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Effectiveness of Monetary Transmission Channels in Bangladesh: Evidence from a Floating Exchange Rate Regime

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Abstract

The intention of this study is to examine the relative effectiveness of the monetary transmission channels in Bangladesh.A five-variable unrestricted Vector Auto Regression (VAR) technique is used to examine the relative effectiveness for the sample period from 2004.M7 to 2016.M1. Bangladesh has initiated several reforms in monetary policy and exchange rates since 2002 to increase the transparency and efficacy of the monetary transmission channels. In this regard, several monetary transmission channels have been analyzed such as the interest rate or money channel, bank lending or credit, and the exchange rate channel.The empirical results derived from VAR show that both money supply and the policy rates have significant impact on output and the price level in Bangladesh implying that monetary transmission channels are effective in influencing real variables. The variance decompositions and impulse response functions derived from VAR show that an increase in money supply tends to increase GDP growth.It decreasesthe lending rate and increases private sector credit. On the other hand, an increase in the policy rate decreases inflation and also decreases GDP growth. Transmission channels through the real exchange rate increase exports, which in turn increase output.The polciy implications of this study is that monetary authority can use money suppy and the policy rate to increase output and control inflation in Bangladesh.

JEL Classification: C32, E52, E58, F41
Keywords: Impulse response functions; variance decompositions, open economy, monetary policy transmission channels; VAR models; intermediate channels.

I. Introduction

It is important to understand the channel/s through which monetary policy transmits to the economy so thatmonetary authority hit the targets through the adjustments of appropriate tools and instrument.The monetary policy transmission mechanism describes how monetary policy actions are transmitted to the economy via various intermediate channels such as monetary aggregates, interest rates, credit, asset prices and exchange rates.

Various studies have examined the monetary transmission mechanism in Bangladesh. For example, Alam (2015) using Structural Vector Auto Regression Model (SVAR) and quarterly data from 1995.Q1 to 2011.Q1 examines the effectiveness of monetary policy in Bangladesh. Younus (2004) also using SVAR model and quarterly data from 1973:Q1 to 2000:Q4examines the impact of monetary policy on the output

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and the price level in Bangladesh. Ahmed and Islam (2006) using unrestricted VAR model, examine monetary transmission through the bank lending and the exchange rate channels in Bangladesh. Younus (2009) examines the impact of changes in monetary policy in Bangladesh. Specifically, the study examines the impact of domestic and foreign monetary shocks on Bangladesh's major economic aggregates using Near Vector Autoregressive (NVAR) model.

However, this study differs significantly from other studies in that it includes the sample period when Bangladesh adopted various reform policies.There was a significant change in the policy level in Bangladesh at the end of May 2003, when Bangladesh entered into the flexible exchange rate regime.Theoretically, monetary policy is expected to be more effective after that change. Repurchase Agreement (Repo) and Reverse Repo were introduced in July 2002 & April 2003, respectively for banks and financial institutions as an indirect monetary policy tool for day-to-day liquidity management in response to temporary and unexpected disturbances in the supply of and demand for money. Various government treasury bills have been used to conduct an open market operation to alter money to its desired level. Therefore, this study differs from other studies in terms of variables and include more recent sample periods particularly the periods when significant change in the monetary and the exchange rate policy was initiated. The current study moreover, unlike others uses both money supply and the policy rate to examine the impact of monetary policy on output and the price level.

Therefore, the plan of the study is as follows. After an introduction in Section-I, Section II deals with detailing monetary policy framework and practices in Bangladesh. Section III provides the theoretical background followed by the relevant literature review in Section IV. Section V provides methodology followed by the empirical examination in Section VI. Finally, conclusions and recommendations are presented in Section VII.

II. Monetary Policy in Bangladesh

Bangladesh Bankwas established with the aims of maintaining stability in the price level, promoting a high level of output and real income and sustained economic growth, the stability of the exchange rate and the overall financial system.[2]During the early 1990s, initiatives were taken to bring significant changes in the financial system of Bangladesh. Under Financial Sector Reform Program (FSRP),initial restrictions were withdrawn from the interest rates alongwith other conducive policies to liberalize the financial sector.

[2]Bangladesh Bank (BB), the Central Bank of Bangladesh was established by the Bangladesh Bank Order of 1972 (Presidential Order No. 127 of 1972) which became effective from 16th December of 1971.

All of these developments help the monetary authority to formulate policies based on the market requirement to bring effective changes in some macroeconomic variables. For better implementation of monetary policies in the market-based policy formulation, better-functioning credit and debt market are necessary and following this Bangladesh Bank recently developed a secondary market fortrading Treasury bonds.Monetary policy framework followed by the Bangladesh Bank is mostly market based, influencing the target variables through supply and demand framework.

The monetary authorities estimate the required level of money growth to facilitate required level of credit growth to the private sector to achieve sustained inclusive economic growth. It determines both reserve money and broad money growth so as to facilitate continued economic growth along with stability in the price level. This implies that monetary policies focus more on achieving target economic growth while keeping the inflationary pressure low.

Focuses are also given to the development of effective credit and debt market as the authority believes that efficient transmission of monetary policies depended on better functioning and strengthened credit and debt markets. Broad money is the intermediate target of BB to achieve its goals and objectives of sustained economic growth, external sector stability, and to keep the inflation as anticipated. Before formulating its monetary policy, BB takes into account of the domestic macroeconomic perspectives along with global context. The monetary authority of Bangladesh takes into consideration the recent macro-variables to formulate monetary policy decisions.

BB influences its intermediate target broad money of its monetary policy through operating **target of reserve money.**???However, it cannot directly affect broad money or money supply rather it indirectly affects money supply through various direct and indirect policy instruments. These policy instruments immediately affect operating target that is reserve money.

III. The Channels of Monetary Policy Transmission.

To understand the impact of monetary policy on economic activity in Bangladesh, it is necessary to study the role of the commercial banking system because banksplay an important role in the monetary transmission process. Whether monetary policy transmits through bank assets (credit channel) orliabilities, (money channel) is currently under debate.

According to Walsh (1998, page 285), under the traditional money view, following an expansionary monetary policy, when banks' reserves increase, interest rates fall, which stimulates consumption and investment decisions by households and firms. This reflects the adjustments on the liabilities' side of the banking sector's balance sheet by increasing the demand for money. However, two conditions must be satisfied for the existence of a money channel: (1) stickiness of price, so that the

monetary innovation can affect real money balances, and (2) short-term interest rates must influence long-term interest rates, which could further influence investment (Agung & Ford 1998, page 4).

Under the credit view (Walsh 1998, page 286), following an expansionary monetary policy, banks' reserves increase as well. If there is no close substitute, an increase in banks' reserves will be reflected by an increase in bank credit, which is on the asset side of the balance sheet. If there is a close substitute for bank credit (e.g., commercial paper, treasury bills) borrowers will switch from other close substitute assets to bank credit, which in turn increases the bank credit and economic activity.

In contrast, a contractionary monetary policy constrains banks' loan supply because banks cannot replace their shortfall of deposits by raising other non-deposits sources, such as securities issues and foreign borrowings. According to the credit view, small banks are more affected than are large banks. This holds for small firms as well because, just as small banks have relatively limited access to other non-deposits funds, small firms have limited access to external financing. Therefore, two conditions need to be satisfied for the credit channel to work: (1) banks must not insulate themselves by selling their securities, and (2) there must be some bank-dependent borrowers who find it difficult to finance their projects by issuing commercial paper other than bank loans. Also, this paper finds that the existence of banks' excess reserves is responsible for thenon-existence of credit channels in Bangladesh.

Several studies, including Bernanke (1988, 1993), Bernanke and Blinder (1992), Kashyap, Stein and Wilcox (1993), Cecchetti (1995), and McMillin (1996), find evidence in favor of a credit channel or bank-lending channel in the monetary policy transmission process in the U.S.[3] On the other hand, Oliner and Rudesbusch (1995) and Morries and Sellon (1995) do not find evidence of a credit channel in the U.S.

The money channel of the monetary transmission mechanism is believed to be linked to a traditional interest rate channel.[4] Nonetheless, recent evidence of financial deregulation, banking failures, and debt default have prompted some economists, such as Bernanke (1988), and Brunner and Meltzer (1988), to suggest that there may be important channels other than the traditional interest rate channel of the monetary transmission mechanism. Bernanke (1988, page 10) suggests that the central bank should look at both money and credit aggregates when judging a policy's impact, because he argues when both money and credit are growing rapidly or slowly then it is logical to think that the economy is growing in

[3]The terms "credit channel" and "bank lending channel" are used by many authors (such as, Oliner and Rudesbusch (1995) and Morries and Sellon (1995) synonymously.

[4]Following an expansionary monetary policy, banks' reserves increase causing interest rates to fall. This increases consumption and investment by households and firms. This reflects the adjustments on the liabilities side of the banking sector's balance sheet.

the same way. However, if money and credit are sending conflicting signals, then the central bank should concentrate more on credit than money due to its closer link withaggregate spending.

Monetary policies can also find their ways into the economy through the exchange rate channel. Involving interest rate this channel (Mishkin,1995) may also transmit monetary policy stance changes onto the economy as the exchange rate is positively sensitive to the real interest rate that is with a rise in interest rate exchange rate appreciates and vice-versa. With an expansionary monetary policy real interest rate (deposits interest rate, i) falls thus affecting exchange rate (E) as domestic currency depreciates due to less attractiveness of domestic currency **about** foreign currency. Depreciation of domestic currency has an impact on net export (NX) as export goes up while import falls because domestic goods become relatively cheap than foreign goods. Eventually aggregate demand or economic output (Y) is affected by the monetary policy.

IV. Literature Review

Monetary transmission mechanism is studied extensively by academicians, policy makers, researchers due to its importance in policymaking. Monetary policies are expected to find their effects on economic output and prices through various channels known as monetary transmission channels. Romer and Romer (1989), Bernanke and Blinder (1992), Christiano, Eichenbaum and Evans (1994a, b) reconfirmed empirical research findings of Friedman and Schwartz (1963) by showing that movements in real output respond to change in monetary policy stances for two years or more (Bernanke and Gertler, 1995).

Eichenbaum and Evans (1995) have conducted a study to investigate the U.S. monetary policy shocks on the exchange rates using VAR approach for the period from 1974:1 to 1990:4. They have considered three measures of the monetary policy: The Federal fund rates, theratio of non-borrowed to total reserves and changes in the Romer and Romer index. The empirical results from all three measures show that due to a contractionary monetary policy shocks lead to a persistent and significant appreciation in the nominal exchange rate and the real exchange rate as well. In a similar study using Vector Autoregression models (VAR) Koray and McMillin (1999) found that due to monetary policy innovations in the U.S. economy (during the period from 1973:1 to 1993:12.) output and price level decline and the exchange rate appreciates.

Fung et al. (1997) tried to identify the uncertainty about the monetary transmission mechanism for the six G-7 countries. A VAR model has been used to identify the monetary policy shock on the key macroeconomic variables such as money, the interest rate, prices and output. Empirical results of the paper show that initial responses to the monetary stock differ across countries. However, interest rate

responses follow a similar pattern for all the countries. Perera, A. (2013),found that an unanticipated increased in the short-term interest rate (a restrictive monetary policy shock) causes reductions in real GDP and consumer price levels via interest rates, credit, the exchange rates and the asset prices.The interest rate channel remains the most important transmission channel in Sri Lanka though other channels also help to propagate monetary policy shocks. From the CBSL's perspective, these results provide implications, as the reaction of target variables has been substantially enhanced, i.e. prices are more responsive to interest rate shocks, it provides a strong justification for moving towards an inflation targeting framework, which is considered as an appropriate monetary policy framework for emerging market economies.

Alam (2015), using quarterly data from 1995 to 2011 examined the effectiveness of monetary policy on the price level, output and the exchange rate in Bangladesh. The model variables employed in this model are reserve money, broad money (M2), 3-month Treasury bill rate, industrial production index, consumer price index and the nominal and real exchange rate. The empirical results derived from Structural Vector AutoRegression model showed whether the T-bill rate or reserve money or broad money have any impact on the output, price level and the exchange rate in Bangladesh. The author argued that may be excessive government borrowing, or the existence of microcredit may have contributed to the ineffectiveness of monetary policy in Bangladesh.

Younus (2004) examined the transmission channel through bank portfolio (credit or deposits) in Bangladesh. Quarterly data on six variables from the period of 1975:Q11 to 2000:Q4 were used to examine the dynamism of the relationship between monetary policy and bank portfolio and subsequently on the economy. The variables used here are all in log scaled and seasonally adjusted except for lending rate. Structural VAR is also applied for developing IRF's and VDCs. SVAR estimation shows that monetary base describes interest rate to some extent at lag length 8 and 12 and output at lag length 8 for time horizon 16 & 20.

Mala *et al.* (2012) conducted an in-depth investigation analyzing the Malaysian monetary policy using Structural Vector Autoregression (SVAR) model. The sample period covers only the post (Malaysian) liberalization period 1980:01 to December 2007:12, which also includes the 1997 Asian financial crisis. Given the changes in the financial environment and the choice of policy regimes, the sample period of study is divided into the pre-crisis period (1980:01 to 1997:06) and the post-crisis period (1999:01 to 2007:12). In the pre-crisis period, domestic variables appear to be more vulnerable to foreign monetary shocks. Further, the exchange rate played a significant role in transmitting the interest rate shocks, whereas credit and asset prices helped to propagate the money shock. In the post-crisis period.

However, asset prices play a more dominating role in intensifying the effects of both interest rate and money.

Kapur and Behera (2012) examine the monetary transmission mechanism in India. The study was based on a small model known as New Keynesian Model (NKM) to examine the monetary transmission mechanism in India. Developing three key equations of NKM, the IS curve, Philips curve and monetary reaction function using forward-looking approach this study found that interest rate channel is the most efficient in Indian monetary transmission process. That is, the interest rate channel plays a significant role inaffecting the monetary policy on the economy of India. On the other hand, Bhattacharya et al. (2011) found that the most effective transmission channel in India is the exchange rate channel. Interest rate channel is weak. It has been argued that interest rate channel has no direct impact on inflation rather it is the exchange rate channel through which interest rate affect inflation.

Disyatat and Vongsinsirikul (2003) conducted study to examine monetary transmission mechanism in Thailand using VAR model. The objective was to examine interest rate, credit, exchange rate channel, and other asset price channel so as to find out the monetary transmission channel(s) in Thailand. The model variables used are real output or GDP, CPI and 14-day repurchase rate for interest rate channel using quarterly data from 1993Q1 to 2001Q4 using seasonally adjusted data. It was found that GDP's response to interest rate was negative and quite persistent for the long time horizon, but price puzzle was found for short time horizon as IRFs showed thepositiveresponse of price to **repo rate**?but after quarter six this becomes significant.

Kim (1999) conducted a study to discern whether credit channel works as the key monetary transmission channel in Korea. The model variables used to identify the impact of monetary policy on output through bank lending, or credit channel are monetary base, total reserves maintained, narrow money, bank loans, movements in the short-term interest rate.. The empirical result shows that credit channel is found to play a substantial role in affecting output after a crisis that is it played a role in transmitting the tight monetary policy on real economic output following the crisis.

V. Model variables, Methodology and Model Specification

Monthly data for the sample period of 2004: M7 to 2016:M1 have been used to examine the monetary transmission channels through the interest rate or money channel, banklending or credit channel, and the exchange rate channel.Repurchase Aagreement (repo rate) and broad money (M2)are used as a proxy for the monetary policy. Use of broad money asa proxy for monetary shocks or money supply is influenced by the work of Friedman and Schwartz (1963) as their findings show that on an average monetary base was stable during the Great Depression 1929-1933, while money supply, as measured by M2, declined continuously. That is even if monetary base remains the same money supply

could vary significantly due to changes in the money multiplier. Over time, money multiplier could change dramatically causing unstable money supply that should affect economic price level and output.

Therefore, M2 is used to have a greater impact of monetary shocks on the economy and at the same time, M2 is the intermediate target of Bangladesh Bank's monetary policy. The bank lending rate and the deposits rates are used based on the assumption that money supply transmits through banks portfolio (private sector credit and total deposits) on economic activity and the price level.

Consumer Price Index (CPI) has been considered as the proxy for the price level. It also affects purchasing power of consumers, and the nominal cost of capital thus affects both demand for real money balance and real cost of capital subsequently changing consumption and investment, two components of GDP or economic output. Log of CPI is employed as a proxy for the price level during the period of interest. Bangladesh is a a small open economy, therefore, the real exchange rate variable is used as explanatory variables of monetary transmission channel.

The final variable, for all channels that are expected to be affected by monetary shocks, is an economic activity or aggregate output. The proxy for economic output (Y) has been the GDP (Log real value) in this report. GDP measures the value of goods and services produced in the economy during a specified period. Again for a proxy of the economic activity log value of real GDP has been employed. Therefore, the variables of interest for this study are as follows:

Real_Broad_Money= The log of domestic real money supply (M2/CPI);

Real_Repo=The real repo rate is calculated by using the formula (nominal repo rate-inflation).

Real_Lending Rate=Weighted average real lending rate of commercial banks loans to individuals and businesses; (Nominal Interest Rate-Inflation).

Real_Deposit Rate=Weighted average real deposits rate of commercial banks is calculated by using the formula nominal deposits rate-inflation

Real Total Deposit=Log of Real Total Deposits (Total deposits*100/cpi).

Real_Private Sector Credit=log of Real Private Sector Credit (Total Private Sector Credit*100/cpi).

Inflation=Rate of change of log of consumer price index.

Real_GDP= log of real output (Nominal GDP/CPI).

RER= log of real exchange rate; Calculated by nominal exchange rate*(Foreign CPI/Domestic CPI).

V.1 Data Analysis

All the variables in this report have been collected in the form of nominal value. In this report,real values of all variables have been employed. Using CPI all the nominal variables have been transformed into a real variable. Real value= {Nominal Value*100/ CPI}.

Seasonal adjustment: As these variables are now in quarterly frequency there remains the chance that theses all-time series do contain seasonality. That is time series may have a pattern that repeats each year. These seasonal patterns need to be adjusted to have smooth time series for all the variables to better fit the linear regression, model. Seasonality might make the regression results biased and so to have better outcomes from regression model seasonal effects are to be removed. In this study using census X11 technique all the time, series variables have been adjusted for seasonal effect. These deseasonalized time series of all the variables have been employed in this study to have better results.

Use of a Logarithmic form of Time Series Variables*:* In this report the relevant time series variables except interest rate (repo rate, lending and deposit interest rate) have been used taking their natural log.. The rationale for using the logarithm of each time series variable is that logarithmic transformation makes the residuals of a time series variables more homoscedastic, that is the logarithm makes them more random rather than being in a particular pattern.

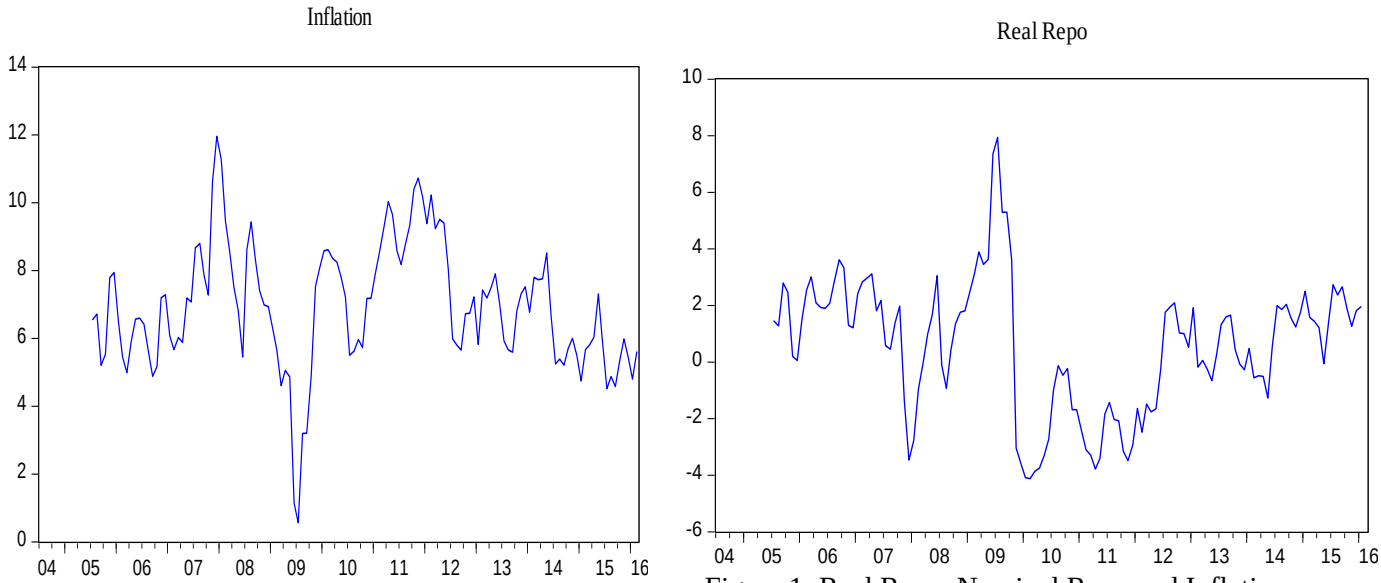


Figure 1: Real Repo, Nominal Repo and Inflation

Source: Monetary Policy Department, Bangladesh Bank.

The above Figure 1 show trends of Inflation, Real Repo and actual Repo Rate. The picture show some rate hike during the period of 2004 to 2008 which decreased to below 5 percent in 2009 and the policy rate again increased from 2010.

V. 2 Econometric Methodology

If we assume the dynamics of $Z_t = \begin{bmatrix} m_t \\ lr_t \\ psc_t \\ p_t \\ y_t \end{bmatrix}$ is a P^{th} order Gaussian vector auto-regression process, we could write

$$Z_t = c + \Phi_1 Z_{t-1} + \Phi_2 Z_{t-2} + \ldots\ldots\ldots\ldots\ldots\ldots \Phi_p Z_{t-p} + \varepsilon_t;$$

$$\varepsilon_t \sim \text{iid}, N(0,\Omega).$$

Here, Φ_i is a 5x5 coefficients matrix; m, lr, psc, p and y are money supply, lending rate, private setcor credit, price level and output respectively. A vector autoregressive (VAR) model is an appropriate econometric technique when we are interested in dynamic relationships among variables in the presence of possible feedback among the variables and ambiguity about the exogeneity of the right hand side variables (Sims, 1980 and Enders, 1995). Vector autoregression has become quite popular as noted by Keating (1992, page 37) because of the inability of macroeconomists to agree on the correct structural model of the economy.As noted by Fackler and McMillin (1989), among others, "A VAR technique is well suited to an examination of the channels through which a variable operates since few restrictions are imposed on the way the variables interact." (Fackler and McMillin, 1989, page 995).

This study uses a VAR model to derived Impulse Response Functions (IRFs) and Variance Decompositions(VDCs). The IRFs show the dynamic response of each variable in the system to shocks from each variable in the system. A VAR model is a reduced form model. Therefore, there are several drawbacks in using a VAR model. As noted by Cooley and LeRoy (1985), an estimated shock in VAR is not a structural shock, but linear combinations of structural disturbances. In that case IRFs and VDCs derived by using Cholesky ordering are difficult to interpret because these IRFs and VDCs represent a complicated function of all the structural disturbances. Besides, Cholesky ordering in a VAR imposes a recursive contemporaneous structure on the variables but most of the theories do not imply recursive structure on system.

IRFs calculated using VAR approach helps to discern the dynamic response of a variable in the linear equation to the lagged innovations of all system variables in the model (Enders, 1995). IRFs graphically show the response or movement of a variable to shocks in the all other variables in a particular channel to understand the dynamic relationship between the variables in a channel. Variance Decompositions show the magnitude of the co efficients.Hafer and Sheehan(1991) argued that VAR

results could be very sensitive to the choice of lag length. Therefore, Akaike's Information Criterion (AIC), is used to select the lag length for the VAR model. Lag orders of one through eight are used. The Maximum lag length of eight is used to preserve degrees of freedom.

A lag order of 4 produces the minimum AIC. Q-statistics are used to see if VAR residuals of each equation are white noise at this minimum AIC, and it turns out that Q-statistics show white noise residuals for each equation at lag order four. Therefore, a lag of four is used to estimate a five-variable VAR, model.

To estimate IRFs and VDCs, orthogonalization of the VAR residuals is required. Cholesky decomposition is used to orthogonalize the residuals. Cholesky ordering requires the variables to order in a particular way where variables placed higher in the ordering have contemporaneous impacts on the variables lower in the ordering, but the variables lower in the ordering do not have a contemporaneous effect on the variable higher in the ordering.Therefore, Sims correctly stated, “in the Cholesky ordering, …due to the cross-equation residual correlation when a variable higher in the ordering changes all the variables lower in the ordering are assumed to change.”Therefore, it is important to decide proper ordering of the variables.Because this study is mainly interested in examining the impact of monetary policy on the macroeconomic variables, M2/policy rate is placed first followed by the lending rate/deposits rate,banks private sector credit/total deposits, the price level/output depending on the transmission channel we are examining.Switching the ordering between the price level and the exchange rate are also attempted. However, policy conclusions remain the same for both the orderings.

Placing the monetary policy variable first in the ordering allows the policy variable to affect other model variables contemporaneously. However,policy variables respond to the lag effect of other variables, because it is reasonable to assume that information of other variables is not readily available to the decision makers. The first variable implies that innovation to domestic money supply is contemporaneously exogenous. It has a contemporaneous effect on the rest of the model variables, but none of the model variables has a contemporaneous impact on the first variable). Placing the banks’ deposits after domestic money supply implies that innovation to domestic money has a contemporaneous effect on the deposits, but banks deposits rate does not have any contemporaneous impact on the domestic money. The third variable is the private sector credit variable, followed by the price level and income. The third variable implies that domestic money supply and the deposits have contemporaneous impacts on the private sector credit; however, private sector credit does not have any contemporaneous effects on the domestic money or the deposits and so on.

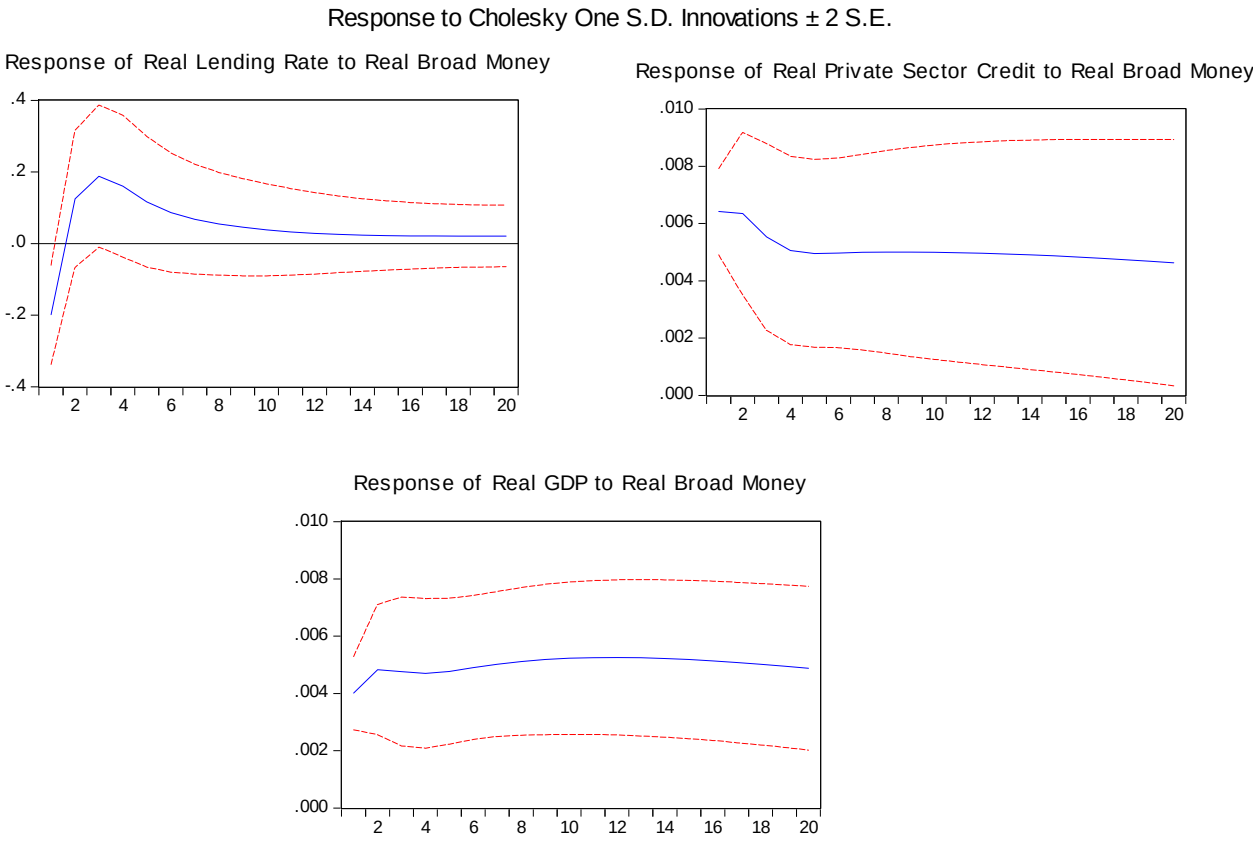
VI. Empirical Results:

Efficacy of Monetary Transmission Mechanism: Money Supply (M2) and the Policy Rate.

VI.A. Impulse Response Functions (IRFs): Credit Channel

The Impulse Response Functions (IRFs) show the response of each variable in the system due to a shock from each variable in the system. A two-standard-deviation confidence interval is reported for each IRF. A confidence interval containing zero indicates a lack of significance. The confidence interval for each IRF is computed from one thousand Monte-Carlo simulations. The IRFs showing the response of the deposits, credit, interest rate, price level, and output due to innovations (shocks) to domestic monetary policy are shown in Figure-2.

Figure 2: Impulse Response Functions of the Lending Rate, Private Sector Credit, and GDP to Money Supply Shock



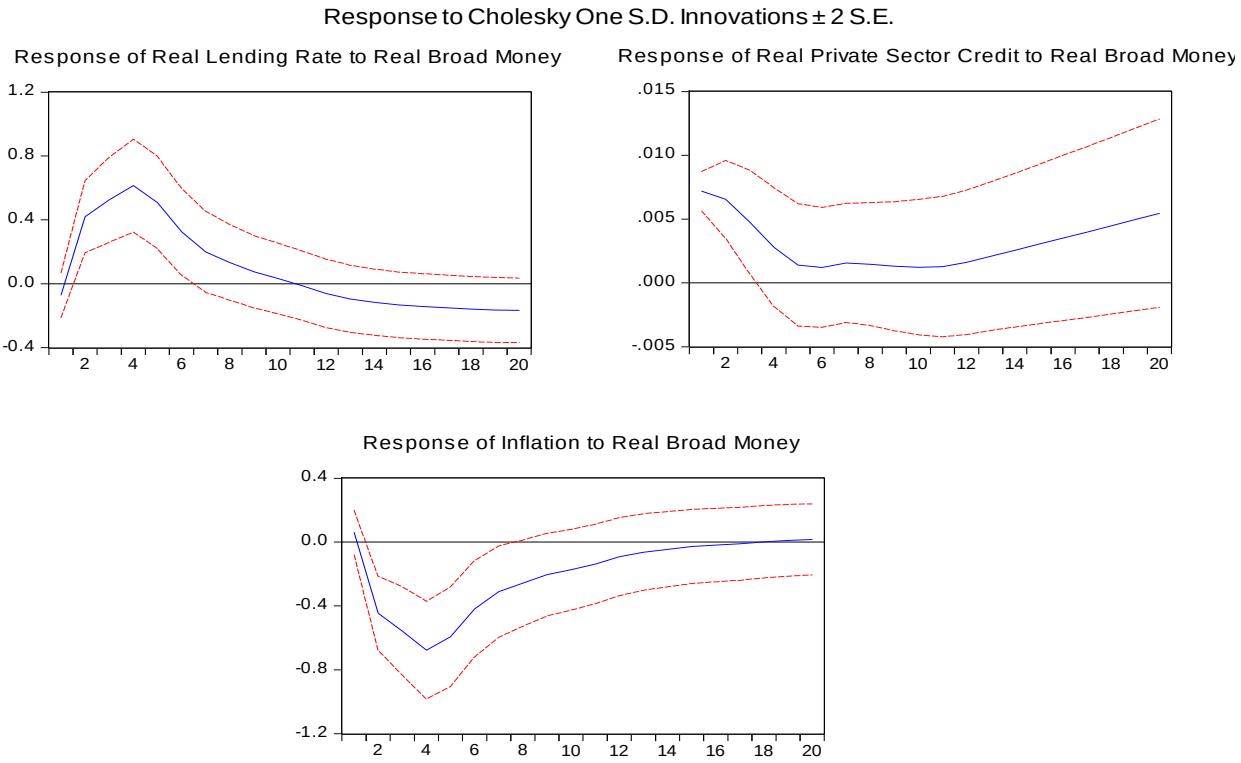
Source: Various issues of Economic Trends, a Bangladesh Bank Publication, 2003-2016

VI.1.A1.Response of GDP to Money Supply Shock

The response of real lending rate to real money balance is significant and negative as expected at period 1 and then became insignificant thereafter, while the response of the real private sector credit to real money supply shock is significant and positive at period 1 and remain significant until period 22nd and then became insignificant thereafter. The response of GDP due to shock to money supply is also appear significant and positive at period 1 and remain significant for the whole period. This implies that monetary transmission channel through credit channel is effective in altering output.

VI.1.A2.Response of Inflation to Money Supply Shock

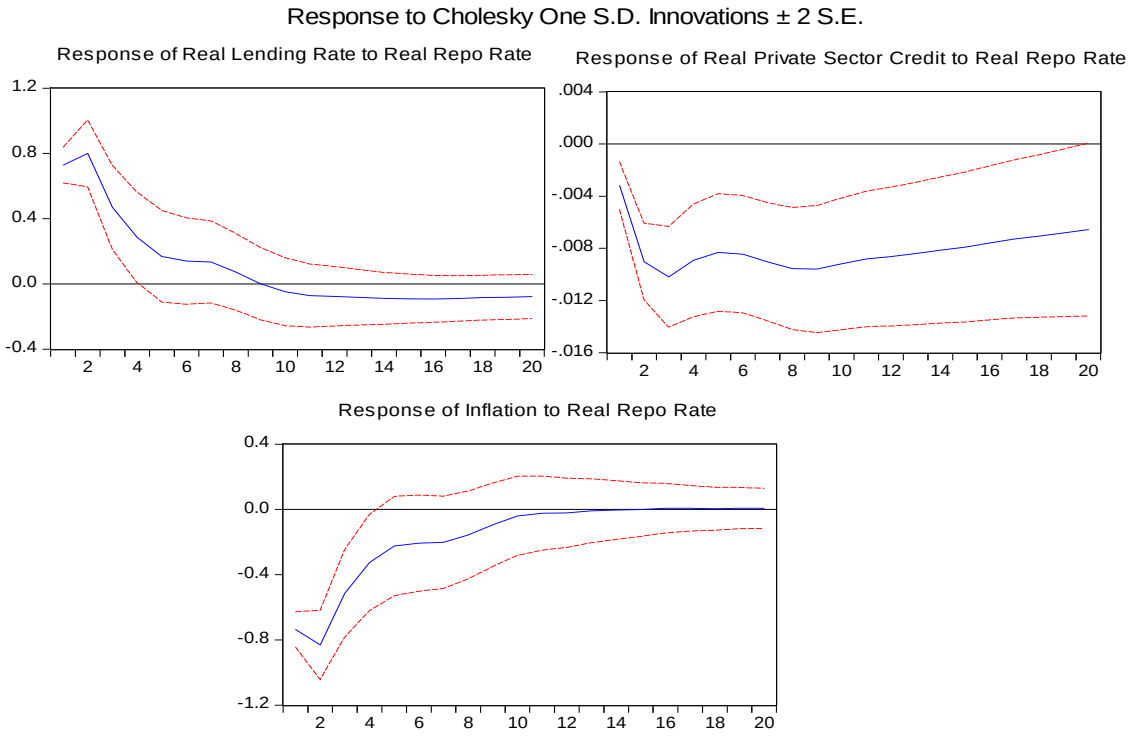
Figure 3: Impulse Response Functions (IRFs) of the Lending Rate, Private Sector Credit, and Inflation to Money Supply Shock



Source: Various issues of Economic Trends, a Bangladesh Bank Publication, 2003-2016.

The response of real lending rate to real money balance is significant and positive at period 2 showing liquidity puzzle(interest rates do not decrease rather increase)while the response of the real private sector credit to real money supply shock is significant and positive at period 1 and remain significant until period 4 and then became insignificant thereafter. The response of inflation to money supply shock is significant and negative at period 2 showing also price puzzle (price level decrease instead of increase is called price puzzle in the literature in the model).

Figure 4: Impulse Response Functions (IRFs) of Lending Rate, Private Sector Credit, Inflation to Policy Rate (Repo) Shock



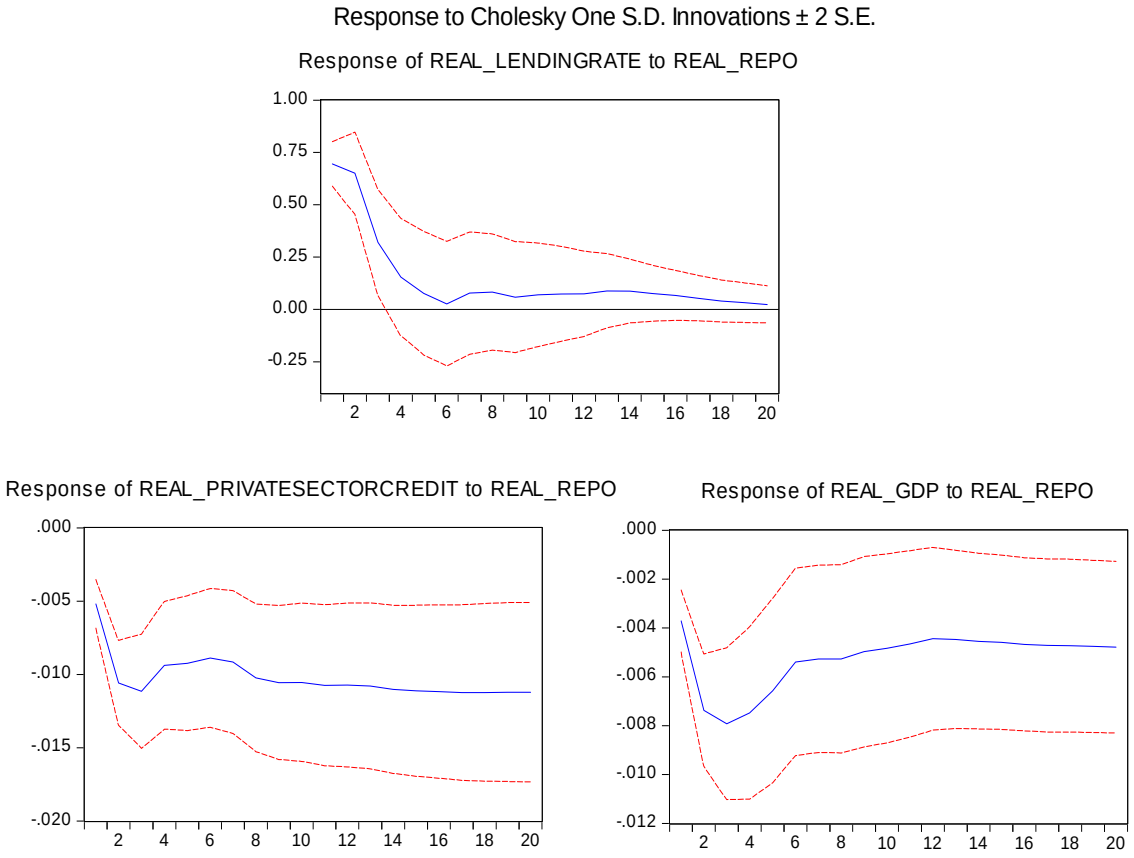
Source: Various issues of Economic Trends, Bangladesh Bank Publication, 2003-2016.

VI.1.A3.Response of Inflation to Policy Rate (Repo) Shock[5]

The response of real lending rate to real policy rate shock is significant and positive as expected at period 1 and remains significant until the 7th period and then becomes insignificant thereafter, while the response of the real private sector credit to real money supply shock is significant and negative as expected at period 1 and remains significant thereafter. The response of inflation due to shock to policy rate is significant and negative at period 1 and remain significant until the 8th period and then becomes insignificant thereafter implying rate monetary transmission channel through policy rate is significant in influencing inflation.

[5] The reverse repo rate has the similar impact on inflation.

Figure 5: Impulse Response Functions (IRFs) of lending Rate, Private Sector Credit and GDP to Policy Rate (Repo) Shock



Source: Various issues of Economic Trends, a Bangladesh Bank Publication.

VI.1.A4.Response of GDP to Policy Rate (Repo) Shock

The response of real lending rate to real policy rate shock is significant and positive as expected at period 1 and remains significant until 7th period and then became insignificant thereafter, while the response of the real private sector credit to real money supply shock is significant and negative at period 1 and remains significant thereafter. The response of GDP due to shock to policy rate is also significant and negative at period 1 and remains significant thereafter.

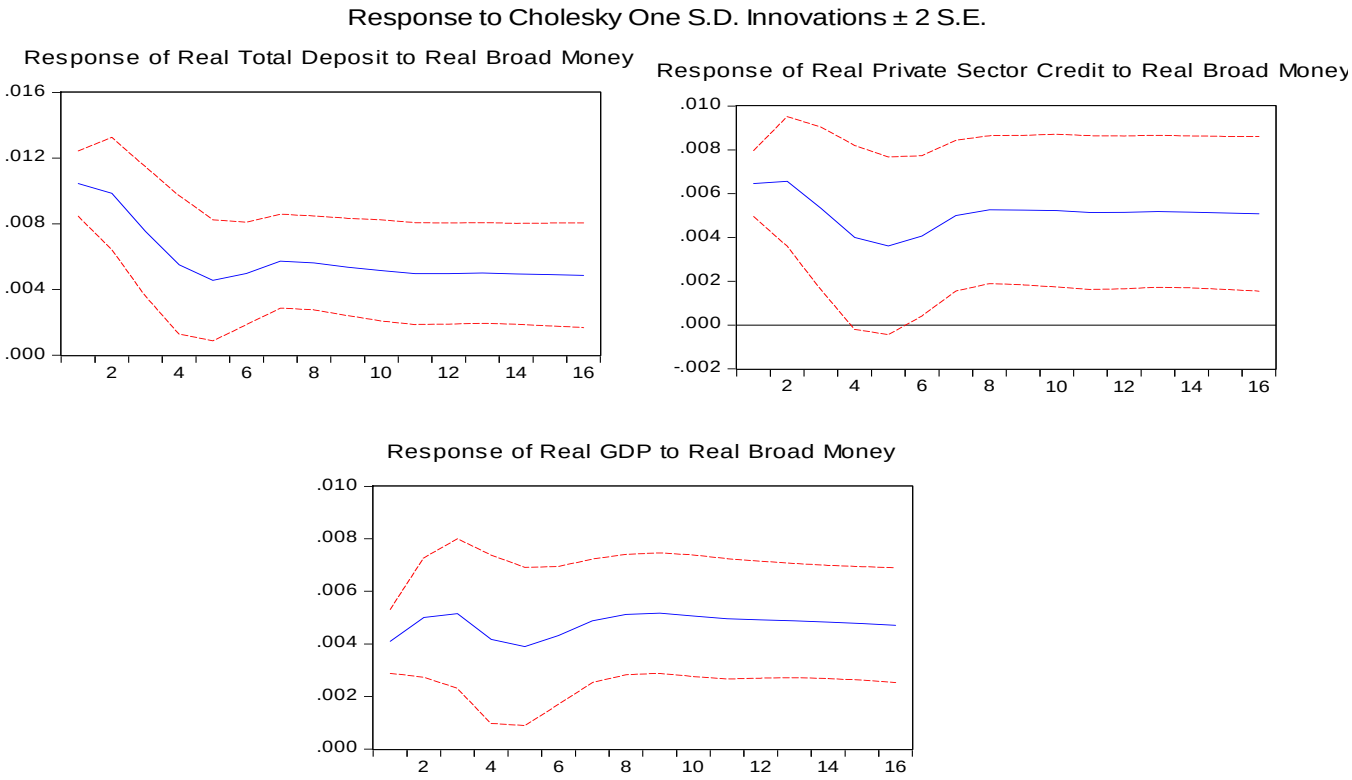
VI.1.B1.Response of GDP to Money Supply Shock

The response of real deposits to real money balance is significant and positive as expected at period 1 and remains significant at 3rd period and then became insignificant thereafter, while the response of the real private sector credit to real money supply shock is significant and positive at period 1 and remain significant until 3rd period. The response of GDP due to shock to money supply is also appear

significant and positive at period 1 and remain significant for the whole period implying that monetary transmission mechanism in influencing GDP is effective as well through money channel.

VI.1.B. Money Channel

Figure 6: Impulse Response Functions (IRFs) of Total Deposits, Total Private Sector Credit and GDP to real Money Supply Shock



Source: Various issues of Economic Trends, a Bangladesh Bank Publication, 2003-2016

VI.1.C.Exchange Rate Channel

The response of real exchange rate to real money balance is significant and negative as expected at period 1 and remain significant until period 3 and then became insignificant thereafter, while the response of real export to real money supply shock is significant and positive at period 1 and remain significant until the 2nd period. The response of real GDP due to shock to real money supply is significant and positive at period 1 and remains significant until the 4th period implying that monetary transmission channel is effective in influencing real GDP through exchange rate channel. The responses of inflation is continuously showing the price puzzle due to money supply shock.

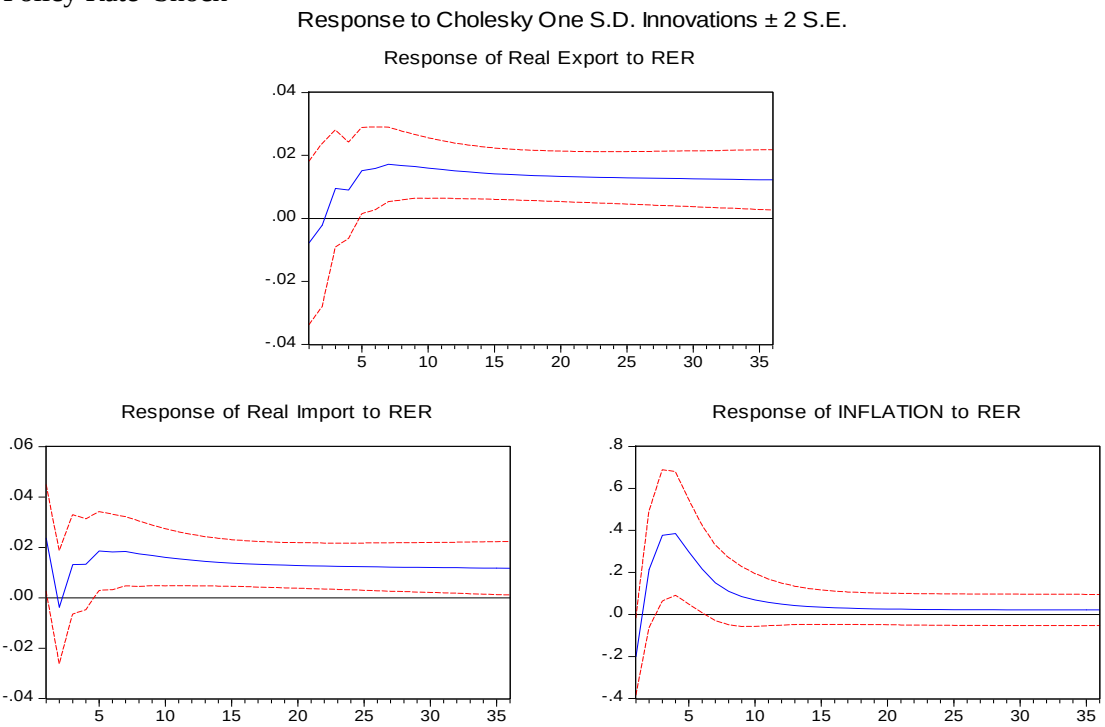
VI.1.C.1.Response of Inflation Real Exchange Rate Shock

If there is any positive shock in the real exchange it constitutes the responses of real export and real import are insignificant initially which became significant at period 5 and remain significant and positive thereafter, while the response of inflation to real exchange rate is insignificant initially which becomes significant and positive at period 2 and remains significant until period 7th and then becomes insignificant thereafter implying that exchange rate depreciation will increase inflation through increase in real exports and real imports. Similar responses in seen in the reponses of real GDP to real exchange rate shock.

VI.1.C.2.Response of GDP to Policy Rate Shock

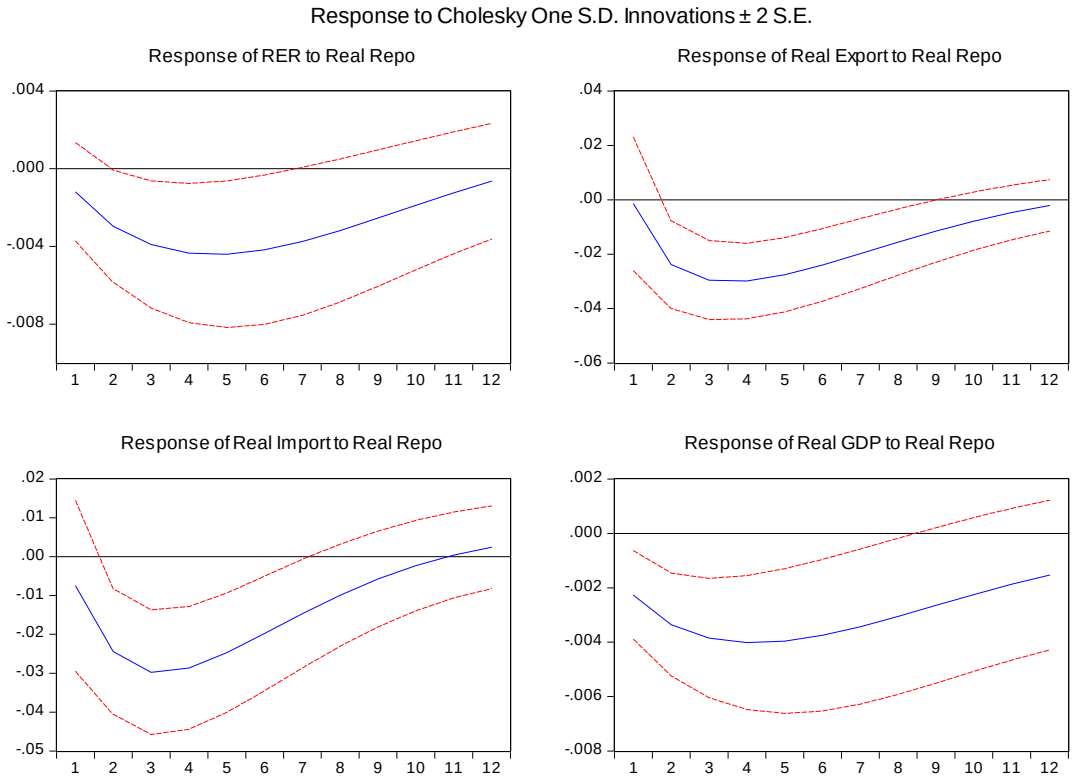
The response of real exchange rate to real policy rate is significant and negative as expected at period 2 and remain significant until period 6 and then became insignificant thereafter, while the response of real export to real policy rate shock is also significant and negative at period 2 and remain significant until the 9th period. The response of real imports to real policy rate shock is significant and negative at period 1 and remain significant until period 2 and then became insignificant thereafter. The response of real GDP due to shock to real policy rate shock is significant and negative at period 1 and remains significant until the 8th period and then becomes insignificant thereafter.

Figure 7: Impulse Response Functions (IRFs) of Real Exchange Rate, Export, Import and Inflation to Policy Rate Shock



Source: Various issues of Economic Trends, a Bangladesh Bank Publication, 2003-2016.

Figure 8: Impulse Response Functions (IRFs) of Real Exchange Rate, Export, Import and GDP to Policy Rate Shock



VI.1.C.3.Response of Inflation to Policy Rate Shock

The response of real exchange rate and real imports to real policy rate shock is significant and negative at period 2 and remains significant until period 9 and then becomes insignificant thereafter, while the response of real exports is insignificant to real policy rate shock. The response of inflation to real policy rate shock is significant and negative at period 1 and remains significant until period 5 and then becomes insignificant thereafter.

VI.D. Variance Decompositions (VDCs): Credit Channel

In order to know the magnitudes of a shock, VDCs of time horizon of 2, 4, 6,8,10 and 12 are computed. [1] Similar results have been found from the variance decompositions of inflation and output. The estimates of the forecast error variance are considered significant if the point estimate is at least two times as large as the standard error. Ten thousands bootstrap simulations are used to construct the standard errors for VDCs. Because, this study is most concerned with the forecast error variance in LR,

deposits, credit, and inflation and output explained by monetary policy shock, VDCs of only interest rates, deposits, credit, price level and output are reported in the appendix.

VI.D.1.An Innovation to Money Supply: Variance Decompositions of Output

Table 1 in the appendix shows the variance decompositions of real GDP due to shock to real money supply, real lending rate and real private sector credit. The point estimates and standard errors of real money supply, real lending rate, real private sector credit and real output due to a shock to money supply are reported in Table 1. From Table 1, it is evident that real money supply explains 21% of the forecast error variance in the real GDP, while real lending rate explains 25.26% variations in real GDP at period two which increased to 33.34%, and 34.01% respectively at period 12. On the other hand, forecast error variance explained by real GDP itself was 41.18 percent at period 2 which decreased to 27.20% at period 12. This implies that variance decompositions of GDP show that money supply, real lending rate have significant impact on GDP.

VI.D.2.Variance Decompositions of Inflation

Variance decompositions of inflation due to shock to real money supply, real lending rate, real private sector credit is reported in Table 2, which shows that real money supply explains 27.97% of the variations in the forecast error in inflation at period two which increased o 62.86 at period 12%, while real lending rate explain 62.32% variations in inflation at period 2 which decreased to 28.00% at period 12. This implies that money supply and the lending rate have significant impact on inflation.

VI.D.3.An Innovation to Policy Rate: Variance Decompositions of Output

Table 3, shows the variance decompositions of real GDP due to shock to real repo rate, real lending rate and real private sector credit and real GDP. The point estimates and standard errors of real repo rate, real lending rate, real private sector credit and real output due to a shock to real policy rate are reported in Table 3. from Table 3, it is evident that real policy rate explains 41.90% variations in the real GDP at period 2, which decreased to 30.17% at period 12. While real GDP explains 42.94% variations in the forecast error at period 2, which increased to 44.13% at period 12.

VI.D.4.Variance Decompositions of Inflation

Variance decomposition of inflation due to shock to real policy rate, real lending rate, real private sector credit is reported in Table 4, which shows that real repo rate explains 74.80% of the variations in the forecast error in inflation while real lending rate explain 8.76% variations and real private sector credit explains 13.53% variations in inflation at period two. However, at period 12 real repo explains 61.34% and real private sector credit explains 31.43% variations in inflation.

VI.D.5.Money Channel: Variance Decompositions of Output

Table 5, shows the variance decompositions of real GDP due to shock to real repo rate, real lending rate and real private sector credit and real GDP. The point estimates and standard errors of real money supply, real lending rate, real private sector credit and real output due to a shock to real policy rate are reported in Table 5. From Table 5, it is evident that real policy rate and real GDP itself explain 41.90% and 42.94% forecast error variance in the real GDP at 2nd period, which increased o 30.17%, and 44.13% respectively at period 12.

VI.D.6.Exchange Rate Channel

Variance decompositions derived from VAR show that the monetary policy (both money supply and repo rate) transmits to the economy through exports. However, the impact of monetary policy on inflation transmits through the real exchange rate channel.

VII. Conclusion

This study focuses on examining the transmission of monetary policy shocks onto the economy and the price level through different channels.In this backdrop, a five variable unrestricted Vector Auto Regression (VAR) technique is used to examine the effectiveness of monetary transmission channels in Bangladesh. In this study, several monetary transmission channelssuch as interest rate or money channel, bank lending or credit channel, and the exchange rate channel have been analyzed. The Impulse Response Functions and Variance Decompositions derived from VAR show that money supply and the policy rate both have significant impacts onoutput and the inflationin Bangladesh implying that monetary policy transmission channel is effective in influencing macroeconomic variables in Bangladesh.

In addition, the empirical results show that bank lending, money and the exchange rate channels work efficiently to affect output and the price level.Bank deposits and credit channel work better as an intermediate channels to transmit monetary policy on output and the price level. An increase in repo rate tends to control inflation but also hurt GDP. Therefore, policy implications of this study would be to contain higher inflation any drastic measures taken by the monetary authority may hurt GDP growth.So, we need to be cautious while making changesin the policy rates as monetary policy tools to contain inflation.

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Appendix
An Innovation to Money Supply: Sample Period: 2004:7 to 2016:1

Table-A1: Variance Decompositions of Output

Months	REAL_M2	REAL_LENDING_RATE	REAL_PSC	REAL_GDP
2	21.02***	25.26***	12.53	41.18***
	(7.03)	(6.61)	(4.86)	(6.51)
4	20.96***	33.39***	9.58	36.06***
	(8.11)	(9.09)	(5.22)	(8.13)
6	24.04***	35.50***	7.81	32.65***
	(9.58)	(10.85)	(5.13)	(8.802)
8	27.43***	35.63***	6.67	30.26***
	(11.06)	(12.33)	(5.12)	(9.26)
10	30.57***	34.97***	5.93	28.52***
	(12.32)	(13.53)	(5.25)	(9.66)
12	33.34***	34.01***	5.44	27.20***
	(13.35)	(14.45)	(5.49)	(10.01)

Table-A2: Variance Decompositions of Inflation

Period	REAL_M2	REAL_LENDING_RATE	REAL_PSC	INF
2	27.97***	62.32***	6.38	3.32
	(7.95)	(7.99)	(3.29)	(1.69)
4	50.83***	39.44***	7.82	1.91
	(10.54)	(9.53)	(5.15)	(2.09)
6	59.44***	32.44***	6.44	1.69
	(11.29)	(10.05)	(5.05)	(3.42)
8	63.20***	28.74***	6.10	1.95
	(11.57)	(10.24)	(4.75)	(4.62)
10	63.25***	28.51***	5.99	2.25
	(11.95)	(10.70)	(4.90)	(5.42)
12	62.86***	28.00***	6.21	2.92
	(11.91)	(10.40)	(4.88)	(5.88)

Table-A3: Variance Decompositions of Output

Months	REAL_REPO	REAL_LENDING_RATE	REAL_PSC	REAL_GDP
2	10.70	4.46	41.90***	42.94***
	(6.57)	(3.91)	(8.69)	(8.35)
4	10.79	7.11	43.55***	38.55***
	(8.19)	(6.13)	(11.64)	(10.90)
6	11.08	12.32	35.69***	40.90***
	(8.63)	(8.15)	(11.43)	(11.68)
8	10.18	15.05	32.90***	41.88***
	(8.09)	(9.03)	(11.31)	(11.71)
10	9.29	16.72	30.81***	43.18***
	(7.64)	(9.35)	(11.02)	(11.63)
12	8.46	17.24	30.17***	44.13***
	(7.22)	(9.51)	(10.91)	(11.54)

Table-4: Variance Decompositions of Inflation

Months	REAL_REPO	REAL_LENDING_RATE	REAL_PSC	INF
2	74.80***	8.76***	13.53***	2.92
	(5.37)	(3.36)	(4.31)	(1.35)
4	62.09***	6.76	29.01***	2.14
	(8.50)	(3.84)	(7.93)	(1.55)
6	61.30***	6.06	30.69***	1.94
	(8.93)	(4.07)	(8.25)	(1.63)
8	61.31***	5.67	31.20***	1.82
	(9.16)	(4.50)	(8.42)	(1.73)
10	61.31***	5.51	31.42***	1.76
	(9.35)	(4.91)	(8.57)	(1.91)
12	61.34***	5.49	31.43***	1.75
	(9.46)	(5.40)	(8.66)	(2.16)

Cholesky Ordering: REAL_REPO REAL_LENDING_RATE REAL_PSC INF
Standard Errors: Monte Carlo (10000 repetitions)

Table-5:Variance Decompositions of Output

Months	REAL_M2	REAL_DEPOSIT_RATE	REAL_TD	REAL_GDP
2	21.11***	24.23***	0.43	54.23***
	(7.08)	(6.64)	(1.35)	(7.18)
4	21.74***	29.86***	0.34	48.06***
	(8.14)	(9.05)	(1.42)	(8.62)
6	24.89***	29.99***	0.94	44.18***
	(9.21)	(10.67)	(2.62)	(9.55)
8	28.15***	29.078***	1.51	41.26***
	(10.25)	(11.93)	(3.90)	(10.39)
10	31.15***	28.04***	1.87	38.93***
	(11.21)	(12.90)	(4.94)	(11.12)
12	33.90***	27.05***	2.03	37.02***
	(12.08)	(13.61)	(5.72)	(11.72)

Table-6: Variance Decompositions of Inflation

Months	REAL_M2	REAL_DEPOSIT_RATE	REAL_TD	INF
2	11.80***	84.61***	0.69	2.88
	(5.62)	(5.83)	(1.19)	(1.39)
4	33.92***	61.07***	3.01	2.00
	(10.01)	(9.84)	(3.67)	(2.01)
6	40.54***	53.46***	3.56	2.44
	(10.99)	(10.5018)	(4.55)	(2.47)
8	41.13***	52.35***	3.46	3.06
	(11.23)	(10.63)	(4.53)	(3.61)
10	40.88***	51.33***	3.80	3.99
	(11.31)	(10.61)	(4.85)	(4.64)
12	40.45***	50.57***	4.29	4.69
	(11.35)	(10.61)	(5.48)	(5.44)

Exchange Rate Channel

Table-7: Variance Decompositions of Output

Months	REAL_M2	RER	REAL_EXPORT	REAL_IMPORT	REAL_GDP
2	31.43**	11.13	5.58	5.66	46.20***
	(8.34)	(5.68)	(4.02)	(3.9)	(7.72)
4	29.23***	10.33	18.20**	4.61	37.63***
	(10.13)	(7.09)	(8.51)	(4.12)	(8.96)
6	28.40***	8.81	23.29***	4.29	35.21***
	(11.09)	(6.67)	(10.31)	(3.92)	(9.25)
8	30.29***	9.47	22.46***	5.12	32.67***
	(11.68)	(6.39)	(10.10)	(4.61)	(9.16)
10	32.24***	10.43	21.63***	4.82	30.88***
	(12.24)	(7.18)	(9.81)	(4.77)	(9.09)
12	33.36***	10.83	21.13***	4.62	30.07***
	(12.67)	(7.88)	(9.68)	(4.85)	(9.07)

Table-8: Variance Decompositions of Inflation

Months	REAL_REPO	RER	REAL_EXPORT	REAL_IMPORT	INF
2	76.94***	10.22***	0.27	1.94	10.63***
	(6.25)	(4.94)	(1.08)	(2.00)	(3.41)
4	69.87***	19.71***	1.51	1.36	7.54***
	(9.83)	(9.43)	(3.18)	(2.33)	(3.49)
6	60.27***	30.58***	1.46	1.44	6.24
	(11.36)	(11.84)	(3.14)	(3.01)	(3.44)
8	57.76***	31.88***	1.98	2.46	5.91
	(11.73)	(12.37)	(3.37)	(4.07)	(3.58)
10	57.07***	31.20***	2.20	3.74	5.78
	(11.77)	(12.18)	(3.43)	(4.92)	(3.77)
12	56.79***	30.82***	2.17	4.45	5.77
	(11.72)	(11.97)	(3.41)	(5.35)	(3.98)

Table-9: Variance Decompositions of Output

Months	REAL_REPO	RER	REAL_EXPORT	REAL_IMPORT	REAL_GDP
2	25.12***	9.86	1.939	3.12	59.97***
	(7.94)	(5.42)	(2.67)	(3.23)	(8.21)
4	31.63***	5.68	11.84	2.44	48.42***
	(9.87)	(4.25)	(7.30)	(3.49)	(10.02)
6	30.47***	5.77	20.25***	2.22	41.29***
	(10.37)	(4.05)	(9.55)	(3.38)	(10.69)
8	27.65***	7.62	24.10***	2.74	37.88***
	(10.47)	(5.59)	(10.18)	(3.98)	(11.26)
10	25.12***	9.88	25.68***	2.96	36.36***
	(10.47)	(7.27)	(10.42)	(4.58)	(11.86)
12	23.00***	12.45	26.32***	2.91	35.32***
	(10.43)	(8.85)	(10.58)	(5.01)	(12.37)

Cholesky Ordering: REAL_REPO RER REAL_EXPORT REAL_IMPORT REAL_GDP Standard Errors: Monte Carlo (10000 repetitions