

Examining the Efficacy of the Monetary Transmission Mechanism Channels of Bangladesh: A Vector Autoregression Approach

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Abstract

This paper examines the efficacy of the monetary transmission channels in Bangladesh using a five variable unrestricted vector auto-regression (VAR) technique for the sample period from June 2003 to June 2015. Several monetary transmission channels, i.e., interest rate channel, bank lending channel or credit channel, and the exchange rate channel, have been analyzed to investigate the efficacy of policy reforms undertaken in the arena of monetary and exchange rates since 2002. Results from estimated VAR show that money supply (M2) have significant impacts on output (GDP) and the price level (Inflation) in Bangladesh implying that the monetary policy transmission channels are effective in influencing real variables through banks portfolio. Although all the monetary transmission channels work in Bangladesh, the bank lending channel has relatively more impact than that of interest rate or exchange rate channel in Bangladesh. Conversely, this study finds that the policy rate responds to inflation implying that the transmission channels work from inflation to policy rate as the central bank responds to higher inflation by raising policy rate in Bangladesh.

Keywords: impulse response functions, open economy, monetary policy transmission channel, VAR models, intermediate channels.

JEL Classification: C32, E52, E58, F41.

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I. Introduction

The purpose of this study is to examine the relative effectiveness of the monetary transmission channels in Bangladesh because it is important to understand the channels through which monetary policy transmits to the economy so that monetary authority achieve can the targets through adjustments of appropriate tools and instruments. The monetary policy transmission mechanism, or what is commonly referred to as the 'Black Box', 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. There are some studies examining the monetary transmission mechanism in Bangladesh. For example, Alam (2015) using Structural Vector Auto Regression Model (SVAR) and quarterly data from 1995 to 2011 examines the effectiveness of monetary policy in Bangladesh. Younus (2004) also using SVAR model examines the impact of monetary policy on the output and the price level in Bangladesh using quarterly data from 1973:1 to 2000:4. Ahmed and Islam (2006) using Unrestricted VAR examines the monetary transmission channel through bank lending channel and the exchange rate channel 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 with the other study in that this study includes the sample period when Bangladesh adopted various reform policies, i.e., there was a significant change in the policy level in Bangladesh. For example, at the end of May 2003, Bangladesh entered into the flexible exchange rate regime. Repurchase Agreement (Repo) (July 2002) and Reverse Repo (April 2003) were introduced 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 open market operation to keep money to its desired level.

II. Monetary Policy in Bangladesh

Bangladesh Bank was 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 system² During the early 1990s,

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.

initiatives were taken to bring significant changes in the financial system of Bangladesh. Under Financial Sector Reform Program (FSRP), initial restrictions were withdrawn from interest rates along with other conducive policies to liberalize financial sector. All of these developments help the monetary authority to formulate monetary policies based on the market requirement to bring effective changes in some macroeconomic variables to achieve goals and objectives of monetary policies.

Monetary policy framework followed by the Bangladesh Bank is now mostly market based that is 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 economic growth. It determines both reserve money and broad money (M2) 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 markets as the authority believe that efficient transmission of monetary policies depended on better functioning credit and debt markets.

BB uses net domestic assets as its key operating target and imposes a ceiling on it to influence reserve money and thus broad money. 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 in Bangladesh takes into consideration of the recent macro-variables to formulate monetary policy decisions. BB does influence its intermediate target (broad money M2) of its monetary policy through operating target of net domestic assets and 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 net domestic assets and thus reserve money.

The study has been organized as follows. After an introduction in section-I, Section II deals with the details of monetary policy framework and practices in Bangladesh. Section III provides the theoretical background followed by the relevant literature review in Section IV. In Section V provides methodology followed by the empirical examination in Section VI. Finally, conclusions and recommendations presented in Section VII.

III. Theoretical Review: The channels of monetary policy transmission.

Monetary authorities handle managing the money supply and interest rates in most countries. Policies adopted and used by monetary authorities to maintain the growth of money supply and interest rates to affect some desired economic variables. Banks for International Settlements (1998) in its policy paper has identified at least four channels of monetary policy in the modern financial system. The first is through the direct interest rate effects. Interest rate affects not only the cost of credit but also the cash flows of debtors and creditors. Changes in interest rates alter the marginal cost of borrowing, leading to changes in investment and saving and thus in aggregate demand.

The second channel is through the impact of monetary policy on domestic asset prices - including bond, the stock market, and real estate prices. The third channel is through the exchange rate. Credit availability is the fourth major channel. However, in countries with either poorly developed or tightly controlled financial systems, the interest rate may not move to clear the market. The quantity of credit often influences aggregate demand rather than its price. An increasing body of research has found that the financial condition of households, firms, and financial institutions can play a critical role in the propagation of monetary policy actions (Kamin, Turner, and Van'dack- 1998)³. However, the function of this channel in a given economy depends on its financial structure and the macroeconomic environment.

III.1 Direct interest rate channel: cost of credit and cash flow

In the most conventional model of monetary transmission, a shift in policy leads to a change in the money supply that, for a given money demand, leads to a change in market interest rate. Changes in policy and interbank rates lead, in turn, to change in bank loan rates for borrowers, which may consequently affect investment decisions, and in deposit rates, which may influence the choice between consuming now or later. The Keynesian view of how monetary tightening is transmitted to the real economy can be characterized with the following schematic diagram⁴:

$$M \downarrow \Rightarrow i \uparrow \Rightarrow I \downarrow \Rightarrow Y \downarrow$$

Where $M \downarrow$ indicates a contractionary monetary policy leading to rising interest rates ($i \uparrow$), which in turn raise the cost of capital, thereby causing a decline in investment spending ($I \downarrow$), thus leading to a decline in aggregate demand and a fall in output ($Y \downarrow$).

³ Kamin, S, Turner, P and Van'tdack, "The Transmission Mechanism of Monetary Policy in Emerging Market Economies: An overview" Bank for International Settlement, Basle, January 1998.

⁴ Frederic S. Mishkin "Symposium on the monetary transmission mechanism", Journal of Economic Perspective, Volume - 9, No. 4 fall - 1995 p. 3 - 10.

Although domestic interest rates have become a major channel of monetary transmission, they are mostly influenced by foreign interest rates in industrial countries. Even in the developing economies, with financial liberalization, the household and corporate sectors enjoying a higher degree of leverage, therefore, the interest rate channel is likely to become a more important channel of the transmission mechanism.

III.2 Exchange rates channel

In many developing countries, particularly those with only rudimentary markets for bonds, equities, and real estate, the exchange rate is probably the most significant asset price affected by monetary policy. When the exchange rate fixed or heavily managed the effectiveness of monetary policy is reduced but not eliminated. Often relatively wide margin exists within which the exchange rate can fluctuate. Moreover, if domestic and foreign assets are only imperfectly substitutable, there is some scope for domestic interest rates to deviate from international level. Therefore, even if the nominal exchange rate is fixed, monetary policy may be able to affect the real exchange rate by acting on the price level. In this manner, monetary policy retains its ability to affect net exports. Hence, Taylor, J. B (1995)⁵ and Obstfeld, M & Rogoff, K (1995)⁶ have identified the exchange rate as the key variable in the monetary policy transmission mechanism.

When the exchange rate is floating, a tightening of monetary policy increases the interest rates, raises the demand for domestic assets and hence leads to an appreciation of the nominal and, at least initially, the real exchange rate. Therefore, the higher value of the domestic currency (appreciation of the domestic currency, denoted by $E \uparrow$) makes domestic goods, more expensive thereby causing a fall in net export ($NX \downarrow$) and hence in aggregate output ($Y \downarrow$). Mishkin (1995) has expressed this transmission mechanism with the following schematic diagram:

$$M \downarrow \Rightarrow i \uparrow \Rightarrow E \uparrow \Rightarrow NX \downarrow \Rightarrow Y \downarrow$$

However, where domestic and financial assets are close to perfect substitute (as in Argentina or Hong Kong) or where there is a long tradition of dollarisation (e.g. in Argentina and Peru), the scope for monetary policy with exchange rate channel is severely limited. Nonetheless, in small open economies with flexible exchange rates, the exchange rate channel is likely to be particularly important because, in contrast to another channel,

⁵ John B. Taylor "The Monetary Transmission Mechanism: An Empirical Framework", Journal of Economic Perspectives, Vol. 9, No. 4, Fall- 1995, pp. 11- 26.

⁶ Maurice Obstfeld and Kenneth Rogoff "The mirage of Fixed Exchange Rates", *ibid.*

it affects not only aggregate demand but also aggregate supply. Therefore, a loosening of monetary policy, for example, may lead to a depreciation of the exchange rate, an increase in domestic currency import costs, and hence induce firms to raise their price even in the absence of any expansion of aggregate demand. Because exchange rate changes are viewed as a signal of future price movements in many countries, especially those with a history of high and variable inflation.

III.3. Credit Channel

The bank lending channel is based on the view that banks play a special role in the financial system because they are especially well suited to deal with the certain type of borrowers, particularly small firms where the problem of asymmetric information can be especially pronounced. After all, large firms can directly access the credit market through stock and bond markets without going through banks. Thus, a contractionary monetary policy that decreases bank reserves and bank deposits will have an impact through its effect on these borrowers. Schematically, the monetary policy effect is:

$$M \downarrow \Rightarrow \text{Bank Deposits} \downarrow \Rightarrow \text{Bank Loans} \downarrow \Rightarrow I \downarrow \Rightarrow Y \downarrow.$$

In countries where private markets for credit either are poorly developed or are prevented by government regulation from operating freely, monetary policy is likely to affect aggregate demand more by altering the quantity or availability of credit than through the direct or indirect effects of changes in the price of credit. Binding ceiling on interest rates or direct government involvement in the loan market, either through state owned commercial bank or fiscal subsidies of commercial bank loan, will have a non-price rationing effects in the credit market. The liberalization of the financial market does not necessarily eliminate availability credit effects. In the liberalised system, several central banks like in India, Indonesia, Israel, Malaysia, Peru, Thailand, and Venezuela explicitly monitor credit growth in evaluating the stance of monetary policy (Kamin, Turner and Van'tdack- 1998).

A tightening of monetary policy leads to a greater cut back in lending by small banks than by large banks, thereby supporting the existence of a credit channel for monetary policy. To the extent that certain firms depend on heavily or exclusively on bank financing, shifts in loanable resources from banks to other markets may exert an impact on aggregate demand that goes beyond the effects of increased interest rate alone.⁷

⁷ Bank of Korea, "Korea's experience of the monetary transmission mechanism": A paper submitted to BIS, Basle, in January 1998, seminar..

Monetary policy may affect the availability of credit more directly through effects on the value of assets of both borrowers and lenders. As changes in monetary conditions lead to a change in asset prices, the value of collateral for bank loans may be affected, and changes in the access of borrowers to credit could be induced. Also, where a large proportion of bank assets is invested in equities or real estate, the decline in asset prices, by lowering capital/ asset ratios, could force the bank to tighten the supply of credit.

Ben S. Bernanke and Mark Gertler⁸ has suggested two channels to explain the link between monetary policy actions and the external finance premium: the balance sheet channel (sometimes called the net worth channel) and the bank lending channel. According to them, monetary policy affects not only the general level of interest rates but also the size of the external finance premium.

The credit view contends that two channels of monetary transmission arise due to informational asymmetries between borrowers and lenders in the financial market. The bank lending channel emphasizes the special role of bank loans, particularly for "bank-dependent" borrowers (e.g. small firms), while the balance sheet channel operates through the balance-sheet position of the business firm.

III.3.1 Bank Lending Channel

The bank-lending channel rests on the idea that small firms, facing informational frictions in financial markets, must rely primarily on bank loans for external finance because it is prohibitively expensive for these borrowers to issue securities in the open market. When bank loans are of special importance for bank-dependent small firms, the effects of a monetary contraction may be amplified through the following two channels beyond those working through the interest rate channel: the direct channel operates through the reduced willingness of banks to lend at the going market interest rates owing to institutional factors such as regulatory action and moral suasion to restrain bank lending directly.

This channel is direct because it does not depend on the extent to which market interest rates rise. The indirect channel becomes operative when the increase in market interest rates following a monetary contraction raises loan rates enough both to cover the increase in lenders' cost of the fund as a result of the higher interest rates and to compensate them for the default risk. Banks also tend to tighten other non-price terms of lending, such as

⁸ Ben S. Bernanke and Mark Gertler, " Inside the black box: The credit channel of Monetary Policy Transmission" Journal of Economic Perspectives, Vol. 9, NO. 4, Fall, 1995.

collateral requirements and the maturity of loans (Morgan-1992).⁹ When either of these two bank lending channels operates, the banks are forced to reduced their total lending, and in most cases small firms that rely primarily on banks for credit must curtail their spending on investment.

Kasyap and Stein (1993)¹⁰ argue that banking firms may be subject to the same sort of capital market imperfections as their non-financial counterparts. According to their view, if a bank-lending channel is effective, a monetary contraction should have a disproportionately large impact on the lending behavior of small banks. Which are more likely to experience difficulties offsetting a loss of reserves by expanding non-deposit sources of external finance. Consequently, they wish to cut loan supply by relatively more than do large banks.

However, Allan, H. Meltzer (1995)¹¹ has rejected the lending channel as a separate hypothesis of monetary transmission mechanism because his study on the US Economy in the Great Depression did not support this channel. He argued, "If the lending channel is a separate transmission mechanism affecting small firms differently, bank loan should have fallen during the Great Depression more rapidly than open market commercial paper and banker's acceptances." He worked on U S with available monthly data of credit instruments. He produced his finding as "Both bank and open market lending first rise and then fall during the Great Depression. The initial relative decline in bank loans, following the August 1929 peak, occurred before the first wave of bank failures, so it does not support the non-monetary transmission process. In this period, open market lending declined at twice the rate of bank lending."¹² Moreover, Haubrich study (1990)¹³ on Canada casts doubt on the importance of the bank lending as a separate channel of the monetary transmission mechanism. In contrast, according to Bernanke (1983)¹⁴, "disruption of the lending channel during the Great Depression supplemented the effects of

⁹ Morgan, Donald P. "Are bank loans a force in monetary policy?" *Economic Review*, Federal Reserve Bank, 1992, pp. 31- 41.

¹⁰ Kashyap, Anil K. , Jeremy C. Stein and David W. Wilcox, "Monetary Policy and Credit Conditions: Evidence from the composition of external finance". *American Economic Review*, Vol. 83, No. 1, 1993, pp.78- 98. They found when the Federal Reserve tightens monetary policy, commercial paper issuance rises sharply, even while bank loans are falling. Thus bank lending channel may not be so effective if commercial paper can be substitutable for bank loan.

¹¹ Allan, H. Meltzer, "Monetary, Credit and (Other) Transmission Process: A monetarist Perspective" *Journal of Economic Perspectives*, Vol. 9. No. 4, Fall-1995, pp. 49- 72.

¹² *Ibid*, p.67

¹³ Haubrich, Joseph G., "Non-monetary effects of Financial crises: Lesson from Great Depression in Canada", *Journal of Monetary Economics*, March 1990.

¹⁴ Bernanke, Ben S., "Nonmonetary Effects of the financial crisis in the propagation of the Great Depression," *American Economic Review*, June 1983.

a decline in money stock by reducing the quality of financial services." On the other hand, the monetarist hypothesis recognizes that bank failures or commercial and industrial failures may have disrupted financial relations or encouraged banks to screen loans more carefully during the depression.

III.3.2 The balance sheet channel

The balance sheet channel of monetary policy transmission arises because rising interest rates, following the adoption of a tight monetary policy, directly increase the interest expenses of those firms that rely heavily on short-term debt to finance inventories and working capital. Which causes to reduce their net cash flows and consequently weaken their financial position. Furthermore, rising interest rates are always associated with falling asset prices, which indirectly erode the value of the firms' collateral. These effects lead to a reduction in the firms' net worth, thereby raising the premium for external finance. Small businesses are most likely to face a proportionately larger premium for external finance. One possible reason for this is that small businesses have proportionately less collateralizable net worth. Therefore, small companies that have relatively poor access to short-term credit markets respond to the deteriorated balance-sheet positions by drawing down inventories and cutting investment spending more than big business do. However, some research suggests that in a high inflation economy balance sheet mechanism loses strength because long-term debt disappears (Lopes-1997).¹⁵

III.4. Factors influencing the transmission of monetary policy

Two aspects are important in evaluating how fast monetary policy affects the real economy. The first is the transmission from the instruments directly under the central bank's control. Short-term interest rates or reserve requirements most directly influence the non-financial sector through loan rates, deposit rates, asset prices and exchange rate. The linkage is determined primarily by the structure of the financial system. The second aspect of the monetary transmission process is the link between financial condition and the spending decision of household and firms. In this regard, the initial financial position of household, firms and banks play a crucial role, including denomination of assets and liabilities and degree of dependence upon external sources of finance. Both aspects of the monetary transmission channel are likely to have been affected by the process of financial liberalization. The reduced role of the government has lessened the importance of the credit availability channel of monetary policy compared with the interest rate channel.

¹⁵ Francisco L. Lopes "The monetary transmission mechanism of monetary policy in a stabilising economy: notes on the case of Brazil", a paper submitted at BIS seminar, January 1997.

IV. Literature Review

In the literature, the 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 an empirical research findings of Friedman and Schwartz (1963) by empirically showing that movement in real output respond to change in monetary policy stances for two years or more (Bernanke and Gertler, 1995).

Eichenbaum and Evans (1995) conduct 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 consider three measures of the monetary policy: The Federal fund rates, the ratio of non-borrowed to total reserves and change 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.

Koray and McMillin (1999) investigate the responses of the exchange rate and the trade balance to monetary policy innovations in the U.S. economy during the period from 1973:1 to 1993:12. Vector autoregression models (VAR) are employed to derived impulse response functions (IRFs) and variance decompositions (VDCs).

Koray and McMillin (1999) used the Federal fund rates and Non-borrowed Reserve (NBR) as monetary policy variables. The empirical results show that after an adverse shock to NBR, output and price level decline and 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 is used to identify the monetary policy shock on the key macroeconomic variables such as money, the interest rate, prices and output. Fung et al. (1997) try to determine whether the effects of monetary policy shocks are common across the countries. Fung et al. (1997) identified monetary shocks by the assumption that due to a permanent change in the nominal stock, the price level increases proportionately with no long-run real economic effect. 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), unanticipated increase in the short-term interest rate (a restrictive monetary policy shock) causes reductions in real GDP and consumer price levels via interest rates, credit, exchange rates and 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, which are consistent with the Bank's move towards a monetary policy framework focusing on indirect instruments of monetary policy. 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.

Perera and Jayawickrema (2014) empirically estimated the monetary policy reaction function of the Central Bank of Sri Lanka over the period from 1996Q1 to 2013Q2 using OLS and GMM method. The estimates provide evidence of a change in the coefficients for the inflation gap and the output gap during the period of analysis, in particular with a stronger response of monetary policy to the inflation gap and the output gap being observed since 2007. There is also evidence of a greater weight being placed on output stabilization, which could reflect both the preference of the central bank and structural issues relating to the slower transmission of monetary policy. A relatively strong response to the output gap maybe attributed to a lower sensitivity of output to the interest rate. However, there appears to be a shift in monetary policy from greater responsiveness to the output gap to more focus on inflation. Their study, however, does not provide any evidence that monetary policy is responsive to the exchange rate.

Alam (2015) using quarterly data from 1995 to 2011 examine 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 nominal and real exchange rate. The empirical results derived from Structural Vector Auto Regression model show that either T-bill rate or the reserve money or broad money does not have any impact on the output, price level and 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 (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.

Ahmed and Islam (2006) conducted a study to examine whether bank lending and exchange rate channels exist in Bangladesh as the monetary transmission mechanism. The study attempted to identify the existence of bank lending channels for two sample periods, one is full sample period of July-September 1979 to April-June 2005, and the other is a sub-sample period January-March 1990 to April-June 2005. The model variables used for both full sample and sub-sample periods are reserve money (RM), total deposits, private sector advance, consumer price index (CPI) and Real GDP (RGDP) for bank lending channel while the model variable for exchange rate channel are reserve money, CPI, nominal exchange rate, export, import and real GDP. VDCs for Bank lending channel shows that Reserve money has no explanatory power over the other variables' movement while private Sector advance has some impact to explain total deposits' and CPI's. The result indicates that the Bank lending channel weekly exists as monetary transmission mechanism in Bangladesh. Impulse Response Function's also explain that reserve money has no explanatory power to explain the changes or movements of other variables in the model implying that RM's shock does not generate any significant response to other variables in the model. CPI can explain forecast error variances of the nominal exchange rate (NER) over the time horizon 12th & 16th quarter.

Younus (2004) examined the transmission channel through bank portfolio (credit or deposits). Quarterly data on six variables from the period of 1975:1 to 2000:4 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. The methodology used are structural VAR (SVAR) technique and Cholesky decompositions to construct VDC. Structural VAR is also applied for developing IRF's. These models are used to see the impact of monetary policy on the bank portfolios in Bangladesh and to determine whether money and credit

channel as monetary transmission mechanism exist in Bangladesh. SVAR estimation shows that monetary base does not explain forecast error variances of bank portfolios, price level, interest rate and output at optimal lag length 3. However, 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). The overall results suggest that the crisis and the subsequent significant shift in the exchange rate regime have significantly affected the Malaysian 'Black Box.' 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 domineering role in intensifying the effects of both interest rate and money.

Kapur and Behera (2012) examined 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 interest rate channel plays a significant role in affecting the monetary policy on the economy of India. On the other hand, Bhattacharya et al. (2011) found that 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 the inflation.

Disyatat and Vongsirikul (2003) conducted study to examine monetary transmission mechanism in Thailand. 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. VAR model was developed based on recursive Cholesky decomposition. The study first examined the impact of monetary policy on the GDP and price level using VDC and IRFs. It was found that GDP's response to interest rate was negative and quite persistent for long time horizon, but price puzzle was found for short time horizon as IRFs showed the positive response 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, M1, MCT (M2+CD), bank loans, movements in the short-term interest rate and the difference between target & actual growth rate of M1 and MCT. 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. The bottom line of this study is that interest rate and credit shocks play a significant role in affecting economic activity and price level.

V. Model variables, Methodology and Model Specifications

Monthly data for the sample period of 2004:m1 to 2015:m1 have been used to examine the monetary transmission channel through interest rate channel, bank lending, and exchange rate channel. Reserve Money or monetary base (RM)¹⁶ and Broad Money (M2)¹⁷ are used as proxy for the monetary policy. Use of M2 as a proxy for monetary shocks or money supply instead of RM is influenced by the work of Friedman and Schwartz (1963) as their findings show that on an average monetary base was stable during great depression 1929-1933 while money supply, as measured by M1, 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

¹⁶ Monetary Base = Currency + Reserve Money

¹⁷ M2 = M1 + Term Deposits, Money supply M1 has been strictly defined as currency outside bank plus demand deposit

the economy and at the same time, M2 is the intermediate target of Bangladesh Bank's monetary policy.

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 price level during the period of interest.

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.

V.1 Data Analysis

All the variables in this study have been collected in the form of nominal value. Real values of all variables have been employed. Using CPI all the nominal variables have been transformed into a real variable. $\text{Real value} = \{\text{Nominal Value} / (\text{CPI}/100)\}$.

Seasonal adjustment: As these variables are now in quarterly frequency there remains the chance that these 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 report 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 from the analysis.

Use of a Logarithmic form of Time Series Variables: In this report the relevant time series variables except interest rate (both lending and deposit interest rate) have been used taking the natural log of them. 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 logarithm makes them more random rather than being in a particular pattern. Use of raw data in an ordinary least squares (OLS) method in

regression analysis better fits when the time series variable trends linearly but for nonlinear or curvilinear raw data use in regression analysis may result is biased output. Time series variables need to be smoothed to fit better OLS method so that robust result can be obtained from theregression analysis. In this report, log-log model has been applied. Log-log model means the use of a logarithmic form of both dependent and independent variables. The econometric model in this report uses all the variables as both dependent and independent variables in turn. So to have better forecast response of a variable to impulses/shocks from another variable logarithmic form for all variables have been used which tend to smooth the trend of the variables and make them more normally distributed.

That is to comply with two fundamental assumptions that residuals are homoscedastic & random and usually distributed of regression analysis log form of time series variables is used in this report as the variables do not show a linear trend in their raw form. For example, a graphical representation of both raw data and log form time series for GDP has been produced below.

V. 2 Econometric Methodology

If we assume the dynamics of $Z_t = \begin{bmatrix} m_t \\ DR_t \\ PSC_t \\ P_t \\ y_t \end{bmatrix}$ is a Pth order Gaussian vector auto-regression process, we could write

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

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

Here, Φ is a 5x5 coefficients matrix; 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 IRFs. The IRFs show the dynamic response of each variable in the system to shocks from each variable in the system.¹⁸ 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. 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.¹⁹ 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, 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, domestic money (M2) is placed first followed by the bank deposits, banks credits, interest rates, the price level, and output.²⁰

¹⁸ 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.

¹⁹ The Maximum lag length of eight is used to preserve degrees of freedom.

²⁰ 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 domestic monetary policy variable first in the ordering allows the policy variable to affect other model variables contemporaneously. However, policy variable 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:

VI.1. Efficacy of Monetary Transmission Mechanism: Money Supply (M2)

The IRFs shows 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 money are shown in Figure-1.

IRF of deposits rate in Figure-1 indicates that a positive shock to domestic monetary policy produces a statistically significant positive impact on the banks deposits, credit and GDP, which are expected implying that due to an expansionary monetary policy bank deposits, credit and output increased significantly. However, on the other hand, interest rate increased due to shock to M2, which is contradictory to the expectations. Theoretically, due to an expansionary monetary policy shock interest rate should decrease.

Figure-1: Interest Rate Channel: Responses of lending interest rate, private sector credit and the GDP to monetary policy shock (M2)

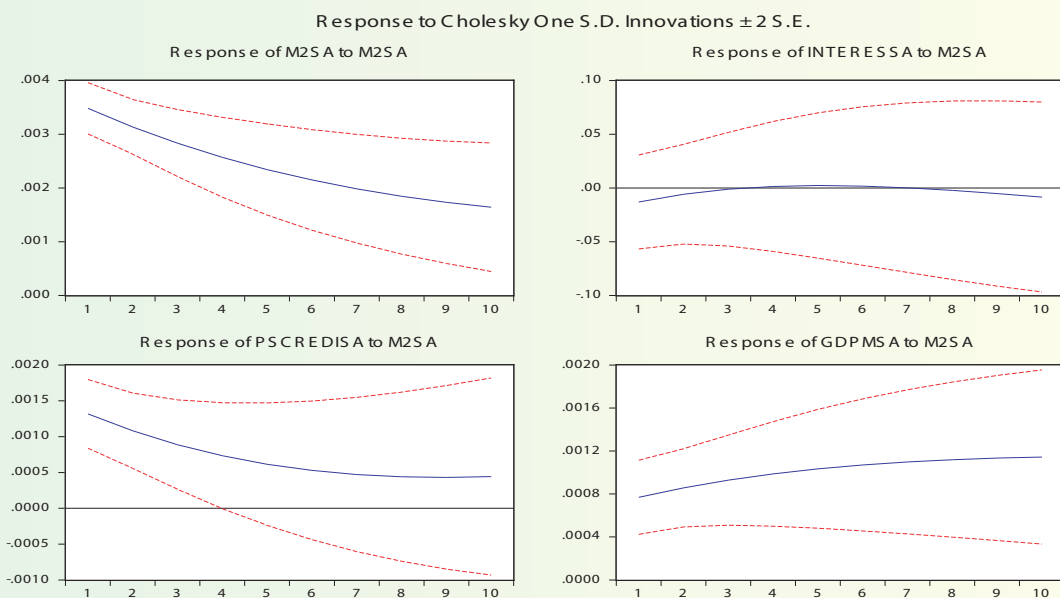
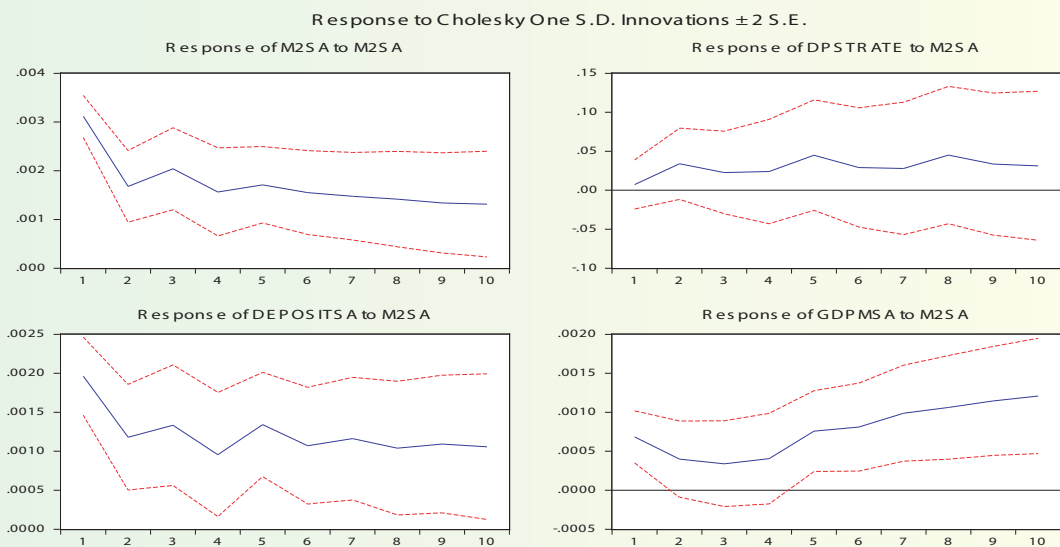


Figure-2: Interest Rate Channel: Responses of deposit interest rate, bank deposits and the GDP to Monetary Policy Shock (M2)



The above Figure-1 and 2 implies that although interest rate does not decrease due to monetary policy shock money supply has an impact on bank deposits and credit, which in turn increase output or GDP growth in Bangladesh.

In Figure-3, IRFs showing the response of the deposits, credit, price level, and output due to innovations (shocks) to M2 . The IRFs of deposits indicates that a positive shock to domestic monetary policy shock produces a statistically significant positive impact on banks deposits, credit and GDP, which are expected implying that due to an expansionary monetary policy bank deposits, credit and output increased significantly. The IRFs of the price level in Figure-3, show that domestic money supply (M2) initially produces an insignificant impact on the price level (since the confidence band contain the zero line), which became significant and positive at time horizon 7th and remained significant for the rest of the period implying that the response of the price level is permanent and no turning back to the initial position. This is consistent with the theory.

Figure-3: Bank Lending Channel: Responses of Deposits, Credit, Price level and GDP to Monetary Policy Shock

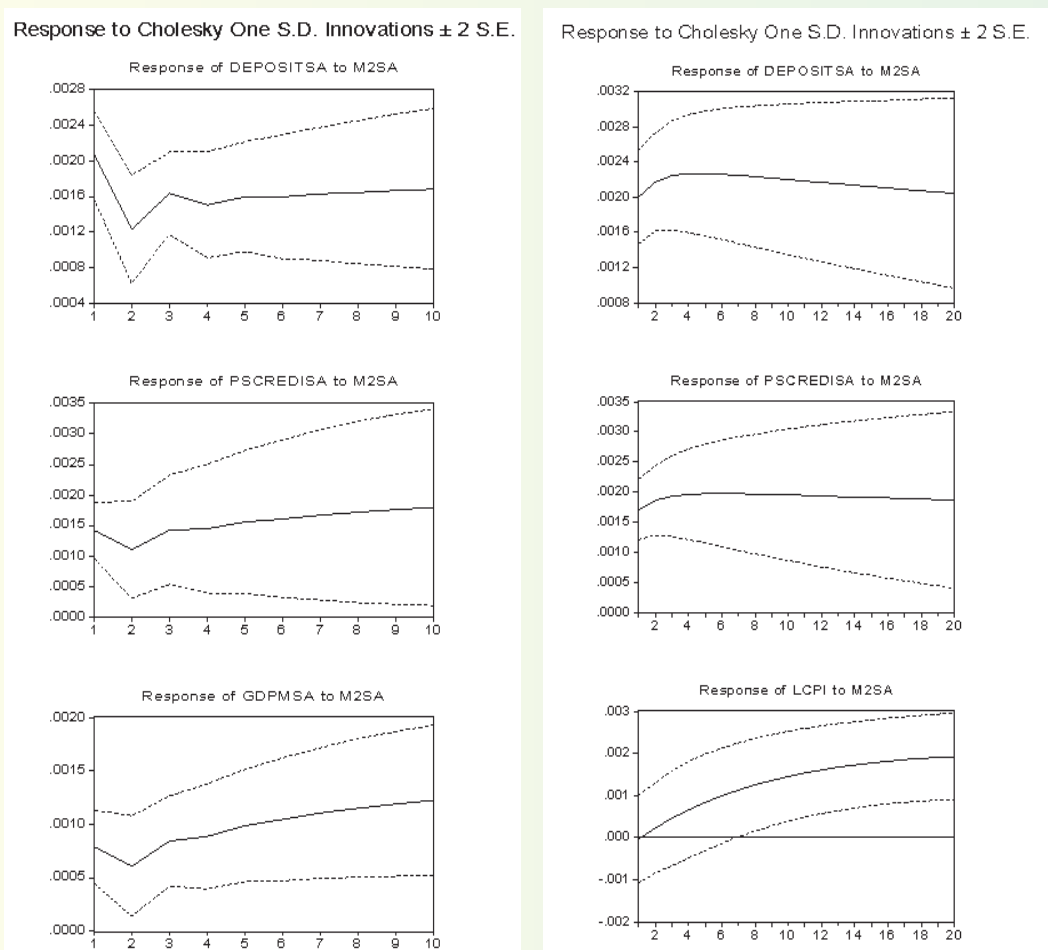
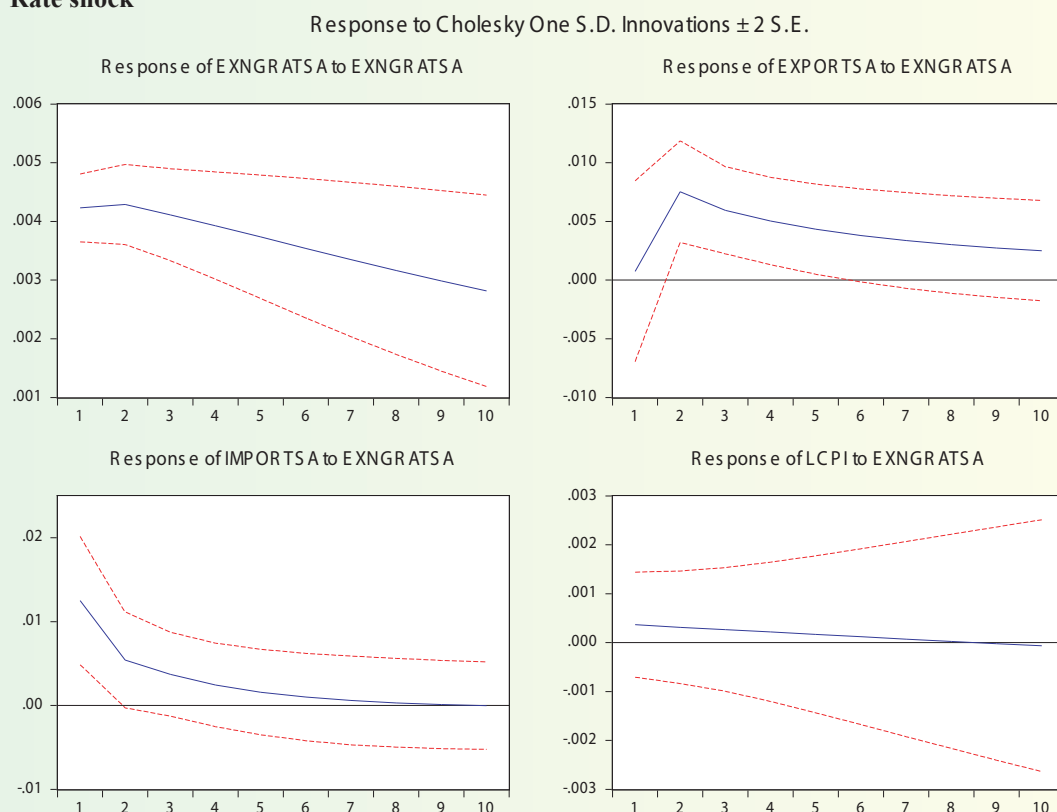


Figure-4: Exchange Rate Channel: Response of Export, Import and Price level to Exchange Rate shock



In Figure-4 the IRFs of the exports, imports, and the price level showed due to shock to the exchange rate exports and imports both became statistically significant and positive. The IRF of exports due to the shock to the exchange rate is insignificant initially which became significant and positive at time horizon 1st, and remain significant up to period 5th then becomes insignificant after that.²² The response of imports due to positive exchange rate shock is significant and positive also implying that if exchange rate depreciates that will increase exports and imports both because for exports we need raw materials that we import from rest of the world. The response of GDP and the price level due to shock to the exchange rate is insignificant. This is because GDP and the price level determined by some other factors rather than exchange rate itself.

²² An attempt also been made to gauge the impact of expansionary monetary policy on the exchange and the interest rate. Both the variable appear to be insignificant due to shock to an expansionary monetary policy. However, M2 and exchange rate found to have independent impact on exports and imports.

It is evident from Figure-5 that money supply decrease to higher inflation that also cause the interest rate to rise. The increase in banks' lending rate causes banks private sector credit to decline and so is GDP rate. Figure 5 and 6 shows how money supply changes respond to changes in inflation.

Figure-5: Bank Lending Channel: Responses of Money Supply (M2), Lending Rate, Credit and GDP to Inflation Shock

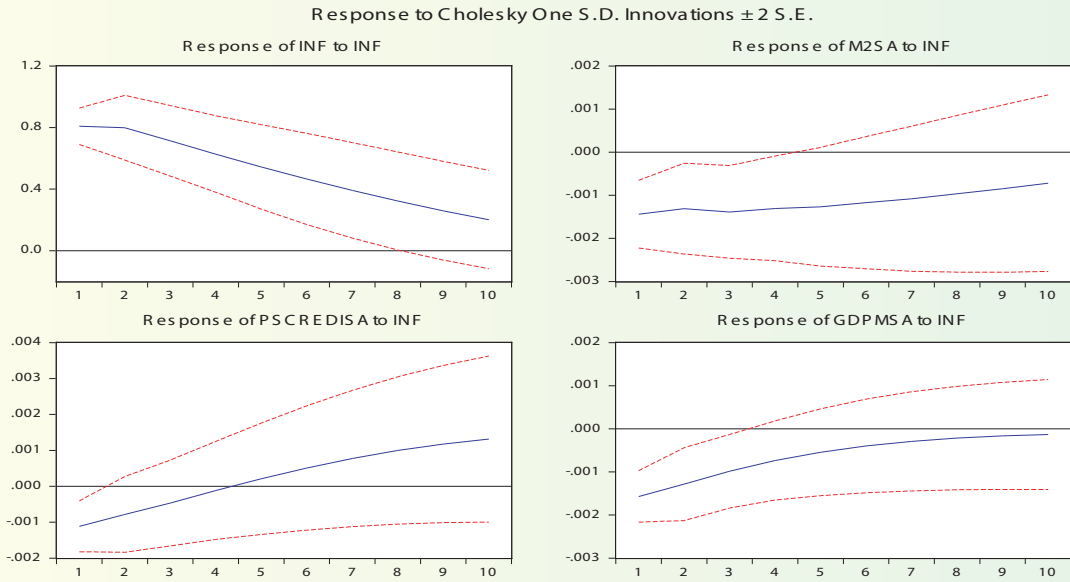
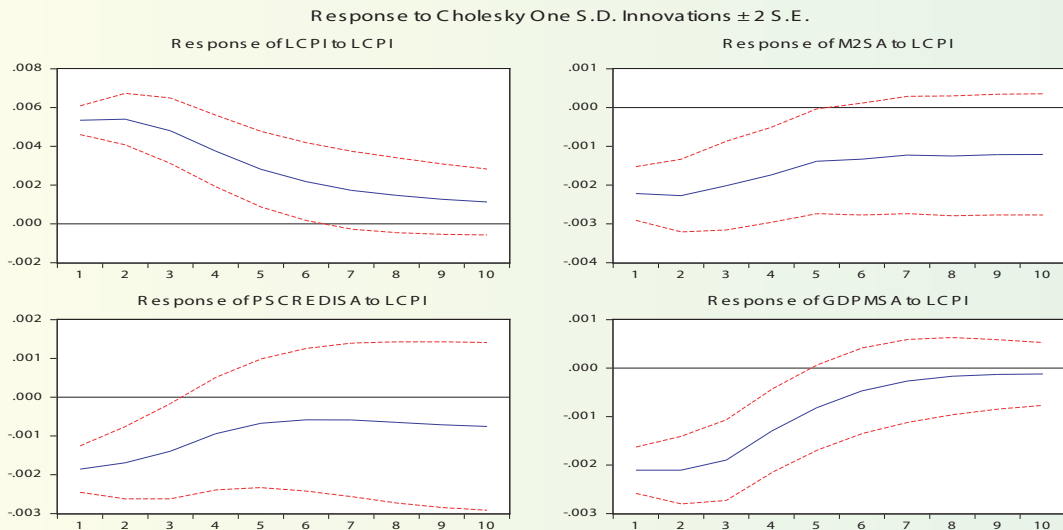


Figure-6: Bank Lending Channel: Responses of Money Supply, Lending Interest Rate, Credit and GDP to Price level shock

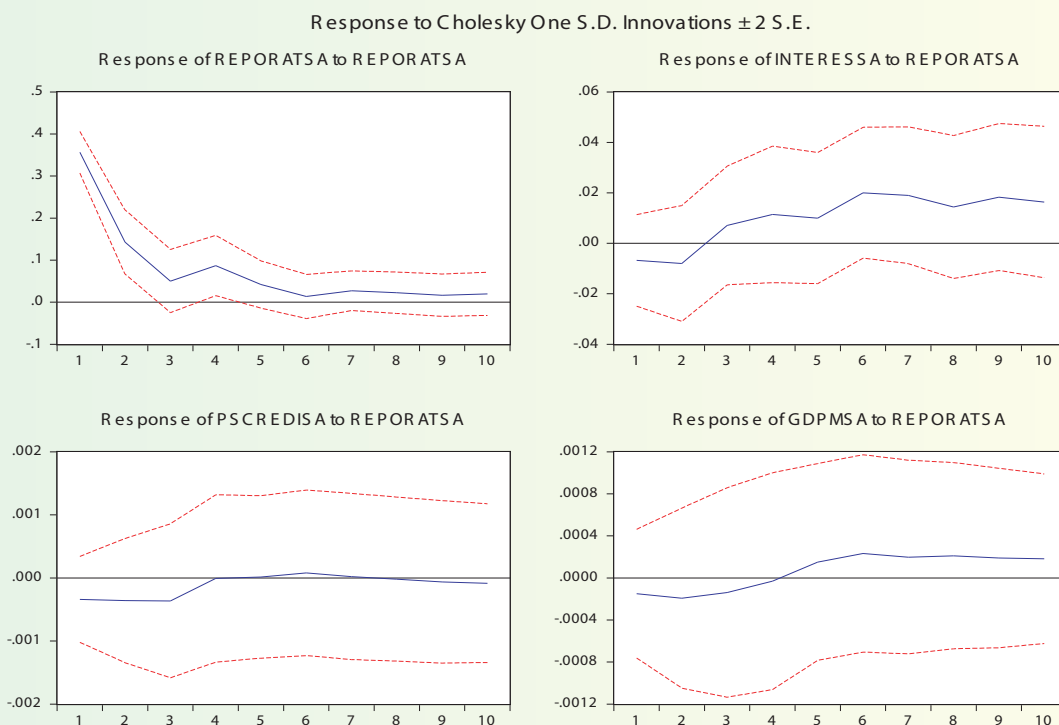


In Figure-6, shows the similiar impact of the price level. Money supply, private sector credit and GDP decreases dur to higher price level.

VI.2. Efficacy of Monetary Transmission Mechanism: Policy Rate

Bangladesh Bank uses Repo and Reverse Repo rates alongwith M2 as an indirect monetary policy tools since 2002 and 2003 respectively to control money supply or liquidity in the money market. Therefore, it is worthwhile to examine the efficacy of the monetary transmission channel of the policy rates. Pair-wise Granger causality test shows that there is a one-way causality from inflation to Repo Rate.

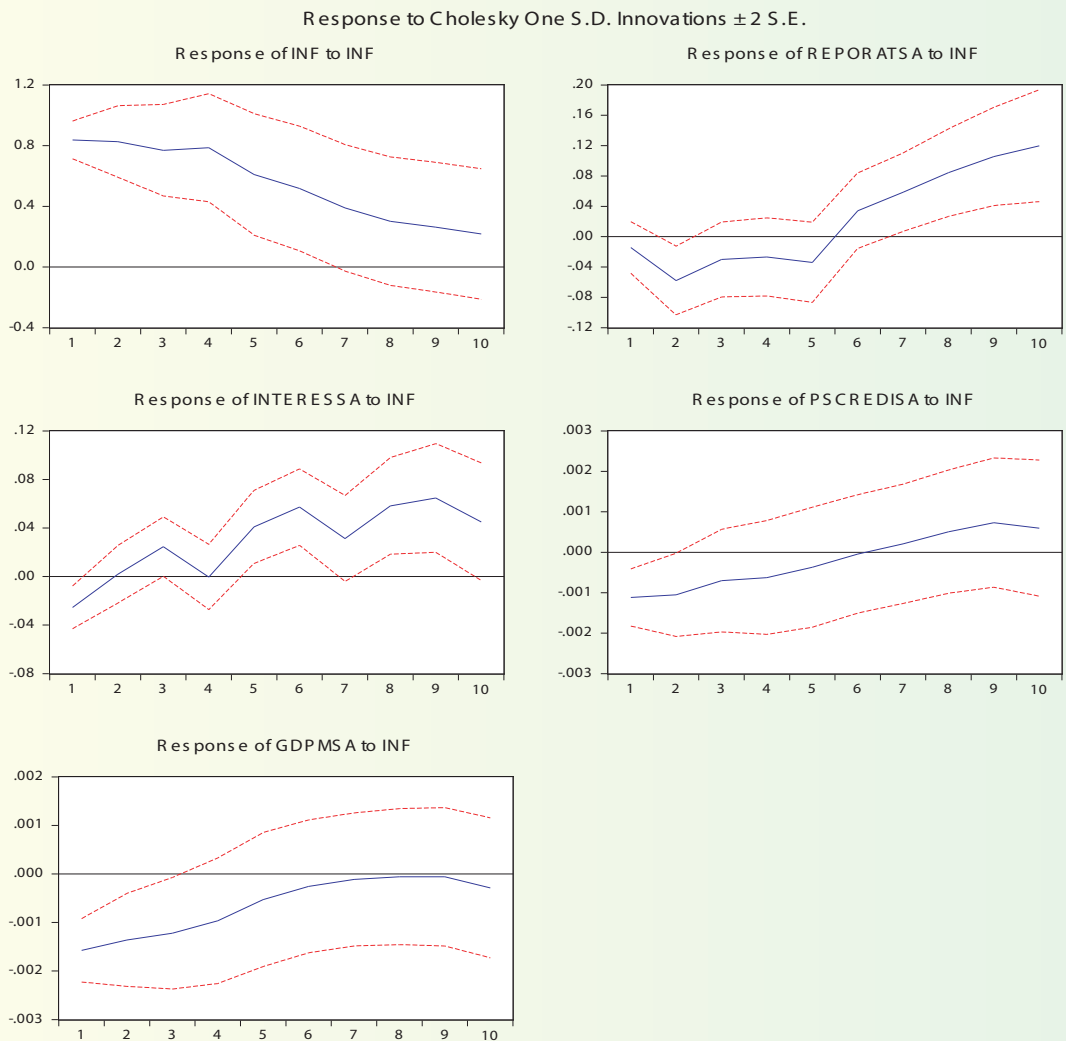
Figure-7: Bank Lending Channel: Responses of lending interest rate, credit, and GDP to Monetary Policy Shock (Policy rate)



In Figure-7 show the impact of policy rate on the interest rate, private sector credit and the GDP. Due to one S.D shock to policy rate (repo rate) the impact on the interest rate, private sector credit and GDP is insignificant . This is because the central bank do not use policy rate for increasing output. The policy rate is used to control money supply or liquidity in the market.?

The above Figure-7 show that Repo rates do not have any impact on GDP. However, in Figure-8, Repo rate responds to higher inflation. This implies that monetary authority responds to the rise in inflation by increasing repo rate, that causes bank lending rates to increase and decrease private sector credit and output.

Figure-8: Bank Lending Channel: Responses of Policy Rate, Lending Rate, Bank Credit and GDP to Inflation Shock



VII. Conclusion:

This study focuses on examining the transmission of monetary shocks onto the economy through different channels. Therefore, the dynamic relationship between the variables of each channel is to be examined to find out the impact of monetary shocks on to the final variable of each channel, the economic output, and the price level. If the responses of the core variable of each channel are significant to monetary shocks implying that monetary policy stance changes have a considerable impact on the economy through the respective channel/s. In this backdrop, a five variable Unrestricted Vector Auto Regression (VAR) techniques are used to examine the effectiveness of monetary transmission channels in Bangladesh. In this study, several monetary transmission channel has been analyzed. For example, interest rate channel, bank lending channel or credit channel, and the exchange rate channel. The IRFs derived from VAR show that money supply(M2) have significant impacts on output (GDP) and the price level (Inflation) in Bangladesh implying that monetary policy transmission channel is effective in influencing macroeconomic variables in Bangladesh. Also, the empirical results show that although the interest rate, lending, and 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.

References

- Ahmed, S., & Islam, M. E. (2006). The Monetary Transmission Mechanism in Bangladesh: Bank Lending and Exchange Rate Channels, *Working Paper Series, WP 0702, Policy Analysis Unit (PAU), Research Department, Bangladesh Bank*.
- Alam, M. R. (2015). Effectiveness of Monetary Policy in Bangladesh, *The Journal of Developing Areas*. 49(2).
- Benhabib, J., & Farmer, R. E. A. (2000). The Monetary Transmission Mechanism. *Review of Economic Dynamics*. 3(3), 523-50.
- Bernanke, B. S. & M. Gertler (1995). Inside the Black Box: The Credit Channel of Monetary Policy Transmission. *Journal of Economic Perspectives*, 9, 27-48.
- Patnaik, I., Shah, A., & Bhattacharya, R. (2011). Monetary Policy Transmission in an Emerging Market Setting. IMF Working Papers, 11(5), 1. doi:10.5089/9781455211838.001
- Braun, P. A. & Mittnik, S. (1993). Misspecifications in Vector Autoregressions and Their Effects on Impulse Responses and Variance Decompositions. *Journal of Econometrics*. 59, 319-41.
- Disyatat, P. & Vongsinsirikul, P. (2003). Monetary policy and the transmission mechanism in Thailand. *Journal of Asian Economics*. 14, 389-418.
- Eichenbaum, M. & Evans, C., (1995). Some Empirical Evidence on the Effects of Shock on Exchange Rates. *Quarterly Journal of Economics*. 110, 975-1009.
- Faik, K. & W. Douglas, McMillin, (1997). Monetary Shocks, the exchange rate, and the trade balance. *Journal of International Money and Finance*, 18(6), 925-940.
- Friedman, M. (1963). *Inflation: Causes and Consequences* (Bombay: Asia Publishing House), reprinted in Friedman, Dollars and Deficits (Englewood Cliffs, N.J.: Prentice-Hall, 1968), 39.
- Fung, B & Kasumovich, M. (1998). Monetary Shocks in the G-7 Countries: Is there a Puzzle? *Journal of Monetary Economics* (0304-3932), 42(3), 575-92.
- Hafer, R. W. & Sheehan, R. G. (1989). The Sensitivity of VAR Forecasts to Alternative Lag Structures. *International Journal of Forecasting*, 5, 399-408.
- Friedman, M., & Schwartz, J. (1963). *A Monetary history of the United States 1867-1960: Milton Friedman. Anna Jacobson Schwartz*. A study by the National bureau of economic research. Princeton: Princeton university press.
- Kim, H. E. (1999). Was Credit Channel a Key Monetary Transmission Mechanism Following the Recent Financial Crisis in the Republic of Korea?. *Policy Research Working Paper 3003*. World Bank.
- Kapur, M. & Behera, H. (2012). Monetary Transmission Mechanism in India: A Quarterly Model. *RBI Working Paper Series*. WPS (Dper): 09/2012, Department Of Economic And Policy Research, Reserve Bank of India.

- Loayza, N., & Schmidt-Hebbel, K. (2002). Monetary Policy Functions and Transmission Mechanisms: An Overview. in Loayza N. and K. Schmidt-Hebbel, eds., *Monetary Policy: Rules and Transmission Mechanisms*, Central Bank of Chile. Mishkin, Frederic S. (1995), Symposium on the Monetary Transmission Mechanism. *Journal of Economic Perspectives*, 3-10.
- Raghavan, M., Silvapulle, P., & Athanasopoulos, G. (2012). Structural VAR models for Malaysian monetary policy analysis during the pre- and post-1997 Asian crisis periods. *Applied Economics*, 44(29), 3841-3856. doi:10.1080/00036846.2011.581360
- McCallum, B. (1994). A Reconsideration of the Uncovered Interest Rate Parity Relationship, *Journal of Monetary Economics*, 33(1), 105-32.
- McCandless, G., & Warren, W. (1995). Some monetary facts. *Federal Reserve Bank of Minneapolis Quarterly Review*, 19(3), 2-11.
- Mishkin, Frederic S. (1996). The Channels of Monetary Transmission: Lessons for Monetary Policy. *National Bureau of Economic Research (NBER) Working Paper No. 5464*.
- Modigliani, F. (1971). *Monetary Policy and Consumption*. In *Consumer Spending and Monetary Policy: The Linkages*. Boston: Federal Reserve Bank of Boston. 9-84
- Montiel, P. J. (1991). The Transmission Mechanism for Monetary Policy in Developing Countries. *Staff Papers - International Monetary Fund*. 38(1), 83-108.
- Patinkin, D. (1965). *Money, interest and prices: An integration of monetary and value theory (2nd ed.)*. New York: Harper and Row.
- Perera, A. (2016). Monetary Transmission Mechanism in Sri Lanka: A Comprehensive Assessment with New Evidence. *Staff Studies*, 43(1-2), 31. doi:10.4038/ss.v43i1-2.4690
- Perera, R. & Jayawickrema, V. (2014). Monetary Policy Rules in Practice: Evidence for Sri Lanka. *Research paper, Economic Research Department, Central Bank of Sri Lanka*.
- Rabin, A. A. & Yeager, L. B. (1997). The Monetary Transmission Mechanism. *Eastern Economic Journal*. 23(3), 293-299.
- Taylor, J. B. (1995). The Monetary Transmission Mechanism: An Empirical Framework. *Journal of Economic Perspectives*. 9(4), 11-26.
- Tobin, J. (1969). A General Equilibrium Approach to Monetary Theory. *Journal of Money, Credit and Banking*. 1, 15-29.
- Younus, Sayera (2004), The Impact of Monetary Policy on the Bank Portfolio in Bangladesh. *Bank Parikrama*. 17&19, June 2003- December 2004.
- Younus, Sayera (2009). Impact of Monetary Policy Changes in a Semi-Global Economy: Evidence from Bangladesh. *Working Paper Series 0902, Policy Analysis Unit, Bangladesh Bank*.