Interest Rates and the Demand for Money in Bangladesh: An Empirical Investigation with Quarterly Data, 1997Q4-2006Q4

Akhand Akhtar Hossain
Sayera Younus *

ABSTRACT

This paper investigates the sensitivity of money demand to interest rates on treasury bills in Bangladesh with quarterly data for the period 1997Q4-2006Q4. A standard demand for money function is specified with real output and a representative interest rate on treasury bills as key determinants. The ADF and the KPSS test results suggest that real money balances (narrow or broad) and real output appear to have a unit root while the interest rates on treasury bills are stationary. The paper estimates the long-run demand for money relationship sequentially with a representative interest rate on treasury bills of a particular maturity by using both Ordinary Least Squares and Dynamic Ordinary Least Squares methods. Empirical results suggest that there exists a well-behaved and stable money demand function and that the demand for money is sensitive to interest rate, e.g. on 182-day treasury bills. The long-run income elasticity of the demand for narrow money is about 1.15 while the corresponding value for broad money is about 1.7. The long-run interest elasticity of the demand for money is about (-) 0.2. Finally, the paper, following Heller and Khan (1979), incorporates the term-structure of interest rates in the money demand function. Empirical results are however unsatisfactory, in that the coefficients on the pre-estimated parameters of a quadratic yield curve are insignificant and/or not consistent with a priori theoretical expectations.

Term Structure of the Interest Rates and the Demand for Money in Bangladesh: An Empirical Investigation with Quarterly Data, 1997Q4-2006Q4

I. INTRODUCTION

The role of monetary policy in Bangladesh has gained increasing importance over the last decade or so for maintaining macroeconomic stability in general and price stability[1] in particular. In late 2005, the Bangladesh Bank (the country's central bank) formalized the framework for the conduct of monetary policy to achieve what it calls '*price stability with the highest sustainable output growth*' (Bangladesh Bank 2005). This has been part of its strategy to make monetary policy more credible and effective in achieving and maintaining price and thereby exchange rate stability. Since then, the Bank has continued with monetary targeting given that a loose form of monetary base targeting has been in place since 2003 under the IMF-supported *Poverty Reduction and Growth Facility* program. The experience of the past two years however reveals that the Bank does not follow a strict rule-based monetary targeting for long-term price stability but uses various monetary policy instruments to stabilise the short-term fluctuations of output and prices. This policy note investigates whether the key underlying relationship in monetary targeting, such as the stability of the money demand function remains valid and that whether (or to what extent) the demand for money has become sensitive to market-determined interest rates on treasury bills.[2]

II. INTEREST RATES AND THE DEMAND FOR MONEY: THEORY AND EMPIRICAL STUDIES IN BANGLADESH

One key issue in the literature on monetary policy is the role of interest rates in the demand for money function. While the Keynesian economists consider the interest rate an important determinant of money demand (and therefore a source of instability in the money demand function), the monetarists downplay the role of interest rates in the money demand function unless the interest elasticity of money demand is very large as the Keynesians claim.[3] According to Friedman (1956), the relevant interest rate in the demand for money function should be the interest rate on bonds (i_b) minus the interest rate on money itself (i_m), which is considered zero but, in Friedman's view, should be positive when the implicit rate of return on money is treated as a return on money. In a competitive financial system, the interest rates on bonds and the implicit rate of return on money move together and

* Associate Professor of Economics, Faculty of Business and Law, University of Newcastle, Australia, email: *akhtar.hossain@newcastle.edu.au* and Senior Research Economist, Policy Analysis Unit, Research Department, Bangladesh Bank, Bangladesh, email: *sayera33@yahoo.com*, respectively.

[1] For all intents and purposes, price stability means 'low and stable inflation' without suggesting any particular rate of inflation that should be considered low and stable in a statistical sense.

[2] Although the money and capital markets in Bangladesh are yet to be adequately developed for any successful implementation of a sophisticated strategy of monetary policy such as full-fledged inflation targeting, it is important to determine whether the money demand function has become sensitive to market determined interest rates given that financial reforms have allowed the interest rates to be determined by market forces over the past decade or so. This information is important under monetary targeting that relies heavily on stability of the demand for money function in which interest rates have some role.

[3] For example, Friedman (1969:155) writes:

> It is important that we try to determine as accurately as possible the characteristics of the demand for money, including the elasticity of demand with respect to interest rates. But in my opinion no "fundamental issues" in either monetary theory of monetary policy hinge on whether the estimated elasticity can for most purposes be approximated by zero or is better approximated by –.1 or -.5 or -2.0, provided it is seldom capable of being approximated by - ∞. The important consideration for monetary theory and policy is whether the demand for money can be treated as a reasonably stable function of a fairly small number of variables and whether this function can be empirically specified with reasonable accuracy. Whether one important argument of the function is an interest rate or set of interest rates is much less important.

therefore the interest rate differential ($i_b - i_m$) may remain relatively unchanged and should not affect the demand for money (Friedman1959; Mishkin 2007).

Until recently, most interest rates in developing countries (including Bangladesh) were institutionally set at levels below the rates that competitive markets would have generated otherwise. In some instances, the interest rates were kept well below the inflation rate, implying negative real interest rates.[4] Furthermore, in the absence of a range of financial assets, asset substitution took place between money and physical assets[5] and not between money and interest-bearing financial assets, since if the prices of alternate assets rise with the price level, their real returns are zero whereas the real return on money (given that its nominal value is fixed) is minus the rate of inflation. Physical assets therefore represented a major hedge against inflation and acted as alternative assets in the portfolio of non-bank public. All these factors made expected inflation a better proxy for the opportunity cost of holding money in Bangladesh. Still, following the empirical literature, researchers have used both the deposit rate of interest and a proxy for expected inflation in the empirical money demand function for Bangladesh.[6]

III. ESTIMATING A MONEY DEMAND RELATIONSHIP WITH INTEREST RATES ON TREASURY BILLS

Estimation of a long-run money demand function involves the establishment of a cointegral relationship among money, prices, income and the interest rates. As part of empirical investigation of the money demand behaviour in Bangladesh, the time series properties of variables in the money demand function are investigated by both the ADF and the KPSS tests. The definitions of variables and the unit root tests results suggest that real money balances (narrow or broad) and real output appear to have a unit root but the interest rates on treasury bills are stationary. This indicates that real money balances and real output are eligible to form a cointegral relationship while the interest rates and any other stationary variables may be included in the long-run regression to reduce bias in the estimates.[7]

Tables 1-2 report both the OLS and DOLS estimates of the demand for money function where the interest rate on treasury bills of a particular maturity is used for estimation purposes. After experimentation with the general form of the DOLS specification (with $\kappa = 2$), a simplified equation is reported with an interest rate of a particular maturity after elimination of the first-difference terms that are statistically significant. In the results the figures in parentheses are absolute t-ratios, R^2 is the adjusted coefficient of determination, SER is the standard error of the regression, DW is the cointegration regression Durbin-Watson statistic, DF is the Dickey-Fuller statistic for a unit root in the residuals and SM, SJ and SS are seasonal dummies.

The regression results obtained by the DOLS are superior to those of OLS. They suggest that the coefficients on both output and the interest rate on treasury bills of longer-term maturities bear their expected signs and are highly significant. The DOLS regression equation with the interest rate on 182-day treasury bills performs the best and is used for interpretation. The Wald test statistic (not reported)

[4] This has been the case for Bangladesh especially during the early 1970s.

[5] They include land, houses, gold, silver and consumer durables.

[6] The major studies on money demand in Bangladesh include Ahmed (1977), Rahim and Sohrabuddin (1986, 1988), Bahar (1987), Taslim (1983, 1984), Hossain (1988), Hasan (1992), Islam (2000), and Hossain (2003, 2006). These studies have included real output and the deposit rate of interest, with or without expected inflation, as the opportunity cost of holding money.

[7] Note that real balances and real output are I(1) and therefore the cointegrating equation between real balances, real output and the interest rate is balanced. The inclusion of the interest rate, which is I(0), is appropriate on both theoretical and statistical grounds (Vogelvang 2005).

suggests that the long-run income elasticity of the demand for narrow money is significantly greater than one. The null hypothesis that the coefficient on the interest rate is zero is also rejected. The coefficient values obtained here with quarterly data are not much different from those obtained by annual data in other studies such as Hossain (2006). The estimated equation is well-behaved and stable, as the CUSUM and CUSUM-SQ of residuals suggest. [8]

Table 2 reports the regression results for real broad balances. The results are similar to those obtained with real narrow balances. The coefficients on real output and the interest rate on treasury bills of a longer-term maturity bear their expected signs and are highly significant. The Wald test statistic (not reported) suggests that the income elasticity of the demand for broad money is significantly greater than one. The null hypothesis that the coefficient on the interest rate on treasury bills is zero is also rejected. The preferred model with the interest rate on 182-day treasury bills performs the best. The model is well-behaved and stable, as the CUSUM and CUSUMSQ of residuals suggest.

IV. ESTIMATING THE MONEY DEMAND FUNCTION WITH THE TERM STRUCTURE OF INTEREST RATES

In an influential theoretical paper, Friedman (1977) argued that in a demand for money equation the whole term structure of interest rates is relevant. Heller and Khan (1979) adopted Friedman's idea and estimated a quarterly U.S. money demand equation over the period 1960-1976. In a follow-up paper, Friedman and Schwartz (1982) incorporated the term structure of interest rates with their phase-average data for the United States covering the period 1873-1975.

Empirical Results

In this note, equation (6) has been used for estimation purposes. Table 3 reports the regression results. The overall results are unsatisfactory, in the sense that the coefficients on estimated yield curve parameters are insignificant or unstable. The equations remain relatively stable when only the intercept and the slope parameter of the yield curve are used. The diagnostic statistics also suggest that the equations suffer from other statistical problems.

V. SUMMARY AND CONCLUDING REMARKS

Empirical results of the present analysis suggest that there exists a well-behaved and stable demand for money function and that the demand for money (narrow or broad) is sensitive to the interest rate, e.g. on 182-day treasury bills. The long-run income elasticity of the demand for narrow money is about 1.15 while the corresponding value for broad money is about 1.7. The long-run interest elasticity of the demand for money (narrow or broad) is about (-) 0.2. Finally, the analysis incorporates the term-structure of interest rates in the money demand function. Empirical results are however unsatisfactory, in the sense that the coefficients on the pre-estimated parameters of a quadratic yield curve are insignificant and/or not consistent with *a priori* theoretical expectations.

The overall results suggest that there exists a stable money demand function in Bangladesh, in which a representative interest rate on treasury bills of a relatively longer-maturity gives better results irrespective of the definition of money. This finding makes sense because the term structure of interest rates is not yet fully developed and therefore it does not provide adequate information on market sentiments of inflationary expectations and their impact on money demand. A relatively small number of interest rates on treasury bills of shorter maturities also do not give robust estimates of the yield

[8] Figures are available upon request

curve parameters and therefore their incorporation in the money demand function has not been satisfactory.

The key finding that there exists a stable money demand function has, however, implications for the design and conduct of monetary policy in Bangladesh. Inflation in Bangladesh remains volatile, although such volatility has diminished since the 1980s. Under the circumstances, for price stability and steady economic growth, the Bangladesh Bank needs to maintain a steady money supply growth target through well-designed monetary control measures provided that the money demand function remains stable. The conduct of monetary policy within this framework would raise the credibility of the Bangladesh Bank and also stabilise the prices and outputs and thereby help individuals to smooth their consumption over time. Unstable money supply growth and inflation instability would adversely affect economic growth and undermine the authority and credibility of the Bangladesh Bank. At the same time, as money is not neutral in Bangladesh, the Bangladesh Bank, though may remain under pressure to generate ‘inflation surprises’ to stimulate economic activity, needs to avoid policies that create both monetary policy and inflation uncertainties.

Appendix

Table 1
The Estimates of Income and Interest Elasticity's of the Demand for Narrow Money

	Model 1 (with 28-day TB rate)		Model 2 (with 90-day TB rate)		Model 3 (with 182-day TB rate)		Model 4 (with 364-day TB rate)	
Variables	OLS	DOLS	OLS	DOLS	OLS	DOLS	OLS	DOLS
Constant	-1.46(2.26)	-1.18 (1.59)	-1.11 (1.66)	-0.29 (0.40)	-0.98(1.44)	-0.01 (0.01)	-1.10 (1.50)	-0.39(0.46)
ln y_t	1.23(22.14)	1.23 (19.06)	1.21 (21.18)	1.16(18.76)	1.20(21.07)	1.15(18.09)	1.21 (19.61)	1.17 (16.44)
ln i_t	0.01 (0.37)	-0.04(1.21)	-0.02 (0.48)	-0.12(2.78)	-0.04 (0.75)	-0.18(3.09)	-0.02 (0.42)	-0.12 (2.19)
Δln y_{t+1}		-1.04 (1.74)		-1.04 (1.95)		-1.05 (1.92)		-0.95 (1.59)
Δln y_t		-1.67 (2.71)		-1.52 (2.71)		-1.41 (2.38)		-1.42 (2.26)
Δln y_{t-1}								-0.09 (1.16)
Δln i_{t+1}						-0.13 (1.64)		-0.10 (1.55)
Δln i_t						0.12 (1.42)		0.12 (1.42)
Δln i_{t-1}		0.10 (1.76)		0.22 (3.03)		0.17 (2.30)		0.08(1.06)
SM	0.03 (1.42)	-0.15 (1.83)	0.025 (1.29)	-0.12 (1.55)	0.02 (1.22)	-0.10 (1.22	0.03 (1.26)	-0.11 (1.33)
SJ	-0.04 (1.93)	-0.19 (2.54)	-0.04 (2.02)	-0.18 (2.62)	-0.04 (2.08)	-0.16 (2.27)	-0.04 (1.99)	-0.16 (2.14)
SS	0.13 (6.20)	-0.11 (0.96)	0.12 (6.03)	-0.06 (0.58)	0.12 (5.88)	-0.03 (029)	0.12 (5.89)	-0.06 (0.55)
Diagnostics								
R^2	0.95	0.96	0.95	0.97	0.95	0.97	0.95	0.96
SER	0.042	0.033	0.041	0.029	0.041	0.030	0.042	0.032
DW	0.76	0.95	0.76	1.08	0.80	1.28	0.77	1.17
DF	-3.53		-3.50		-3.65		-3.55	

Table 2
The Estimates of Income and Interest Elasticity's of the Demand for Broad Money

	Model 1 (with 28-day TB rate)		Model 2 (with 90-day TB rate)		Model 3 (with 182-day TB rate)		Model 4 (with 364-day TB rate)	
Variables	OLS	DOLS	OLS	DOLS	OLS	DOLS	OLS	DOLS
Constant	-5.59(9.23)	-5.22 (6.82)	-5.45 (8.70)	-4.67(5.80)	-5.47(8.51)	-4.51(5.69)	-5.49 (7.91)	-4.94 (6.88)
ln y_t	1.74(33.28)	1.73 (26.41)	1.73 (32.60)	1.69(25.11)	1.73(32.39)	1.68(25.83)	1.73 (29.87)	1.71 (28.68)
ln i_t	-0.04(1.20)	-0.09(2.28)	-0.05(1.42)	-0.15(2.82)	-0.06 (1.32)	-0.19(3.14)	-0.04 (1.07)	-0.11 (2.47)
Δln y_{t+1}								
Δln y_t		0.99(2.35)		-0.91 (2.26)		-0.78 (1.85)		-0.89 (2.26)
Δln y_{t-1}								
Δln i_{t+1}		-0.06(1.21)				-0.16(1.87)		
Δln i_t				-0.06 (1.03)		0.13(1.54)		
Δln i_{t-1}		0.12(1.87)		0.22 (2.57)		0.16(2.05)		0.16 (2.11)
SM	0.10(5.22)	-0.11(1.25)	0.10 (5.21)	-0.09 (1.04)	0.10(5.11)	-0.06 (0.73)	0.10(5.06)	-0.08 (1.07)
SJ	-0.03(1.78)	0.08(2.84)	-0.03 (1.84)	-0.07 (2.49)	-0.03(1.87)	-0.05(1.65)	-0.03(1.71)	-0.07 (2.65)
SS	0.20(10.05)	-0.06 (0.55)	0.20(10.20)	0.04(0.32)	0.19(9.99)	0.01 (0.06)	0.20(9.86)	-0.05 (0.45)
Diagnostics								
R^2	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
SER	0.039	0.034	0.039	0.032	0.039	0.032	0.039	0.033
DW	0.67	0.39	0.67	0.49	0.72	0.49	0.65	0.60
DF	-3.22		-3.20		-3.40		-3.19	

Table 3
Estimates of Income and Interest Elasticity's
With the Term Structure of Interest Rates

Variables	Narrow Money Demand: ln (NM/P)			Broad Money Demand: ln (BM/P)		
Variables	OLS*	DOLS**	DOLS***	OLS*	DOLS**	DOLS***
Constant	1.69(2.66)	-1.80 (3.57)	1.80 (3.82)	-6.13(9.45)	-6.89 (10.36)	-6.89 (9.01)
ln y_t	1.26(22.92)	1.29 (29.44)	1.29 (31.65)	1.78(31.72)	1.86 (31.94)	1.86 (26.60)
Intercept (α)	-0.03 (0.64)	-0.05(1.36)	-0.05(1.02)	0.003 (0.08)	0.01(0.23)	0.01(0.19)
Maturity (β)	0.27 (0.27)	-0.62 (2.65)	-0.62 (2.40)	0.77 (0.76)	0.77 (0.72)	0.77 (0.63)
Maturity-sq(γ)	12.16(0.77)			11.08(0.69)	11.06 (0.63)	11.06 (0.55)
Δln y_{t+1}					-0.65(0.90)	-0.65(1.27)
Δln y_t					-2.20 (2.60)	-2.20 (3.29)
Δln y_{t-1}		-0.82 (2.18)	-0.82 (2.26)		-0.90(1.35)	-0.90(1.43)
SM						
SJ	0.03 (1.52)	-0.12 (1.59)	-0.12 (1.79)	0.10 (5.19)	0.02 (0.13)	0.02 (0.15)
SS	-0.05 (2.35)	-0.08 (3.02)	-0.08 (2.98)	-0.03 (1.55)	-0.12 (1.33)	-0.12 (1.82)
	0.13 (6.70)	-0.08 (0.75)	-0.08 (0.83)	0.20 (9.94)	-0.06 (0.43)	-0.06 (0.49)
Diagnostics						
R^2	0.95	0.97		0.98	0.98	0.98
SER	0.040	0.033		0.041	0.037	0.037
DW	1.08	1.01		0.66	0.45	0.45
CUSUM	Unstable	Stable		Unstable	Stable	Stable
CUSUM-SQ	Stable	Stable		Stable	Stable	Stable
Test for:						
Serial Correlation		F(4,24) =1.71			F(4,19) = 8.44	
Functional form mis-specification		F(1,27) = 0.03			F(1,22) = 22.83	
Normality of the residuals		$\chi^2_{(2)}$ = 0.05			$\chi^2_{(2)}$ = 2.19	
Heteroskedasticity		F(1,34) = 3.17			F(1,32) = 0.29	

Notes: *Estimation Period: 1997Q4-2006Q4 **Estimation Period: 1998Q2-2006Q4 ***t-ratios are based on heteroskedasticty-adjusted standard errors.

Data Sources and the Time Series Properties

The unit root test results of the series have been performed by augmented Dickey-Fuller (ADF) and the Kwiatkowski, Phillips, Schmidt and Shin (KPSS) tests. On the basis of the ADF and the KPSS tests, it appears that real narrow money balances (narrow or broad) and real output have a unit root while the interest rates on treasury bills are stationary. The tests results are not conclusive and remain sensitive to the inclusion of the trend. Given the small sample size, the regression analysis is based on the decision that real balances, real output and the yield curve parameters have a unit root while the interest rates are stationary. It is better when these tests results are consistent or confirmatory because most unit root tests have low power, especially when the span of the sample is short (Maddala 2001). For testing purposes, all the series (except yield curve parameters) have been transformed into natural logarithmic form. The tests are conducted for the period 1997Q4-2006Q4. The lag-adjusted sample size is however smaller, depending on the number of lag terms used in the regression. Since the tests results are sensitive to the lag length, the Schwartz Bayesian Criterion (SBC) is used for selection of the optimal lag length under the restriction that the maximum lag length is nine. For all the series, the nine lag terms are more than adequate to make the residuals a white noise. [9]

[9] The detail test results are available upon request.

Econometric Methodology

This paper applies the Engle-Granger approach to cointegration which involves a two-step estimation of cointegral and error-correction models. In the first step, the cointegrating coefficients β_1 and β_2 between Y, X1 and X2 in the form of a regression $Y_t = \alpha + \beta_1 X1_t + \beta_2 X1_t + z_t$ is estimated by OLS. The null hypothesis that Y, X1 and X2 are integrated of order one I(1) and cointegrated with the cointegrating coefficients β_1 and β_2, then $Y_t - \beta_1 X1_t - \beta_2 X2_t$ should be stationary; otherwise $Y_t - \beta_1 X1_t - \beta_2 X2_t$ is non-stationary; that is, $Y_t - \beta 1 X1_t - \beta 2 X2_t$ is I(1). Therefore, in the second step a Dickey-Fuller t-test (with an intercept but no trend) is used to test for a unit root in the residuals from the first-step regression, z_t. Given that the cointegration coefficients β_1 and β_2 are estimated in the first step prior to testing for a unit root in the error-correction term, z_t, different critical values are to be used. For example, the large-sample critical value at the 5 per cent level for 3-variable case (Y, X1 and X2) is -3.80 (Stock and Watson 2007, p.660).

In order to draw inference on the cointegration coefficients, there are estimators such as the dynamic OLS (DOLS) that can be applied. When the variables say Y and X are I(1) and cointegrated, the DOLS estimator of the cointegration coefficient is efficient and statistical inference about the cointegration coefficient based on heteroskedasticity-adjusted standard errors is valid in large samples (Stock and Watson, 2007). The DOLS estimator is based on a modified version of the cointegrating equation: $Y_t = \alpha + \beta X_t + z_t$, in which it includes past, present and future values of the change in X. That is, the estimating equation takes the following general form:

$$Y_t = \alpha + \beta X_t + \Sigma \delta_j \Delta X_{t-j} \ (j=-\kappa \text{ to } \kappa) + u_t.$$

ESTIMATING THE MONEY DEMAND FUNCTION WITH THE TERM STRUCTURE OF INTEREST RATES

Heller and Khan (1979:114) have considered the following two functions:

$$\log R_i = \alpha + \beta \tau_i \qquad (2)$$

$$\log R_i = \alpha + \beta \tau_i + \gamma \tau^2_i \qquad (3)$$

where R_i (i = 1,…..,n) is the rate of interest on the financial asset with the i_{th} maturity period, τ. This means R_1 is the interest rate on financial asset with the shortest time of maturity. The quadratic equation (3) can be used to interpret the parameters α, β and γ. The intercept term (α) is the shift parameter for the entire term structure of interest rates. The slope and curvature of this function are given by: $d \log R_i/d\tau_i = \beta + 2\gamma\tau$ and $d^2 \log R_i/d\tau^2_i = 2\gamma$. Given that the yield curve is usually inverted U-shaped, β is expected to be positive and γ negative. However, when the yield curve takes a U-shape, β is expected to be negative and γ positive. A U-shaped yield curve suggests that the short-term interest rate is likely to fall in the near future while it would rise in the distant future. Assuming that there are a relatively large number of interest rates on bonds for different maturities[10], Equation (3) can be estimated for each data point and the estimated parameters can be introduced into a long-run money demand function. Accordingly, Heller and Khan (1979) have specified their conventional money demand function in the following log-linear form:

$$\log m^d_t = \delta_0 + \delta_1 \log y_t + \eta_1 R_{1t} + \eta_2 R_{2t} + \ldots. + \eta_n Rn_t \qquad (4)$$

where the desired demand for real money balances m^d (= M^d/P where M^d is the desired demand for nominal money and P is the general price level) depends on real income (y) and the returns on

[10] This is usually true for developed bonds markets in countries such as the United States, the United Kingdom and Japan but not so in developing countries especially because they are often highly inflationary and their capital markets are dominated by very short-maturity treasury bills.

alternative financial assets of different maturities (R_i) as opportunity cost variables. In this specification, all the interest rates affect the demand for money simultaneously. As it is difficult to estimate the model with all interest rates because of multicollinearity problem, they estimated parameters of the yield curve (α, β, and γ) and used them to re-specify Equation (4) in the following form:

$$\log m^d_t = \delta_0 + \delta_1 \log y_t + \delta_2 \alpha_t + \delta_3 \beta_t + \delta_4 \gamma_t \quad (5)$$

where δ_s are parameters to be estimated. At equilibrium, the desired demand for real balances equals actual real balances ($m^d = m$). Equation (5) is then expressed in the following equilibrium from for estimation purposes:

$$\log m_t = \delta_0 + \delta_1 \log y_t + \delta_2 \alpha_t + \delta_3 \beta_t + \delta_4 \gamma_t \quad (6)$$

The expected signs of the parameters are as follows: $\delta_1>0$, $\delta_2<0$, $\delta_3<0$ and $\delta_4>0$.

Definitions of Variables:

RGDP = GDP at constant prices (Millions of Taka)
NM = Narrow Money (currency plus demand deposits) at the end of the period (Millions of Taka)
BM = Broad money (NM plus time deposits) at the end of the period (Millions of Taka)
CPI = Consumer Price Index in Bangladesh
INT28= Yield on 28-day Treasury Bills (per cent)
INT90= Yield on 90-day Treasury Bills (per cent)
INT182= Yield on 182-day Treasury Bills (per cent)
INT364= Yield on 364-day Treasury Bills (per cent)
Intercept (α), Maturity (β) and Maturity-Sq (γ) are estimated parameter values of the quadratic yield curve generated from yields on treasury bills of different maturities (INT28, INT90, INt182 and INT364).
Source: Research and Monetary Policy Departments, Bangladesh Bank.

References

Ahmed, S. (1977), "Demand for Money in Bangladesh: Some Preliminary Evidences", *The Bangladesh Development Studies*, Vol.5, No.2, (April), pp.225-237.

Bahar, H.(1987), "Demand for Money in Bangladesh", *Bank Parikrama, Vol.12, No.2, pp.101-107*

Bangladesh Bank (2005), "Notes on the Monetary Policy Strategy of the Bangladesh Bank", Policy Notes Series: PN0602, Bangladesh Bank, Head Office, Dhaka.

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

Friedman, M. (1956), "The Quantity Theory of Money: A Statement". In Friedman, M. (ed), *Studies in the Quantity Theory of Money*, The University of Chicago Press, Chicago, pp.3-21.

Friedman, M. (1959), "The Demand for Money: Some Theoretical and Empirical Results", *Journal of Political Economy*, Vol.67, No.4, pp.327-351.

Friedman, M (1969). "The Optimum Quantity of Money". In Friedman, M. (ed.), *The Optimum Quantity of Money and Other Essays*. Chicago: University of Chicago Press, pp.1-50.

Friedman, M. (1977), "Time Perspective in Demand for Money", *Scandinavian Journal of Economics*, Vol.79, No.4, pp.397-416.

Friedman, M. and A.J. Schwartz (1982). "The Effect of Term Structure of Interest Rates on the Demand for Money in the United States", *Journal of Political economy*, Vol.90, No.1(February), pp.201-212.

Hasan, K. (1992). "An Econometric Analysis of Credit Constraint, Foreign Interest Rate and Currency Depreciation in the Demand for Money in Bangladesh", *The Bangladesh Development Studies*, Vol.20, No.4, (December), pp.25-43.

Heller, H. R. and M.S. Khan (1979). "The Demand for Money and the Term Structure of Interest Rates", *Journal of Political Economy*, Vol.87, No.1 (February), pp.109-129.

Hossain, A. (1988), "A Quarterly Short Run Money Demand Model for Bangladesh'. *Bangladesh Development Studies*, Vol.16, No.3, pp.1-30.

Hossain, A. (2003), An Examination of Some Key Issues in the Conduct of Monetary Policy in Bangladesh", in Ali, A., R. Kuddus and S.S. Andaleeb (eds.), *Development issues of Bangladesh-II*, The University Press Limited, Dhaka, pp.269-303.

Hossain, A. (2006), "The Money Demand Behavior in Bangladesh, 1973-2006: An Application of the Cointegration and Error-Correction Methods", *Indian Economic Review*, Vo.41, No.1, pp.55-80.

Islam, M.A (2000),"Money Demand Function for Bangladesh", *Bangladesh Development Studies*, Vol.26, No.4, pp.89-111.

Johansen, S. (1988). Statistical Analysis of Cointegration Vectors. *Journal of Economic Dynamics and Control*, 12 (June-September), 231-254.

Johansen, S. and K. Juselius (1990), "Maximum Likelihood Estimation and Inference on Cointegration with Applications to the Demand for Money*', Oxford Bulletin of Economics and Statistics*, Vol.52 (May),pp.169-210.

Maddala, G.S. (2001), *Introduction to Econometrics*. John Wiley and Sons, New York.

Mishkin, F.S. (2007), *The Economics of Money, Banking and Financial Markets*, Addison-Wesley, New York.

Rahim, A.M.A and M. Sohrabuddin (1988), 'Central Banking, Monetary Management and Related Issues with Reference to Bangladesh Experience', *Bangladesh Journal of Political Economy*, Vol.8(1), pp.182-201.

Sohrabuddin, M. (1986), "Monetary Policy in the Third Five Year Plan", *Bangladesh Journal of Political Economy*, Vol.7(1A), pp.198-209.

Stock, J.H. and M.W. Watson (2007), *Introduction to Econometrics*, Pearson Addison-Wesley, New York.

Taslim, M.A. (1983), "Aid-Elasticity of Demand for Money in Bangladesh", *Indian Economic Review*, Vol.18(2), pp.285-91.

Taslim, M.A. (1984), "On Rate of Interest and Demand for Money in LDCs: The Case of Bangladesh", *Bangladesh Development Studies*, Vol.12 (Sept), pp-27.

Vogelvang, B (2005), *Econometrics: theory and Applications with Eviews*. New York: Addison-Wesley.