_t$  &  $R_t$  are said to be cointegrated and equation (2) is referred to as the cointegrating regression, as in Engle and Granger (1987).

In matrix notation, an equilibrium money demand model requires that

$$\mu_t = \beta' X_t = [1 - \alpha - \beta_1 - \beta_2 - \beta_3 - \beta_4] \begin{bmatrix} M_t \\ 1 \\ Y_t \\ I_t \\ P_t \\ R_t \end{bmatrix} = \text{Stationary}$$

The vector  $\beta' = [1 - \alpha - \beta_1 - \beta_2 - \beta_3 - \beta_4]$  is called the *cointegrating vector* for the nonstationary stochastic process  $X_t$ , corresponding to  $[M_t, Y_t, I_t, P_t \text{ \& } R_t]'$ . This cointegrating vector isolates (in the present context) the stationary linear combination,  $\mu_t$ .

### 3.2 Data

A definition of broad money ( $M_2$ ) is a better measure than a narrow money ( $M_1$ ) and nominal deposit rate as proxy for long-term interest rate that is a better than the short-term interest rate to measure the opportunity cost of holding money in considering the long-run economic impacts of changes in monetary policy in developing country. After compilation of the all data series were transformed into natural log form. That can reduce the problem of heteroskedasticity because it compresses the scale in which the variables are measured, thereby reducing a tenfold difference between two values to a twofold difference.

The paper outlines real money balance determining by the five indicators, it is assumed that in the long run, broad money ( $M_2$ ) deflated by the price level, gross domestic product (GDP) as proxy for aggregate real national income (Y), nominal rate of interest rate (I), rate of inflation (P) is proxied by consumer price index and exchange rate (R) as ratio of Bangladesh Taka and

U.S. Dollar respectively for the past four decades starting from year 1981 to 2012 from the World Development Indicators (WDI) data base of the World Bank (WDI, CD-Rom) published on April, 2013 and Bangladesh Bank.

#### 4. Analytical Framework

##### 4.1 Unit Root Tests

The Augmented Dickey-Fuller (ADF) test can also be generalized to allow for higher-order autoregressive dynamics, in case that an AR(1) process is inadequate to render  $\varepsilon_t$  white noise (Dickey and Fuller, 1981). The ADF test for a unit autoregressive root tests the null hypothesis  $H_0: \delta = 0$ , against the alternative  $H_1: \delta < 0$  in the following regression equation with an intercept of the form:

$$\Delta Y_t = \alpha_0 + \delta Y_{t-1} + \theta_i \sum_{i=1}^m \Delta Y_{t-i} + \varepsilon_t \quad (4)$$

If  $Y_t$  is stationary around a deterministic linear time trend, then the trend 't' i.e., the number of observation must be added as an explanatory variable. Alternatively (4) can be written as following regression equation with an intercept and a trend of the form:

$$\Delta Y_t = \alpha_0 + \beta_0 t + \delta Y_{t-1} + \theta_i \sum_{i=1}^m \Delta Y_{t-i} + \varepsilon_t \quad (5)$$

Assumed to be this regression identically and independently distributed (IID) random variable. Where  $\Delta Y_t = Y_t - Y_{t-1}$  is the first difference operator of Y series, and Y is the variable under consideration, is chosen by Schwarz Information Criterion (SIC),  $\alpha$  is intercept term,  $\beta_t$  is trend variable and  $\varepsilon_t$  is a white noise error term, m is the number of lags in the dependent variable. The optimal lag length, m, can be chosen using data dependent methods that have desirable statistical properties when applied to unit root tests.

In the equation (4)  $Y_t$  is corresponds to modeling a random walk without drift (intercept  $\alpha = 0$  and coefficient of trend  $\beta = 0$ ), and  $Y_t$  is a random walk with drift ( $\beta = 0$ ) around a stochastic trend in the equation (5). A test for nonstationary of the series,  $Y_t$ , amount to a t-statistic of  $\delta = 0$ , alternatively hypothesis of stationary requires that  $\delta$  be significantly negative.

##### 4.2 Cointegration Test

The Johansen's (1988) maximum likelihood (ML) approach is sufficiently flexible to account for long-run properties as well as short-run dynamics, in the context of multivariate vector autoregressive models. Let us consider the following p-dimensional vector autoregressive (VAR) model of order k

$$X_t = \sum_{i=1}^k A_i X_{t-i} + u_t \quad (6)$$

Where  $X_t$  is a  $p \times 1$  vector and  $u_t$  is an independently and identically distributed. In the case of the stochastic process  $X_t = [\ln M_t, \ln Y_t, \ln I_t, \ln P_t, \ln R_t]'$ . Where  $I$  is the  $n \times n$  identity matrix  $A$  and elements of  $X_t$  will be given by the rank of  $\Pi$ , denoted as  $r$ . Hence,  $\lambda$  is an eigenvalue of  $A$ . First, letting  $\Delta = 1 - L$ , where  $L$  is the lag operator, Johansen and Juselius (1990) suggest writing equation (6) as

$$\Delta X_t = \sum_{i=1}^k \Gamma_i \Delta X_{t-i} + \Pi X_{t-k} + u_t \quad (7)$$

Where

$$\Gamma_i = -\left(I - \sum_{j=1}^i A_j\right) \quad \text{and} \quad \Pi = -\left(I - \sum_{i=1}^k A_i\right)$$

Johansen proposes two tests for the number of distinct cointegrating vectors. In the trace test, the null hypothesis that there are at most  $r$  cointegrating vectors is tested (against a general alternative) by calculating the test statistic

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^p \ln(1 - \hat{\lambda}_i) \quad (8)$$

In this case, each  $\ln(1 - \hat{\lambda}_i)$  will equal zero (since  $\log 1 = 0$ ), and  $\lambda_{trace}$  equals zero. However, the farther the estimated eigen values are from zero, the more negative is each of the expressions, and the larger the  $\lambda_{trace}$  statistic.

In the maximum eigen value test, the null hypothesis of  $r$  cointegrating vectors is tested against the alternative of  $(r + 1)$  cointegrating vectors by calculating the test statistic.

$$\lambda_{max}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1}) \quad (9)$$

Again, if the estimated eigen value,  $\hat{\lambda}_{r+1}$ , is close to zero,  $\lambda_{max}$  will be small, and the null hypothesis that the number of cointegrating vectors is  $r$  will not be rejected.

#### 4.3 Vector Error Correction Model

The cointegration and error-correction frameworks have proved to be successful tools in the identification and estimation of aggregate money demand functions. This type of approach to the demand for money captures the long-run equilibrium relationship between money and its determinants as well as the short-run variation and dynamics. In fact, there may be disequilibrium in the short run. To investigate the short run dynamics among the concerned time series variables, Vector Error Correction Model (VECM) should be developed according to Enders (2009). Therefore, an unrestricted VECM considering up to  $p$  lags for demand for money functions is respectively as follows:

$$\begin{aligned} \Delta \ln M_t = & \delta_0 + \sum_{j=1}^p \theta_k \Delta \ln M_{t-j} + \sum_{j=1}^p \eta_k \Delta \ln Y_{t-j} + \sum_{j=1}^p \phi_k \Delta \ln I_{t-j} + \sum_{j=1}^p \varphi_k \Delta \ln P_{t-j} + \sum_{j=1}^p \psi_k \Delta \ln R_{t-j} \\ & + \lambda \left[ \ln M_{t-1} - \hat{\alpha}_0 - \hat{\beta}_1 \ln Y_{t-1} - \hat{\beta}_2 \ln I_{t-1} - \hat{\beta}_3 \ln P_{t-1} - \hat{\beta}_4 \ln R_{t-1} \right] + \varepsilon_t \end{aligned} \quad (10)$$



Where  $\Delta$  is the first difference operator,  $\lambda$  depict the speed of adjustment from short run to the long run equilibrium,  $\varepsilon_t$  is a purely white noise term. In particular, if the variables are integrated and cointegrate, then there is an error-correction representation that enables the estimation of long-run equilibrium relationships without simultaneously having to take a strong position on how to model short-run dynamics.

## 5. Empirical Results<sup>1</sup>

The standard practice is to begin the empirical analysis by examining the time-series properties of the data. It starts with the test of stationarity of variables of the model (2), using unit root test procedures. The reason for knowing whether a variable has a unit root (that is, whether the variable is nonstationary) is that under the alternative hypothesis of stationarity, variables exhibit mean reversion characteristics and finite variance, and shocks are transitory and the autocorrelations die out as the number of lags grows, whereas under nonstationarity they do not. The standard ADF test has been used to perform the unit root test to the  $M$ ,  $Y$ ,  $I$ ,  $P$  and  $R$  series separately of the model and examine their *order of integration*. The ADF test used here includes a constant and linear trend in the test regression since it has more general specification. The test has employed automatic lag length selection using a Schwarz Information Criterion (SIC) and a maximum lag length of 7. SIC is considered to be more appropriate because of small numbers of observations in the study (32 observations). Table-1 reports the test statistics for the model with a time trend and intercept in level and in first differences respectively.

Table -1: ADF Statistics for Testing For Unit Roots in Level and First Differences

| Variables | t-ADF(Intercept and Trend) |         |                      |         |
|-----------|----------------------------|---------|----------------------|---------|
|           | Level ( )                  | P-Value | First Difference ( ) | P-Value |
| $\ln M$   | -1.981 (1)                 | 0.587   | -4.483*** (0)        | 0.006   |
| $\ln Y$   | -0.478 (0)                 | 0.979   | -6.019*** (0)        | 0.000   |
| $\ln I$   | -2.792 (1)                 | 0.210   | -3.598*** (0)        | 0.029   |
| $\ln P$   | -2.724 (1)                 | 0.234   | -5.938*** (1)        | 0.000   |
| $\ln R$   | -4.295*** (1)              | 0.010   | -4.723*** (0)        | 0.003   |

**Note:** (i) \*, \*\* and \*\*\* denote rejection of the unit root hypothesis at the 10%, 5% and 1% level of significance respectively. (ii) Figures in the parentheses represent the optimal lag length as determined by Schwarz information criteria.

The estimated statistic for all the variables *at level* does not exceed ADF test statistics. It shows that the null hypothesis of unit root cannot be rejected at 5 per cent level of significance for all variables at level. To test for the presence of more than one unit root in all these variables, the unit root tests of the variables *at first difference* have to be checked. The results, of table-1, show that the unit root hypothesis is rejected at the first differences for all variables.

This result from unit root tests provide strong evidence of non-stationarity *at levels* and stationarity *at first difference* for all variables, these series are integration to degree one,  $I(1)$ . The residuals are also found stationary using a Schwarz Information Criterion (SIC) and a maximum lag length of 7 and 32 observations. The result provide the basis for the test of long-

<sup>1</sup> After operating analysis in software *EViews-5.1* version, we got the result significant and observing the obtained result we can illustrate that the macroeconomic variables in Bangladesh.

run relationship among all variables, that is  $p$ -value statistically highly significant at 1%, 5% and 10% level, are stationary.

The cointegration between variables reveals the existence of the stable long-run (equilibrium) relationship. To test for cointegration among the variables, Johansen Maximum Likelihood procedure has been applied to a vector autoregressive (VAR) version. The results show that  $\lambda_{trace}$  and  $\lambda_{max}$  indicate 1 cointegrating equation at the 5 percent level of significance, presented in table -2.

Table-2: The Cointegration Analysis

| Series: LnM, LnI, LnP, LnY & Exogenous Series: LnR<br>Lags interval (in first differences): 1 to 1 |             |   |                     |         |                 |                     |         |
|--|-------------|---|---------------------|---------|-----------------|---------------------|---------|
| Hypothesized No. of CE(s)  | Eigen value | Unrestricted Cointegration Rank Test ( <i>Trace and Maximum Eigen value</i> ) |                     |         |                 |                     |         |
|  |             | $\lambda_{trace}$   | 0.05 Critical Value | Prob.** | $\lambda_{max}$ | 0.05 Critical Value | Prob.** |
| None   | 0.701961    | 64.22940  | 54.07904*           | 0.0048  | 36.31589        | 28.58808*           | 0.0042  |
| At most 1  | 0.458623    | 27.91351  | 35.19275            | 0.2452  | 18.40919        | 22.29962            | 0.1602  |
| At most 2  | 0.169893    | 9.504316  | 20.26184            | 0.6883  | 5.586027        | 15.89210            | 0.8325  |
| At most 3  | 0.122440    | 3.918289  | 9.164546            | 0.4244  | 3.918289        | 9.164546            | 0.4244  |

**Note:** Trace test and Max-eigenvalue test indicate 1 cointegrating eqn(s) at the 5% level, \*denotes rejection of the hypothesis 5% level, \*\* probability values.

The results provide evidence that the null hypothesis of no cointegration, i.e.,  $r = 0$ , is rejected for estimated demand for real cash balance of Bangladesh. So there is a single cointegrating vector relationship among the variables of equation (2) at the 5 percent level of significance. The parameter estimates representing the cointegration between the demand for real cash balance and the endogenous factors in the model, is specified as:

$$\ln(M) - 0.683 \ln(Y)_t + 0.602 \ln(I)_t + 0.305 \ln(P)_t + 5.124 = 0$$

$$\text{Or, } \ln(M) = -5.124 + 0.683 \ln(Y)_t - 0.602 \ln(I)_t - 0.305 \ln(P)_t \quad (11)$$

(-6.231) (3.285) (-4.452) (-7.338)

With the existence of cointegration established, equation (2) is re-parameterised as an error correction model (ECM) to estimate a model for improved forecasting, including the effects of exogenous variables. The cointegrating equations are generally interpreted as the long run equilibrium relationships characterising the data, with the error correction equations representing short-run adjustment towards such equilibria. The error correction model alone also can make direct inference both about the long-run and short-run relationships. Since there is a single cointegrating equation, the vector autoregressive (VAR) needs to include an error correction term involving levels of the series, and this term appears on the right-hand side of each of the VAR equations, which otherwise will be in first differences. The error correction model for the real money balance is including the *exchange rate (R)* to capture the effects of currency appreciation or depreciation on demand for money of Bangladesh.

The estimated equation of the model in error correction form for the demand for real money

balance ( $M$ ) is:

$$\begin{aligned}
 \Delta \ln(M_t) = & 0.377\Delta \ln(M_{t-1}) + 0.257\Delta \ln(M_{t-2}) \\
 & (2.184) \quad (2.343) \\
 & + 0.410\Delta \ln(Y_{t-1}) + 0.698\Delta \ln(Y_{t-2}) \\
 & (3.356) \quad (2.724) \\
 & - 0.183 \Delta \ln(I_{t-1}) - 0.104 \Delta \ln(I_{t-2}) \\
 & (-3.735) \quad (-2.985) \\
 & - 0.101\Delta \ln(P_{t-1}) + 0.111\Delta \ln(P_{t-2}) - 0.571\ln(R_t) \\
 & (-3.438) \quad (2.382) \quad (-2.957) \\
 & - 0.319 [\ln(M) - 0.683\ln(Y)_t + 0.602\ln(I)_t + 0.305\ln(P)_t + 5.124] \quad (12) \\
 & (-3.759) \quad (-3.285) \quad (4.452) \quad (7.338) \quad (6.231)
 \end{aligned}$$

In equation (12) parentheses represents the  $t$ -statistics for the respective sign of the estimated coefficients. In the short-run the sign of the estimated coefficients of the real national income ( $Y$ ) at 1 and 2 period time lag both are positive and 5% level of significant, which shows an increased of the demand for real cash balance ( $M$ ) at both period lag. As a consequence, the positive effect of the rise in real national income on real cash balance of Bangladesh is consistent. Conversely, the sign of the estimated coefficients of the nominal rate of interest ( $I$ ) at 1 and 2 period time lag both are negative and 5% level of significant, which shows an reduced of the demand for real cash balance ( $M$ ) at both period lag. It measure the opportunity cost of holding money in considering the long-run economic impacts of changes in monetary policy in developing country.

With respect to the rate of inflation ( $P$ ) the demand for real cash balance of Bangladesh responds following a cyclical pattern, that is, deterioration in real cash balance at 1-period time lag, improvement in the next period which is followed by deterioration. The effect of changes in rate of inflation on the real cash balance of Bangladesh is negative in the beginning and positive from the second period. This implies that effect of changes in rate of inflation on the demand for real cash balance of Bangladesh decrease immediately after the decrease in their real cash balance, which is consistent with the idea of the inflationary approach and later it reverses.

The key finding from the short-run dynamics above is that of a negative and statistically significant speed of adjustment coefficient (the error correction term). This means that the speed at which the rate of variation of the demand for real cash balance,  $\Delta \ln(M)$ , the dependent variable in the first equation of the vector error correction (VEC) system, adjusts towards the single long-run cointegrating relationship differs from zero. In other words, the equation for the demand for real cash balance  $\Delta \ln(M)$  contains information about the long-run relationship since the cointegrating vector does enter this equation. According to the estimates, short-run demand for real cash balance disequilibrium is corrected at the rate of 32 percent per annum. The speed of adjustment coefficient indicates that demand for real cash balance convergent to the equilibrium and their convergent sign indicate that statistically significant in the long run.

### *An Extension of the Long -run relationship*

Solving equation (12) the long-run relationship between the variables in the model can be written as (while all the  $\Delta$ 's equal zero at equilibrium):

$$\ln(M) = -1.634 + 0.218\ln(Y)_t - 0.192\ln(I)_t - 0.097\ln(P)_t - 0.571\ln(R)_t$$

(-6.231)    (3.285)    (-4.452)    (-7.338)    (-2.957)

At this point exchange rate ( $R$ ) enters in the equation as an *exogenous* variable. The equation reveals that the estimated coefficient of real national income ( $Y$ ) has a positive sign with high level of significance. Accordingly increase real income of Bangladesh leads to an expansion in the demand for real cash balance ( $M$ ). The resulting estimate of  $\beta_1$  is 0.218, with a *t-value* of 3.285. It indicates that a one basis point (percent point) increase in the real national income, keeping the other variables constant, leads to an average 0.218 basis point increase in the real cash balance. That is, the point estimate suggests that a change in real national income is associated with increase in the real cash balance.

The negative sign of the estimated coefficient for nominal interest rate ( $I$ ) variable is consistent with the monetary view and is statistically significant, denoting significant negative effect of the change in nominal interest rate on the change of his/her demand for real cash balance ( $M$ ) in the long run. The resulting estimate of  $\beta_2$  is 0.192, with a *t-value* of -4.452. Similarly, negative sign of the estimated coefficient for rate of inflation ( $P$ ) variable is consistent with the resulting estimate of  $\beta_3$  is 0.097, with a *t-value* of -7.338. It provides a rationale for the idea that monetary policy should be concerned with managing inflation expectations in order to keep real interest rates at a stable level that promotes saving and investment. This implies that in the long-run Bangladesh comparatively individuals less of his/her demand for real money.

The sign of the estimated coefficient of exchange rate ( $R$ ) is negative and statistically significant. The resulting estimate of  $\beta_4$  is -0.571, with a *t-value* of -2.957. It indicates that a one basis point increase in the exchange rate, assuming other variables remain constant, lead to an average - 2.957 basis point reduced of the demand for real cash balance. As a consequence this interaction suggests that depreciation of exchange rate associated with reduced of the demand for real cash balance of Bangladesh.

### **6. Summary and Conclusion**

The paper has sincerely developments in the macroeconomic situation and the monetary system, and identified only few but highly significant existing variables influence on demand for real balance under the open-economy formulations. The opportunity cost variables carry the expected sign according to economic theory. It is also observable that the demand for real balances in the economy is strongly dominated by the transactions motive for holding money. The model is estimated using standard time series econometric techniques, cointegration and error-correction method after testing the stationary of the data series and cointegration among variables of the model. Cointegration analysis reveals that there is a stationary long run relationship between demand for real cash balance, real national income, nominal interest rate, rate of inflation and

exchange rate. The estimation results show that both the long- and short-run demand for real cash balance model of Bangladesh are well specified, stable and statistically significant. Implication of one major policy is that the estimated effect resulting from variation in the exchange rate plays a key role in Bangladesh's money demand behavior. The speed of adjustment coefficient is negative and indicates that demand for real cash balance convergent to the equilibrium and their convergent sign indicate that statistically significant in the long run. Finally, the result also indicates that demand for real money balances in Bangladesh remained stable throughout the period under investigation.

### References:

Adekunle, J. O. (1968). The Demand for Money: Evidence from Developed and Less Developed Economies. *IMF Staff Papers* 2: 251-265.

Ahmad, S. (1977). Transactions Demand for Money and the Quantity Theory. *Quarterly Journal of Economics* 91: 327-335.

Bangladesh Bank (Various issues). Scheduled Bank Statistics. Banking and Statistics Division. Statistics Department. BB.

Bangladesh Bank (Various issues). Monthly Economic Indicators: Monthly Update. Monetary Policy Department. BB.

Baumol, W. J. (1952). The Transactions Demand for Cash: An Inventory Theoretic Approach. *Quarterly Journal of Economics* 66: 545-556.

Chow, G. C. (1966). On the Long-Run and Short-Run Demand for Money. *Journal of Political Economy* 74: 111-131.

Dickey, D. A. and Fuller, W. A. (1981). Likelihood Ratio Tests for Autoregressive Time Series with a Unit Root. *Econometrica* 49: 1057-1072.

Enders, W. (2009). *Applied Econometric Time Series*, 3rd edition, Wiley.

Engle, R. and Granger, C. W. J. (1987). Cointegration and Error Correction: Representation, Estimation and Testing. *Econometrica* 55: 251-276.

Fisher, I. (1911). *The Purchasing Power of Money*. London: Macmillan.

Friedman, M. (1956). *The Quantity Theory of Money: A Restatement*. In *Studies in the Quantity Theory of Money*. M. Friedman (ed.). Chicago: University of Chicago Press.

Friedman, M. (1969). *The Optimum Quantity of Money and Other Essays*. Chicago: University of Chicago Press.

Goldfeld, S. M. (1973). *The Demand for Money Revisited*. *Brookings Papers on Economic*

Activity 3: 577-638.

Hossain, A. (1992). Financial reforms, stability of the money demand function and monetary policy in Bangladesh: An econometric investigation. *Indian Economic Review* 16: 85-100.

Hossain, A. (2006). The Money Demand Behaviour in Bangladesh, 1973-2003: An Application of the Cointegration and Error-Correction Methods. *Indian Economic Review* 41(1): 55-80.

Islam, A. M. (2000). Money Demand Function for Bangladesh. *Bangladesh Development Studies* 16(3):1-30.

Johansen, S. (1988). Statistical Analysis of Cointegrating Vectors. *Journal of Economic Dynamics and Control* 12: 231-54.

Johansen, S. and Juselius, K. (1990). Testing Structural Hypotheses in a Multivariate Cointegration Analysis of the PPP and UIP for the UK. *Journal of Econometrics* 53: 211-244.

Keynes, J. M. (1936). *The General Theory of Employment, Interest, and Money*. Londoand New York: Macmillan.

Miller, S. M. (1991). Monetary Dynamics: An Application of Cointegration and Error Correction Modeling. *Journal of Money, Credit, and Banking* 23: 139-54.

Murti, G. V. S. N. and Murti, S. (1978). The Functional Form of the Demand for Money in Bangladesh. *Bangladesh Development Studies* 6(4): 443-460.

Philips, A. (1988). The Demand for Money in Small Developing Economies: An Application of the Error Correction Mechanism. *Contemporary Issues in Money and Banking*. Chaltenham, Edward Elgar.

Pigou A. C. (1917). The Exchange Value of Legal Tender Money. *Quarterly Journal of Economics* 110-129.

Taslim, M. A. (1984). On the Rate of Interest and Demand for Money in LDCs: The Case of Bangladesh. *Bangladesh Development Studies* 12(3): 19-36.

Tobin, J. (1956). The Interest Elasticity of the Transactions Demand for Cash. *Review of Economics and Statistics* 38: 241-247.

Tobin, J. (1958). Liquidity Preference as Behaviour Towards Risk. *Review of Economic Studies* 25: 65-86.

World Bank (2013). *World Development Indicators-2012*. World Bank CD-ROM. Washington.