





## EXCHANGE RATE UNCERTAINTY AND THE DEMAND FOR MONEY IN BANGLADESH: AN ANALYSIS OF VECM MODEL



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### ABSTRACT

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This paper examines the effect of the exchange rate and its volatility on the demand for money in Bangladesh along with other relevant variables based on monthly data from January 1999 to June 2018. This study applies the Phillips-Perron test to check the stationarity of the variables, Johansen tests for cointegration analysis, and Vector error-correction approach for short and long estimation. The results indicate that income and interest rates positively affect the demand for money in the long run, while exchange rate and volatility in the exchange rate have a negative and significant impact on money demand function in the long run. On the other hand, the variables such as income, exchange rate, and volatility in the exchange rate, have a positive and insignificant relationship with money demand function in the short run, while the interest rate is negative and insignificant associated with money demand function in the short run.

**Contribution/ Originality:** This study contributes to existing literature by examining the impact of exchange rate uncertainty on real money supply in Bangladesh.

### 1. INTRODUCTION

A stable money demand function is usually considered as fundamental for the formulation and application of effective monetary policy since it enables a policy-driven shock in monetary aggregates to have a predictable impact on output, interest, export, and ultimately price (Sriram, 2000). Consequently, a strong effect on both theoretical and empirical literature has been compiled to identify the determinants that affect the stability of money demand function (Sichei & Kamau, 2012). According to the volatility hypothesis of Milton Friedman, the volatility in monetary growth leads to a reduction in velocity or a rise in the demand for money. However, Friedman (1984) argued that the exceptional volatility of monetary growth enhances the dimension of perceived uncertainty and raises the demand for money. After this argument, scholars, and researchers use the volatility of money growth as an indicator of the money demand function.

In the case of developed countries, there is a better performance of estimated functions due to the introduction of uncertainty in the money demand scheme. Since the term of uncertainty is not directly observable, there is an

open discussion about the proper definition of uncertainty. A significant positive coefficient gained for the volatility measurement will confirm Friedman's hypothesis. The list covers only a limited number of studies, i.e., [Choi and Oh \(2003\)](#) who checked the hypothesis in the U.S. and exhibited that monetary uncertainty declined the demand for money in the U.S. A similar conclusion was focused by [Brüggemann and Nautz \(1997\)](#) who investigated the hypothesis applying data from unified Germany. More recent researches, however, tried to recognize the short-run effects of monetary uncertainty from its long-run effects.

The stability of money demand is especially significant for Bangladesh, where the characteristics of the monetary transmission procedure and measurement of some important variables, for instance: output gap and the equilibrium real interest rate are not well-decorated due to the economic fluctuations. The continuous reduction in the dollarization rate, lack of stability in interest rates structure, the rising value of short term capital flows moving suddenly in and out of the country and the proposition of the new credit instruments by the banking sectors are some examples that the forward-thinking policymakers have to deal with when they estimate the impact of their decisions on the economy.

Several pieces of research have been studied on various aspects of money demand functions considering or disregarding the monetary uncertainty. [El-Rasheed, Abdullah, and Dahalan \(2017\)](#) indicated that monetary uncertainty, income, domestic interest rate, inflation, exchange rate, and broad money (M2) were cointegrated. The result found that monetary uncertainty has a significant influence on the demand for money function in Nigeria. [Ajayi \(1977\)](#) examined the money demand function in Nigeria for the period from 1960 through 1970. His result revealed that real income and interest rates have a significant impact on M2, and that money demand function is stable in Nigeria for the study period. [Darrat \(1986\)](#) resulted in surrounding Kenyan M1, which pointed out that the elasticity of income is high with a value of 1.8. [Ghartey \(1998\)](#) estimated the demand for M1 money and found a stable money demand function for Ghana. [Nell \(1999\)](#) examined the stability of the long-run money demand function for M3 over the period 1965-1997 for South Africa. The result confirmed a stable money demand function for M3 while demand for M1 and M2 display parameter instability due to the financial reforms in South Africa since 1981.

However, [Ahmed \(1977\)](#) investigated the money demand function for Bangladesh and he experienced that real income and nominal interest rates are statistically significant at moderate levels. He also estimated that the money demand in Bangladesh is stable. [Murty and Murty \(1978\)](#) applied the appropriate functional structure of money demand function employing the generalized Box-Cox transformations. The empirical findings are similar to [Ahmed \(1977\)](#). On the contrary, [Taslim \(1984\)](#), [Taslim \(1983\)](#) criticized [Ahmed \(1977\)](#). [Hassan \(1992\)](#) studied the stability of the money demand function of Bangladesh. They discovered that real income, interest rate, and expected rate of inflation are the most significant components of money demand function in Bangladesh.

On the whole, it looks that most of the studies on the money demand function of Bangladesh are stable. However, there are some limitations in the prior studies. There are some works, examined times series data, performed regression analyses considering that time series are stationary. Other papers, followed by appropriate time series procedures, have ignored many relevant variables from their models and, thereby, committed specification bias. None of the papers considered the exchange rate uncertainty as an element of the money demand function. [Mundell \(1963\)](#) explained that the effectiveness of monetary and fiscal policies under the floating exchange rate scheme figure on the sensitivity of the demand for money to the exchange rate. It may be a topical factor for the money demand function of a small open economy like Bangladesh.

Addressing this issue, this current paper attempts to find out the limitation of the prior studies on the money demand function of Bangladesh and follows all necessary steps of the time series mechanism.

## 2. DATA AND METHODOLOGY

According to Bahmani-Oskooee, Chang, and Wu (2014) the following empirical model has been constructed to estimate the demand for money in Bangladesh after including a measure of volatility of nominal exchange rate.

$$\ln m2_t = \alpha_0 + \alpha_1 \ln y_t + \alpha_2 \ln m m r_t + \alpha_3 \ln n e r + \alpha_4 \ln n e r\_v_t + \varepsilon_t \quad (1)$$

Where,  $\ln m2$  is a measure of real money supply.  $\ln y$  is industrial production index (IPI) (as a proxy of income).

$\ln m m r$  is nominal money market (Interest) rate.  $\ln n e r$  is rate between nominal exchange BDT and USD.  $\ln n e r\_v$  is the volatility of nominal exchange rate. The volatility of the nominal exchange rate is incorporated from autoregressive conditional heteroscedasticity (ARCH) model. All variables are taken in natural logarithm.

This study is based on monthly data from January 1999 to June 2018 taken. All data are collected from the IFS database published by the IMF. To fulfill the objective of the paper, we use several empirical test. For instance: unit root test, cointegration analysis, and Vector Error Correction Model.

### 2.1. Unit Root Tests

In order to test for the long-run relationship among time series variables, the time series properties of each variable are estimated by the unit autoregressive tests i.e., whether a time series variable is stationary. In this paper, the Phillips–Perron test is used for detecting a unit autoregressive root.

$$\Delta y_t = (\rho - 1)y_{t-1} + y_t \quad (2)$$

Where,  $\Delta$  is the first difference operator. The Phillips–Perron test discuss the issue that the process formatting data for  $y_t$  might have a higher integration order of autocorrelation than is included in the test equation-constructing  $y_{t-1}$  endogenous. Moreover, the Phillips–Perron test reveals a non-parametric correction to the t-test statistic. The analysis is robust regarding unspecified autocorrelation as well as heteroscedasticity in the disturbance procedures of the test equation.

### 2.2. Cointegration Test

The Søren Johansen (1988) maximum likelihood (ML) approach is sufficiently flexible to account for the 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.

$$X_t = \sum_{i=1}^k A_i X_{t-i} + \mu_t \quad (3)$$

Where  $X_t$  a  $p \times 1$  vector and  $\mu_t$  is an independently and identically distributed. In the Case of the stochastic process  $X_t = (\ln M_t, \ln Y_t, \ln e x, \ln V, \ln i_t)$ .

S Johansen and Juselius (1990) suggest writing Equation 6 as:

$$\Delta X_t = \sum_{i=1}^k \Gamma_i \Delta X_{t-i} + \Pi X_{t-k} + \mu_t \quad (4)$$

where,  $\Gamma_t = - (I - \sum_{j=1}^p A_j)$  and  $\Pi = - (I - \sum_{j=1}^k A_j)$  and  $\Delta = 1 - L$ , where  $L$  is the lag operator;  $I$  is the  $n \times n$  identity matrix;  $A$  and elements of  $X_t$  will be given by the rank of  $\Pi$ , denoted as  $r$ ,  $\lambda_i$  is an eigenvalue of estimated  $\Pi$ .

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

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^p \ln(1 - \lambda_i) \tag{5}$$

In this case, each in  $(1 - \widehat{\lambda}_i)$  will be equal to zero (since  $\log 1 = 0$ ), and  $\lambda_{trace}$  will also be equal to zero. However, the farther the estimated eigenvalues are from zero, the more negative is each of the expressions and the larger the  $\lambda_{trace}$  statistic. In the maximum eigenvalue test, the null hypothesis of  $r$  cointegrating vectors is tested against the alternative of  $(r + 1)$  cointegrating vectors by calculating the test Statistic.

$$\lambda_{max}(r, r + 1) = -T \ln(1 - \lambda_{r+1}) \tag{6}$$

Again, if the estimated eigenvalue,  $\lambda_{r+1}$ , 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.

### 2.3. Vector Error Correction Model (VECM)

The cointegration among variables exclusively indicates a long run equilibrium relationship. In point of fact, there may be imbalance in the short run. To examine the short run kinematics among the concerned time series variables, Vector Error Correction Model (VECM) should be promoted.

$$\begin{aligned} \Delta \ln m2_t &= \beta_0 + \sum_{j=1}^m \theta_k \Delta \ln m2_{t-j} + \sum_{j=1}^m \gamma_k \Delta \ln y_{t-j} + \sum_{j=1}^m \tau_k \Delta \ln m m r_{t-j} + \sum_{j=1}^m \varphi_k \Delta \ln n e r_{t-j} + \\ &\sum_{j=1}^m \sigma_k \Delta \ln n e r_{t-j} + \lambda [\ln m2_{t-1} - \widehat{\alpha}_0 - \widehat{\alpha}_1 \ln y_{t-1} - \widehat{\alpha}_2 \ln m m r_{t-1} - \widehat{\alpha}_3 \ln n e r_{t-1} - \widehat{\alpha}_4 \ln n e r_{t-1}] + \varepsilon_t \end{aligned} \tag{7}$$

Where  $\Delta$  uses as the first difference sign,  $\lambda$  exhibits the speed of adjustment from short run to the long run equilibrium and  $\varepsilon_t$  shows as a purely white noise term.

## 3. IMPIRICAL RESULTS

Table 1 indicates the unit root test results. Here, we select the models on the basis of Newey-West lags. According to this finding, all the variables are integrated in both level and first difference for with and without trend. The variables, such as: real money supply, income, exchange rate and exchange rate volatility, are integrated in order one for without trend while only interest rate is stationary at level. On contrary, income and interest rate are integrated in level for trend and other variables also exhibit similar findings like without trend. The results provide the basis for the test of a long-run relationship among the variables.

Table-1. Unit root test.

Variable	Phillips-Perron test				Order of Integration	
	Without Trend		With Trend		Without Trend	With Trend
	Level	1 <sup>st</sup> Diff.	Level	1 <sup>st</sup> Diff.		
lnm2	-1.530	-18.25***	-2.586	-18.49***	I(1)	I(1)
lny	-0.302	-27.95***	-8.233***	---	I(1)	I(0)
lnmmr	-4.810***	---	-5.218***	---	I(0)	I(0)
lnner	-1.897	-11.43***	-2.013	-11.49***	I(1)	I(1)
lnner_v	-1.369	-15.91***	-1.304	-15.95***	I(1)	I(1)

Note: \*, \*\* and \*\*\* represents the level of significance in critical value for 10%, 5% and 1% respectively.

Table 2 reports the Johansen Maximum Likelihood Test for Cointegration analysis. The results reveal that the null hypothesis of no cointegrating equation, i.e.,  $r=0$ , is rejected for both the trace statistics and max statistics. This is because  $\lambda_{trace}$  and  $\lambda_{max}$  are higher than the critical values at the 5% level of significance. The result proves that there is at least one cointegrating equation in each case. The results represent a long run relationship between exchange rate volatility and money demand function in Bangladesh.

Table-2. Johansen Maximum Likelihood Test for Cointegration.

$H_0$	$\lambda_{trace}$ Statistic	5% critical value	$\lambda_{max}$ Statistic	5% critical value
$r = 0$	84.9685***	68.52	40.6390***	33.46
$r \leq 1$	44.3296	47.21	27.0019	27.07
$r \leq 2$	17.3277	29.68	9.5766	20.97
$r \leq 3$	7.7511	15.41	6.3540	14.07
$r \leq 4$	1.3971	3.76	1.3971	3.76

Notes: (i)  $r$  = number of cointegrating vectors; (ii) The lag order is 2, which is chosen by the AIC; (iii) \* and \*\* denote rejection of the hypothesis at the 5% and 1% significance level respectively.

Table-3. Vector error correction model.

Variable	Long run relationship			
	Coefficient	Standard Error	Z-value	P>  Z
lnm2	1	---	---	---
lny	-7.47028***	1.254437	-5.96	0.000
lnmmr	-2.792956***	.4471588	-6.25	0.000
lnner	18.22153***	3.846341	4.74	0.000
lnner_v	.3954449***	.1144522	3.46	0.001
Constant	-62.06363	---	---	---

The long run equation:

$$\widehat{\ln m2} = 62.06 + 7.47\widehat{\ln y} + 2.79\widehat{\ln mmr} - 18.22\widehat{\ln ner} - .395\widehat{\ln ner\_v}$$

$$\text{S.E.} = \quad (1.54) \quad (.447) \quad (3.846) \quad (.114)$$

$$\text{P-value} = \quad (.000) \quad (.000) \quad (.000) \quad (.001)$$

Table 3 exhibits the long run Vector error correction model test results. Here, all coefficients are significant at 1% significance level. Considering the findings of model 7, the estimated coefficient sign of income is positive and significantly associated to money demand function. Theoretically, an increase in income leads to raise the demand for money in Bangladesh. Also, interest rate has positive and significant relationship with the money demand function. That means, when interest rate increases the demand for money and consequently decreases saving deposits. The coefficient of nominal exchange rate is negative and significant related to the demand for money function. An appreciation of US dollar increases the value of foreign assets in terms of taka which ultimately

motivates the citizens of Bangladesh to demand less money. However, nominal exchange rate volatility negatively affects the money demand function which explains that the volatility in the foreign exchange market minimizes the demand for real money balance. To alleviate the potential loss occurred from the volatility of the foreign exchange rate, the citizens will retain less money and deposits more in the financial institutions. On contrary, uncertainty in exchange rate market will encourage people to reserve more dollar than local currency (Taka).

Table-4. Vector error correction model.

Variable	Short run relationship			
	Coefficient	Standard Error	Z-value	P> Z
_ce1 L1.	.0014033	.0010223	1.37	0.170
lnm2 LD.	-.162768	.0727389	-2.24	0.025
lny LD.	.0189332	.0155195	1.22	0.222
lnmmr LD.	-.0005118	.0036046	-0.14	0.887
lnner LD.	.0804372	.1181973	0.68	0.496
lnner_v LD.	.0056286	.0036282	1.55	0.121
_Constant	.008405	.0011509	7.30	0.000

Table 4 reports the short run vector error correction model test results. Based on the findings, the variables such as: income, exchange rate, and exchange rate volatility, have positive but insignificant association with money demand function in the short run, while interest rate has inverse relationship related to demand for money.

#### 4. CONCLUSIONS

This current study examines the cointegrating causality of money demand with exchange rate volatility in Bangladesh using monthly data covering January 1999 to June 2018. This paper lights on the impact of some key variables of exchange rate and exchange rate uncertainty on the money demand function in Bangladesh. In General, the demand for real money in the economy is robustly dominated by the nominal exchange rate, income, exchange rate volatility, and interest rate. To fulfill the objectives this study applies the Phillips-Perron test for unit root, Johansen tests for cointegration, and the Vector error-correction approach.

Based on the estimated findings, income and interest rates positively affect the demand for money in the long run, while exchange rate and volatility in the exchange rate have a negative and significant impact on money demand function in the long run. On the other hand, the variables such as income, exchange rate, and volatility in the exchange rate, have a positive and insignificant relationship with money demand function in the short run, while the interest rate is negative and insignificant associated with money demand function in the short run.

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