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Monetary Policy and Macro-Economy: An Empirical Study Based on Economic Statistics

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Abstract: *Like other central banks, Bangladesh Bank adopts monetary policy for controlling the supply of money as an instrument to accomplish the goals of general economic policy. The long term objective of monetary policy in Bangladesh is to ensure sustainable economic growth. The short term objectives are generally determined after a careful and pragmatic evaluation of the current economic condition of the country. This research article focuses on the association between monetary policy and GDP. Along with similar studies by various researchers, the ARDL Model analysis has been applied to test the hypothesis. Economic statistics of past 35 years of Bangladesh have been used to reach to the conclusion. The study shows significant relationship between interest rate and GDP in the long run. And the study also shows significant relationship between Money Supply (M2) and GDP in the long run but it shows insignificant relationship in the short run between monetary policy and GDP. It must be noted that this study did not consider other tools of monetary policy which can alter the impact of monetary policy on GDP. The findings from this research encourage further sophisticated research considering other factors to have more transparent outcomes.*

Keywords: Monetary policy, hypothesis, *GDP, Money Supply, M2, macro-economic research.*

Introduction

Monetary policy can be described as ways of managing the supply of money in an economy of a country. It is the process by which the central bank of a country regulates the supply of money by targeting a rate of interest for the purpose of improving economic growth and stability. Monetary policy relies on the relationship between the rates of interest at which money can be borrowed in an economy, and the total supply of money. Bangladesh economy is experiencing significant problems both from demand side and supply side. Developing countries always suffer from poverty, imperfection in both factor and product markets, continuous disequilibrium in the economy, poor administrative structure, inappropriate tax structure, deep dependence on external sector, lack of capital stock, and substantial unemployment. Bangladesh is not only administratively disorganized but also underdeveloped in the transport, telecommunication, and energy sectors. Massive amount of unemployment, low standard of living, low level of saving, excess unskilled labor, severe balance of trade deficit and low growth rates are always

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being faced by the economy. Moreover, political instability causes serious problem for the economy.

Apart from these, both the agricultural and the industrial sectors have not developed their full potential yet. Large portion of public and private investment sectors are unutilized. The economy is cursed by the amount of classified debts each year. Monetary and fiscal policy of the country is also not properly coordinated and well managed.

As the banking sector always have to face the wave of any sort of economic disorder in the macro-economy, the central bank needs to be very cautious for the proper implementation of the monetary policy to navigate the economy for a long term growth

Objectives of the Study

Central bank, the highest authority of making such kind of decisions relevant to monetary policy, employs the policy to control the macro-economy. The purpose of this study is to find out the association of four tools of monetary policy (Interest Rate, Real Effective Exchange Rate and M2) on the GDP growth of Bangladesh. Apart from Inflation, the other tools of monetary policy and economic factors were considered as not affecting the findings of this study.

Literature Review

Government policies, including monetary policy, affect the growth of domestic output to the extent that they affect the quantity and productivity of capital and labor. Monetary policy is only one element of overall macroeconomic policy, and can only affect the production process through its impact on interest rates. There are two main channels of monetary policy. One is through the effect that interest rate changes have on the exchange rate of a currency, and the other is through the effect that interest rate changes have on demand. Therefore monetary policy has an impact on economic activity and growth through the workings of foreign and domestic markets for goods and services (Boweni, 2000)

Although monetary policy is the principal stabilization tool for most economies used by an independent and credible central bank, still there are economists who see important stabilization role for fiscal policy working alongside monetary policy. Even there are economists who say, no matter how independent central bank is, the monetary policy may not be sufficient for determining the price level and there is role for fiscal policy (Hanif and Arby, 2003).

The instrument of monetary policy ought to be the short-term interest rate, that policy should be focused on the control of inflation, and that inflation can be reduced by increasing short-term interest rates (Alvarez, 2001).

The investigations into the existence and nature of the link between inflation and economic growth have experienced a long history. Originating in the Latin American context in the 1950s, the issue has generated an enduring debate between structuralists and monetarists. The structuralists believe that inflation is essential for economic growth

whereas the monetarists see inflation as detrimental to economic progress. There are two aspects to this debate: (a) the nature of the relationship if one exists and (b) the direction of causality (Mallik, 2001).

Although economists now widely accept that inflation has a negative effect on economic growth, researchers did not detect this affect in data from the 1950s and the 1960s (Min, 2005). A series of studies in the IMF Staff Papers around 1960 found no evidence of damage from inflation (Wai, 1959; Bhatia, 1960; Dorrance, 1963, 1966). Therefore, a popular view in the 1960s was that the effect of inflation on growth was not particularly important.

This view prevailed until the 1970s, when many countries, mainly in Latin Americans experienced hyperinflation. Numerous empirical studies were devoted to finding the effects of inflation in high-inflation countries. These studies repeatedly confirmed that inflation had a significant negative effect on economic growth, at least at sufficiently high levels of inflation. Therefore, today, the dominant view regarding the effects of inflation has changed dramatically. It has been found that in developing countries as the inflation rate exceeds a specified threshold, it affects the growth rate adversely (Min, 2005).

Monetary policy plays a key role in determining inflation rates. Various studies provide the empirical evidence on the relationship between inflation and growth. (Lucas, 1973) held that inflation in any economy induces uncertainty in economy and increased economic uncertainty negatively affects the output growth. Inflation overall effects the growth of the country, the financial sector development and the vulnerable poor segment of the population. There is clear consensus that even moderate level of inflation, damage real growth.

Kremer' et al. (2008) examined the impact of inflation on long-term economic growth for a panel of 63 industrial and non-industrial countries. Their results revealed that inflation obstructs growth if it exceeds thresholds of 2% for industrial and 12% for non-industrial countries. However below these thresholds, effect of inflation on growth remained significantly positive. Bruno and Easterly (1998) demonstrated that a number of economies have experienced sustained inflations of 20 percent to 30 percent without suffering any apparently major adverse consequences. However, once the rate of inflation exceeds some critical level (which Bruno and Easterly estimated to be about 40 percent), significant declines occur in the level of real activity. Barro (1995) very precisely examined the five-year average data of 100 countries over the period of 1960-90. His result shows that an increase in average inflation by 10 percentage points per year would slow the growth rate of the real per capita GDP by 0.2-0.3 percentage points per year. He argued that although the adverse influence of inflation on growth appeared small, the long term effects on standards of living were actually substantial. Nevertheless, some other empirical and theoretical studies argued that the inflation-growth relationship is fragile. Maghyereh (2003) also reported that the effect of inflation rate on the economic growth is strongly negative and statistically significant.

Mundell (1965) and Tobin (1965) predict a positive relationship between the rate of inflation and the rate of capital accumulation, which in turn, implies a positive

relationship to the rate of economic growth. They argue that since money and capital are substitutable, an increase in the rate of inflation increases capital accumulation by shifting portfolio from money to capital, and thereby, stimulating a higher rate of economic growth (Gregorio, 1996).

Ahmad and Mortaza (2005) evaluated the concept that moderate and stable inflation rates promote the development process of a country, and hence economic growth. Using annual data set on real GDP and CPI of Bangladesh for the period of 1980 to 2005, they demonstrate statistically significant long-run negative relationship between inflation and economic growth for the country as indicated by a statistically significant long-run negative relationship between CPI and real GDP. Also as a threshold they suggested 6% of inflation above which inflation adversely affects economic growth.

However, Johanson (1967) found no conclusive empirical evidence for either a positive or a negative association between the two variables. Therefore, a popular view in the 1960s was that the effect of inflation on growth was not particularly important. Also Fischer and Modigliani (1978) suggest a negative and nonlinear relationship between the rate of inflation and economic growth through the new growth theory mechanisms (Malla, 1997). They mention that inflation restricts economic growth largely by reducing the efficiency of investment rather than its level. Fisher (1993) also found negative associations between inflation and growth for a large set of countries.

Dewan and Hussein (2001) found in a sample of 41 middle-income developing countries including Fiji, that inflation was negatively correlated to growth. While examining relationship of inflation and growth in Fiji, Dewan (1999) found that changes in the difference between actual GDP and potential GDP (output gap) had a bearing on Fiji's inflation outcome.

Faria and Carneiro (2001) investigated the relationship between inflation and economic growth in the context of Brazil which has been experiencing persistent high inflation until recent. Analyzing a bivariate time series model with annual data for the period between 1980 and 1995, they found that although there exists a negative relationship between inflation and economic growth in the short-run, inflation does not affect economic growth in the long run.

Mallik (2001) examine the relationship between inflation and GDP growth for four South Asian countries i.e. Bangladesh, India, Pakistan and Sri Lanka. Their results provided the evidence of a long-run positive relationship between GDP growth rate and inflation for all four countries. They also concluded that moderate inflation is helpful to growth, but faster economic growth feeds back into inflation. Thus, these countries are on a knife-edge.

Kuttner and Mosser (2002) indicated that monetary policy affects the economy through several transmission mechanisms such as the interest rate channel, the exchange rate channel, Tobin's q theory, the wealth effect, the monetarist channel, and the credit channels including the bank lending channel and the balance-sheet channel. But mainly monetary policy plays its role in controlling inflation through money supply and interest

rate. Money Supply would affect real GDP positively because an increase in real quantity of money causes the nominal interest rate to decline and real output to rise (Hsing, 2005). Taylor (1995) emphasized the importance of the interest rate channel in this regard.

Hsing (2005) examined an annual sample during 1959-2001 to find possible relationships between real GDP for Venezuela and selected macroeconomic variables. According to his study more real money supply, more government deficit spending, real depreciation, a higher expected inflation rate, and higher world oil price would help raise real GDP in Venezuela.

Qayyum (2006) investigated the linkage between the excess money supply growth and inflation in macro-economy. Also he examined the similarity between inflation and monetary phenomenon. His results from the correlation analysis indicated that there is a positive association between money growth and inflation. The money supply growth at first-round affects real GDP growth and at the second round it affects inflation in macro-economy. The important finding from the analysis is that the excess money supply growth has been an important contributor to the rise in inflation in macro-economy during the study period. This supports the monetarist proposition that inflation in macro-economy is a monetary phenomenon.

Fry (1988) and Gleb (1989) find, from pooled cross-economy time series data, a consistently positive and significant relationship between economic growth and the real rate of interest. In order to separate the effects of inflation and real interest rates on growth, World Bank conducted a study. This study provides evidence from a sample of twenty countries, for the impact of the real interest rate and the inflation rate on the growth rate. The real interest rate has a statistically significant and positive impact on growth. But when inflation is included, the coefficient for the real interest rate is no longer statistically significant, while the negative coefficient on the rate of inflation is. This suggests that the positive relation between real rate of interest and growth was actually reflecting a negative relation between inflation and growth in financially repressed regimes, where nominal interest rates are kept fixed (World Bank 1993).

Relationship between inflation, interest rate, and growth has been the consideration of researchers since very long. An examination of this relationship in USA shows that the U.S. inflation of the 1970s and 80s can be fully accounted for by the corresponding increase in money supply growth rates, and the return to relatively low inflation rates in the 1990s can be explained by the correspondingly low average rate of money supply growth in that decade. Inflation in the 90s was about 3.5 percentage points lower than its average in the 70s and 80s, and the growth rate of money supply was about 5 percentage points lower (Alvarez, 2001).

All of the above discussion shows that there is a non-linear relationship between inflation and economic growth. However inflation does affect economic growth directly. Monetary Policy variables such as Money Supply and Interest rates with affect the economic growth & inflation in economy.

Research Data and Methodology

This study is on the effect of monetary policy on the economic growth of Bangladesh for the last 35 years. Major two tools: Interest Rate & Money Supply have been used to evaluate their impact on GDP growth. Secondary data were obtained from Bangladesh Bank's published and unpublished sources of various years. The data would be analyzed, interpreted and tested in order to facilitate a valued conclusion on the effect of interest rate fluctuation in Bangladesh.

Non-stationary is a very common property that is found in many macroeconomic and financial time series. It usually can incorporate the spurious correlation error into the econometric methodology. That is why; the differencing and logarithmic transformation are used to make the time series stationary and used for further processing too. Only for the purpose of modeling the long-run equilibrium which can be referred as a stationary linear combination of respective time series, the non-stationary data are utilized by the econometric researchers. Then, each & every deviation from the equilibrium is assumed to be amended or corrected in the next time period (Engle, Granger, 1987).

There are many econometric methods are available for investigating the long-run equilibrium co-integration approach with multiple time series variables. Examples of the boosting research of the late 20th century include the seminal works of Phillips and Hansen (1990), Engle and Granger (1987), and Johansen (1988) are some of the most prominent ones. In this present study, the Autoregressive Distributed Lag (ARDL) modeling approach developed by Pesaran and Pesaran (1997), Pesaran and Smith (1998), and Pesaran et al. (2001) have been chosen. The reason behind the popularity of ARDL is because of multiple advantages in comparison with other single equation co-integration procedures. It is able to estimate the long and short-run parameters of the model simultaneously to avoid of the problems that are posed by non-stationary time series data. Moreover, among the five variables of this study, two are stationary at I (1) and three are stationary at I (0). In this type of scenario, ARDL model is used. If all the variables were stationary in I (0), then OLS method would be used. But it is really unusual and happens very hardly. If all the variables get stationary at I(1), the Johansen test is used to find out whether VECM or VAR would be used to investigate the long-term equilibrium of co-integration.

But before implementing the co-integration and ARDL model, econometric methodology needs to ensure that the data are stationary. To do that Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1979) has been used to verify that whether the data series are stationary and to determine the order of integration of each of the data series studied.
The conceptual model formulated for the study is given by:

MEG = f (INR, INF, MNS2, REER, U) ---------- (i)

Here,

INTR = Interest rate
INF= Inflation Rate

MEG = Macro-economical Growth (Gross demotic product growth)
MNS2= Money Supply (M2)
REER = Real Effective Exchange Rate

After analyzing for the optimum number of lags, the following ADRL model has been found:

$$\Delta LGDP_t = \alpha_{1i} + \sum_{i=1}^{k} \alpha_{1i} \Delta LGDP_{t-1} + \sum_{i=1}^{k} \beta_{1i} \Delta LINF_{t-1} + \sum_{i=1}^{k} \beta_{2i} \Delta LIR_{t-1} + \sum_{i=1}^{k} \beta_{3i} \Delta LM2_{t-1} + \sum_{i=1}^{k} \beta_{4i} \Delta LREER_{t-1} + \rho_1 ECT_{t-1} + u_{1t}$$

In equation (2),
LGDP = LOG of GDP

LINF = LOG of Inflation

LIR = LOG of Interest Rate

LM2= LOG of M_2

LREER= LOG of Real Effective Exchange Rate

Δ = First Difference operator

Δ LGDP, Δ LINF, ΔLIR, ΔLM2, Δ LREER are the differences in these variables that capture their short run disturbances.

ECT_{t-1} = the lagged error correction term, which captures the long run effects. It refers to the speed of adjustment or correction from the deviation of dependent variable that will adjust to minimize the long run equilibrium error.

ρ_1 = the error correction coefficient

υit = pure white noise disturbance term

Research Questions and Hypothesis

The study is on the effect of monetary policy on the GDP of Bangladesh for the last 35 years. It has been tried to find out the effect of interest rate and money supply on the gross domestic product. Money supply, M2, has been taken to the study The hypotheses are the following:

H1: The Explanatory variables (Monetary Policy) has association with the GDP in the Long Run
H2: Inflation The Explanatory variables (Monetary Policy) has association with the GDP in the Short Run
H3: The Explanatory variables (Monetary Policy) is associated with the GDP significantly in the long run
H4: The Explanatory variables (Monetary Policy) is associated with the GDP significantly in the short run

Empirical Results and Findings

The results of the descriptive statistics have been presented in Table 1. All the variables have positive mean. LOG of GDP, LOG of MONEY-2 SUPPLY & LOG of REAL

EXCHANGE RATE are positively skewed. On the other hand, LOG of INFLATION and LOG of INTEREST RATE are negatively skewed. Apart from LOG of M2, all the variables are relatively symmetric.

Table 1: Descriptive statistics of the variables of the study

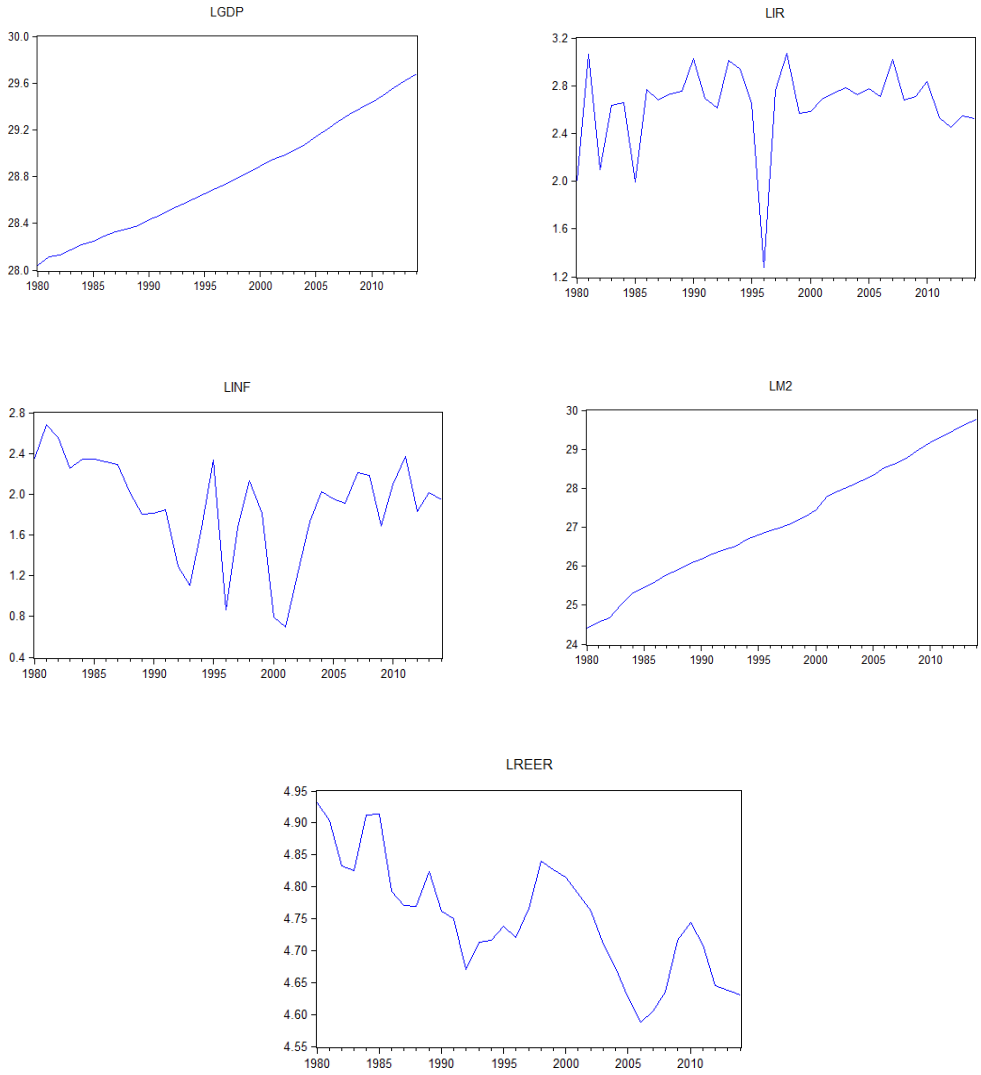
	LGDP	LINF	LIR	LM2	LREER
Mean	28.78985	1.889505	2.636851	27.14507	4.750428
Median	28.74438	1.952548	2.692717	27.00424	4.750442
Maximum	29.67812	2.677247	3.068977	29.76917	4.931158
Minimum	28.04153	0.696728	1.276433	24.40868	4.588238
Std. Dev.	0.486639	0.492620	0.347046	1.561714	0.091353
Skewness	0.232859	-0.898422	-2.013837	0.009814	0.183748
Kurtosis	1.861017	3.196306	8.313011	1.928313	2.332493
Jarque-Bera	2.208173	4.764647	64.82328	1.675478	0.846735
Probability	0.331514	0.092336	0.000000	0.432688	0.654838
Sum	1007.645	66.13269	92.28978	950.0775	166.2650
Sum Sq. Dev.	8.051794	8.250943	4.095000	82.92434	0.283742
Observations	35	35	35	35	35

The figure1 represents the variables graphically. By analyzing the graph, it seems that LGDP, LM2 & LREER have trends with time series. On the other hand, LIR & LINF are found to be a bit stationary. To clarify this issue, Augmented Dickey-Fuller test (ADF test) has been used. The statistical results from the ADF test are on the Appendix-2. From the test, it is found that LIR and LREER are stationary in level (Integrated of Order Zero, I (0)). On the other hand, LGDP, LM2 & LINF are non-stationary in level (Integrated of Order Zero, I (0)) but stationary in first difference (Integrated of Order One, I (1)).

So from the result of ADF, it has been finalized that ARDL model will be perfect for this study. But before that optimum number of lags needs to be identified and to do so AIC and SC test have been used. The result is available in the Appendix 3. It proves that we could take any number of lags between 1 and 4.

In lag 4 and lag 3 the models are found to be highly auto-correlated. In the lag 2, the model has been found to be perfect in both auto-correlation test and Cusum test. But all the betas of the explanatory variables are found to 0 in the WALD test.

Figure1: The graphical presentation of the variables under study



The null and Alternative hypothesis of the WALD test of ARDL model with lag 2 are the following:

H0: C(12)=C(13)=C(14)=C(15)=C(16)=0
H0: C (12)≠C(13) ≠C(14) ≠C(15) ≠C(16) ≠0

The probability of the test has been more that 5%. So the Null hypothesis could not be rejected. That is why, the Lag1 ARDL model has been used to conduct the study. The result is in Appendix. The model has been:

$$\Delta LGDP_t = \alpha_{1i} + \sum_{i=1}^{k} \alpha_{1i} \Delta LGDP_{t-1} + \sum_{i=1}^{k} \beta_{1i} \Delta LINF_{t-1} + \sum_{i=1}^{k} \beta_{2i} \Delta LIR_{t-1} + \sum_{i=1}^{k} \beta_{3i} \Delta LM2_{t-1} + \sum_{i=1}^{k} \beta_{4i} \Delta LREER_{t-1} + \sum_{i=1}^{k} \beta_{1i} LINF_{t-1} + \sum$$

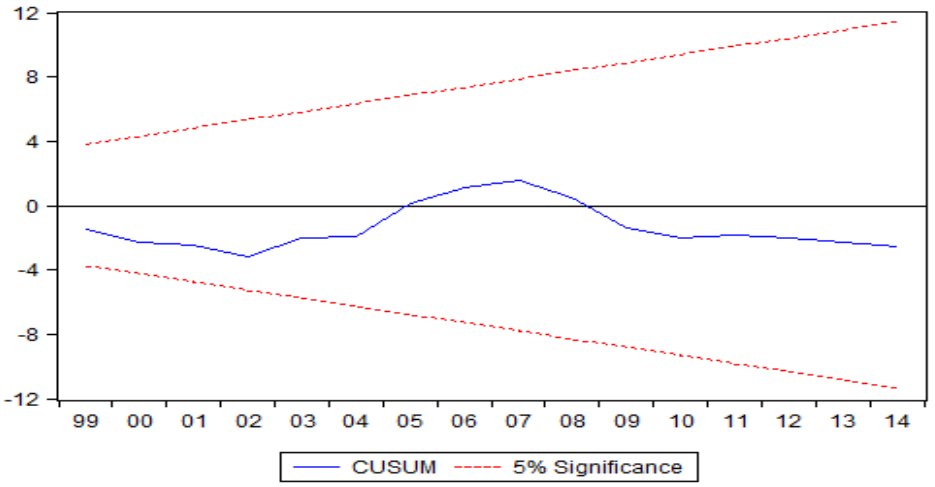


Figure 2: Cusum test of the ARDL model

The model has been very fit. The check the reliability of the model cusum test has been used. The result shows that, the model is reliable.

In the lag 2, the ARDL model has been found to be perfect in both auto-correlation test and Cusum test. But all the betas of the explanatory variables are found to non-zero in the WALD test.

The null and Alternative hypothesis of the WALD test of ARDL model with lag 1 are the following:

H0: C(7)=C(8)=C(9)=C(10)=C(11)=0
H0: C (7)≠C(8) ≠C(9) ≠C(10) ≠C(11) ≠0

The probability of the test has been less that 5%. So the Null hypothesis could be rejected. From the statistical result presented in Appendix 4, it can be predicted that all the explanatory variables under study have a long term association with the dependent variable GDP.

But in the short run the model has been following:

$$\Delta LGDP_t = \alpha_{1i} + \sum_{i=1}^{k} \alpha_{1i} \Delta LGDP_{t-1} + \sum_{i=1}^{k} \beta_{1i} \Delta LINF_{t-1} + \sum_{i=1}^{k} \beta_{2i} \Delta LIR_{t-1} + \sum_{i=1}^{k} \beta_{3i} \Delta LM2_{t-1} + \sum_{i=1}^{k} \beta_{4i} \Delta LREER_{t-1} + \rho_1 ECT_{t-1} + u_{1t}$$

The outcome of the model is in the Appendix-5. The result shows that the explanatory variables are insignificantly associated with the dependent variable. And even after dropping the explanatory variable ΔLGDP and ΔLINF from the model, the remaining explanatory variables of the model are found to be associated with the dependant variable but the association is insignificant. All the result has been shown in the Appendix 5.

So from these results we could conclude that GDP is associated with the Inflation Rate, Interest Rate, M2 supply and Real Effective Exchange Rate in the Long-run significantly but the association is insignificant in the short run.

Conclusion

The main function of Central Bank is to manage the expansion and cost of money and credit. Other functions of central bank include conducting monetary policy, maintaining the stability of the financial system and performing banking supervision and regulation. Central bank does all these functions as means of achieving the predetermined goals. This study focused on the association of monetary policy on GDP of Bangladesh and attempted to discover the degree of association between monetary policy and economic growth. It is found that the supply of M2 has significant association on GDP in long run in Bangladesh. It can be concluded that in addition to money supply policy there are several other tools of monetary policy which can alter the assumptions found in this study. Therefore further study analyzing the impact of other tools of monetary policy such as reserve requirements, lending & deposit facilities etc can be conducted for more reliable findings. So finally we can conclude that, although monetary policy is one of the vital tools to impact on macro-economy, and according to this study we can ensure that it has significant association with the macro-economy in the long run.

Appendix

A1- 1-ADF test of LINF

Null Hypothesis: LINF has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.063513	0.1310
Test critical values:	1% level	-4.252879	
	5% level	-3.548490	
	10% level	-3.207094	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LINF)
Method: Least Squares
Date: 04/05/16 Time: 07:54
Sample (adjusted): 1981 2014
Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LINF(-1)	-0.465083	0.151814	-3.063513	0.0045
C	0.928142	0.354607	2.617384	0.0136
@TREND("1980")	-0.003545	0.007621	-0.465089	0.6451

R-squared	0.235061	Mean dependent var	-0.011912
Adjusted R-squared	0.185710	S.D. dependent var	0.465238
S.E. of regression	0.419821	Akaike info criterion	1.186122
Sum squared resid	5.463745	Schwarz criterion	1.320800
Log likelihood	-17.16407	Hannan-Quinn criter.	1.232051
F-statistic	4.763048	Durbin-Watson stat	1.881440
Prob(F-statistic)	0.015711		

ADF test of LINF at First Difference

Null Hypothesis: D(LINF) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.981978	0.0000
Test critical values:	1% level	-4.273277	
	5% level	-3.557759	
	10% level	-3.212361	

*MacKinnon (1996) one-sided p-values.
Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LINF,2)
Method: Least Squares
Date: 04/05/16 Time: 07:57
Sample (adjusted): 1983 2014
Included observations: 32 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LINF(-1))	-1.741420	0.249416	-6.981978	0.0000
D(LINF(-1),2)	0.490859	0.162524	3.020220	0.0053
C	-0.170448	0.170624	-0.998965	0.3264
@TREND("1980")	0.007470	0.008238	0.906834	0.3722

R-squared	0.686003	Mean dependent var	0.001491
Adjusted R-squared	0.652361	S.D. dependent var	0.723395
S.E. of regression	0.426521	Akaike info criterion	1.250158
Sum squared resid	5.093761	Schwarz criterion	1.433375
Log likelihood	-16.00252	Hannan-Quinn criter.	1.310889
F-statistic	20.39096	Durbin-Watson stat	2.204822
Prob(F-statistic)	0.000000		

***A2- 2* ADF test of LIR**

Null Hypothesis: LIR has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.697186	0.0034
Test critical values:	1% level	-4.262735	
	5% level	-3.552973	
	10% level	-3.209642	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LIR)
Method: Least Squares
Date: 04/05/16 Time: 07:59
Sample (adjusted): 1982 2014
Included observations: 33 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LIR(-1)	-1.239498	0.263881	-4.697186	0.0001
D(LIR(-1))	0.168082	0.172529	0.974224	0.3380
C	3.181024	0.690309	4.608118	0.0001
@TREND("1980")	0.005333	0.006343	0.840784	0.4073

R-squared	0.552890	Mean dependent var	-0.016221
Adjusted R-squared	0.506638	S.D. dependent var	0.484041
S.E. of regression	0.339989	Akaike info criterion	0.793406
Sum squared resid	3.352185	Schwarz criterion	0.974801
Log likelihood	-9.091200	Hannan-Quinn criter.	0.854440
F-statistic	11.95368	Durbin-Watson stat	1.748530
Prob(F-statistic)	0.000029		

***A2- 3* ADF test of LM2**

Null Hypothesis: LM2 has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.090223	0.5326
Test critical values:	1% level	-4.252879	
	5% level	-3.548490	
	10% level	-3.207094	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LM2)
Method: Least Squares
Date: 04/05/16 Time: 08:00
Sample (adjusted): 1981 2014
Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LM2(-1)	-0.207583	0.099311	-2.090223	0.0449
C	5.235311	2.424301	2.159513	0.0387
@TREND("1980")	0.030924	0.015118	2.045518	0.0494

R-squared	0.131660	Mean dependent var	0.157661
Adjusted R-squared	0.075638	S.D. dependent var	0.062079
S.E. of regression	0.059685	Akaike info criterion	-2.715380
Sum squared resid	0.110431	Schwarz criterion	-2.580701
Log likelihood	49.16146	Hannan-Quinn criter.	-2.669451
F-statistic	2.350153	Durbin-Watson stat	1.472068
Prob(F-statistic)	0.112122		

ADF test of LM2 at First Difference

Null Hypothesis: D(LM2) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.413071	0.0069
Test critical values:	1% level	-4.262735	
	5% level	-3.552973	
	10% level	-3.209642	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LM2,2)
Method: Least Squares
Date: 04/05/16 Time: 08:01
Sample (adjusted): 1982 2014
Included observations: 33 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LM2(-1))	-0.786714	0.178269	-4.413071	0.0001
C	0.133858	0.038162	3.507658	0.0014
@TREND("1980")	-0.000547	0.001161	-0.471292	0.6408

R-squared	0.393721	Mean dependent var	-0.000378
Adjusted R-squared	0.353302	S.D. dependent var	0.078678
S.E. of regression	0.063271	Akaike info criterion	-2.596262
Sum squared resid	0.120098	Schwarz criterion	-2.460216
Log likelihood	45.83832	Hannan-Quinn criter.	-2.550486
F-statistic	9.741068	Durbin-Watson stat	1.925642
Prob(F-statistic)	0.000550		

***4.2-4* ADF test of LREER**

Null Hypothesis: LREER has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.034429	0.0183
Test critical values:	1% level	-4.296729	
	5% level	-3.568379	
	10% level	-3.218382	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LREER)
Method: Least Squares
Date: 04/05/16 Time: 08:04
Sample (adjusted): 1985 2014
Included observations: 30 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LREER(-1)	0.649544	0.161000	4.034429	0.0005
D(LREER(-1))	0.614440	0.176607	3.479126	0.0020
D(LREER(-2))	0.332291	0.163887	2.027557	0.0543
D(LREER(-3))	-0.058535	0.154218	-0.379562	0.7078
D(LREER(-4))	0.501365	0.157571	3.181827	0.0042
C	3.153206	0.786456	4.009385	0.0005
@TREND("1980")	-0.003916	0.001320	-2.965902	0.0069

R-squared	0.551160	Mean dependent var	-0.009432
Adjusted R-squared	0.434071	S.D. dependent var	0.045156
S.E. of regression	0.033970	Akaike info criterion	-3.725707
Sum squared resid	0.026541	Schwarz criterion	-3.398761
Log likelihood	62.88560	Hannan-Quinn criter.	-3.621114
F-statistic	4.707200	Durbin-Watson stat	2.347504
Prob(F-statistic)	0.002911		

***4.2-3* ADF test of LGDP**

Null Hypothesis: LGDP has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.275369	0.9977
Test critical values:	1% level	-4.252879	
	5% level	-3.548490	
	10% level	-3.207094	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGDP)
Method: Least Squares
Date: 04/05/16 Time: 07:26
Sample (adjusted): 1981 2014
Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGDP(-1)	0.011758	0.042700	0.275369	0.7849
C	0.293531	1.193202	0.246002	0.8073
@TREND("1980")	0.000197	0.002008	0.098307	0.9223

R-squared	0.370254	Mean dependent var	0.048135
Adjusted R-squared	0.329625	S.D. dependent var	0.012273
S.E. of regression	0.010049	Akaike info criterion	-6.278663
Sum squared resid	0.003130	Schwarz criterion	-6.143984
Log likelihood	109.7373	Hannan-Quinn criter.	-6.232734
F-statistic	9.113103	Durbin-Watson stat	1.881532
Prob(F-statistic)	0.000771		

ADF test of LM2 at First Difference

Null Hypothesis: D(LGDP) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.064099	0.0000
Test critical values:	1% level	-4.262735	
	5% level	-3.552973	
	10% level	-3.209642	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGDP,2)
Method: Least Squares
Date: 04/05/16 Time: 07:22
Sample (adjusted): 1982 2014
Included observations: 33 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LGDP(-1))	-1.112605	0.137970	-8.064099	0.0000
C	0.034376	0.005527	6.219149	0.0000
@TREND("1980")	0.001027	0.000175	5.851209	0.0000

R-squared	0.690054	Mean dependent var	-0.000318
Adjusted R-squared	0.669370	S.D. dependent var	0.013438
S.E. of regression	0.007727	Akaike info criterion	-6.801707
Sum squared resid	0.001791	Schwarz criterion	-6.665661
Log likelihood	115.2282	Hannan-Quinn criter.	6.755932
F-statistic	33.39241	Durbin-Watson stat	1.670231
Prob(F-statistic)	0.000000		

A3-1

VAR Lag Order Selection Criteria
Endogenous variables: LGDP LINF LIR LM2 LREER
Exogenous variables:
Date: 04/06/16 Time: 13:23
Sample: 1980 2014
Included observations: 31

Lag	LogL	LR	FPE	AIC	SC	HQ
1	198.9824	NA	9.31e-12	-11.22467	-10.06823*	-10.84770
2	228.9030	40.53756*	7.53e-12	-11.54213	-9.229244	-10.78818
3	264.8672	37.12438	5.12e-12*	-12.24950	-8.780173	-11.11858*
4	294.0534	20.71281	8.50e-12	-12.51958*	-7.893811	-11.01169

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

A3-2

AIC and SC at different lags

	Lag-1	Lag-2	Lag-3	Lag-4
Akaike info criterion	-6.39247	-6.29702	-5.98976	-6.86074
Schwarz criterion	-5.89363	-5.56415	-5.01835	-5.64637

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