Essays on Monetary Policy in Bangladesh

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ESSAYS ON MONETARY POLICY IN BANGLADESH

by

Sayera Younus

A Dissertation
Submitted to the
Faculty of The Graduate College
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requirements for the
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Sayera Younus
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PART I

INTRODUCTION

Bangladesh is a small open economy that gained independence from Pakistan on December 16, 1971. A period of reconstruction and rehabilitation occurred after independence. Bangladesh followed a socialist plan within a closed economic framework with widespread nationalization of private businesses and financial institutions following independence. Bangladesh initiated a structural adjustment program in the early 1980’s, which was implemented in 1990. Before 1983, all the financial institutions in Bangladesh operated under a strict regime of regulations and directives by the government and the central bank. This in turn led to inefficiency in the financial sector and mis-utilization of scarce resources.¹

In 1986, a National Commission on Money, Banking and Credit was appointed by the Bangladesh government to identify the problems and to suggest remedies of the financial sector. Based on this commission’s report, and an in-depth study made by the World Bank suggested a series of policy measures to ensure a sound, safe and efficient monetary sector. The main objective of the financial sector reform program was to create a market oriented financial system by reducing a direct control of the central bank.

The Bangladesh Bank, the central bank in Bangladesh, is responsible for formulation and implementation of monetary policy. According to the Bangladesh Bank order of 1972, the main functions of the monetary policy in Bangladesh are: (1) to maintain reasonable price stability, (2) to ensure a stable balance of payment

¹ Unpublished reports on the financial sector reform programs (FSRP), Bangladesh Bank.
position and maintained an external competitiveness of Bangladesh Taka, and (3) obtain sustained economic growth through increased production, employment and real income. Therefore, this dissertation consists of three essays illustrate the main functions of the monetary policy in Bangladesh.

This dissertation uses three measures of monetary policy. In the first essay, narrow money supply (M₁) is used to examine the effectiveness and independence of monetary policy. In the second essay, the monetary base (MB) is used to examine the channel through which monetary policy transmits to the economy. In the third essay, domestic credit, the domestic component of the monetary base is used as a measure of monetary policy to examine the exchange market pressure model (EMP) in Bangladesh.

There is no consensus regarding the best indicator of monetary policy. Some economists, including Bernanke (1992), put emphasis on the interest rate, for example, the federal fund rate is the best indicator of monetary policy especially for the U.S. Others including Basurto and Ghosh (2000) argue that monetary aggregates are the best measure of the monetary policy, especially for the East Asian developing countries. Therefore, this dissertation uses monetary aggregates because most of the studies on developing countries used monetary aggregates rather than interest rate as a measure of monetary policy.

Consistent with previous literature, M₁ is used as the measure of monetary policy in the first essay. The monetary base and domestic credit are used in the second and third essays because these two components are under the direct control of the central bank. In addition, the use of these variables is consistent with the existing literature on credit channels and exchange market pressure.

In the first essay, in measuring effectiveness and independence of monetary
policy in altering economic activity and the price level, the following variables are used. Economic activity is measured by industrial production. The real money supply \((M_1)\) is used as the measure of monetary policy. The lending rate on commercial loans is used to see the impact of monetary policy on the interest rate. The consumer price index of middle-income families in Dhaka is used to examine the impact of monetary policy on the price level. Because Bangladesh is a small open economy, the real exchange rate is also used as an explanatory variable. This paper also examines the impact of the India's monetary policy, as an external factor, on economic activity in Bangladesh. India's monetary policy is of interest because, India's economy is large compared to Bangladesh and Bangladesh shares most of its border with India. Therefore, it is reasonable to see whether, in a small open economy like Bangladesh, foreign monetary policy plays any role in the effectiveness of monetary policy.

Impulse response functions and variance decompositions, derived from a near vector auto regression (NVAR), are used to examine the effectiveness and independence of monetary policy in Bangladesh.

In the second essay, the impact of monetary policy on bank portfolios is analyzed. The objective of the second essay is to examine empirically the channels through which monetary policy transmits to the economy in Bangladesh. In order to examine if monetary policy transmits through bank assets (credit channel) or liabilities (money channel) of bank portfolios, this paper examines the impact of monetary policy on bank deposits and credit. This essay also looks at the impact of bank assets and liabilities on the price level and economic activity. Economic activity is measured by industrial production. The real monetary base (MB) is used as the measure of domestic monetary policy. The consumer price index for middle-income families in Dhaka is used as the measure of the price level. Bank total deposits are
used as the liability variable and total domestic credit to the private sector is used as an asset variable. The bank-lending rate on commercial loans is used as an interest rate variable. Impulse response functions (IRFs) and variance decompositions (VDCs), derived from structural (Bernanke, 1986) VAR and a VAR with Cholesky decompositions are used to examine the monetary policy transmission mechanism in Bangladesh. That is, VDCs and IRFs are used to examine the impact of the monetary base on bank credit and deposits and the impact of bank credit and deposits on the price level and output.

The third essay illustrates the relationship between monetary policy and exchange market pressure. The objective of this essay is to examine empirically the impact of the monetary policy on exchange market pressure (EMP) in Bangladesh. EMP is measured as the sum of the percentage change of the international reserves scaled by the monetary base and the percentage change of the nominal exchange rate appreciation. The sum of domestic credit to the private sector and the government sector scaled by the monetary base is used as the measure of monetary policy (d). Domestic credit, the domestic component of the monetary base, is considered the variable controlled by policy makers. It is also used by other studies on EMP including Girton and Roper (1977) and Tanner (2001).

This essay also examines the impact of real income (y), the money multiplier (mm), and foreign inflation rate (p*) on EMP. The percentage change in industrial production is used as a measure of real income. The percentage change of the money multiplier is used to see the impact of money multiplier on the EMP. The percentage change of the consumer price index of the U.S. (or India) is used to examine the impact of foreign inflation on the EMP in Bangladesh. Because Bangladesh is a small open economy, the Taka/Dollar and Taka/Rupee nominal exchange rates are used to
estimate separate EMP models. The reason for using Taka/U.S. Dollar and Taka/Indian Rupee nominal exchange rates is that the U.S. and India are the major trading partners of Bangladesh.\(^2\)

Engle and Granger's (1987) two-step single-equation model is used to examine Girton and Roper's (1977) monetary model of the EMP. IRFs and VDCs, derived from a vector error correction model (VECM), are also used to see the robustness of the impact of the monetary policy, foreign inflation (U.S. and India), domestic real income and money multiplier on the EMP.

\(^2\) During the period of 2000, Bangladesh exports to the U.S. were $1779.5, which was 34.94% of the total exports, while imports from India were $945.4, which was 11.31% of total imports (source: Direction of Trade).
PART II

ESSAY-1: EFFECTIVENESS AND INDEPENDENCE OF MONETARY POLICY

Introduction

The objective of this study is to examine the effectiveness and independence of monetary policy in Bangladesh. Recent data shows that there is a low correlation between money supply growth, output growth and inflation in Bangladesh. For example, the inflation rate was at 1.6% in 2001, while money supply growth was 8.11% during the same period. However, gross domestic product (GDP) maintained a moderate rate of growth (on average 4% per annum) over the last few years.

This paper addresses the issue of effectiveness of monetary policy on economic activity and the price level in Bangladesh. In doing so, I examine domestic as well as foreign monetary policy and their impacts on economic activity and the price level in Bangladesh. Indian monetary policy is used as a foreign monetary policy because the India’s economy is large compared to the Bangladesh economy, and Bangladesh shares most of its border with India. It is possible that Indian monetary policy has a strong influence on the economic activity in Bangladesh, which may contribute to the ineffectiveness of domestic monetary policy. Thus, it is reasonable to examine whether the Indian monetary policy has any impact on the Bangladesh economy.

In a small open economy like Bangladesh, the exchange rate plays a very important role in affecting macroeconomic variables. In order to reduce the balance of payment deficits Bangladesh devalued her currency about 130 times from 1972 to
2001. Therefore, it is reasonable to believe that the exchange rate may exert some pressure on output and the price level in Bangladesh.

This study contributes to the literature by examining the important issue of the effectiveness and independence of monetary policy in Bangladesh. This is the first paper that looks at these issues. That India’s monetary policy (as a foreign monetary policy) may have a strong influence on the Bangladesh economy has not been studied before.

Bangladesh gained independence from Pakistan on December 16, 1971. From 1972 to 1978 is a period of reconstruction and rehabilitation. Bangladesh followed a socialist plan within a closed economic framework along with widespread nationalization of private business. Over the period from 1979 to 1990, Bangladesh gradually changed to a free market economy.

Bangladesh initiated a structural adjustment program in the early 1980’s, which was implemented in 1990. Before 1983, all the financial institutions in Bangladesh operated under a strict regime of regulations and directives by the government and the central bank. This in turn led to inefficiency of financial intermediation and misutilisation of scarce resources.\(^3\)

In order to create an efficient banking system in Bangladesh, a National Commission on Money, Banking and Credit was appointed by the Bangladesh government to identify the problems and to suggest remedies. Following this commission’s report, the World Bank suggested reforms to ensure the safety, soundness and efficiency of the banking sector. Based on these suggestions the Bangladesh government adopted a number of institutional reforms, policy reforms and liberalization measures. Therefore, it would be interesting to examine the

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\(^3\) Unpublished report on the financial sector reform program (FSRP), Bangladesh Bank.
effectiveness of monetary policy in Bangladesh. This essay also examines the independence of Bangladesh's monetary policy compared with India's monetary policy.

Literature Review

Effectiveness and Independence of Monetary Policy

In the following section, the literature that contributes to our knowledge of the effectiveness and independence of monetary policy is reviewed. Monetary policy effectiveness and independence are important in order to achieve macroeconomic goals, such as price stability, employment and economic growth, and external balance.

To understand the effectiveness of a policy, one should examine the interdependence among the policy and the target variables. In this perspective, the literature is reviewed in the following manner. First, the literature that discusses the relationship among money, price level, interest rate, exchange rate and output is reviewed. In doing so, I hope to clarify how monetary policy affects macroeconomic variables in general. Second, I review the literature that deals with the impact of foreign monetary policy on the domestic macroeconomic variables because an increased degree of globalization plays a very important role in transmitting economic shocks from a large country to a small country. In order to understand the nature of the transmission process in different development stages the literature is separated into studies dealing with developed and developing countries.

Monetary Policy and Macroeconomic Variables in Developed Countries

Several studies examine the relationship between the monetary policy effectiveness and macroeconomic variables among developed countries. These studies
include Friedman and Kuttner (1992), McCandless and Weber (1995), and Leeper, Sims and Zha (1996). These studies reveal that the nature of the relationship between money and macroeconomic variables varies significantly across countries. The nature of the relationship between money and macroeconomic variables is discussed in the following section in detail.

Friedman and Kuttner (1992) examine the relationship between money, income, prices and the interest rates for the U.S. economy for the three sample periods: 1960:2-1979:3, 1960:2-1990:4, and 1970:3-1990:4. All variables are in the log difference form. They estimate the following equation:

\[
\Delta y = \alpha + \sum_{i=1}^{4} \beta_i \Delta m_{t-1} + \sum_{i=1}^{4} \lambda_i \Delta g_{t-1} + \sum_{i=1}^{4} \gamma_i \Delta y_{t-1} + \mu_t
\]

Where, y and m denote for nominal income and the financial variables respectively. The financial variables include monetary base, M1, M2, credit, interest rate on 4-6 months commercial paper, the 90-day treasury bill rate, and the difference between two interest rates, and g refers to federal government expenditures.

Granger causality tests for the sample period 1960:2 to 1979:3 shows that monetary base, M1, M2 and credit Granger cause income. The results change when the sample period is extended from 1960:2 to 1990:4. In this sample period, only M1 and M2 remain significant. The results change again during the sample period from 1970:3 to 1990:4. In this sample period, none of the financial variables is significant except for M1, which is significant only at the 10% level.

The above equation has also been estimated by replacing Vm with the interest rate. The F-statistics show that the commercial paper rate, treasury bill rate and the interest rate spread Granger cause real income in both the sample period 1960:4 to 1990:4 and the sample period of 1970:3 to 1990:4. These results imply that, over time, the relationship between money and income has changed significantly.
The results are replicated for the price level as the dependent variable (using the GNP deflator) with real income, a fiscal variable, financial variables and the lag value of the price index. The monetary base, $M_1$, and credit explain a significant portion of the fluctuations of the price level when a fiscal variable is included, but monetary base, $M_1$ and credit become insignificant during the extended sample period of 1960:2 to 1990:4 and from 1970:3 to 1990:4.

The commercial paper rate remains significant in explaining price variations for all three-sample periods, whether a fiscal variable is included or not. It turns out that the interest rate spread is not very successful in explaining significant fluctuations in prices.

McCandless and Weber (1995) examine the long-run correlations among money, inflation and output using time series data for 110 countries over the period 1960 to 1990. They also examine the correlations over the two sub-samples of countries. One of the sub-samples consists of twenty-one OECD countries; the other consists of fourteen Latin American Countries.

The monetary fact derived from McCandless and Weber (1995) is: In the long-run there are high correlations between money growth and inflation over the full sample and two sub-samples of countries and across the three definitions of money. The correlation between $M_1$ and inflation is 0.925, $M_2$, inflation is 0.95, and $M_0$ and inflation is 0.89. A data plot of average rates of change of $M_2$ and inflation of 110 countries shows that the slope coefficient is close to unity implying that there is a one to one relationship between money growth ($M_2$) and inflation supporting the quantity theory of money.

Another fact that has been derived from the McCandless and Weber's (1995) study is there is no correlation between money growth and real output growth for the
full sample period and for all definitions of money. The relationship is positive for the OECD countries, consisting with the hypothesis that monetary authorities of the OECD countries follow a feedback rule from real output growth to money growth.

Finally, McCandless and Weber (1995) show that in the long run there is no correlation between inflation and real output growth for the full sample and the two sub-samples of countries. This result is different from the results of most of the other studies, such as Kormendi and Meguire (1985), Fischer (1983), and Barro (1990), which find a negative relationship between inflation and growth rate of output. One of the pitfalls of McCandless and Weber's (1995) study is the fact that from correlation one cannot tell anything about causation. Therefore, further study is required.

Leeper, Sims and Zha (1996) examine, using monthly data from January 1960 to March 1996, how shocks to monetary aggregates (M1 and M2), the interest rate (RF, Federal Funds rate), the price level (CPI) and output (y, real GDP) can explain fluctuations of the variable itself and other variables in the system for the United States. A vector autoregression (VAR) model is used to derive a set of impulse response functions (IRF).

A three-variable, VAR model constructed by Leeper, Sims and Zha (1996) with M1, the CPI and y shows that the response of y is statistically significant and negative due to shock to M1, while the response of the CPI is positive and statistically significant. The responses of M1 show little predictive power due to a shock in y or the CPI. The response of the CPI due to a shock in M2 is similar to M1 but the output response due to an innovation to M2 is more persistent than M1.

Leeper, Sims and Zha (1996) estimate a four-variable VAR model containing the CPI, y, RF and M1. An innovation to the interest rate (RF) has a significant and negative effect on output (y). One interesting result from this study is that when an
interest rate variable is added to the model, the predictive power of the money stock on output diminishes significantly, indicating that the interest rate has more predictive power on output than money stock does. However, an innovation to the money stock shows the liquidity puzzle. The theoretical meaning of a liquidity effect is that following an expansionary monetary policy, the interest rate decreases. However, Leeper, Sims, and Zha (1996) find a persistent increase in the interest rate implying that there is a liquidity puzzle present in the model.

The liquidity puzzle disappears if an innovation to the interest rate is considered. An innovation to the interest rate shows a persistent decrease in the money stock. On the other hand, a price puzzle shows up due to an innovation in the interest rates. A price effect implies that following a positive interest rate shock the CPI decreases but the impulse response function of CPI due to a shock in the interest rate shows persistent increase in the price level. Leeper, Sims and Zha (1996) try to explain why the price puzzle appears but they did not provide any information concerning why the liquidity puzzle appears. As Sims (1992) notes,

“A price puzzle-rising interest rates accompanied by inflation-might emerge in a model that does not include a rich enough specification of the information available to policy makers. If policy makers can observe variables that forecast inflation, but those variables are not included in the model, there will be apparently unpredictable changes in interest rates that are actually systematic responses to information implying that inflation is on the way. This could give the impression that tightening monetary policy generates inflation.” (Sims, 1992, p.989)

Finally, the response of the interest rate due to a shock to y is statistically significant and positive. However, an innovation to y does not have a significant impact on other variables in the model. It is also observed that the response on y due to an innovation to the CPI is negative and significant, while a response of the interest rate is positive and significant.
The studies by Friedman and Kuttner (1992) and Leeper, Sims and Zha (1996) on U.S. show similar patterns. One of the main findings from their studies is that the monetary aggregates have predictive power in explaining output and price variation. However, the predictive power of money on output diminishes when an interest rate variable is included in the model. Leeper, Sims and Zha (1995) show the presence of a liquidity puzzle and price puzzle for interest rate and price variables.

McCandless and Weber (1995) however find no correlation between money growth and output growth except for the OECD countries. This implies that in the OECD countries the monetary authority follows feedback from the economy. They also find no correlation between output and inflation. However, they do find a one to one correlation between money growth and inflation.

Monetary Policy and Macroeconomic Variables in Developing Countries

The relationship between money and output, inflation, the interest rate, and the exchange rate in developing countries has been investigated extensively in several studies. Parikh and Starmer (1988) and Hossain (1996) examine causality between the money supply and prices in Bangladesh, while Darrat (1988) examines the monetary approach to inflation in Libya, Tunisia, and Morocco. de Silva (1977) examines whether monetary expansion has an impact on inflation in Srilanka. Soyoung (2000) identifies and examines the importance of monetary policy disturbances in affecting output, price, and exchange rate fluctuations in Korea. Siregar and Ward (2000) examine the sources of fluctuations of some major macroeconomic variables in Indonesia.

Parikh and Starmer (1988), Hossain (1996) investigate the relationship between money supply and prices in Bangladesh. These studies are of interest here, because it has been generally observed that inflation is a result of differences in the
money supply and money demand in developing countries (Darrat, 1987). The literature in this area will give us some ideas about the direction of causality among money supply, prices, the interest rate and output.

Using monthly data on the cost of living index of Dhaka middle-class families (P) and money supply (M₁), Parikh and Starmer (1988) examine the extent to which the money supply is responsible for increasing the price level and they run a test to find out if price level is endogenous during the period from 1975:2 to 1986:4. According to them (1988), there are several reasons for the price level to stay at a higher level compared to the 1950’s and 1960’s in Bangladesh. As they argued that, following the independence war in 1972, the increased food price due to discrepancy between supply and demand of food contributes to keep price level higher. Following independence, the increasing import requirements resulting from the government’s ambitious programmes led to persistent balance of payment deficits, which in effect, created more pressure on the government to devalue the currency and thus put more pressure on the price level. Parikh and Starmer (1988, p.61) further stated that in a country like Bangladesh, the absence of developed capital markets causes the government to borrow from the central bank to maintain fiscal expenditures, which creates more government deficit and necessitates more money supply increases and hence more inflation.

Parikh and Starmer (1988) employ Granger (1969) and Geweke (1987) approaches to estimate their models. According to the definition of Granger causality, x causes y if taking account of past values of x leads to improved prediction for y. According to Geweke (1987), total feedback between two time series, p and m₁ can be decomposed into the sum of (1) linear feedback from p to m₁ or (2) feedback from m₁ to p and (3) instantaneous linear feedback (Parikh and Starmer, 1988, p.64).
Parikh’s and Starmer’s (1988) estimated results show evidence that during the 1970’s and 1980’s causality in Bangladesh runs from prices to money. They find no evidence of causality running in the opposite direction i.e., money to price. The results remain robust when they use the broad money supply ($M_2$) and the price level or the growth rate of the money supply and inflation. These results cast doubt that inflation is a monetary phenomenon. They stated during the 70’s and 80’s,

“...in Bangladesh price levels increase due to other structural constraints such as, government budget deficits, food shortages or devaluation, and subsequent monetary expansion” (Parikh and Starmer, 1988, p.69).

Hossain (1996) examines the relationship between two definitions of the money supply growth ($M_1$ and $M_2$) and wholesale price index (WPI) as a measure of inflation for the period from 1973:q1 to 1989: q4 in Bangladesh. Hossain (1996) also conducted cointegration tests to examine the long-run equilibrium relationship between narrow money growth, broad money growth and the wholesale price index (WPI).

Hossain (1996) performs Granger causality tests between the growth of the money stock and inflation rate to find out that unidirectional causality runs from $M_2$ growth to inflation, but did not find evidence of causality running from $M_1$ growth to inflation. Unlike Parikh and Starmer (1988), Hossain’s (1996) study did not find the evidence of causality running from price to money either. The cointegration results show that there are long-run relationships between $M_1$ and wholesale price index (WPI) as well as $M_2$ and wholesale price index (WPI).

The results of Parikh and Starmer (1988) are different from Hossain (1996) mainly due to differences in specifications of the variable (as a measure of inflation) and in the estimation techniques. Hossain (1996) used the wholesale price index, while Parikh and Starmer (1988) used the consumer price index of Dhaka middle-
income families. Parikh and Starmer (1988) used Granger causality and Geweke approaches, while Hossain (1996) performed unit root tests, cointegration tests, Granger causality tests and an error correction model (ECM). Based on the above two studies the direction of causality between money and prices are inconclusive for Bangladesh.

According to Parikh and Starmer (1988), food shortages, the balance of payments deficit, and government borrowing from the central bank are the principle reasons for high inflation in Bangladesh, rather than an exogenous money supply increase. But recent data shows that food shortages were reduced dramatically during the 1990's due to increases in domestic food production and increased imports from the neighboring countries. Both legal and illegal imports include rice, eggs, fish, vegetables, and oil. These changes may help keep the price level lower.

Darrat (1986) examines empirically the validity of the monetarist approach to inflation for three North African developing countries, Morocco, Tunisia and Libya, by using quarterly data over the period of 1960 to 1980. During the 1970s and 1980s, those countries suffered from high inflation. The objective of Darrat’s (1986) study is to find out the reasons for high inflation. Darrat specifies and estimates a model based on the monetary approach to inflation in the following way:

\[ P = M_s - \left( \frac{M_s}{P} \right)^d, \]

Where \( P \) is the price level, \( M^s \) is nominal money supply. \( \left( \frac{M_s}{P} \right)^d \) is the real money demand and a dot indicates growth rate of that variable. Darrat (1986) also extended the model by incorporating variables that might influence the price level such as real income, inflationary expectations (lag values of the actual price level) and foreign

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interest rates. The consumer price index has been used to measure the price level, real GNP as real income, narrow money (M1) as the money supply, and foreign interest rate as an average of quarterly short-term interest rates in major OECD countries.

Akaike’s final prediction criteria and Theil’s minimum residual variance criteria have been used to select the lag length. Finally, the Almon lag estimation technique is used to estimate the model. The estimation results for Tunisia and Morocco show that the inflation elasticity with respect to money supply growth is not significantly different from unity, while for Libya it is less than unity. These results imply that a 1% increase in money supply growth increases inflation by 1% in Tunisia and Morocco. However, 1% increase in money supply growth increases inflation less than 1% in Libya. Real income is statistically significant with the expected negative sign for all three countries. The feedback effect from prices to money and money to prices is examined by using the Geweke, Meese, and Dent (1983) procedure. The null hypothesis of no causality running from money supply growth to inflation has been rejected for Morocco and Libya at the 5% level and for Tunisia at the 10% level. However, the null hypotheses of no causality running from inflation to money growth cannot be rejected for any of the sample countries implying that there is a unidirectional causality from money to prices without having any significant feedback effect.

Soyoung (2000) identifies and examines how important monetary policy disturbances are in effecting output, price, and the exchange rate fluctuations in Korea. Soyoung (2000) uses a structural vector autoregression (SVAR) model developed by Kim and Roubini (1999). The reason for using this model is to show the usefulness of this approach in identifying monetary policy shocks in a small open economy. This approach also eliminates the puzzles (liquidity puzzle, price puzzle...
and the exchange rate puzzle) that show up in other studies. A seven-variable SVAR is estimated using monthly data on short-term interest rates, a monetary aggregate (M2), the consumer price index, industrial production, the U.S. Federal Funds Rate, oil prices in terms of U.S. dollars and the nominal exchange rate. The estimation period is 1980 to 1996. The oil price, the exchange rate and the U.S. federal funds rate are included to control for exogenous monetary policy changes. All variables are in logs except for the interest rate.

The impulse response functions derived from the SVAR do not show any puzzles. Following a contractionary monetary policy, the interest rate rises up to one year, the money stock falls, and the price level declines. All responses are significant. The output fall is significant and stays significant for about ten months. The exchange rate appreciates, implying that no exchange rate puzzle exists.

Variance decompositions show that monetary policy shocks are not a major source of fluctuation in output, price and the exchange rate. However, a monetary policy shock explains thirty six percent (36%) of the variation in the interest rate, while it explains fifty percent (50%) of the variation in the monetary aggregate at the six-month horizon. The variation reduces to eighteen and twenty percent (18% and 20%) respectively at the forty-eight month horizon.

Siregar and Ward (2000) examine sources of the fluctuations of some major macroeconomic variables in Indonesia. The objectives of their study are to identify the important shocks in the economy and to analyze the transmission mechanism of these shocks to key macroeconomic variables. A four variable structural vector autoregression (SVAR) model is estimated using annual data from 1969 to 1997. Real GDP in 1990 prices is used as a measure of output; the six-month time deposit rate is used as a measure of the interest rate, M1 is used as money supply. M1 divided by

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consumer price index is used as real balances. All variables are in logs except for the interest rate. To identify structural parameters theoretical restrictions on the parameters have been employed following Blanchard (1989). The contemporaneous restrictions are as follows:

1. \( y_t = B_1 e_{t}^{as} \)
2. \( r_t = A_1 y_t + B_2 e_{t}^{is} \)
3. \( m_{pt} = A_2 y_t + A_3 r_t + B_3 e_{t}^{md} \)
4. \( m_t = A_4 y_t + A_5 r_t + A_6 m_{pt} + B_4 e_{t}^{ms} \)

Equation 1 implies that output is determined by the aggregate supply shock or technology only. Equation 2 represents interest rate as a function of output and an IS shock or spending balance shock. Equation 3 is a money demand equation that specifies as a function of output, the interest rate and a money demand shock. Equation 4 is a money supply function, which specifies as a function of output, interest rate, real money demand and a money supply shock.

The impulse response functions estimated from the SVAR show that the responses of output demand, the real money demand and the money supply are statistically significant and positive due to a shock to aggregate supply, while the response on the interest rate is significant and negative. The impulse response functions of the interest rate and output due to a spending balance or a IS shock decreases significantly. The responses of real money demand, money supply, output and the interest rate due to innovation to a money demand are positive and significant. The responses of real money demand, money supply, and output to a shock in the money supply are significant and positive also but the response of the interest rate is negative and significant due to a shock in the money supply.

Variance decompositions of output show that aggregate supply explains 100% of the variation in output during the first period but declines to 87% in the 20th period.
periods. Shocks to spending balances explain only 7% of output variation during the three-year time horizon, which is the highest among the sample periods considered in the study. Shocks to real money demand and the money supply appear insignificant in explaining output variations. The variation in the interest rate is mainly explained by the spending balance shocks, especially in the short-run. However, in the long-run aggregate supply shocks become important source of explaining interest rate variation.

The fluctuations in real money demand are explained mainly by its own shocks and shocks to aggregate supply. A shock to the money supply is important in explaining real money demand fluctuation only in the long-run. The variations in the money supply are mostly determined by its own shocks and technology (or aggregate supply) shocks. A shock to the real money supply is important in explaining source of variations in the money supply in the short run.

Based on the studies of Parikh and Starmer (1988) and Hossain (1996) on Bangladesh we cannot reach any conclusion regarding the relationship between money growth and inflation because Parikh and Starmer (1988) find unidirectional causality from prices to money, while Hossain (1996) finds unidirectional causality from money growth to inflation. Darrat (1987) also finds the evidence of unidirectional causality from money growth to inflation in the case of Morocco, Libya, and Tunisia. Studies based on other developing countries such as Korea and Indonesia show that monetary policy has a significant effect on macroeconomic variables such as output and the price level.

Foreign Monetary Policy and Macroeconomic Variables in Developed Countries

The increased degree of globalization plays an important role in transmitting...
economic shocks from a large country to a small country. These studies are of particular mainly due to their importance in understanding the independence of domestic monetary policy in effecting domestic variables. As stated by Fumio (1994), policy coordination between foreign and domestic variables during the 1980s became very important due to growing interdependence among nations. As international interdependence grows, changes in foreign economic policies exert greater shocks to domestic economies. As a result, the 'controllability' of the domestic policy over the domestic economy declines. It is evident from the previous statement that to measure effectiveness of a domestic policy, it is necessary to consider the decision of the foreign policy makers (Fumio, 1994, pp.435).

Sheehan (1992) conducted a study to examine the impact of monetary policy of the G-7 countries, Switzerland, and the U.S. on the monetary policy of the G-7 countries and Switzerland. He found that the G-7 countries are unsuccessful in influencing money growth of other G-7 economies. U.S. money growth, domestic inflation and domestic real output have significant impacts on France, Germany, Italy, Japan, United Kingdom and Switzerland's money growth.

A study by Mixon, Pratt and Wallace (1979) examines the causal relationship between U.S. money to U.K. income. The objectives of this study are to test the hypothesis that U.S. money affects U.K. income under fixed exchange rates and to determine how the causality pattern varies across the exchange rate regimes. They employed Granger causality tests using quarterly data on nominal gross domestic product and on the nominal money supply.

Mixon, Pratt and Wallace (1979) separate the exchange rate regimes as fixed, transition, and flexible exchange rate. The fixed rate period is 1962.I to 1970.IV, the transition regime is from 1971.I to 1974.III, and flexible exchange rate regime is from
1974.IV to 1977.III. They regressed the U.K. nominal GDP on U.S. money supply, a
trend variable, and a set of dummy variables for different exchange rate regimes and
seasonal dummy variables.

An F-test fails to reject the hypothesis that U.S. money supply has no affect on
U.K. income during a fixed exchange rate period. The U.S. money supply has a
positive effect on U.K. income in both the transition and flexible exchange rate
periods. The differences in the results as noted by Mixon (1992) are due to differences
in the exchange rate regimes.

Sheehan (1992) examines the impact of U.S. domestic variables on the money
growth of the G-7 countries and Switzerland during the period from 1957:1 to 1990:2.
A U.S. money growth variable is used to see the direct impact of U.S. money on the
money growth of other (G-7 and Switzerland) countries. U.S. inflation and real output
growth are included to see the impact of world inflation and world demand on the G-7
and Switzerland money growth. Sheehan found that in fixed exchange rate periods,
the U.S. money supply has significant impacts on the money growth of six of seven
countries. Japan is the exception. In Japan’s case, even in the fixed exchange rate
period, domestic variables are significant in explaining money supply growth in
Japan. However, the U.S. variables are insignificant.

Switzerland is the only country in the sample that supports the theory that in
the fixed exchange rate period domestic monetary policy is ineffective in changing
money supply growth in Switzerland, while during the flexible exchange rate period
domestic variables (Switzerland’s) have an impact on domestic money growth.

In the floating exchange rate period, U.S. money growth is unsuccessful in
influencing the money growth of France, Germany, Italy, Japan, Switzerland and the
United Kingdom. However, money growth of the G-7 countries and Switzerland does
respond to U.S. inflation and real output. These results are the opposite of what Mixon, Pratt and Wallace (1979) find in their study.

Selvor and Round (1996) examine to what extent Japanese business cycles are transmitted to Australia over the period from 1961.1 to 1994.4. Japan is the major trading partner of Australia. Japan contributes twenty five percent (25%) of Australian exports to Japan and receives twenty percent (20%) of imports from Japan. To examine the impact of Japanese GNP on the Australian GDP, producer prices, short-interest rates and the money supply \((M_1)\) are included in the model.

Selvor and Round (1996) estimate a two variable vector autoregressive (VAR) model because an examination of the cointegrating relationship between Japanese GNP and Australian GDP finds no cointegration is present. A three-variable vector error correction (VEC) model is used because the null hypothesis of no cointegration is rejected for producer prices, short-term interest rate and the money supply.

World oil prices, U.S. GDP and U.K. GDP are included in the Australia’s GDP equation to control for the common exogenous shock from both countries and to eliminate the impact of two other strong economies. Chow tests and recursive least squares (RLS) coefficients are estimated to check for structural change.

Impulse response functions estimated from the VAR show that an innovation to Japan’s GNP has a significant positive impact on Australian GDP. U.S. GDP also has a significant positive impact on the Australian GDP, which is twice as large as the impact of Japanese GNP. However, Australian GDP does not have any significant impact on the Japanese GNP.

Cushman and Zha (1997) address the issues of empirical puzzles (liquidity puzzle, price puzzle and exchange rate puzzle) that are produced by using reduced-form equations and Cholesky techniques in various macroeconomic models on small
open economies. They argue that the puzzles arise due to an inappropriate identification of monetary policy in these economies. As they noted, reduced-form equations are successful in measuring monetary policy shocks in the U.S. because the U.S. economy is considered relatively closed compared to other economies. It is less likely that U.S. monetary policy responds to other economies’ policy shocks.

Cushman and Zha (1997) examine monetary policy shocks in Canada by using a structural vector autoregression (SVAR) model with monthly data form 1974 to 1993. They used the methodology developed by Bernanke (1986), Blanchard and Watson (1986) and Sims (1986). The variables they used are: the U.S. dollar price of Canadian currency, a Canadian monetary aggregate ($M_1$), the Canadian three-month treasury bill rate, the Canadian consumer price index, Canadian industrial production, Canadian total exports to the U.S., and Canadian total imports from the U.S., U.S. industrial production, the U.S. consumer price index, the U.S. Federal Funds rate, and the world total exports commodity price index in U.S. dollars. All variables are in logarithmic form except for the interest rates.

They identified three sectors: money sector (money demand equation and money supply equation), the information sector, and the production sector. The money demand equation is specified based on existing monetary theory with income and the interest rate. The money supply or policy reaction function is identified by the variables of the Bank of Canada that react contemporaneously such as interest rate, exchange rates (foreign and domestic), and money stock and commodity prices. The information market equation includes all eleven variables. Finally, the production sector includes exports, imports, industrial production and the consumer price index. The results from contemporaneous coefficients show that all the variables in the money demand and money supply equations are significant with the expected sign.
except for the foreign interest rates. The estimated results of the information market
variables are significant except for domestic (Canada) and U.S. industrial production,
the foreign interest rate and world commodity price index of exports.

The estimated results from the impulse response functions show that due to a
one standard deviation contractionary monetary policy shock the exchange rate
appreciates immediately, the interest rate increases, the price level decreases and
output declines significantly. There is no sign of liquidity, price, or exchange rate
puzzles following a contractionary monetary policy. Due to appreciation, exports fall,
imports rise and the trade balance worsens. The price level decreases mostly due to
the worsened trade balance.

The variance decompositions of output fluctuations of one to forty eight
months show that the production and the information sectors are the primary sources
of output fluctuations. The production sector explains 100% of the fluctuations in
output during the first month. It declines to 21% percent after forty-eight months. The
information sector explains four percent of output variations after forty-eight months,
while money policy shocks have little (0.31% and 0.61% respectively) impact on
Canadian output. The foreign sector became important after twelve months. It
explains seventy four percent of variations in output during the forty-eight periods.

Amuedo-Dorantes and Wheeler (2001) examined the impact of the European
Union (EU) on Spanish economic activity during the period from 1987 to 1997. They
employ monthly data to estimate the impulse response functions and variance
decompositions derived from a near vector autoregressive (NVAR) model. Historical
decompositions also have been derived to examine how shocks in the European
Union close the gap between the actual and the base projection (BP) of Spanish
inflation and output in the model. All techniques support the hypothesis that the European Union’s income and prices had a strong influence on Spanish income and price variables.

Borda, Manioc and Montauban (2000) address the issue of the impact of foreign monetary policy on domestic output fluctuations by conducting an empirical investigation on the U.S. and 12 Caribbean countries. They hypothesize that economic fluctuations in the Caribbean countries are driven by U.S. monetary policy. In order to test this hypothesis they use a panel VAR model for real output, consumer price index, the real exchange rate and world (the U.S.) real interest rate. The results show that output fluctuations are driven by shocks to the real exchange rate and domestic supply shocks in the flexible exchange rate countries (five countries) during the period 1979-1997. However, output fluctuations in the fixed exchange rate countries (seven countries) are mainly due to domestic supply shocks. Therefore, the hypothesis that the economic fluctuations in a small open economy are driven by external shocks is true when the exchange rates are flexible for those Caribbean countries.

The literature review on foreign monetary policy and domestic macroeconomic variables show that U.S. monetary policy has a significant positive impact on monetary policy in other countries in general. However, results vary across exchange rate regimes.

Foreign Monetary Policy and Macroeconomic Variables in Developing Countries

The study containing foreign monetary policy and the macroeconomic variables for developing countries has not much been done yet. However, Farrell

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5 BP is the path Y would have taken without shocks to the variables in the system.
(1980) empirically examines the impact of U.S. monetary policy on Mexico's monetary policy. Hoffmaister, Roldos and Wickman (1997) examine empirically whether the external sector has an impact on macroeconomic variables in Sub-Saharan African countries, especially output and prices.

The empirical results of Farrell’s (1980) study show that when the growth rate of the U.S. monetary base is excluded, the impact of domestic credit on Mexico’s monetary base increases significantly, which lends support to the impact of the U.S. monetary policy on the monetary aggregates of Mexico. In the case of Mexico, the foreign (U.S.) monetary base is significant in effecting domestic monetary base, while the interest rate differential or inflation differential are not. In conclusion, Farrell suggests that Mexico’s policy makers should keep an eye on the direction of U.S. money supply rather than U.S prices while attempting to evaluate the impact of their own money supply (Farrell, 1980, p.442).

Hoffmaister, Roldos and Wickman (1997) examine empirically the sources of macroeconomic fluctuations, especially output and prices, in Sub-Saharan African countries. They divide the countries into CFA franc countries (where exchange rates are pegged vis-a-vis with the French franc) and non-CFA franc countries (where exchange rate can adjust frequently).

They examine whether differences in macroeconomic fluctuations between CFA franc and non-franc countries are due to domestic shocks such as supply shocks, fiscal and nominal shocks or external shocks such as world interest rate or terms of trade shocks. They also examine whether structural differences among countries and differences in the exchange rate regimes contribute to the differences in macroeconomic fluctuations to the CFA franc and non-CFA franc countries.

A five variable (output, real exchange rate, and the price level, the world
interest rate, and the terms of trade) structural vector autoregressive (SVAR) model is used to derive variance decompositions and impulse response functions. Variance decompositions and impulse response functions show that the sources of output fluctuations in Sub-Saharan African countries are mainly due to the domestic supply shocks. External sectors also have some impact on the domestic output, prices and the real exchange rate more in CFA franc countries than non-CFA franc countries.

In the CFA-franc countries, sixty percent of price fluctuations are due to demand shocks, while twenty percent of price fluctuations are due to domestic supply and external shocks. In the non-CFA-franc countries, eighty-five percent of fluctuations of prices are due to demand shocks. Due to favorable terms of trade shock, the price level declines temporarily and then quickly revert to its original level (Hoffmaister, Roldos and Wickman, 1997, p.20). An examination of differences in economic structure across the countries does not appear to have significant impact on the differences in macroeconomic fluctuations. However, differences in exchange rate regimes turn out to have significant impact on the macroeconomic fluctuations.

The previous studies lend suggest that foreign monetary policy may have a strong impact on the domestic economy of the country such as Mexico and Sub-Saharan African countries. Evidence shows that Mexico monetary policy is strongly influenced by the U.S. monetary policy. Studies based on developing countries such as Sub-Saharan African countries show that output fluctuations of those countries are mainly due to domestic supply shocks. External shocks also have some impact on output and the price level.

Theoretical Background

Most of the theory on the effectiveness of monetary policy was developed in a closed economy context. Nevertheless, the nature of effectiveness may vary in an
open economy. As Raha (1991) noted,

"Theoretical formulations of the policy ineffectiveness proposition typically ignore the implications of international linkage...." (Raha, 1990, p-vi).

Therefore, examining the policy impact on domestic target variables disregarding foreign policy affect may be mis-specified.

In a closed economy, monetary policy influences real aggregate demand through the domestic interest rate. Nevertheless, in an open economy the exchange rate plays an important role. Depreciation due to monetary policy shocks raises the domestic consumer price index. As noted by Walsh (1998), this exchange rate effect induces substitution effects between domestic and foreign goods, thereby influencing aggregate demand and supply.

A two-country open economy model such as, Mundell (1963), Fleming (1962), and Frenkel (1980), describes the possible channels through which a monetary policy shock affects the economy. According to them, due to a positive monetary policy shock, output and the price level increase, interest rates fall, and the exchange rate depreciates. Due to this depreciation in domestic currency, aggregate demand for this country's output increases; this will increase exports and income and improve the trade balance. For example: due to India's expansionary monetary policy, Bangladesh faces a currency appreciation, which in turn increases imports from India and decreases output in Bangladesh.

There are studies (e.g., Hoffmaister, Roldos and Wickman, 1997; Borda, Manioc and Montauban 2000; Farrell 1980; Amuedo-Dorantes and Wheeler, 2001) that find evidence that economic fluctuations in a small open economy are driven by external shocks of large countries. There are also some studies that deal with the impact of the U.S. monetary policy on developed countries money growth. For
example, Sheehan (1992), Mixon, Pratt, and Wallace (1979) examine the impact of U.S. monetary policy on the G-7 countries.

This paper examines empirically the importance of external and internal factors in altering economic activity in Bangladesh. India's monetary policy is used as a measure of external influence. India's monetary policy is of interest because the Indian economy is large relative to the Bangladesh economy and Bangladesh shares most of its border with India. Therefore, it is reasonable to see if, in a small open economy like Bangladesh, whether foreign monetary policy plays any role in the effectiveness of domestic monetary policy. Accordingly, this study tests: (i) the effectiveness of domestic monetary policy in altering macroeconomic variables, and (ii) the effectiveness of foreign monetary policy in altering domestic money and macroeconomic variables.

Model Variables

The sample period covered in this study is 1975:1 to 2001:4. Quarterly data are employed to estimate a near vector autoregression (NVAR) model. To see the dynamic relationship among domestic monetary policy and foreign monetary policy on the exchange rate, interest rate, price level and output in Bangladesh, a six variable NVAR model is estimated. The variables used in the model are as follows:

- MI = log of foreign real money supply (M1, India);
- MB = log of domestic real money supply (M1);
- LR = lending rate of commercial banks loans to individuals and businesses;
- CPI = log of consumer price index;
- Y = log of real output measured by industrial production.
- RER = log of real exchange rate (Tk./Rupee); Calculated by nominal exchange
rate*(Foreign CPI/Domestic CPI).  

Seasonally adjusted data are used for all the variables except for the nominal exchange rate and the interest rate. All the variables are in logs except for the interest rate. A description of the variables is given in detail in the Appendix-A.

Econometric Methodology

A near vector autoregressive (NVAR) model is an appropriate econometric technique when we are interested in dynamic relationships among variables in presence of different explanatory variables in different equations (Enders, 1995). Based on the assumption that India is a large country relative to Bangladesh a near VAR (NVAR) is estimated. The NVAR contain five variables from Bangladesh and one variable from India. The five equations for the Bangladesh variables are standard VAR equations. That is, in these equations, all model variables enter each equation. Because India is assumed a large country relative to Bangladesh, the equation for India’s money supply contains lagged values of India’s money supply only. That is, Bangladesh variables are not allowed to have any impact on India’s money supply. The appropriateness of this restriction is confirmed with a likelihood ratio test. The efficiency of the estimates can be improved by using seemingly unrelated regression (SUR) estimation technique in this case. Hence, the model is estimated with iterative SUR.

The NVAR is used to derive VDCs and IRFs. The VDCs show the portion of the variance in the forecast error for each variable due to innovations to all variables

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6 Due to unavailability of quarterly data of total trade volume, this study uses real exchange rate as a channel through which foreign monetary policy transmits to the domestic economy.
7 A VAR standard model using the same variables has also been estimated. However, major policy conclusions do not change.
8 A chi-square test fails to reject the null hypothesis that Bangladesh variables are not significantly different from zero in the equation for India’s money supply.
in the system. This study is mostly interested in the portion of the forecast error variance in the exchange rate, domestic real money balances, interest rate, price level and output explained by the shocks to foreign money and domestic money. If foreign money explains a significant portion of the forecast error variance in the exchange rate, domestic real money balances, interest rate, price level or output, we can say that foreign money has a significant impact on domestic economy. If domestic money explains a significant portion of the forecast error variance in the exchange rate, interest rate, price level or output then we can conclude that domestic money has a significant impact on domestic economy.

The IRFs show the response of each variable in the system to shock from system variables. A significant impact on these variables due to shocks to foreign money and domestic money will test the hypothesis that India’s monetary policy and Bangladesh’s monetary policy are effective in influencing domestic macroeconomic variables.

A lag length of eight has been selected to estimate the model. A likelihood ratio test fails to reject the null hypothesis that lag length is 7 against lag length of 8. Q-statistics are used to see if VAR residuals of each equation are white noise. The likelihood ratio tests and the Q-statistics select the lag order of 8.

To estimate VDCs and IRFs, orthogonalization of the residuals is required. A Cholesky decomposition is used to orthogonalize the residuals. A Cholesky decomposition requires the variables to be ordered in a particular way, where variables placed higher in the ordering have contemporaneous impact on the variables.

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9 In order to see the robustness of the results with respect to lag length, an NVAR with a lag length of 4 has also been estimated. Policy conclusions derived from IRFs remain the same while estimating the model using lag lengths of 4 with the exception of the response of domestic money. The response of domestic money due to a shock to foreign money become significant and negative at quarter 11 and remains significant thereafter.

10 A maximum lag length of eight has been used in order to preserve degrees of freedom.
which are lower in the ordering, but the variables lower in the ordering do not have contemporaneous impact on the variables those are higher in the ordering. In the Cholesky decomposition,

"...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" (Wheeler 1999, p.277).

Therefore, it is important to decide proper ordering of the variables. The Cholesky ordering of the variables is as follows: MI, RER, MB, LR, CPI, Y. Because we are interested in examining the impact of foreign and domestic monetary policies on the domestic key macroeconomic variables, India’s money and Bangladesh’s money are placed first and third in the ordering. The exchange rate variable is placed second in the ordering because in a small open economy like Bangladesh, a shock to foreign money will transmit into the domestic economy through the exchange rate. The Cholesky ordering of the rest of the variables, for example, the interest rate, price level and output relative to each other is a matter of indifference as long as we are only interested in examining the impact of the shocks to foreign money and the domestic money on other system variables. This ordering does allow policy variables and the exchange rate to respond to other variables with a lag.

The Cholesky ordering of the first variable implies that an innovation to foreign money supply is contemporaneously exogenous. It has a contemporaneous effect on the rest of the model variables, but none of the other model variables have contemporaneous impact on the foreign money supply. This is consistent with the assumption that India is a large country relative to Bangladesh. The exchange rate is

\[ \text{exchange rate} \]

\[ \text{foreign money} \]

\[ \text{domestic money} \]

\[ \text{interest rate} \]

\[ \text{price level} \]

\[ \text{output} \]

\[ \text{indifference} \]

\[ \text{exogenous} \]

\[ \text{impact} \]

\[ \text{assumption} \]

\[ \text{large country} \]

\[ \text{excessive} \]

\[ \text{small} \]

\[ \text{open} \]

\[ \text{economy} \]

\[ \text{shocks} \]

\[ \text{variables} \]

\[ \text{lag} \]

\[ \text{variables} \]

\[ \text{impact} \]

\[ \text{supply} \]

\[ \text{orderings} \]

\[ \text{changed} \]

\[ \text{exception} \]

\[ \text{output} \]

\[ \text{shocks} \]

\[ \text{real exchange rate} \]

\[ \text{significant} \]

\[ \text{negative} \]

\[ \text{horizon} \]

\[ \text{insignificant} \]

\[ \text{thereafter} \]

\[ \text{model has also been estimated switching the RER and MB in the ordering. Major policy conclusions when the orderings is changed remain the same with the exception of output. When RER and MB switched in the ordering, the response of output due to a shock to real exchange rate becomes significant and negative at time horizon 2, remains significant until the 4th quarter, and then becomes insignificant thereafter.} \]
placed second in the ordering because in a small open economy the exchange rate plays an important role in transmitting foreign shocks to the domestic economy. An innovation to real exchange rate has contemporaneous impact on domestic money supply, but the domestic money supply has no contemporaneous impact on the real exchange rate.

Placing the domestic money supply after foreign money and the real exchange rate implies that innovations to foreign money and the real exchange rate have a contemporaneous impact on the domestic money, but the domestic money supply does not have any contemporaneous impact on the foreign money and the real exchange rate. The ordering of LR, CPI, and Y relative to each other is a matter of indifference as long as we are interested in examining the impact of the shocks to foreign money and the domestic money on domestic macroeconomic variables.

Empirical Results

Variance Decompositions (VDCs)

In order to know the impacts of shocks to MI and MB, VDCs at time horizon of 4, 6, 12, 16 and 20 are computed. The estimates of the forecast error variance are considered significant if the point estimate is at least two times as large as its standard error. Twenty-five hundred bootstrap simulations are used to construct the standard errors for VDCs. Because, this study is mostly concerned with the forecast error variance in MB, LR, CPI, Y, RER explained by foreign money and domestic money, VDCs of only domestic money, interest rate, price level, the exchange rate and output are reported. In Table-1 and 2, point estimates and the standard errors of domestic money, interest rate, price level, exchange rate and output due to a shock in the foreign money and domestic money are shown.
Table-1 shows that an innovation to foreign money explains significant portions of the forecast error variance in the interest rate and exchange rate at all time horizons. An innovation to foreign money explains significant portion of forecast error variance of output at time horizons 12, 16 and 20 and a significant portion of the forecast error variance in domestic money at time horizons 16 and 20. Indian money explains 57.05%, of the variation in the interest rate, 70.16% variation in the real exchange rate, 65.46% variation in output, and 58% variation in the domestic money at time horizon 20. However, foreign money does not explain significant portion of the variation in the domestic price level at any time horizon.

In Table-2, point estimates and the standard errors of domestic money, interest rate, price level, output and the real exchange rate due to a shock to domestic money are reported. Table-2 shows that an innovation to domestic money explains a significant portion of the forecast error variance in the price level and domestic money itself. However, domestic money does not explain a significant portion of the forecast error variance in the interest rate, exchange rate, and output at any time horizon.
Table 1

Forecast Error Variance explained by Innovation to Foreign Money (MI)
Sample Period: 1975:1 to 2001:4

<table>
<thead>
<tr>
<th>Lag 8</th>
<th>Variance decomposition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Domestic Real Money Balances (MB)</td>
</tr>
<tr>
<td></td>
<td>4</td>
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<tr>
<td></td>
<td>8</td>
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<td>12</td>
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<td></td>
<td>16</td>
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<td></td>
<td>20</td>
</tr>
</tbody>
</table>

Note: Asterisks (***) indicate significance of the point estimate. Numbers in each cell are point estimates. Point estimates are considered significant if they are twice as large as the standard error. Numbers in the parenthesis are standard errors.
Table 2
Forecast Error Variance explained by Innovation to Domestic Real Money Balances (MB): Sample Period: 1975:1 to 2001:4

<table>
<thead>
<tr>
<th>Lag 8</th>
<th>Variance decompositions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Domestic Real Money Balances(MB)</td>
</tr>
<tr>
<td>4</td>
<td>77.93*** (13.50)</td>
</tr>
<tr>
<td>8</td>
<td>60.57*** (14.58)</td>
</tr>
<tr>
<td>12</td>
<td>36.03*** (13.45)</td>
</tr>
<tr>
<td>16</td>
<td>23.79 (12.15)</td>
</tr>
<tr>
<td>20</td>
<td>18.51 (11.17)</td>
</tr>
</tbody>
</table>

Note: Asterisks (*** ) indicate significance of the point estimate. Numbers in each cell are point estimates. Point estimates are considered significant if they are twice as large as the standard error. Numbers in the parenthesis are standard errors.
Impulse Response Functions (IRFs)

The IRFs show the response of each variable in the system to shocks from MI and MB. A two-standard-deviation confidence interval is reported for each IRF. A confidence interval containing zero indicates lack of significance. The confidence interval for each IRF is computed from twenty-five hundred Monte-Carlo simulations. The IRFs due to shocks to foreign money and domestic money derived from near-VAR using a lag length of 8 are reported.

The IRFs due to shocks to foreign money are reported at Figure-1. The response of the exchange rate due to shock to foreign money is significant and positive up to the time horizon 8, and then becomes insignificant. The response of interest rate due to shock to foreign money is insignificant initially and then it becomes significant and positive at time horizon 2 and remains significant thereafter. The response of the price level due to shock to foreign money is insignificant regardless of the time horizon. The IRF for output indicates that a shock to foreign money initially produces a negative and significant impact on output. This impact become significant and positive at time horizon 2 and is insignificant thereafter. The IRF of Figure-1 also shows that a shock to MI has no impact on MB.12

The IRFs due to shocks to domestic money are reported at Figure-2. The response of the exchange rate due to a shock to domestic money is insignificant initially. It becomes significant and positive at time horizon 9, remains significant up to time horizon 13, and is insignificant thereafter. The IRFs due to an innovation to domestic money show an insignificant response of the interest rate up to the time horizon 10, the response then becomes significant and negative, and remains

12 At lag 4, the response of domestic money due to a shock to foreign money become significant and negative at quarter 11 and remains significant thereafter.
significant up to period 15. The IRF of the price level shows a negative and significant response of the price level due to an expansionary monetary policy. This impact remains significant up to time horizon 4. Hence, there is a price puzzle. This result is consisting with the standard result that has been found in other literature dealing with a monetary policy shock (see for example, Leeper, Sims and Zha 1996). The response on output due to a shock to domestic money is insignificant, with the exception of period five.
Figure-1: Shock to Foreign Money

Response of RER to MI

Response of R to MI

Response of MS to MI

Response of CPI to MI

Response of Y to MI

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Figure-2: Shock to Domestic Money

- Response of RER to MB
- Response of R to MB
- Response of MB to MB
- Response of CPI to MB
- Response of Y to MB
Conclusion

This study has examined empirically the effectiveness and independence of monetary policy in Bangladesh. For effectiveness, this paper examines the impact of domestic monetary policy shocks in altering key macroeconomic variables such as the interest rate, price level, exchange rate and output. If domestic monetary policy has a significant impact on the domestic macroeconomic variables, we would say that domestic monetary policy is effective in altering macroeconomic variables in Bangladesh.

For independence, this paper examines the effectiveness of foreign monetary policy in altering domestic money and other domestic macroeconomic variables. If foreign monetary policy has a significant impact in altering domestic money and economic activity, then we would conclude that both domestic monetary policy as well as domestic economy is influenced by the foreign monetary policy. This in turn, implies that domestic monetary policy is not independent of foreign monetary policy.

An analysis of the IRFs derived from the NVAR shows that, due to an innovation to foreign money, the response of the real exchange rate and the interest rate are significant and positive, while the IRF of output due to a shock to foreign money is significant and negative. The IRF of the price level due to a shock to foreign money is insignificant. Therefore, based on the results of the IRFs, we can conclude that domestic money is independent of foreign money. However, foreign money has a significant and positive impact on the real exchange rate and the interest rate and has a negative impact on output.

An analysis of the variance decompositions shows that foreign money can explain significant portions of the forecast error variance in the interest rate, exchange rate, output and domestic money. Therefore based on the results of variance
decompositions we can say that the domestic economy is not independent of the impact of foreign money, and foreign money has a significant impact on domestic monetary policy.

The IRFs of the exchange rate derived from the near VAR due to a shock to domestic money show significant and positive impact, while the response of the interest rate and the price level is negative and significant. The IRF of the price level shows a price puzzle, while IRFs of the exchange rate and the interest rate do not show the exchange rate puzzle or liquidity puzzle. VDCs of domestic money show that domestic money can explain significant portions of the forecast error variance in the price level at all time horizons. Therefore, based on the IRFs and VDCs we can say that domestic money has a substantial impact on the price level. Domestic money has also some impact on the real exchange rate, interest rate and output. However, the impact on output is very short lived.

Based on these results it is not difficult to draw conclusions regarding the impact of foreign money on domestic money or on domestic economy. We can see from IRFs and VDCs that foreign monetary policy does have a significant impact on the real exchange rate, the interest rate, and output. IRFs and VDCs due to a shock to domestic monetary policy show that domestic monetary policy has a significant impact on the price level, and the real exchange rate.
PART III

ESSAY-2: THE IMPACT OF MONETARY POLICY ON THE BANK PORTFOLIO IN BANGLADESH

Introduction

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 banks play an important role in the monetary transmission process. Whether monetary policy transmits through bank assets (credit channel) or liabilities, (money channel) is currently under debate.

It is difficult to separate the money channel from the credit channel, because, following an expansionary monetary policy, bank reserves increase in both cases. This, in turn, increases bank liabilities (deposits) and bank assets (through loan and securities). Therefore, the channel through which monetary policy transmits to economy is not easy to identify. It may due to the money channel, or due credit channel or both.

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
Also according to Walsh (1998, page 286), under the credit view, following an expansionary monetary policy, banks' reserves increase too. 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 short fall 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. In addition, this paper finds that existence of banks' excess reserves is responsible for non-existence of credit channel 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 U.S.¹³

¹³ 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.
On the other hand, Oliner and Rudesbusch (1995), Morries, and Sellon (1995) do not find evidence of a credit channel in the U.S. However, an examination of whether the credit channel plays a role in the monetary policy transmission process is useful as Brunner and Meltzer (1988, page 446) noted,

"The analysis of the transmission process is incomplete without both the money and credit markets and their interaction".

The evidence on the monetary transmission mechanism in the non-U.S. countries provides mixed results. A study by Bacchetta and Ballabriga (2000) examines the impact of U.S. monetary policy on the balance sheets of U.S. banks and compares it to the impact of thirteen European countries’ monetary policies on their banks’ balance sheets. Responses of bank portfolios due to a shock in money market rates vary in countries other than the United States. Copelman and Werner's (1995) study examines the monetary transmission mechanism in Mexico and finds evidence of the existence of a credit channel.

The money channel of the monetary transmission mechanism is generally believed to be linked to a traditional interest rate channel. Nonetheless, recent evidences 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 strongly or slowly then it is logical to think that the economy is growing strongly or slowly respectively. However, if money and credit are sending conflicting signals, then the

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14 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.

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central bank should concentrate more on credit than money due to its closer link with the aggregate spending.

Therefore, in order to understand the effectiveness of the monetary policy, it is important to know the channels through which the monetary policy transmits in Bangladesh. In doing so, this study will examine the impact of monetary policy on bank portfolios, i.e. on the assets and the liabilities and also the channel through which monetary policy transmits to the economy.

Several studies have examined the existence of a broad credit channel. Jaffee and Russel (1976), Stiglitz and Weiss (1981), Oliner and Rudebusch (1995, 1996a, 1996b), and Peek and Rosengren (1995), examine the role of a credit channel by incorporating imperfect information. The main theme of these studies is the asymmetric information, such as uncertainty, moral hazard, adverse selection or high monitoring costs, which forces banks to operate in the credit rationed equilibrium. A higher interest rate raises the cost of finance and reduces the borrowers' access to the loan market, which in turn reduces investment, employment and production levels (Walsh 1998, page 318). Jaffee and Russell (1976) find that higher interest rates due to uncertainty attract high-risk borrowers and drive low risk borrowers away.

Though my study does not examine the monetary transmission mechanism by incorporating imperfect information into the credit channel, it is evident from the

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15 The difference between the narrow credit channel and the broad credit channel, is as Oliner and Rudebusch (1995, page 4) note, the broad credit channel incorporates the asymmetric information problem. For example, asymmetric information includes uncertainty, moral hazard, adverse selection and monitoring costs between borrowers and lenders, which may restrict the supply of debt from all sources (bank debt or non-bank debt) after a monetary shock. The credit channel or bank-lending channel emphasizes only bank debt as a source of monetary transmission mechanism.

16 It's a situation where firms do not get loans even at the higher interest rates (Stiglitz & Weiss, 1981). So, there is always excess demand for loans, which helps banks keep higher interest rates. Stiglitz and Weiss (1981) show that credit rationing could be in equilibrium in the presence of imperfect information in the loan market.
recent experience on commercial banks in Bangladesh (nationalized and private) that all banks have large amount of default of loans by borrowers. The default loan rate was 33.49% (of total loans) in 1997, 40.65% in 1998, 41.11% in 1999 and 34.92% during 2000. The problems of loan defaults in Bangladesh are due to (1) information problems in the form of moral hazard, adverse selection, or monitoring cost of commercial banks in selecting borrowers; (2) the lack of legal actions against defaulters (because a major portion of the loans goes to the influential businessmen, politicians, and insiders); and (3) the government’s policy of debt forgiveness which encourages non-payment of debt in Bangladesh. For example, according to a local newspaper ‘Daily Star’ dated March 8, 2002,

"About 77% of the big defaulters used their political affiliations in obtaining large amount of loans against different investment projects but diverted the funds to other purposes."

Due to the alarming number of non-performing loans, banks are unable to make their operations profitable. Most commercial banks have been suffering from capital deficiencies. Therefore, there is a possibility that the default problem of borrowers may force commercial banks in Bangladesh to ration credit. This may prevent interest rates from falling following an expansionary monetary policy, which causes bank credit, deposits and economic activity to remain unchanged or even fall following a monetary expansion. This would lead to an insensitivity of economic activity to monetary policy changes. However, my study does attempt to identify the channels through which monetary policy transmits to the economy in Bangladesh.

Theoretical Background

According to Bernanke (1988, page 3) in the traditional view of the monetary

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17 Source: Staff Reporter, "Banking Sector Plagued by Poor Loan Recovery," BSS, Dhaka, Bangladesh.
18 Source: www.e-mela.com
transmission mechanism, if the central bank wants to boost the pace of economic activity of a country, the central bank could do so by adding reserves to the banking system; this helps banks create more money. The added liquidity reduces market interest rates. Lowers market interest rates, and greater liquidity, encourages new spending and economic activity. In addition to the money view, according to Bernanke (1988, page 4) the alternative approach, which is known as the “credit view” emphasizes that

“...in the process of creating money, banks extend credit (make loans) as well, and their willingness to do so has its own effect on aggregate spending. Proponents of the money view suggest that the Fed keep an eye on the volume of bank loans, as well as the money supply and interest rates, when setting policy.”

Following Bernanke (1988, page 9), the mechanisms of monetary influence are shown in figures 3-5. In Figure-3, the IS curve show the combinations of the interest rate and the output level that keep the market for goods and services is in equilibrium. The LM curve shows the combinations of the interest rate and the level of output that keeps supply and demand for money is in balance. In equilibrium, the market for money and market for goods are in balance with an equilibrium interest rate and level of output.

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19 This is known as the “money view.”
Figure-3: Money Market Equilibrium (IS-LM framework)

Figure-4: Money View

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In Figure-4, according to the money view, an increase in reserves by the central bank will increase the money supply, which will shift the LM curve to the right. Therefore, equilibrium will settle at a lower interest rate $i^{**}$ and a higher level of output $y^{ll}$, due to an increase in the interest sensitive investment by firms and individuals.

Figure-5: Credit View

In Figure-5, according to the credit view, an increase in reserves by the central bank not only will shift the LM curve rightward, but also will shift the IS curve upward. Because if banks have decided to increase deposits by supplying more loans, then spending of some bank dependent firms will increase also and that will shift the IS curve. Therefore, the economy will settle at a new higher level of output at $y^{lll}$, but

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the impact on the interest rate is not clear due to increase in reserves. It will depend on the magnitude of the shifts in LM and IS curves.

Therefore, based on the theory by Bernanke (1988), this paper will examine the monetary transmission mechanism in Bangladesh. That is, I will estimate whether it is bank assets, bank liabilities, or both through which monetary policy transmits to the economy.

Literature Review

Monetary Transmission Mechanism in Developed Countries

Though a large number of studies (Bernanke & Blinder, 1992; Kashyap, Stein and Wilcox, 1993; McMillin, 1996; Morris & Sellon, 1995; Bacchetta & Ballabriga, 2000) have examined the role of banks' portfolios in the monetary transmission mechanism, the debate on the importance of banks' assets or liabilities has not yet provided a unique solution. The results vary when different monetary policy variables, sample periods, and/or econometric techniques are used.

Bernanke and Blinder (1992) examine the impact of U.S. monetary policy on banks' portfolios and economic activity. Using monthly data over the sample period 1959:1 to 1978:12, a six-variable VAR model is developed. The variables are as follows: the federal funds rate, which is used as an indicator of monetary policy, the unemployment rate, which is used as an indicator of economic activity, the log of the consumer price index, and the log level of real deposits, the log of real securities, and the log of real loans are used as bank portfolio variables.

The impulse response functions estimated from the VAR show that, due to a positive shock, (contractionary monetary policy) to the federal funds rate, banks' deposits fall immediately and reach a minimum after about twelve months and remain
significant over the twenty-four-month horizon.

The response of the securities to a federal funds shock is similar to the response of deposits, but the fall is deeper than the fall in deposits, implying that banks tend to react more often by decreasing holdings of the securities due to a shock to the federal funds rate.

The response of loans to a federal funds shock is slower than that of deposits or securities because of the quasi-contractual nature of loans (Bernanke & Blinder 1992, page 919). Following a shock to the federal funds rate, loans remain constant for up to six-months, and then fall, while the response remains negative over the next twenty-four months. This implies that banks' assets as well as liabilities are important in transmitting monetary policy in the U.S. The impact on unemployment is similar to the responses of the loans up to six months; after six months unemployment begins to increase and remains constant over the next twenty-four months. The similar response of loans and unemployment provide evidence that even though loans do not Granger cause unemployment, loans are an important channel of monetary transmission mechanism. Another explanation as noted in the paper that the similar responses of loan and unemployment might be due to slow loan demand rather than loan supply (Bernanke and Blinder 1992, page 919).

Unlike Bernanke and Blinder (1992), Kashyap, Stein and Wilcox (KSW, 1993) use non-bank source of finance such as commercial paper to overcome the identification problem. That is whether output falls due to fall in loan demand or loan supply. As they argued, the evidence of fall in output in Bernanke and Blinder (1992) along with the fall in loans does not imply that the output fall is due to fall in loan supply, it might be due to decline in loan demand that works through decline in economic activity following a contractionary monetary policy. As KSW (1993) noted,
if monetary policy works through the 'money channel' then the decline in loan demand following a decrease in economic activity will decrease commercial paper as well. If monetary policy works through a bank-lending channel then a decline in bank loan supply following a contractionary monetary policy will increase commercial paper holding. KSW (1993) examine how bank loans and commercial paper change due to a change in the monetary policy. KSW (1993) perform two sets of tests. In their first test, they follow the technique by Romer and Romer (1990). KSW (1993) use the Romer dates to compare the behavior the bank loans and the commercial paper before and after the Romer dates.\textsuperscript{20} In the second test, they look at the correlation between the federal funds rate, the spread between the commercial paper and the treasury bill rate and the three financial variables: the volume of commercial paper, commercial bank loans and a mix variable.\textsuperscript{21} Both tests show that commercial paper increases substantially after the Romer dates. Bank loans decline after two years following each Romer episode. The mix variable also declines immediately after the Romer dates indicating that monetary policy operate through bank-lending channel.

KSW (1993) also perform Granger causality tests to see whether movement of any of the financing variable (such as mix, commercial paper, loans) can forecast the movement of the firm financing options. They create two dummy variables. The first dummy includes only 'Romer dates' and takes 'one' on a Romer date and 'zero' otherwise. The second dummy includes 'Romer dates and the year 1966' and takes 'one' at the Romer dates and also the date of 1966 'credit crunch' and 'zero'\textsuperscript{20}

\textsuperscript{20} The Romer dates are the dates the Federal Reserve conducted a contractionary monetary policy to control bank reserves. The dates are October 1947, September 1955, December 1968, April 1974, August 1978, and October 1979.

\textsuperscript{21} Mix is defined as the ratio of bank loans to the sum of the bank loans and the commercial paper.
otherwise. They perform 'bivariate' and 'multivariate' versions of the test. In the bivariate test, they regress the change in the financing variable on eight lags of itself and on eight lags of the dummy variable. In the multivariate version, they add eight lags of GNP to control for the cyclical fluctuation. They conduct four separate tests for each financing variable. KSW (1993) find that the coefficients of the sum of dummies are statistically significant and negative in all four-mix regressions as expected. They find statistically significant and positive coefficient of dummies in the commercial paper regressions only when the 1966 'credit crunch' is included. The sum of the coefficients of dummies in the loan equations has a statistically significant and negative impact only in the bivariate specification. All the results support the hypothesis that bank lending channel works.

McMillin (1996) estimates the impact of monetary policy on banks' portfolios using the same variables as Bernanke and Blinder (1992). The variables are the federal funds rate, the log of the CPI, the log level of real bank deposits, the log of real bank securities, the log of real bank loans and the unemployment rate. In addition, McMillin (1996) uses the log level of real commercial paper issued by non-financial corporations and the spread between the prime rate on bank loans and the commercial paper rate based on the model developed by Kashyap, Stein and Wilcox (1993), to examine whether the bank-lending channel operates in the monetary transmission process in the United States. Kashyap, Stein and Wilcox (1993) find that bank loans decline relative to commercial paper due to a monetary contraction, which

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22 The 1966 date of a credit crunch has been excluded from the Romer dates of credit crunch.
23 KSW (1993) repeated the tests using different measures of monetary policy such as the federal funds rate and the spread between 10-year constant-maturity government bond rate and the fund rate. They find similar results with the two interest rate measures of monetary policy when they include Romer dates of 'credit crunches' and also the 'credit crunch' period of 1966 as a measure of monetary policy.
they take as an evidence of a bank-lending channel. This is because, as Kashyap, Stein and Wilcox (1993) noted, if decline in bank loans is due to decline in loan demand following an economic downturn, then commercial paper outstanding would have declined also.

McMillin (1996) estimates a VAR model using a six-month lag for the period 1973:1 to 1994:11. Impulse response functions for deposits, securities, loans and the unemployment rate due to a one-standard-deviation positive shock to the federal funds rate show similar patterns to those in Bernanke and Blinder's (1992) study. The responses of loans are faster than those in Bernanke and Blinder's research. There is no evidence that the response of unemployment and loans coincide as in Bernanke and Blinder (1992). The responses of the commercial paper and the spread are positive as expected, which support the existence of a credit channel.

The sample period examined in McMillin's (1996) study spans several policy regimes. During the sample period from 1979 to 1982, the Federal Reserve was targeting non-borrowed reserves rather than the federal funds rate. The stability of the estimates was tested by the multivariate extension of the procedure suggested by Dufour (1980, 1982). The stability tests show instability over the sample period 1979 to 1982. Therefore, McMillin re-estimated the model excluding the unstable period. Impulse response functions due to a shock to the federal funds rate appear similar to the responses in Bernanke and Blinder (1992) for all the variables except for the loans. The response of loans due to a shock to the federal funds rate is positive which does not support the bank-lending channel. This is because, as argued in the paper, the period 1979 to 1982 contains data from periods of credit controls (from March 1980 to June 1980) by the Federal Reserve. Excluding the periods of credit shock from the full sample eliminates the evidence of a bank-lending channel implying that the
effects on the real value of loans are the results of a single contractionary monetary policy shock rather than systematic effect on loans (McMillin 1996, page 331).

Morris and Sellon (1995) find no evidence of a credit channel in the U.S. during the period 1976 to 1994. Using survey information, they examine banks' balance sheets and the terms of business loans when monetary policy is tightened. They find that banks do not reduce business loans when monetary policy is tightened. However, they find some evidence that the financial condition of small firms is more constrained by the restrictive monetary policy than are the financial condition of large firms. They provide several reasons for monetary policy not constraining bank lending, such as growing use of loan commitments and the lesser use of banks as the sources of short-term business loans. As mentioned in the paper, over a 20-year period, short-term loans provided by banks dropped from 80% to 50% of total loans. Other sources of loans, such as commercial paper markets and non-bank financial intermediaries, increased substantially. However, during the same period, loan commitments increased from 20% to 75%.

Oliner and Rudebusch's (1995) findings are in line with the findings of Morris and Sellon (1995). Oliner and Rudebusch (1995) find no evidence of a bank-lending channel for the U.S. during the period 1973.q1 to 1991.q2. They examine the mix of banks' debt and non-banks' debt using quarterly data on small and large firms. Oliner and Rudebusch (1995) separate out short-term debt from long-term debt. Short-term debt consists of trade debt (TD), commercial paper (CP), short-term bank loans (B), and short-term 'other' debt (O), while long-term debt consists of total bank debt (TB) and total 'other' debt (TO). An examination of the financing options of small and large firms shows that small firms depend more on short-term bank loans than do
large firms. However, both small and large firms depend heavily on trade debt\textsuperscript{24} on the other hand, small firms do not issue commercial paper for financing, while large firms have almost as much commercial paper outstanding as they have short-term bank loans (Oliner & Rudebusch, 1995, page 8).

Oliner and Rudebusch (1995) regress three measures of debt mix for short-term debt mix and two measures of long-term debt mix on four lags of the debt mix and eight lags of the monetary policy indicators (MP) by ordinary least square (OLS) using the following equation:

\[
\Delta MIX_{j,t} = c + \sum_{i=1}^{4} \alpha_i \Delta MIX_{j,t-i} + \sum_{i=8}^{3} \beta_i MP_{t-i} + \mu_{j,t} \quad (j = KSW, O, TD)
\]

To check the robustness, two measures of monetary policy: the federal funds rate and a dummy variable for the Romer dates (the dates the Federal Reserve Bank adopted anti-inflationary monetary policy, which are April 1974, August 1978, October 1979, and December 1988) are used as monetary policy variables. The dummy variable takes 'one' during the quarter of the Romer dates and 'zero' otherwise. In the estimated results, they find no evidence of a lending channel, either for small firms or for large firms, or for short-term or long-term debt MIX.\textsuperscript{25} However, they do find evidence of the existence of a lending channel in the aggregate manufacturing short-term (MIX\textsuperscript{KSW} and MIX\textsuperscript{O}) debt mix. The reason for getting the evidence of a lending channel in aggregate manufacturing debt MIX is, as Oliner and

\textsuperscript{24} Trade debt is an important form of short-term debt (maturity of one year or less). According to the Quarterly Financial Report for Manufacturing, Mining and Trade Corporations (QFR), trade debt is defined as 'trade accounts and trade notes payable' of firms (Oliner and Rudebusch, 1995, page 16).

\textsuperscript{25} The measures of short-term debt mix as defined by Kasyap, Stein and Wilcox (1993) are: MIX\textsuperscript{KSW}=B/(B+CP), other short-term debt mix is defined as MIX\textsuperscript{O}=B/(B+CP+O) and a short-term debt mix including trade debt is defined as MIX\textsuperscript{TD}=B/(B+CP+O+TD). The two measures of long-term debt mix are: TMIX\textsuperscript{O}=TB/(TB+CP+TO) and TMIX\textsuperscript{TD}=TB/(TB+CP+TO+TD). Where, B=short-term bank loans, CP=commercial paper, O= other short-term debt, TB=total bank debt, TO=total other debt, and TD= trade debt.
Rudebusch (1995) note, aggregate manufacturing debt MIX is the sum of two terms: (i) the share weighted average of debt MIX of short-term debt held by small firms and large firms, and (2) share of total debt held by small and large firms and mix of debt for both groups. Following a monetary policy shock, aggregate manufacturing debt MIX decreases because the share of total short-term debt from small firms to large firm increases. Because large firms depend much less on bank loans than do small firms, aggregate manufacturing debt MIX decreases following a monetary policy shock. As Oliner and Rudebusch (1995) have argued, a decrease in aggregate manufacturing debt MIX can not be taken as evidence of a lending channel only, because a decline in aggregate manufacturing debt MIX is due to a reallocation of total short-term debt to large firms from small firms, rather than decrease in bank loans following a monetary policy shock. The reason for reallocation of total short-term debt toward large firms from small firms is due to the information problem; banks provide fewer loans to small firms, which cause small firms to cut down on their spending, investment and inventories. They conclude by saying that monetary contractions have not systematically reduced the supply of bank loans relative to other sources of credit, and the supply of bank loans is depressed by sector specific shocks (Oliner & Rudebusch 1995, page 15).

In order to understand the monetary transmission process in other developed countries, (U.K., Germany, France, Italy, Spain, Austria, Denmark, Netherlands, Sweden, Norway, Finland, Switzerland, Ireland and the United States) Bacchetta and Ballabriga (2000) examine the impact of shocks to money market interest rates and real bank reserves on four variables: real bank deposits, real bank loans, the consumer price index, and the industrial production index. In order to see how a monetary policy shock affects macroeconomic variables, the consumer price index is used as
price variable and industrial production is used as the real output variable. Bank deposits and loans are used to examine the channel through which monetary policy transmits. They used quarterly data to estimate a six-variable VAR model for each of fourteen countries (thirteen European countries and the U.S.). The sample periods differ from country to country.

The estimated impulse response functions due to a positive shock to the interest rate show that the output decrease is statistically significant for 11 out of 14 countries. The exceptions are Norway, Finland, and the Netherlands. However, due to a negative shock in the bank reserves, responses of output are statistically significant and negative for all countries except for Norway and Finland. The output responses of these two countries are small and positive. Responses of bank portfolio variables in the U.S. due to a shock to the interest rate are similar to the findings of Bernanke and Blinder (1992). Deposits decrease more than the decrease in loans, but over time the decline in loans is larger than the decline in deposits. Bacchetta and Ballabriga (2000) find the evidence of a broad credit channel, which is in line with the findings of Bernanke ad Blinder (1992).

Responses of banks portfolios for the U.S. due to a shock in the money market rates are similar to Bernanke and Blinder’s (1992) findings. Bank deposits and loans decrease due to a money market shock. However, over time, the loan decline is larger than the decline in deposits. The responses of bank deposits and loans due to a shock in the money market interest rate for the European countries are statistically significant and negative for all countries with the exception of Austria. In Austria, the responses to bank deposits and loans are positive due to an interest rate shock. However, the magnitude of decline in deposits and loans differ from country to country. For example, the U.K. and the Netherlands experience a small decline in
deposits and credits. Other countries have a reaction of deposits and loans similar to the U.S. (Bacchetta and Ballabriga, 2000, page 20).

Subsequently, Bacchetta and Ballabriga (2000) compare the reactions of output with those of bank deposits and loans due to an interest rate shock to examine whether a credit channel exists in European countries. They find that a fall in deposits causes output to fall in all European countries, which is similar to the pattern in the U.S. However, loans and output responses are statistically significant and negative which is more synchronized due to a shock in the interest rates (Bacchetta & Ballabriga 2000, page 20) for all European countries with the exception of Denmark, France and Ireland. Bacchetta and Ballabriga (2000) argue that the similar responses of loans and output are an indication of the existence of a broad credit channel and money channel rather than bank-lending channel.26

Kakes, Sturm and Maier (1999) do not find evidence of a credit channel in the monetary transmission process in Germany. They examine the impact of a monetary policy shock on the banks' balance sheets. Following Bernanke and Blinder (1992), a short-term inter-bank interest rate is used as a proxy for monetary policy variable. Either M₁ or M₃ is included as a liability variable, while securities holdings and bank loans are included as asset variables. Real GDP, the GDP deflator, the effective exchange rate, and a long-term interest rate are used to reflect the ultimate goals of monetary policy.

A vector autoregressive (VAR) model is estimated using quarterly data during the period from 1970.q1 to 1997.q4. Kakes, Sturm and Maier (1999) use aggregated and disaggregated data across different sectors: the corporate sector and the household

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26 Because, as Bacchetta & Ballabriga (2000) note, over time banks are reluctant to lend credit to risky firms and hold safe government securities due to the asymmetric information problem. This is the broader credit view. The decrease in output is due to a decrease in loan demand by firms, rather than decrease in loan supply.
sector, and different terms of loans: short-term, medium-term, and long-term loans. The long-term interest rate and the real effective exchange rate are used to account for other transmission variables. In order to control for supply shocks, the oil price is used as an exogenous shock variable. A set of dummy variables is used to account for the structural changes.

Impulse response functions (IRFs) are estimated from the VAR using aggregate data on the short-term interest rate, real GDP, the GDP deflator, total bank loans, money \((M_3)\), the long-term interest rate, the real effective exchange rate, and banks’ security holdings. The IRFs of real GDP and the GDP deflator due to an interest rate shock are significant and negative. The response of the long-term interest rate is statistically significant and positive, which is similar to the response of the short-term interest rate. The real effective exchange rate does not show any response due to an interest rate shock implying that exchange rate is not an important transmission variable. The response of securities is negative, while the loan response is positive to an interest rate shock. This implies that banks increase loans by reducing security holdings. The response of \(M_3\) is positive, showing that banks liabilities and assets are moving together.

Kakes, Sturm and Maier (1999) re-estimate a VAR model using bank-lending data for firms and households rather than aggregate credit. Real GDP is replaced by industrial production and household expenditures, respectively. The producer price index and the household expenditure deflator replace the GDP deflator as the price index. The response of money \((M_1)\) is negative due to a contractionary monetary policy shock because \(M_1\) represents a smaller portion of the bank liability side of the balance sheet than \(M_3\) and therefore, is not closely related with bank lending.

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27 The analyses are repeated with \(M_4\). The response of money \((M_1)\) is negative due to a contractionary monetary policy shock because \(M_1\) represents a smaller portion of the bank liability side of the balance sheet than \(M_3\) and therefore, is not closely related with bank lending.

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variable. Bank lending to firms and households is used as the loan variable. The response of industrial production is negative and statistically significant, while the response of household expenditure is insignificant due to an interest rate shock, implying that monetary policy has more impact on firms than on households. The response of the household expenditure deflator is significant and negative, while response of the produce price index is significant and positive showing a price puzzle. The responses of bank credit are statistically significant and positive for firms and household sectors due to an interest rate shock.

The response of long-term loans shows a slow response, while short-term and medium-term loans increase significantly due to an interest rate shock when bank lending is disaggregated into different debt maturities. The evidence of a slow response of long-term loans corresponding to a decrease in real GDP or industrial production suggests a reduction of loan demand by firms following a drop in sales rather than loan supply due to an interest rate shock. The positive responses of short-term and medium-term loans due to an interest rate shock imply that firms use short-term loans to buffer liquidity (Kakes, Sturm and Maier 1999, page 11). Finally, Kakes, Sturm and Maier (1999) argue that monetary policy does not seem to work through a credit channel in Germany. In contrast, borrowers are increasing loans through other channels, such as the interest rate channel or the exchange rate channel to offset the negative effect of a monetary policy shock (Kakes, Sturm and Maier 1999, page 13).

Dale and Haldane (1995) examine monetary transmission channels in the U.K. by using aggregate and disaggregate data. Disaggregated data are used for the personal and corporate sectors. The discount rate is used as a monetary policy instrument. Banks’ balance sheet variables (deposits, loans) and asset prices are used
as intermediate channels of monetary transmission process. Real activity and prices are used as final policy objectives. A VAR model is estimated in log levels using monthly data from 1974:6 to 1992:10 for each sector.

The impulse response functions for money and credit show striking differences. The response of credit due to a shock to an interest rate is positive and significant for the corporate sector, while it is negative and significant for the personal sector. The response of deposits due to shock to an interest rate is positive and significant for the personal sector, while it is negative and significant for the corporate sector. Thus, this study lends support in favor of a money view for the corporate sector and a credit view for the personal sector.

Agung and Ford (1998) examine the bank lending, or a credit, channel in Japan by examining differential effects of policy across bank size and across firm size simultaneously and find evidence of a credit channel in the monetary transmission mechanism. They examine balance sheet behavior of two types of Japanese banks, city banks (large banks) and regional banks (small banks), and loan supply to two types of business firms, small firms and large firms. A seven-variable VAR model is estimated using monthly data for the sample period 1965.1 to 1996.7. The variables are a monetary policy indicator (discount rate), stock market index, bank deposits, securities, bank loans, a production index, and the consumer price index.

Impulse response functions show that the responses of deposits due to a monetary shock are initially negative and statistically significant for both small and large banks. However, deposits of large banks recover quickly, while the responses of deposits to a monetary policy shock of small banks remain significant and negative for the rest of the time horizons. The responses of loans and securities to a monetary shock of small and large banks are different. The response of loans of large banks

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declines slightly and recovers after month twenty. The responses of small banks' loans decline over time. However, the decline in small banks' loans is larger than those of large banks and remains significant for the whole period. The response of securities to a monetary shock is less sensitive for small banks than those of large banks, implying that large banks reduced securities more to finance loans to businesses.

To see the differential effects of bank loans on small and large firms, Agung and Ford (1998) disaggregated loans into loans to small businesses and loans to large businesses. The results constantly support the existence of a bank credit channel by showing that small firms' loans decline more due to a monetary policy shock than the decline in loans of the large firms. In Japan, the proportion of the small businesses is large, compared to the number of large firms. Thus, the effect of a decline in bank loan supply on output also happens to be large in Japan (Agung & Ford 1998, page 15).

To examine the impact of monetary policy shocks on banks' portfolios at the aggregate level, Agung and Ford (1998) estimate a seven-variable VAR model. Impulse response functions show similar results in the disaggregate loan data of small and large firms compared to the aggregate data of loans on small and large firms. Due to a shock to the discount rate, the stock market index, bank deposits, loans, securities, real output and price decline. However, the decreases in deposits are larger than the decrease in loans, and loan decline are much quicker than output declines. Agung and Ford (1998) take this as evidence of an existence of a credit channel because the decline in loans is generated by a decline in loan supply rather than the decline in loan demand. Moreover, variance decompositions of loans provide further support in favor of the decrease in loan supply due to a monetary policy shock by
showing that bank deposits account for 16.4% variation of total loans, while output accounts for 8.1% variation of total loans.

To see the effects of the financial regulation, Agung and Ford (1998) divided the sample periods: a pre-regulation period from 1965.1 to 1984.12, and a post-regulation period from 1985.1 to 1996.7. The results estimated from different sample period’s show that the transmission mechanism changes following financial deregulation. An increase in the use of ‘corporate bond’ and ‘foreign bond’ issues reduces the effectiveness of a monetary policy on bank lending as banks are able to increase their loan supply by reducing securities. The surprising results are that before deregulation, loans accounted for a 22% variation in output, while bank deposits and the interest rate accounted for a 0.9% and 14.3% variation in output, respectively. However, after deregulation loans accounted only for 3.2% variation in output, while deposits and interest rates accounted for 7.2% and 35.5%, respectively, indicating that the traditional money/interest rate channel became an important channel of a monetary transmission mechanism in Japan after a financial deregulation.

The above review of the literature shows that the responses of bank assets and liabilities due to a negative monetary policy shock are mixed in the U.S. For example, McMillin (1996), Morries and Sellon (1995), and Oliner and Rudebusch (1995), find no evidence of a credit channel, while Bernanke and Blinder (1992) find evidence of a credit channel. The responses of banks’ assets and liabilities due to a contractionary monetary policy of other developed countries are mostly in line with the results in Bernanke and Blinder (1992) except for the Germany. Kakes, Sturm and Maier (1999) do not find evidence of a credit channel in the monetary transmission process in

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28 Financial deregulation includes, for example, relaxation of corporate bonds’ interest rate, and the loosening of foreign bonds issues (Agung and Ford, 1998, page 19).
Germany.

The reasons for gaining little support in favor of a credit or lending channel in developed countries, as mentioned by Agung and Ford (1998), are that industrial and developed countries have developed financial markets so that firms can circumvent banks as sources of funds by issuing commercial paper and short-term bonds. Banks can issue CDs or other non-deposits liabilities as well, which are not subject to a reserve requirement following a monetary contraction.

Monetary Transmission Mechanism in Developing Countries

There have been many studies addressing to the issue of monetary transmission mechanism in the U.S. However, few studies have focused on developing countries (Copelman and Werner 1995, page 1). Copelman and Werner (1995) find evidence of a credit channel in the monetary transmission mechanism in Mexico. Agung (1998) examines the impact of monetary policy on the bank balance sheets in Indonesia. Cho and Kang (1999) analyze whether monetary policy plays a part in the lending behavior of banks during stable and financial crisis periods in Korea.

Copelman and Werner (1995) use monthly data to determine whether the credit channel is present in the monetary transmission mechanism in Mexico during the period 1984.1 to 1994.5. A VAR model is estimated and Granger causality tests are performed to examine the monetary transmission mechanism. Total loans to the non-financial private sector given by commercial and development banks are used as measures of credit. The depreciation rate of the nominal exchange rate is used as a “credit channel” variable because, as noted by Copelman and Werner (1995), during the period of 1984 to 1995, the government in Mexico followed a policy of depreciating the nominal exchange rate. As they argue, a change in the rate of
depreciation has an effect on the nominal interest rate, which in turn affects the real quantity of money in the economy, thus directly affecting the amount of loans the banking sector is able to make. Therefore, they mention in the paper that the depreciation rate of the nominal exchange rate is suitable to examine whether 'credit channel' exists in Mexico. Two measures of economic activity, industrial production and fixed investment are used. The real exchange rate and the real interest rate are also used to examine the monetary transmission mechanism. All the variables are in logs, except for the interest rate and the depreciation rate.

First, a series of Granger causality tests are performed. The Granger causality tests show that credit variables Granger cause industrial production, while no other variables contains information about economic activity.

Second, to determine the robustness of the results, a four-variable VAR model is estimated with the real exchange rate, the real interest rate, and either with the depreciation rate of the nominal exchange rate or with the level of credit, and either measure of economic activity. Variance decompositions of investment and industrial production show that the credit variable accounted for up to 36% of the variation of total output and 26% of the variation of total investment. However, the depreciation rate does not explain any of the variation in output or investment.

Impulse response functions show that the responses of investment and output to a shock to the level of credit are positive and significant for up to two years. A positive shock to the level of credit also has a significant negative impact on the real exchange rate through increased in aggregate demand. The responses of economic activity to shock to the nominal depreciation rate are negative and significant for eight-months.

Though all the results support the existence of a credit channel in the monetary
transmission mechanism in Mexico, it is difficult to determine whether the credit shock is purely exogenous or induced by the change in the nominal depreciation rate because monetary policy in Mexico targets the exchange rate.

To examine whether the level of credit is exogenous or endogenous, a series of Granger causality tests is undertaken and a VAR model is estimated containing the nominal depreciation rate, the level of credit, the real exchange rate, and the real interest rate. The Granger causality tests still show that the level of credit Granger causes investment. However, variance decompositions of output and credit show that the nominal depreciation rate can account for 26% of the variation of total output and 76% of the variation of total credit, while the responses of economic activity and credit due to a shock to the nominal depreciation rate are negative and significant. Impulse response functions due to a shock to credit show that the responses of economic activity are not significant as before.

Agung (1998) investigates the responses of banks’ balance sheet variables (deposits, loans and securities) to a monetary policy shock, across different classes of banks (such as state banks and foreign exchange licensed banks or large banks, non-foreign exchange licensed banks or small banks), different categories of loans (such as investment, working capital, consumer loans), and heterogeneity of borrowers (consumer vs. non-consumer) in Indonesia. Similar to Bernanke and Blinder (1992), a five-variable VAR model is estimated using monthly data for the period 1983.1 to 1995.12. Banks are separated according to their size and access to the non-deposits funds, such as securities issues and foreign borrowings. The variables used in the study are: a monetary policy indicator (one-month inter-bank interest rates), the exchange rate, balance sheet variables (deposits, loans and securities), real GDP, and the consumer price index. All the variables are in the log levels.
Impulse response functions estimated from the VAR show that, due to a contractionary monetary policy shock, deposits increase initially for state and foreign exchange licensed banks before decreasing. The reasons for the increase in deposits are due to state and foreign exchange licensed banks access to other non-deposits funds, while small banks are unable to obtain external financing.

The responses of loans across heterogeneous banks to a monetary contraction show that the total loans of state banks and foreign exchange licensed banks are positive initially before becoming insignificant. However, the responses of small banks are negative and large compared to large banks.

The possible reason for the large decline in loans in the small banks as noted by Agung (1998) is due to the accessibility of large banks to other non-deposits funds. Whereas small banks are subject to fund constraints following a contractionary monetary policy, and thus unable to replace a fall in deposits, and continue their lending behavior

"...the heterogeneous responses of banks could be due to the nature of loans and advances by different categories of banks."

For example, large banks tend to advance loans to investment firms, while small banks concentrate on consumer loans, such as housing and automobiles.

To examine the issue of the heterogeneity response of banks, loans are disaggregated into investment loans, working capital loans, and consumer loans. Impulse response functions show that the responses of investment loans and working capital loans for large banks increase due to a monetary contraction. However, due to a monetary policy shock the responses of investment loans and working capital loans of both foreign exchange licensed banks and non-foreign exchange licensed banks is negative. Impulse response functions for the consumer loans show a decrease in response to a monetary shock for all banks, implying that small borrowers are the
channels through which monetary policy works in Indonesia.

Cho and Kang (1999) analyze whether monetary policy plays a part in the lending behavior of banks during stable and financial crisis periods in Korea. Monthly data, 1994:1 to 1997:9, of the ratio of loans from banking funds of deposit money banks to claims on the private sector of all financial institutions (lr) is used as a dependent variable, which represents bank-lending behavior. Adjusted reserve money (rbm) is used as a monetary policy variable. The spread between the commercial lending rate and corporate bond yield (I) is used as an indicator of the relative earning rate. Seong and Kang (1999) also used a dummy variable having value 1 from December 1997 to reflect the change in bank lending behavior due to financial crisis. An examination of unit root tests show that ‘lr’ and ‘rbm’ have unit roots in the original series. So, first differences of the two series are used, while the spread between commercial lending rate and corporate bond yield (I) variable are used in levels because they are I(0).

The estimation results using ordinary least square (OLS) shows that the coefficient of adjusted reserve money (rbm) is significant and positive as expected, implying that monetary policy does increase banks’ loan supply compared with other bank assets during the stable periods, while it does not increase banks’ loans supply, compared with other banks’ assets following the crisis periods.

However, the increase in the money supply increases investment in government or public bonds more than loans, because bonds are less risky and more liquid than banks loans (Cho & Kang 1999, page 17). The coefficient of the spread variable also shows the expected positive sign, which implies that bank loans respond significantly to a change of the relative earning rate.

From this review of literature, it is evident that a credit channel exists in the
developing countries. Because, as noted by Agung (1998), in the absence of established financial markets in the developing countries firms have no other option but to depend on banks for financing. Moreover, in developing countries both monetary and non-deposits liabilities are subject to reserve requirements of the central bank (Agung & Ford, page 7).

Model Variables

The sample period covered in this study is 1975:1 to 2000:4. Quarterly data are employed to estimate a six-variable VAR model. To see the dynamic relationships of the monetary policy (monetary base) on the bank portfolios (deposits and credit) and other macroeconomic variables (the price level and output) in Bangladesh, a six-variable VAR model is estimated. A structural (Bernanke 1986) VAR technique and Cholesky decompositions are used to construct VDCs. The structural VAR is also used to construct IRFs. The model variables are as follows:

MB = the log of real monetary base;
Dep = the log of real total deposits in the banking sector;
Dcps = the log of real total domestic credit to the private sector by the financial institutions;
R = the lending rate on commercial loans;
CPI = log of consumer price index; and
Y = log of real output measured by industrial production.

Seasonally adjusted data are used for all the variables with the exception of the lending rate. All the variables are in log form except for the lending rate. A description of the variables is given in detail in the Appendix-B.
As noted by Keating, initial interest in Sim’s (1980) VAR model arose because of the inability of economists to agree on the economy’s true structure. A vector autoregressive (VAR) model is an appropriate econometric technique when we are interested in dynamic relationships among variables in presence of possible feedback and ambiguity about the exogeneity of the right hand side variables (Enders, 1995). However, there are drawbacks in using a VAR model because a VAR model is a reduced-form model. As Cooley and LeRoy (1985) argue, an estimated shock in VAR is not a structural shock, but a linear combination of structural disturbances. In that case, IRFs and VDCs derived by using a Cholesky ordering are difficult to interpret because these IRFs and VDCs represent complicated functions of all structural disturbances. Besides, Cholesky decompositions impose a recursive contemporaneous structure on the variables, but most of the theories do not imply recursive contemporaneous structure.

In response to these criticisms Bernanke (1986) and Sims (1986), among others, developed structural VAR models. They argue that these structural VAR models will overcome the limitations in standard VAR models by unfolding economic information embedded in the reduced-form time series models.

This study uses a VAR model to derived IRFs and VDCs. The IRFs show the dynamic response of each variable in the system to shock from each variable in the system. This study is mostly interested in the responses of the bank portfolio variables (deposits and credit), and macroeconomic variables (price and output) to a monetary policy shock and also the channels (deposits or credit) through which monetary policy operates in the economy. If the responses of both sides of the banks’ portfolios and macroeconomic variables to a monetary policy shock are significant we would
conclude that monetary policy has a significant impact on the banks' portfolios. That
is, both money and credit channels exist in Bangladesh. This study is also interested
in channels through which monetary policy transmits to the economy. Therefore, if
the responses of the price level and output were significant due to shocks to deposits
and credit, then we would conclude that both the money and credit channels function
to transmit the monetary policy shock to the economy.

VDCs show the portion of the variance in the forecast error for each variable
explained by innovations to all variables in the system. Because this study is mostly
interested in the impact of a monetary policy shock on banks' portfolio variables, a
significant portion of the forecast error variance of banks' portfolios and
macroeconomic variables explained by the shocks to monetary policy lead us to the
conclusion that monetary policy shocks have a significant impact on the bank
portfolios (deposits and credit). This study is also interested in the impact of the
banks' portfolio shocks on the price level and economic activity. If the banks'
portfolios explain a significant portion of the forecast error variance of the price level
and the economic activity, then we would say that banks' portfolio have a significant
impact on the price level and the economic activity in Bangladesh.

Following Bernanke (1986), Pozo and Wheeler (2000), and Wheeler (1995), a
structural VAR technique is used to derived variance decompositions (VDCs) and
impulse response functions (IRFs).

Model Specification

In order to estimate VDCs and IRFs orthogonalization of the VAR residuals is
required. Bernanke's (1986) structural VAR technique is used to orthogonalize the
VAR residuals. This technique is used to estimate a just-identified model of VAR
residuals because, as noted by Bernanke (1986), an over-identified model is less likely
to produce orthogonal residuals. With six variables, 21 parameters can be estimated in a just-identified system. Six of these are equation variances. Hence, 15 structural coefficients need to be estimated. The following structural equations are used to estimate a six variable structural model. Theoretical background helps to specify the following structural model:

(5) Supply of Deposits: Monetary Base \( e^{MB} \) = \( f(e^{Dep}, e^{y}) \)

(6) Demand for Deposits: Deposit \( e^{Dep} \) = \( f(e^{y}, e^{CPI}, e^{R}) \)

(7) Credit Supply: Credit \( e^{Dps} \) = \( f(e^{MB}, e^{R}) \)

(8) Credit Demand: Interest Rate \( e^{R} \) = \( f(e^{Dps}, e^{y}, e^{CPI}) \)

(9) Aggregate Demand: \( e^{y} = f(e^{Dep}, e^{Dps}, e^{CPI}, e^{R}) \)

(10) Aggregate Supply: \( e^{CPI} = f(e^{y}) \)

Equation (5) is an inverse deposit supply function showing the structural relationship among deposits, monetary base and real income. The expected signs for monetary base and real income are positive and negative respectively i.e., an increase in monetary base will increase deposits and an increase in real income will decrease deposits, as central bank will take counter cyclical policy.

Equation (6) is a structural demand for deposits equation, which depends on real income, the price level and the interest rate. According to demand for deposits equation, an increase in real income will increase demand for deposits as the transaction demand for money increases. An increase in the interest rate will decrease deposit demand as the opportunity cost of holding money increases. An increase in the price level tends to decrease the demand for deposits as the value of money decreases. Therefore, the expected sign for real income is positive, while the expected signs for the interest rates and the price level are negative in the demand for deposits equation.
Equation (7) shows a structural relationship among credit, the monetary base and the interest rate, which can be considered as a credit supply equation. The expected signs for the monetary base and the interest rate are positive for the credit supply equation. The credit supply equation implies that an increase in the monetary base increases the credit supply by increasing banks’ reserves, which enables banks to create more loans thereby increase loan supply. An increase in the interest rate is likely to increase credit supply because the interest rate is the return on loans.

Equation (8) is an inverse credit demand equation showing a structural relationship among credit, the interest rate, real income and the price level. The expected sign for the interest rate is negative, while the expected signs for the price level and income are positive in the credit demand equation. Equation (iv) suggests that an increase in the interest rate will decrease credit demand because the cost of borrowing will increase. An increase in the real income and the price level tend to increase credit demand due to increase in the economic activity.

Equation (9) is an aggregate demand function, which includes all model variables except for the monetary base. According to aggregate demand equation an increase in deposits and credit tend to increase the demand for real income by increasing economic activity. An increase in the price level is likely to decrease output by decreasing output demand. However, an increase in the interest rate tends to decrease the demand for real income as economic activity falls due to fall in the output demand. Therefore, the expected signs for deposits and credit are positive, while the expected sign for the interest rate and the price level is negative in the aggregate demand equation.

Finally, equation (10) is an inverse aggregate supply equation, the expected sign for the real income is positive in the aggregate supply equation. This is because,
an increase in the price level will increase output supply by increasing price of output.

Hafer and Sheehan (1991) argued that VAR results can be very sensitive to the choice of lag length. Therefore, Akaike’s Information Criterion (AIC) and Schwartz’s Information Criteria (SIC) are used to select the lag length for the VAR model. Lag orders of one through eight are tested. A lag order of three produces the minimum AIC and SIC. Q-statistics are used to see if VAR residuals of each equation are white noise at this minimum AIC and SIC. The Q-statistics show white noise residuals for each equation at lag order three. Therefore, a lag of three is used to derived VDCs and IRFs. To see the robustness of the results, lags of four and eight are also used to estimate the models. This paper reports the estimated results using optimal lag 3 and compares these results to the results derived from lags 4 and 8.

Empirical Results from Structural VAR

In order to see the robustness of the SVAR results, a VAR with Cholesky decompositions is also estimated. The results lie in the VDCs derived from the Cholesky decompositions. In this section, the VDCs derived from the Cholesky decompositions are discussed in detail.

From Table-3, it is evident that none of the coefficient estimates of the structural VAR residual is significant except for the deposits in the monetary base equation and the price level in the demand for deposits equation. Due to shock to deposits the monetary base change by (-1.03), while due to shock in the price level causes deposits to change by (1.68). Both the coefficients appear with the wrong signs.

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29 A maximum lag length of eight is used to preserve degrees of freedom.
Table 3
Coefficient Estimates for the Structural Model of the VAR residuals

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Independent Variable</th>
<th>Dep</th>
<th>y</th>
<th>CPI</th>
<th>R</th>
<th>MB</th>
<th>Dcps</th>
</tr>
</thead>
<tbody>
<tr>
<td>MB</td>
<td>-1.03*** (-8.46)</td>
<td>0.11</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Dep</td>
<td>--</td>
<td>-0.01(-0.57)</td>
<td>1.68*** (2.93)</td>
<td>0.07</td>
<td>(0.55)</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Dcps</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>-0.08 (-0.30)</td>
<td>0.11</td>
<td>(0.53)</td>
<td>--</td>
</tr>
<tr>
<td>R</td>
<td>--</td>
<td>-1.13(-0.35)</td>
<td>-0.75(-0.37)</td>
<td>--</td>
<td>3.64</td>
<td>(0.22)</td>
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</tr>
<tr>
<td>Y</td>
<td>-1.06 (-0.84)</td>
<td>2.35(0.88)</td>
<td>0.06</td>
<td>--</td>
<td>-4.88</td>
<td>(-0.67)</td>
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</tr>
<tr>
<td>CPI</td>
<td>--</td>
<td>3.10 (0.80)</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
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</tr>
</tbody>
</table>

Note: ‘t’ statistics are in the parenthesis.

The low significance level of the structural coefficients is not surprising because, as noted by Fackler (1990), this result is normal for structural models of the type we estimated. Fackler (1990) pointed out three possible reasons for the low significance level of the structural coefficients measured by ‘t’ ratios. Fackler (1990, p.455) mentioned first,

"...with quarterly data and in the presence of data collection and processing lags, it is possible that contemporaneous relationships would only show up weakly since evidence on the current quarter available to agents would be largely impressionistic. Second, it is possible that behavioral responses to innovations in variables occur with a lag. Third, it is always possible that the specified structural model is incorrect."
Bernanke's (1986, page 72) log-differenced money-credit model has only two coefficients out of fifteen that have 't' ratios in higher than 2. Wheeler's (1995, page 96), money-income model in the flexible exchange rate regime has only two coefficients out of fifteen, which have 't' ratios in excess of 2. Wheeler and Pozo (2000, page 692) report two out of fifteen coefficients in the Japan-Singapore money demand model that have 't' ratios exceeding 2 and in the USA-Singapore money demand model, four coefficients have 't' ratio that exceed 2. Therefore, low significance level in terms of 't' ratios is not surprising for the structural model we estimated in this paper.

Variances Decompositions (VDCs) from Structural VAR

In order to know the impacts of a shock, VDCs for time horizon of 4, 6, 12, 16 and 20 are computed. 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. Twenty-five hundred Monte Carlo simulations are used to calculate the standard errors. Because this study is most concerned with the forecast error variance in deposits, credit, the interest rate, the price level, and output explained by the base money, VDCs of deposits, credit, the interest rate, the price level, and output derived from using structural the VAR model at optimal lag 3 are reported in the upper portion of Table-4. This study is also interested in the forecast error variance in the price level and output explained by deposits and credit. Therefore, VDCs of the price level and output due to innovations to deposits and credit are reported in the upper portion of Table-5 and Table-6 respectively.
Table 4

Variance Decompositions of Deposits (Dep), Credit (Dcps), Interest Rate (R), Price (CPI), and Output (Y) explained by Innovations to the Monetary Base (MB)

<table>
<thead>
<tr>
<th>VAR lag Length</th>
<th>Horizon (Quarters)</th>
<th>Variation in</th>
<th>Deposits</th>
<th>Credit</th>
<th>Interest rate</th>
<th>Price</th>
<th>Output</th>
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<td>4.26</td>
<td>0.41</td>
<td>2.23</td>
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<td>(3.79)</td>
<td>(3.72)</td>
<td>(4.66)</td>
<td>(3.75)</td>
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<td></td>
<td>6.85</td>
<td>3.10</td>
<td>1.71</td>
<td>3.80</td>
<td>6.81</td>
</tr>
<tr>
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<td></td>
<td>(6.25)</td>
<td>(6.19)</td>
<td>(4.00)</td>
<td>(6.09)</td>
<td>(6.92)</td>
</tr>
<tr>
<td>12</td>
<td></td>
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<td>7.26</td>
<td>5.86</td>
<td>1.55</td>
<td>2.77</td>
<td>8.54</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(6.69)</td>
<td>(8.16)</td>
<td>(4.69)</td>
<td>(5.99)</td>
<td>(8.04)</td>
</tr>
<tr>
<td>16</td>
<td></td>
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<td>7.31</td>
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<td>8.57</td>
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<td>(5.82)</td>
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<td>9.54</td>
<td>4.35</td>
<td>1.74</td>
<td>7.98</td>
</tr>
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<td>(9.68)</td>
<td>(6.76)</td>
<td>(5.91)</td>
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<td>1.57</td>
<td>4.34</td>
<td>3.88</td>
<td>1.06</td>
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<td>(5.20)</td>
<td>(5.75)</td>
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<td>1.50</td>
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<td>(11.48)</td>
<td>(12.83)</td>
<td>(8.54)</td>
<td>(5.97)</td>
</tr>
<tr>
<td>16</td>
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<td></td>
<td>0.55</td>
<td>9.92</td>
<td>28.60***</td>
<td>12.63</td>
<td>2.81</td>
</tr>
<tr>
<td></td>
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<td>(6.32)</td>
<td>(12.03)</td>
<td>(13.58)</td>
<td>(9.78)</td>
<td>(7.39)</td>
</tr>
<tr>
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<td></td>
<td>0.54</td>
<td>9.98</td>
<td>29.52***</td>
<td>12.31</td>
<td>4.20</td>
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<td>(13.74)</td>
<td>(10.73)</td>
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<td>14.04</td>
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<td>(12.44)</td>
<td>(11.85)</td>
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<td>(8.27)</td>
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Asterisks (*** ) indicate significance of the point estimate. Point estimates are considered significant if they are at least twice as large as their standard errors. Standard errors are reported in the parenthesis. Twenty-five hundred Monte Carlo simulations are used to construct the standard errors.

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Table 5
Variance Decompositions of Price (CPI) and Output (Y)
explained by Innovations in Deposits

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<th>VAR lag Length</th>
<th>Horizon (Quarters)</th>
<th>Variation in</th>
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</thead>
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<td>(10.97)</td>
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<td>(10.79)</td>
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<td>(10.25)</td>
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<td>26.68</td>
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<td>(14.40)</td>
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<td>(10.84)</td>
<td>(8.65)</td>
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Asterisks (*** ) indicate significance of the point estimate. Point estimates are considered significant if they are at least twice as large as their standard errors. Standard errors are reported in the parenthesis. Twenty-five hundred Monte Carlo simulations are used to construct the standard errors.
**Table 6**

Variance Decompositions of the Price (CPI) and Output (Y) explained by Innovations to Credit

<table>
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<th>Horizon (Quarters)</th>
<th>Variation in Price</th>
<th>Output</th>
</tr>
</thead>
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<td>7.76 (4.47)</td>
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<td>16.72 (10.78)</td>
<td>10.47 (6.38)</td>
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<td>21.36 (12.83)</td>
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<td>16</td>
<td>22.58 (14.00)</td>
<td>13.92 (9.91)</td>
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<tr>
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<td>20</td>
<td>23.07 (14.75)</td>
<td>15.17 (10.81)</td>
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<td>9.54 (7.03)</td>
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<td>16.23 (8.98)</td>
<td>10.17 (8.54)</td>
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<td>16</td>
<td>21.62*** (10.59)</td>
<td>10.55 (9.52)</td>
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<td>20</td>
<td>24.57*** (11.48)</td>
<td>10.76 (10.05)</td>
</tr>
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<td>8</td>
<td>4</td>
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<td>5.18 (7.23)</td>
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<td>24.68*** (10.17)</td>
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<td>26.91*** (10.97)</td>
<td>7.83 (7.53)</td>
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</table>

Asterisks (*** ) indicate significance of the point estimate. Point estimates are considered significant if they are at least twice as large as their standard errors. Standard errors are reported in the parenthesis. Twenty-five hundred Monte Carlo simulations are used to construct the standard errors.

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Table-4 shows that when the VAR is estimated at the optimal lag of 3, an innovation to the monetary base cannot explain a significant portion of the forecast error variance in banks' portfolio variables, deposits and credit. This is also the case for the macroeconomic variables: the interest rate, the price level and output at any time horizon.\textsuperscript{30}

Table-5 shows that an innovation to deposits explains a significant portion of the forecast error variance in the price level at time horizon 4, 8, 12, 16 and 20, while deposits do not explain a significant portion of the forecast error variance in output at any time horizon. This is true regardless of the VAR lag length.

Table-6 shows that an innovation to credit does not explain a significant portion of the forecast error variance in the price level or output at any time horizon when the optimal lag of 3 is used to estimate the VAR. However, Table III also shows that these results are not robust with respect to VAR lag length. At lag 4, the portion of the forecast error variance in the price level explained by credit becomes significant at horizons 16 and 20. At lag 8, the portion of the forecast error variance in the price level explained by credit becomes significant at forecast horizons 12, 16 and 20.

From the variance decompositions derived from the structural VAR it is evident that monetary policy does not explain a significant portion of the forecast error variance of deposits and credit. This indicates that neither the 'money channel' nor the 'credit channel' exists in Bangladesh. The failure of the monetary base to affect bank portfolio variables may be due to the excess reserves of the banks. Due to

\textsuperscript{30} However, the results change when the model is estimated at lag 4 and lag 8 as the lower portion of Table II shown. At lag 4, the portion of the forecast error variances in the interest rate explained by the monetary base becomes significant at horizons 16 and 20. At lag 8, the portion of the forecast error variance in the interest rate explained by the monetary base becomes significant at forecast horizons 8, 12, 16 and 20, while the response of output due to shock to monetary base is significant at time horizons 16 and 20.
excess reserves, commercial banks in Bangladesh do not depend on the central bank for liquidity, and thereby not subject to a liquidity constraint. The commercial banks in Bangladesh are holding excess reserves, because of the loan default problem. Due to the high default loan rate, banks prefer to hold excess reserves or invest in the 'safe' government bonds rather than disburse the loans in unprofitable projects. The central bank open market operation (OMO) and government borrowing from the commercial banks sometimes creates a liquidity shortage in the banking sector. In that case, the commercial banks prefer to borrow from other banks with a high interest rate rather than seek funds from the central bank.

The VDCs of the interest rate, the price level and output show that the monetary base does not explain significant portion of the forecast error variance in the interest rate, the price level and output. However, the results are not robust with respect to lag length. The portions of the forecast error variance of the interest rate and output explain by the monetary base change when the model is estimated at lag 4 and lag 8. At lag 4, the portion of the forecast error variance in the interest rate explained by the monetary base becomes significant at quarters 16 and 20. At lag 8, the portion of the forecast error variance in the interest rate explained by the monetary base becomes significant at time horizons 8, 12, 16 and 20, while the response of output due to shock to monetary base is significant at time horizons 16 and 20.

Variance decompositions of the price level and output due to a shock to deposits show that deposits do not explain a significant portion of the forecast error variance of output. However, deposits do explain a significant portion of the forecast error variance in the price level, which is true regardless of the lag length.

Variances decompositions of the price level and output due to a shock to
Impulse Response Functions (IRFs) from Structural VAR

The 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 lack of significance. The confidence interval for each IRF is computed from twenty-five hundred Monte-Carlo simulations. The IRFs showing the response of deposits, credit, the interest rate, the price level, and output due to innovations (shocks) to monetary base are shown in Figure-6. The optimal lag length of 3 is used to derive the IRFs estimated from the VAR. The IRFs showing the responses of the price level and output due to innovations (shocks) to deposits and credit are shown in Figure-7 and 8 respectively.

Figure-6 shows the response of deposits, credit, the interest rate, the price level and output to a shock to monetary base. The IRFs of deposits in Figure-6 indicate that a shock to monetary base does not produce a statistically significant impact on either deposits or credit implying that the ‘money channel’ or the ‘credit

51 However, the results change when the model is estimated using lags 4 and 8. At lag 4, the portion of the forecast variance in the price level due to shocks to credit is significant at the time horizons 16 and 20. At lag 8, the portion of the forecast variance in the price level due to shock to credit is significant at the time horizons 12, 16 and 20.
channel' do not exist in Bangladesh.\textsuperscript{32} The response of the interest rate due to a shock to monetary base is insignificant initially, and then it becomes significant and positive at quarter 4, remains positive until quarter 9, and becomes insignificant thereafter. This implies that there is a ‘liquidity puzzle’ exists in the model.\textsuperscript{33} The response of the price level due to a shock to monetary base is insignificant initially then it becomes significant and positive at the 5\textsuperscript{th} quarter, remains positive until quarter 14, and then becomes insignificant thereafter. This implies that there is no ‘price puzzle’ in the model.\textsuperscript{34}

The IRFs in Figure-7 show the responses of the price level and output due to an innovation to deposits. The IRF of the price level in Figure-7 indicates that a shock to deposits produces a significant and positive impact on the price level initially, which remains significant and positive up to time horizon 20. This implies that there is no ‘price puzzle’ due to a shock to deposits. The IRF of output in Figure-7 shows that due to a shock to deposits the response of output is insignificant initially, but becomes significant and positive at quarter 5\textsuperscript{th} and remains significant up to time horizon 8\textsuperscript{th} and then dies out to zero. This implies that bank deposits have an independent effect on output, though the response is short-lived.

The IRFs in Figure-8 show the responses of the price level and output to an innovation to credit. The IRF of the price level and output in Figure-8 shows that a shock to credit produces an insignificant impact on the price level and output.

\textsuperscript{32} However, the results change when the model is estimated using lag 8. At lag 8, the IRFs of the credit and output become significant. The response of credit is statistically significant and positive, while the response of output is statistically significant and negative.

\textsuperscript{33} A liquidity effect implies that due to a shock to monetary policy, the interest rate would decrease rather than increase. Liquidity puzzles show up when the interest rate increases rather than decreases.

\textsuperscript{34} A price puzzle appears when, following an expansionary monetary policy, the price level decreases rather than increases.
indicating bank credit does not have any impact on either the price level or output.\textsuperscript{35}

The IRFs of deposits and credit derived from the structural VAR indicate that, due to shock to monetary base, the responses of deposits and credit are insignificant. This implies that neither the ‘money channel’ nor the ‘credit channel’ exist in Bangladesh. These results are also consistent with results from VDCs derived from the structural VAR. The positive response of output due to a shock to deposits seems plausible because banks’ deposits might have independent effects on output and the price level in Bangladesh. However, bank credit does not have an impact on either output or the price level. This result is also reasonable because banks are reluctant to loan excess reserves because of the fear of default. Instead, they invest in ‘safe’ government bonds.

\textsuperscript{35} The results change while estimating the model at lags 4 and 8. In these cases the response of the price level due to a shock to credit is statistically significant and positive.
Figure-6: Responses of Deposits (Dep), Credit (Dcps), Interest Rate (R), Price (CPI) and Output (Y) due to Innovation to Monetary Base (MB) estimated at Lag 3
Figure-7: Responses of Price (CPI) and Output (Y) due to Innovation in Deposits (Dep) estimated at Lag 3

Figure-8: Responses of Price (CPI) and Output (Y) due to Innovation in Credit (Dcps) estimated at Lag 3

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To estimate VDCs, orthogonalisation of the VAR residuals is required. In this section a Cholesky decomposition is used to orthogonalise the residuals. Cholesky decompositions require the variables to be ordered in a particular way. The variables placed higher in the ordering have contemporaneous impacts on all variables lower in the ordering, but the variables lower in the ordering do not have a contemporaneous impact on the variable higher in the ordering. 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." (Wheeler 1999, page 277)

Therefore, it is important to decide proper ordering of the variables. The Cholesky ordering of the variables for this study is: MB, Dep, Dcps, R, CPI, and Y. Because, this study is mainly interested in examining the impact of monetary policy on bank portfolios and the impact of the bank portfolios on the domestic key macroeconomic variables, the monetary base (MB) is placed first followed by the deposits and credit. The Cholesky ordering of the rest of the variables relative to each other is a matter of indifference because this paper is interested in examining the impact of a shock to domestic money on the banks' portfolios (deposits, credit), and also the impact of the banks' portfolios on the price level and output.

Placing the domestic monetary policy variable first in the ordering allows the policy variable to affect other model variables contemporaneously. However, the policy variable responds with a lag to other variables; it is reasonable to assume that contemporaneous information on other variables is not readily available to policy makers. Placing banks' deposits after domestic monetary base implies that an innovation to the monetary base has a contemporaneous impact on bank deposits, but

36 Switching the ordering between deposits and credit does not change policy conclusions.
bank deposits do not have any contemporaneous impact on monetary base. The third variable is the credit variable, followed by the interest rate, the price level, and output. The third variable implies that domestic monetary base and the deposits have contemporaneous impacts on the credit, but bank credit does not have any contemporaneous impact on monetary base or the deposits. The interest rate, the price level and output are placed after monetary base, deposits and credit because the intension of this paper is to see the impact of the monetary base, deposits and credit on the interest rate, the price level and output. In other words, if we were interested to see the impact of the interest rate, the price level and output on the monetary base, deposits and credit, then the monetary base, deposits and credit would have been placed at the end.

Variance Decompositions (VDCs) from Cholesky Decomposition

In order to know the impacts of a shock, VDCs for time horizon of 4, 6, 12, 16 and 20 are computed. 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. Twenty-five hundred Monte Carlo simulations are used to calculate the standard errors. Because this study is most concerned with the forecast error variance in deposits, credit, the interest rate, the price level, and output explained by the monetary base, VDCs of deposits, credit, the interest rate, the price level, and output derived from a Cholesky decomposition at optimal lag 3 are reported in the upper portion of Table-7. This study is also interested in the forecast error variance in the price level and output explained by deposits and credit. Therefore, VDCs of the price level and output due to innovations to deposits and credit are reported in Table-8 and Table-9.

\footnote{Cholesky decompositions imposes a recursive structure on contemporaneous relationships of VAR residuals, while in the SVAR, the parameters are estimated by imposing contemporaneous structural restrictions implied by theory.}
respectively.

Table-7 shows that when the VAR is estimate with lag 3 an innovation to the monetary base does not explain a significant portion of the forecast error variance either in deposits or in credit at any time horizon. This implies that neither the 'money channel' nor the 'credit channel' exist in Bangladesh. Variance decompositions of the price level and output show that monetary base does not explain a significant portion of the forecast error variance in the price level or output. However, monetary policy as measured by monetary base does explain a significant portion of the forecast error variance in the interest rate at time horizons 12, 16 and 20. This implies that the monetary base does not have any impact on macro economic variables except for the interest rate. This is consistent with the result derived from SVAR except for the interest rate. The difference in the result derived from structural and Cholesky decompositions lies in the difference in their contemporaneous relationship. Cholesky decompositions imposes a recursive structure on contemporaneous relationships of VAR residuals, while in the SVAR, the parameters are estimated by imposing contemporaneous structural restrictions imposed by the theory.\footnote{However, the results change when the model is estimated using lag 8. At lag 8, the portion of the forecast variance in the credit explained by the monetary base becomes significant at time horizons 8, 12, 16 and 20, the portion of the forecast variance in the price level due to shock to monetary base is significant at time horizons 8, 12, 16 and 20, and the portion of the forecast error variance in output explained by the monetary base becomes significant at time horizons 16 and 20.}

Table-8 shows that innovation to deposits explains a significant portion of the forecast error variance in the price level at time horizon 4, 8, 12, 16 and 20, while deposits do not explain a significant portion of the forecast error variance in output at
any time horizon. This is consistent with the results from the SVAR. These results hold regardless of the lag length.

Table-9 shows that when the model is estimated using optimal lag length 3, an innovation to credit does not explain a significant portion of the forecast error variance in the price level at any time horizon. However, credit does explain a significant portion of the forecast error variance in output at time horizon 12 and 16. This result is true regardless of the lag length. This is in contrast with the findings derived from SVAR. In the SVAR the portions of the forecast error variances in output due to shock to credit is never significant which is true regardless of the lag length. However, the forecast error variances in the price level explained by credit are significant at lag 4 and 8. At lag 4, the portion of the forecast variance in the price level due to shock to credit are significant at the time horizons 16 and 20, while at lag 8, the portion of the forecast variance in the price level due to shock to credit are significant at the time horizons 12, 16 and 20.

VDCs of deposits and credit derived from Cholesky decompositions show that an innovation to monetary base does not explain a significant portion of the forecast error variance either in deposits or in credit at any time horizon. This implies that neither the ‘money channel’ nor the ‘credit channel’ exist in Bangladesh, which is consistent with the result derived from SVAR. VDCs of the price level and output show that monetary base does not explain a significant portion of the forecast error variance in the price level or output implying that monetary base does not have any impact on macro economic variables. However, monetary policy as measured by the monetary base does explain a significant portion of the forecast error variance in the interest rate at time horizon 12, 16 and 20.
Table 7

Variance Decompositions of Deposits (Dep), Credit (Dcps), Interest Rate (R), Price Level (CPI), and Output (Y) explained by Innovations in the Monetary Base (MB) estimated with the Ordering MB, Dep, Dcps, R, CPI, and Y

<table>
<thead>
<tr>
<th>VAR Lag Length</th>
<th>Horizon (Quarters)</th>
<th>Variation in Deposits</th>
<th>Variation in Credit</th>
<th>Variation in Interest Rate</th>
<th>Variation in Price</th>
<th>Variation in Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
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<td>12.21 (8.84)</td>
<td>5.66 (6.11)</td>
<td>7.67 (5.43)</td>
<td>0.52 (4.14)</td>
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<tr>
<td>8</td>
<td>11.24 (9.01)</td>
<td>22.46 (13.15)</td>
<td>20.43 (11.26)</td>
<td>17.13 (8.90)</td>
<td>0.65 (5.16)</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>10.68 (9.13)</td>
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<td>20.44 (10.42)</td>
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<td></td>
</tr>
<tr>
<td>16</td>
<td>11.10 (9.47)</td>
<td>24.48 (14.14)</td>
<td>29.44*** (12.75)</td>
<td>22.17 (11.55)</td>
<td>1.69 (6.12)</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>11.45 (9.77)</td>
<td>24.40 (14.06)</td>
<td>29.75*** (12.74)</td>
<td>23.52 (12.37)</td>
<td>2.59 (6.72)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>8</td>
<td>14.83 (10.07)</td>
<td>8.86 (8.80)</td>
<td>4.87 (6.26)</td>
<td>9.68 (6.32)</td>
<td>0.45 (4.01)</td>
</tr>
<tr>
<td>8</td>
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<td>22.45 (14.27)</td>
<td>23.17 (12.06)</td>
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<td>21.42 (10.98)</td>
<td>1.86 (6.08)</td>
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</tr>
<tr>
<td>16</td>
<td>7.66 (9.51)</td>
<td>26.47 (15.95)</td>
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<td>22.10 (12.40)</td>
<td>3.19 (7.19)</td>
<td></td>
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<td>7.42 (9.87)</td>
<td>26.45 (15.98)</td>
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<td>4.61 (8.15)</td>
<td></td>
</tr>
<tr>
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<td>34.90*** (14.30)</td>
<td>22.57*** (9.39)</td>
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</table>

Asterisks (*** ) indicate significance of the point estimate. Point estimates are considered significant if they are at least twice as large as their standard errors. Standard errors are reported in the parenthesis. Twenty-five hundred Monte Carlo simulations are used to construct the standard errors.
<table>
<thead>
<tr>
<th>VAR Lag Length</th>
<th>Horizon (Quarters)</th>
<th>Variation in Price</th>
<th>Variation in Output</th>
</tr>
</thead>
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<td>16</td>
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<td>4.78 (7.81)</td>
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<td>8</td>
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<td>4.71 (7.08)</td>
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<td>12.60 (6.90)</td>
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<td>10.61 (6.36)</td>
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<tr>
<td></td>
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<td>8.52 (6.32)</td>
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<tr>
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<td>20</td>
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<td>8.35 (6.63)</td>
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</table>

Asterisks (*** ) indicate significance of the point estimate. Point estimates are considered significant if they are at least twice as large as their standard errors. Standard errors are reported in the parenthesis. Twenty-five hundred Monte Carlo simulations are used to construct the standard errors.
Table 9

Variance Decompositions of the Price Level (CPI) and Output (Y) explained by Innovations to Credit with the Ordering MB, Dep, Deps, R, CPI, and Y

<table>
<thead>
<tr>
<th>VAR lag Length</th>
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<th>Variation in</th>
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</thead>
<tbody>
<tr>
<td></td>
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<td>Price</td>
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<tr>
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<td>25.36***</td>
</tr>
<tr>
<td></td>
<td>(6.11)</td>
<td>(12.12)</td>
</tr>
<tr>
<td>20</td>
<td>4.18</td>
<td>28.79***</td>
</tr>
<tr>
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<td>(6.78)</td>
<td>(12.63)</td>
</tr>
<tr>
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<td>0.58</td>
<td>12.64</td>
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<td>(7.22)</td>
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<tr>
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<td>15.72</td>
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<td></td>
<td>(9.58)</td>
<td>(8.27)</td>
</tr>
</tbody>
</table>

Asterisks (***') indicate significance of the point estimate. Point estimates are considered significant if they are at least twice as large as their standard errors. Standard errors are reported in the parenthesis. Twenty-five hundred Monte Carlo simulations are used to construct the standard errors.
VDCs of the price level and output due to a shock to deposits show that an innovation to deposits explains a significant portion of the forecast error variance in the price level at time horizon 4, 8, 12, 16 and 20, while deposits do not explain a significant portion of the forecast error variance in output at any time horizon. This is also consistent with the result derived from SVAR and this result hold regardless of the lag length.

Variance decompositions of the price level and output due to a shock to credit show that an innovation to credit does not explain a significant portion of the forecast error variance in the price level at any time horizon. However, credit does explain a significant portion of the forecast error variance in output at time horizon 12 and 16. This is in contrast with the result derived from SVAR.\(^\text{39}\)

The differences in results derived from SVAR and Cholesky decompositions are due to differences in the contemporaneous relationships. Cholesky decomposition imposes a recursive structure on the contemporaneous relationships. In Cholesky decompositions variables higher in the ordering have contemporaneous impact on variables lower in the ordering but variables lower in the ordering does not have a contemporaneous impact on variables higher in the ordering. For example, this paper uses the Cholesky ordering in the following way: MB, Dep, Dcps, R, CPI, y. This implies that monetary base has contemporaneous impact on Dep, Dcps, R, CPI, and y. However, Dep, Dcps, R, CPI, and y do not have contemporaneous impacts on MB. On the other hand, in SVAR contemporaneous relationships are imposed by theory. For example, in the credit supply equation we assume that deposit and income have a contemporaneous relationship on the monetary base. The results from SVAR are

\(^{39}\) Differences in results derived from SVAR and Cholesky decompositions are due to differences in the contemporaneous relationships. Cholesky decomposition imposes a recursive structure on the contemporaneous relationships, while in the SVAR contemporaneous relationships are imposed by theory.
more plausible because in SVAR economic theory guides the contemporaneous relationships among variables.

**An Analysis of the VDCs And IRFs Derived from a Structural VAR and Cholesky Decompositions**

VDCs derived from structural and Cholesky decompositions show that monetary policy, as measured by the monetary base, does not explain a significant portion of the forecast error variance in deposits or credit. The IRFs derived from the structural VAR indicate that the monetary base does not have a significant impact on deposits or credit. These results imply that neither the 'money channel' nor the 'credit channel' exist in Bangladesh. The ineffectiveness of monetary policy as measured by the monetary base in affecting banks portfolios is due mainly to excess reserves of commercial banks. Due to excess reserves, banks do not depend on the central bank for liquidity. The banks are holding excess reserves because of the loan default. In this respect, we can mention that during the year 2000 the default loan rate is 34.92%, while it is 40.65% of total loans during 1997.

VDCs and IRFs of output derived from structural and Cholesky decompositions show that the monetary base does not have a significant impact on output. VDCs of the interest rate derived from Cholesky decompositions show that monetary base has a significant impact on the interest rate. IRFs of the interest rate derived from the structural VAR show that the response of the interest rate due to a shock to monetary base is statistically significant and positive. However, VDCs of the interest rate derived from structural VAR show that monetary base does not explain a significant portion of the forecast error variance in the interest rate. Because this study is mostly interested with the results of deposits, credit, price and output, less attention

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40 As of June 2001, the excess reserves of commercial banks in Bangladesh stood at Tk.3271 crores, which is 49.10% of total reserves. (Economic Trends, Bangladesh Bank)
are given on the results of the interest rate.

VDCs of the price level derived from Cholesky and structural decompositions show that the monetary base does not have a significant impact on the price level. IRFs of the price level derived from structural VAR show that the response of the price level due to a shock to monetary base is statistically significant and positive showing no 'price puzzle' present in the model.

VDCs of the price level derived from structural and Cholesky decompositions show that an innovation to deposits does explain a significant portion of the forecast error variance in the price level. The IRF of the price level derived from structural VAR shows that, due to a shock to deposits, the response of the price level is significant and positive indicating that there is no 'price puzzle' exists in the model. VDCs of output derived from structural and Cholesky decompositions show that an innovation to deposits does not explain a significant portion of the forecast error variance in output. However, The IRF of output derived from the structural VAR shows that, due to a shock to deposits, the response of output are positive and significant. However, the impact is very short lived. The difference in the result derived from structural and Cholesky decompositions is due to the difference in contemporaneous relationships. Cholesky decompositions impose a recursive structure on contemporaneous relationships of VAR residuals. In the SVAR, the parameters are estimated by imposing contemporaneous structural restrictions suggested by theory.

VDCs and IRFs of the price level as derived from structural and Cholesky decompositions show that credit does not have a significant impact on the price level. VDCs and IRFs of output derived from structural VAR show that an innovation to
credit does not have a significant impact on output. VDCs of output derived from Cholesky decompositions indicate that shock to credit explains a significant portion of the forecast error variance of output at time horizons 12 and 16. This result is reasonable in the sense that bank credit may have independent effect on output. The difference in the results derived from structural and Cholesky decompositions are due to the difference in their contemporaneous relationship. Cholesky decompositions imposes a recursive structure on contemporaneous relationships of VAR residuals, while in the SVAR, the parameters are estimated by imposing contemporaneous structural restrictions as suggested by theory.

Conclusion

This study has examined empirically the channels through which monetary policy in Bangladesh transmits to the economy. In doing so, this paper examines the impact of a domestic monetary policy shock as measured by monetary base in altering banks’ portfolios (i.e., deposits and credit) and the price level and output. If domestic monetary policy has a significant impact on banks’ deposits and credit, we conclude that domestic monetary policy has a significant impact on the bank assets as well as liabilities. In order to see the channels through which monetary policy transmits to the economy, this paper examines the impacts of deposits and credit on the price level and output. If deposits, credit, or both have a significant impact on the price level and output then we would say that monetary policy transmits to the economy through the ‘money channel’, the ‘credit channel’ or both. However, in order to make these changes, the monetary base in Bangladesh must have an impact on both credit and deposits.

41 The results change when estimating the model at lags 4 and 8. In these cases the response of the price level due to a shock to credit is statistically significant and positive.
The VDCs derived from the structural VAR and Cholesky decompositions and the IRFs derived from structural VAR indicate that the monetary base does not have a significant impact on deposits or credit. This implies that neither a 'money channel' nor a 'credit channel' exist in Bangladesh. This result may be due to excess reserves of the commercial banks in Bangladesh, which stood at Tk.3271 crores during the year 2001. In order to have an effect on banks' portfolio variables (deposits and credit), the monetary authority in Bangladesh must be able to constraint banks' liquidity. Besides, since 1990, following the financial sector reform program (FSRP), the commercial banks in Bangladesh borrow from other banks if necessary, for liquidity rather come to the central bank for finance. Therefore, it is possible that call money rate may have an independent effect on the banks' portfolios.\textsuperscript{42}

VDCs and IRFs of output derived from the structural VAR and VDCs from the VAR with Cholesky decompositions show that the monetary base does not have a significant impact on output. VDCs of the interest rate derived from Cholesky VAR and IRFs derived from SVAR show that monetary base has a significant impact on the interest rate. However, VDCs of the interest rate derived from structural VAR show that monetary base does not explain a significant portion of the forecast error variance in the interest rate.

The VDCs derived from structural and Cholesky decompositions show that monetary base does not explain a significant portion of the forecast error variance in the price level. However, IRFs of the price level derived from structural VAR show that the response of the price level due to a shock to monetary policy is significant and positive showing that no price puzzle exists in the model.

\textsuperscript{42} The rate at which commercial banks in Bangladesh borrow from each other. However, unfortunately, due to unavailability of data on call money rate this study is unable to see the impact of the call money rate on banks portfolios in Bangladesh.
VDCs of output derived from structural and Cholesky decompositions show that shocks to deposits do not have a significant impact on output. However, IRFs derived from the structural VAR show that the response of output due to a shock to deposits is significant and positive. However, the impact is very short lived. This implies that even though money 'money channel' does not exist in Bangladesh, whether banks deposits have an independent effect on output is inconclusive.

VDCs and IRFs of output derived from the structural VAR show that an innovation to credit does not have a significant impact on output.\(^{43}\) However, VDCs of output derived from Cholesky decompositions indicate that a shock to credit explains a significant portion of the forecast error variance of output at time horizons 12 and 16. Therefore, even though there is no evidence that 'credit channel' exists in Bangladesh, whether banks total credit has an independent effect on output is not clear due to contradictory results derived from IRFs and VDCs from structural VAR and a VAR with Cholesky decompositions.

VDCs of the price level as derived from structural and Cholesky decompositions show that an innovation to deposits does explain a significant portion of the forecast error variance in the price level. The IRF of the price level derived from structural VAR show that due to a shock to deposits the response of the price level is significant and positive indicating that there is no 'price puzzle' exists in the model.

VDCs and IRFs of the price level derived from structural VAR and VDCs derived from Cholesky decompositions show that credit does not have a significant impact on the price level.

\(^{43}\) The results change while estimating the model at lags 4 and 8. In these cases the response of the price level due to a shock to credit is statistically significant and positive.
PART IV

ESSAY-3: EXCHANGE MARKET PRESSURE AND MONETARY POLICY

Introduction

Effective management of foreign exchange is very important to achieve tolerable inflation and a desired level of economic growth for a country. The intention of this paper is to examine the impact of monetary policy on EMP, and also determine how the central bank of Bangladesh deals with exchange market pressure (EMP): by depreciating the exchange rate, by loosing foreign exchange, or by using a combination of the two.

The monetary approach to the balance of payments is based on assumption of the fixed exchange rate, while the monetary approach to the exchange rate determination is based on the perfectly flexible exchange rate. In practice, many countries have neither a fixed exchange rate nor a perfectly flexible exchange rate. In order to overcome the limitations of the traditional monetary approach to the balance of payments and exchange rate determination, Girton and Roper (1977, p.537) developed the concept of exchange market pressure, which can be use in a fixed exchange rate regime, a flexible exchange rate regime and a managed float exchange rate regime. In the fixed exchange rate regime, the change of the exchange rate will be zero, while in flexible exchange rate regime, the change of international reserves will be zero, and in the managed float, the exchange market pressure is absorbed by either currency depreciation, or reserves losses, or a combination of the two. Girton and Roper (1977) defined EMP as the sum of the percentage change in the nominal
exchange rate appreciation and percentage change in international reserves.

This study uses Girton and Roper's (1977) exchange market pressure (EMP) model rather than monetary approach to balance of payments or the monetary approach exchange rate determination models to examine the exchange market pressure in Bangladesh. This is the first study that uses Girton and Roper's (1977) EMP model in Bangladesh to examine the exchange market pressure measured by the sum of the percentage change in exchange rate appreciation and the percentage change in the international reserves scaled by the monetary base. The traditional monetary approach uses either the exchange rate or international reserves as a dependent variable. This study uses sophisticated econometric techniques, such as Engle and Granger's (1987) single-equation error correction model (ECM) and a vector error correction model (VECM) to estimate the exchange market pressure. These techniques allow us to capture the non-stationarity properties in individual series. The existing literature on exchange market pressure does not use these techniques.

An analysis of exchange market pressure (EMP) model is appropriate for Bangladesh because it experienced managed, pegged but adjustable flexible exchange rate regimes since the country's inception in 1971 until May 31, 2003. On May 31, 2003, the government of Bangladesh introduced a floating (managed) exchange rate system.

Following independence, Bangladesh's currency, the Taka is continued to pegged to U.K.'s pound sterling, the pound sterling being the intervention currency. In order to control capital flight, the government of Bangladesh imposed restrictions on foreign exchange. In the controlled exchange regime, a secondary market developed to satisfy the excess demand for foreign currency. In the secondary market,
the foreign currency price was much higher than the official exchange rate. In May 1975, a major step toward effective exchange management took place with a massive devaluation (by 37%) of the Taka. Since then, the central bank of Bangladesh pursued a policy of depreciating the Taka to improve the balance of payment deficits. It is worthwhile to mention here that in order to reduce balance of payment deficits Bangladesh devalued her currency about 130 times over a thirty-year period.

In 1985, the intervention currency was changed to U.S. dollar. This change was made because most of the official trade in Bangladesh is performed with the U.S. dollar rather than the pound sterling. In order to determine the strength of Taka against foreign currency, a real effective exchange rate (REER) index was introduced in 1985. Since then, the nominal exchange rate of Taka in relation to the U.S. dollar is determined daily by monitoring REER index, the U.S. dollar being the intervention currency. Under the ‘structural adjustment program’ and the ‘financial sector reform program’ ‘Taka’ was declared convertible on the current account beginning March 24, 1994. Finally, the Bangladesh government introduced a floating exchange rate system on May 31, 2003.

In order to examine how the monetary authority in Bangladesh handles exchange market pressure, this study estimates two-exchange market pressure models. One model uses the Taka/Dollar nominal exchange rate and the other uses Taka/Rupee nominal exchange rate to construct EMP. The U.S. and India are the major trading partners of Bangladesh. At the same time, India is a significant competitor of Bangladesh. It is generally believed that in the developing countries

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44 REER is calculated by the following formula: REER index = (ERI* CPI) / Σ (ER*CPI) where, ER=Exchange rate, CPI=Consumer Price Index, wi=trade-weight share for each country, i=Particular country and B is for Bangladesh.

45 The Taka/Rupee exchange rate is a cross rate, which is calculated from the Taka/U.S. Dollar and the Rupee/U.S. Dollar nominal exchange rates.
currency devaluation is not a very popular policy tool to reduce exchange market pressure due to the possibility of higher debt burden and its impact on the domestic price level. It is a crucial issue to investigate empirically whether the monetary authority in Bangladesh reduces EMP by depreciating the domestic currency or losing international reserves or a combination of the two.

Theoretical Background

Exchange market pressure arises due to disequilibrium between the growth rates of domestic supply of, and demand for, money. An excess supply of money creates an excess domestic demand for goods and services, which in turn increases demand for foreign goods and services, and results in reserves flowing out of the domestic money market. Girton and Roper (1977) argue that an excess supply of money relative to demand will result in some combination of currency depreciation and an outflow of foreign reserves. Following the models by Kim (1985), and Shiva and Bahmani-Oskooee (1998), a variant of the Girton-Roper model is outlined below:

\[
(11) \quad M^d = kPY \\
(12) \quad M^s = A(R + D) \\
(13) \quad P = E \times P^* \\
(14) \quad M^d = M^s
\]

Equation (11) represents the demand for nominal balances where P stands for the domestic price level and Y is real income, k is a fraction of nominal income that people want to hold as cash. Equation (12) is a nominal money supply equation. The money supply is the sum of the net foreign assets (R), the foreign component of the monetary base and the domestic assets (D), the domestic component of the monetary base multiplied by the money multiplier (A=M_2/Monetary Base). Equation (13) represents a purchasing power parity condition where E is the nominal exchange rate,
which is defined as the domestic currency per unit of foreign currency, $P^*$ is the foreign price level.\textsuperscript{46} Equation (14) represents a money market equilibrium identity where money demand equals money supply. Substituting (11) and (12) into (14) we get

\begin{equation}
(15) \quad kPY = A(R + D)
\end{equation}

Replacing $P$ by $EP^*$, we get

\begin{equation}
(16) \quad k(EP^*)Y = A(R + D)
\end{equation}

In terms of percentage change and rearranging terms, equation (16) can be rewritten as:

\begin{equation}
(17) \quad r - e - d + p^* + y - a
\end{equation}

Where, $r =$ the percentage change in international reserves;
$e =$ the percentage change in the nominal exchange rate depreciation;
$d =$ the percentage change in domestic credit;
$p^* =$ the percentage change in the foreign price level;
$y =$ the percentage change in domestic real income; and
$a =$ the percentage change in the money multiplier;

The left-hand side of the equation (17) represents the exchange market pressure variable. Equation (17) states that for a given rate of domestic credit, money multiplier and foreign inflation rate an increase in the growth rate of domestic credit results in a proportional depreciation of domestic currency or an outflow of foreign exchange reserves a combination of the two (Shiva and Bahmani-Oskooee, 1998).

Girton and Roper (1977), Connolly and Silveira (1979), and Shiva and Bahmani-Oskooee (1998) propose to include a variable $Q = (e/r)$ to see whether the monetary authority respond to absorb exchange market pressure either by the

\textsuperscript{46} An (*) asterisk indicates foreign variable;
exchange rate depreciation or loosing foreign reserves. A significant and positive
coefficient of Q implies that the monetary authority absorb more pressure by the
exchange rate depreciation, while a significant and negative Q implies that more
pressure is absorbed by reserves losses. An insignificant coefficient implies that the
exchange market pressure is independent of whether monetary authorities absorb the
pressure either by depreciating currency or reserves looses. The significance of the
coefficient of Q is important in the sense that it allows us to examine, whether a
country follows a traditional monetary approach to the balance of payments or
exchange rate determination model or Girton and Roper's (1977) exchange market
pressure model.

Literature Review

Several studies deal with exchange market pressure and monetary policy
including Girton and Roper (1977), Connolly and Silveira (1979), Hodgson and
Schneck (1981), Kim (1985), Wohar and Lee (1992), Mah (1998), Bahmani, and
and Tanner (2001).

Girton and Roper (1977) derive an EMP model for Canada. They use the sum
of the growth rate of the nominal exchange rate appreciation and growth rate of
international reserves scaled by the monetary base as a dependent variable. As an
independent variable, the growth rate of domestic credit scaled by the monetary base
is used as a measure of domestic monetary policy. The growth rate of the U.S.
monetary base is used to represent the foreign monetary variable. They also use
growth rate of domestic income and foreign income as explanatory variables. The
growth rate of the sum of a four-year distributed lag of GNP is used as an income
variable. Girton and Roper (1977) assume that the purchasing power parity condition
holds and the interest rate differential between Canada and the U.S. is zero. They estimate the model using annual data for the period 1952 to 1974. All the equations are estimated using Cochrane–Orcutt’s method to adjust for serial correlation. Girton and Roper (1977) use three measures of foreign monetary policy (M₁, M₂ and the monetary base). They find all the variables are statistically significant with the expected signs. To examine whether the monetary authority is sensitive to the components of exchange market pressure (i.e., EMP is more absorbed by the nominal exchange rate or international reserves), Girton and Roper (1977) construct a variable \[ Q = \frac{e}{r} \]. The estimated coefficient of Q turns out to be insignificant. This implies that EMP is independent whether monetary authorities absorb EMP by depreciating currency or reserves losses, which supports the monetary approach to exchange market pressure.

Connolly and Silveira (1979) apply Girton and Roper’s (1977) EMP model to explain Brazilian data. Like Girton and Roper (1977), Connolly and Silveira (1979) assume purchasing power parity and construct the EMP variable as the sum of the growth rate of the nominal exchange rate and international reserves. The international reserves variable is scaled by the monetary base. Domestic credit is scaled by the monetary base is used as the monetary policy variable, the U.S. wholesale price index is used as a foreign inflation and the three-year moving average of real GDP is used as an income variable. All the variables are in the growth rates. Like Girton and Roper (1977), Connolly and Silveira (1979) estimate the model using a Cochrane-Orcutt iterative technique and annual data for the sample period 1955 to 1975 and 1962 to 1975. In the latter sample period, Brazil imposed fewer restrictions on its exchange rate. The estimated results from the latter sample period perform well, all the variables are statistically significant with the expected sign. In the sample period from
1955 to 1975, only the coefficient of domestic credit is significant. They also estimate a model using international reserves as a dependent variable for both sample periods. In the sample period 1955 to 1975, domestic credit and domestic income are statistically significant, while foreign inflation is not. In the sample period from 1962 to 1975 domestic income is the only significant variable. Finally, they include a variable \( Q = \frac{(e-1)}{(r-1)} \) to examine whether more of the pressure is absorbed by exchange rate depreciation or to loss of reserves. The coefficient of \( Q \) turns out to be insignificant implying that EMP is not sensitive whether the monetary authorities absorb pressure by either depreciating currency or losing reserves.

Hodgson and Schneck (1981), using quarterly data, estimate Girton and Roper’s (1977) monetary model of the exchange market pressure for seven advanced economies (Canada, France, West Germany, Belgium, the Netherlands, Switzerland, and the United Kingdom). For the United Kingdom, the sample period covers 1964:2 to 1976:1 and for the rest of the countries from 1959:2 to 1976:1. The EMP model for each country includes domestic credit, domestic and world money multipliers, domestic and world inflation rates, the domestic forward exchange rate, and world international reserves as explanatory variables. Hodgson and Schneck (1981) use the spot exchange rate and domestic international reserves as the EMP variable. All variables are in growth rates. The weights for the world variables are calculated as the ratio of the individual money stocks to the world money stocks. The world is defined as the seven countries in the sample plus the United States, Japan and Italy.

The equation is estimated using two stage least squares (2SLS). The coefficient of the domestic rate of inflation is significant for Canada only, while the coefficients on domestic and world income are significant only for France. The coefficient of the growth rate of domestic money multiplier is significant and negative.
for Germany, Belgium, the Netherlands and Switzerland. The coefficient of the growth rate of the world money multiplier is insignificant for all the countries. The coefficient on the growth rate of world reserves is significant and positive for France and Belgium, and the coefficient of the growth rate of the world credit is significant and positive only for the Netherlands. The coefficient of home domestic credit is significant and negative for all countries except for France and Switzerland. The coefficient on the rate of change in the forward exchange rate is significant and positive for Belgium, the Netherlands and Switzerland. A structural stability test for each country shows that there is considerable instability between domestic credit and the EMP, which may be due to mis-specification in the monetary equation or shift in the structure due to institutional changes. They do not find a one-to-one negative relationship between domestic credit and EMP. Therefore, they conclude by saying that there may be factors other than the monetary variable that affect EMP.

Kim (1985) estimates Girton and Roper (1977) version of EMP model for Korea using monthly data from March 1980 to July 1983. Korea’s domestic credit is used as the monetary policy variable. The trade-weighted average of Korea’s major trading partners wholesale price index is used as the foreign price variable. Korea’s real wage income is used as a domestic income variable. The sum of net foreign assets and the Korean Dollar/Won exchange rate is used as EMP variable. The estimated results, using OLS, show that all the coefficients are statistically significant with the expected sign except for the foreign rate of inflation. The results support the monetary model of EMP. To see whether monetary authority absorbed EMP by the exchange rate depreciation or the international reserves, a new variable \( Q = (e-1)/(r-1) \) is constructed and added in the model. However, the coefficient of \( Q \) turns out to be insignificant, implying that the EMP is not sensitive whether monetary authority
absorbs pressure either by its currency or by the exchange rate.

Wohar and Lee (1992) estimate a modified version of Girton and Roper's (1977) EMP model for Japan using annual data for the period 1959 to 1991. The sum of the yearly change of net foreign reserves as a percent of high-powered money and the yearly growth rate of the market exchange rate of yen per U.S. dollar is used as an EMP variable. The yearly change of central bank net credit as a percent of high-powered money is used as a monetary policy variable. The yearly growth rate of domestic money multiplier is calculated as the quotient of the money supply and high-powered money. The yearly growth rate of the U.S. monetary base is used as a foreign money supply variable. The yearly growth rate of the Japanese permanent income is calculated from the three-year moving average of the Japanese GNP in 1985 prices. A three-year moving average of the U.S. GNP in 1985 prices is used as a foreign permanent income variable. The differential between the domestic inflation and foreign inflation rate adjusted by the exchange rate and the differential between the lending rate of Japan and the U.S. are used to see the channel through which foreign disturbances transmit to the domestic economy.

Unlike other studies (such as Girton and Roper, 1977, Connolly and Silveira, 1979, Kim, 1985), Wohar and Lee (1992) also estimate Girton and Roper's (1977) EMP model and less restricted alternative models by allowing deviation from the purchasing power parity and the differentials between the domestic interest rates and the foreign interest rates not equal to zero.

In the first model, they use domestic credit, the money multiplier, domestic and foreign income, the foreign money supply, and inflation and interest rate differentials between domestic economy and the U.S. In the second alternative model, they include the foreign inflation rate and foreign interest rate in addition to domestic
credit, money multiplier, domestic income, and the inflation and interest rate differentials between Japan and the United States. They estimate the models with the Cochrane-Orcutt technique. The estimated results of the first EMP model show that all variables are statistically significant with the expected sign except for foreign income. The statistically significant coefficients of inflation and interest rate differentials imply that the purchasing power parity and intra-country equality of interest rates do not hold in the case of Japan. They also estimate Girton and Ropers (1977) restricted model considering that purchasing power parity and the equality of the interest rate differential hold. The estimated results perform poorly in terms of the significance of the variables. In this case, only the coefficients of the domestic credit and domestic income are statistically significant with the expected signs.

Like other studies, Wohar and Lee (1992) also examine whether the monetary authority is sensitive to components of EMP. Unlike other studies, such as Girton and Roper (1977), Connolly and Silveira (1979), and Kim (1985), Wohar and Lee (1992) find a statistically significant and negative coefficient for \( Q = (-e - 1)/(r - 1) \) for all three specifications of the model implying that monetary authority absorb more pressure by reserves losses.\(^{47}\)

The alternative model shows similar results as in the case of the first EMP model where all coefficients are statistically significant with the expected sign except for the foreign inflation. The foreign inflation turns out to be insignificant, this implies that foreign disturbances transmit to the domestic economy through foreign money supply instead of the foreign inflation. Wohar and Lee (1992) also estimate the model using the exchange rate and international reserves as dependent variables. The

\(^{47}\) Where \(-e\) represents the rate of appreciation of Yen in terms of dollar. \(r\) is the percentage change in international reserves.
estimated results from the international reserves equation perform well, where the coefficients of domestic credit, foreign inflation, the foreign interest rate, domestic and foreign inflation differential, and Q are all significant. On the other hand, the estimated results from the exchange rate equation show that the coefficient of domestic and foreign inflation differential is the only one significant. No other variables are significant.

Unlike other studies (for example, Girton and Roper, 1977, Kim, 1985), Mah (1998) estimates a dynamic specification of the EMP model for Korea for the sample period 1980:1 to 1993:1. In the dynamic model, Mah (1998) includes lagged and current value of all independent variables, while the semi-dynamic model includes a lagged dependent variable as a regressor. Akaike's final prediction error criterion is used to select the lag length of the independent variable in the dynamic model. A maximum lag length up to eight is checked and a lag order of three is chosen for the estimation. The sum of the trade-weighted effective exchange rate and percentage change in international reserves of the monetary base is used as EMP variable.48 As independent variables, Mah (1998) uses trade-weighted foreign wholesale price index, domestic real income and the money multiplier. The industrial production index of Korea is used as the domestic real income variable. The money multiplier is calculated dividing $M_2$ by the base money.

Mah (1998) examines the stationarity property of the individual series and finds that all the model variables are stationary. A Hildreth-Lu search method is used to estimate the dynamic and semi-dynamic model. The estimated results of the dynamic model perform better than the semi-dynamic model. In the dynamic model,

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48 The weights are U.S.: 0.47, Japan: 0.38, Germany: 0.07, Canada: 0.04, and U.K. 0.04.
all coefficients are statistically significant with the expected sign, while in the semi-
dynamic model all coefficients are significant other than foreign inflation and
domestic income.

Finally, Mah (1998) applied Thursby and Schmidt's (1977) version of RESET
tests to test for functional form error. Davidson, Godfrey and MacKinnon's (1985)
test is applied to check for dynamic mis-specification. The null hypotheses of no
functional form error and no omitted variables are not rejected in case of dynamic
specifications at the 5% level of significance. Several diagnostic tests are applied to
the dynamic specification model. ARCH is applied to test for homoscedasticity of
residuals. The calculated chi-square statistics show that the null hypothesis of
conditional homoscedasticity is not rejected at reasonable levels of significance. The
Ljung-Box Q statistic is employed to check the serial correlations of the error term.
The results show that the null hypothesis of no autocorrelation is not rejected at the
5% level of significance. The null hypothesis of normal distribution of the error term
is also tested using Rilstone's (1992) augmented Bera-Jarque test. The calculated chi-
square statistic is less than the critical value indicating that the normality of the error
term is not rejected for the dynamic model. Finally, the CUSUM test suggested by
Wright (1993) is applied to test for any structural instability. The CUSUM statistic is
lower than its critical value, implying there is no structural instability present in the
model.

Shiva and Bahmani-Oskooee (1998), using a modified version of the Girton
and Roper (1977) EMP model, examine whether the central bank of Iran engages in
black market activity. In 1979, a period of exchange control due to excess demand for
foreign currency, a black market for foreign exchange developed in Iran. The
exchange rate in the black market rose from 70 rials per dollar in 1979 to 1630 rials
per dollar in 1993 (Shiva and Bahmani-Oskooee, 1998, p.97). Therefore, the central bank decided to unify the black market exchange rate with the official exchange rate in 1993. The rial depreciated substantially due to the removal of foreign exchange controls and reached 7000 rials per dollar in May 1995. This forced the central bank to implement exchange controls again at a fixed rate of 3000 rials per dollar. To check whether the central bank in Iran engaged in black market activity (buying foreign currency, while dumping domestic currency), Shiva and Bahmani-Oskooee (1998) estimate Girton-Roper EMP model using a black market exchange rate and the official exchange rate for the sample period 1959 to 1990.

First, using the black market rate, EMP is regressed on domestic credit, foreign inflation (U.S.), real domestic income and the money multiplier. A $Q = (e-1)/(r-1)$ variable is included to examine whether the monetary authority absorb more pressure by the black market exchange rate or losses of international reserves. Shiva and Bahmani-Oskooee (1998) find all estimated coefficients are statistically significant with the expected signs except for the foreign inflation. The coefficient of $Q$ is negative and statistically significant implying that the central bank in Iran is not engage in a black market activity because the EMP is mostly absorbed by losing reserves.

Second, using the official exchange rate, the EMP model is estimated using all the variables described earlier. They find a statistically significant and negative coefficient on the domestic credit and the money multiplier. However, the coefficients of foreign inflation and real domestic income are not significant. Using the official exchange rate, they find a statistically significant and positive coefficient on $Q$. This implies that more of the pressure is absorbed by the official exchange rate.

Shiva and Bahmani-Oskooee (1998) also estimate an equation using
international reserves as the dependent variable. The results are much better when international reserves are used as a dependent variable. This time, foreign inflation becomes significant together with domestic credit and the money multiplier. Therefore, they conclude that traditional monetary approach to balance of payments performs better in case of Iran than Girton and Roper's (1977) exchange market pressure model.


$$ r - e = -a - c + m^* + \theta + n_1 y - n_2 y^* - s d $$

Where $r$ is the change in foreign reserves as a percentage of monetary base or high-powered money, $e$ is the growth rate of the market exchange rate, and $a$ is the growth rate of the money multiplier, $c$ is the change in net central bank credit as percentage of high powered money, $m^*$ is the growth rate of the U.S. money supply, $\theta$ is the differential of the domestic inflation rate from purchasing power parity, $y$ is the growth rate of the domestic real income, $y^*$ is the growth rate of U.S. real income, and $d$ is the difference between the change in domestic and U.S. interest rate. $n_1, n_2$ and $s$ represent the coefficients of domestic real income, foreign real income, and the spread between domestic and foreign interest rate. Pollard (1999) also uses Wohar and Lee's (1992) alternative specification of the above equation in
the following form.

\[ r - e = -a - c + p^* - s_i^* + \theta + n_i y - sd \]

Where \( p^* \) is the U.S. rate of inflation and \( i^* \) is the change in U.S. interest rate.

The difference between equation (18) and (19) is the way the foreign (U.S.) variables enter into the model. Equation (18) includes the foreign (U.S.) money supply and foreign real income as sources of disturbance, while equation (19) includes foreign (U.S.) inflation and the foreign (U.S.) rate of interest as sources of disturbance. Pollard (1999) also estimates the restricted form of the equation (19) in the following form:

\[ r - e = -a - c + p^* + n_i y \]

Equation (20) is the equation (19) with the restriction that \( s_2 = 0, \theta = 0 \) and \( d = 0 \). In order to decide the correct model formulation, Pollard (1999) uses the technique proposed by Davidson and MacKinnon (1981), Cox (1962) and Pesaran (1974). Pollard (1999) estimates this equation (19) and (20) with OLS and calculates F-tests to determine the correct model formulation of equation (20). He finds that the null hypotheses of zero restrictions are rejected in three out of four cases implying that equation (20) is rejected versus (19) the case of Guyana, Trinidad and Jamaica.

Pollard (1999) estimates equations (18) and (19) with OLS. The estimated results show that the coefficients on credit and the money multiplier are statistically significant for all the countries and not statistically different from hypothesized value of negative one. The coefficient of purchasing power parity is significant for all countries with the exception of Barbados, implying that purchasing power parity holds for three out of four countries. The coefficient of domestic real GDP is statistically significant and positive for all countries. The coefficient of the foreign money supply growth is positive and statistically significant for Barbados and
Guyana, while foreign real GDP growth does not have any impact on the two countries implying that the U.S. money supply is the major sources of disturbance in these two countries. The coefficient of U.S. inflation has a positive and significant impact on Jamaica and Trinidad foreign exchange market pressure and the coefficient of the changes in U.S. interest rate has a significant negative impact on foreign exchange markets in Jamaica only.

Finally, Pollard (1999) estimates the EMP model by including a variable $Q=(-e-1)/(r-1)$ to see whether monetary authority is sensitive to components of EMP. $Q$ is statistically significant and different from zero for Barbados (positive) and Guyana (negative) implying that the authority in Barbados response to EMP by reducing reserve losses, while it is exchange rate depreciation in case of Guyana. The statistically insignificant $Q$ for Jamaican and Trinidad and Tobago implies that the monetary authority adjusts both the reserves and the exchange rate to reduce the exchange market pressure.

Mathur (1999) estimates a modified version of the Girton and Roper’s (1977) EMP model for India using monthly data 1980:1 to 1998:7. Mathur (1999) modified Girton and Roper’s (1977) EMP model by including a variable, the change in the expected rate of appreciation of the nominal exchange rate. Mathur (1999) uses the sum of the rate of change of the exchange rate and the rate of change of the international reserves as a proportion of money as an EMP variable. The growth rates of domestic credit, the foreign monetary base, domestic and foreign income and the change in the expected rate of appreciation are used as the explanatory variables for India’s EMP model. The nominal effective exchange rate (NEER) is used as an exchange rate variable. The NEER is a weighted average of the bilateral nominal exchange rate of the home country in terms of the foreign currencies. The NEER is
calculated using bilateral total trade weights. The number of countries used to construct the NEER is 36. To generate the data on the expected rate of appreciation, Mathur (1999) uses three forecasting methods: the random walk model, Box-Jenkins methodology, and a vector autoregression (VAR). The OECD group of countries is used as a rest of the world. A ‘total OECD’ and ‘OECD major seven’ are used as world variables. The narrow money ($M_1$) index of the ‘OECD total’ and the ‘OECD seven’ are used as a world money variable. In order to calculate the index of $M_1$, weights are derived from the averages of the monthly $M_1$ figures from 1990 for each country converted to dollars using the 1990 purchasing power parity. The weights for the world’s income variable are constructed using GDP from industry and GDP from purchasing power parity.

A set of diagnostic tests shows the absence of multicollinearity, autocorrelation and homoscedasticity. Therefore, OLS is used to estimate the models. Mathur (1999) first estimates the original Girton and Roper (1977) model for the two sets of world variables. The estimated results are not impressive. None of the coefficients are significant except for domestic income. Mathur (1999) also tries to estimate the model by dividing the sample period into two-sub periods. The results do not improve. In the sub-sample periods, domestic real income remains only significant variable.

Mathur (1999) also uses six modified versions of the Girton and Roper (1977) model including the forecasting results from the three methods of forecasting. The estimated results from OLS show improvement over Girton and Roper’s (1977) original model. The coefficients of domestic credit and domestic income appear to be statistically significant with the expected negative and positive signs respectively for all the six variants of the modified Girton and Roper (1977) model. The coefficient of
the expected rate of appreciation also appears to be significant for all the equations except one.

Unlike Girton and Roper (1977), Pentecost, Hooydonk and Poeck (2001) include the short-term interest rate differentials as a measure of the EMP, in addition to reserves and the nominal exchange rate. They estimate EMP for five European countries (Belgium, France, Italy, Spain and Finland) using the quarterly data from 1980 to 1994 where Germany is the foreign country.

Pentecost, Hooydonk and Poeck (2001) use the growth rate of the monetary base differential between domestic and foreign countries as a measure of monetary policy. Real exchange rate depreciation is used as a measure of competitiveness. The change in the long-term interest rate differential is also used as an explanatory variable. As a non-bank private sector wealth variable, a ratio of the current account and national income and a ratio of government budget deficits and national income are constructed. The differentials between the domestic economy and Germany ratios are used as the explanatory variables. The equations are estimated using OLS on the lag values of all the variables to avoid a simultaneity bias. The coefficient of the money supply growth differential has a statistically significant and expected positive sign for Belgium and France, and a statistically significant and negative sign for Finland and Italy. It is insignificant for Spain. The coefficient of the long-term interest differential is statistically significant and negative for France, Italy, Spain and Finland, but insignificant for Belgium. The coefficient of competitiveness has a statistically significant and expected positive sign for Belgium and France and a statistically significant and negative sign for Spanish and Finland, while it is insignificant for Italy. The coefficients of the current account deficit and budget deficit have an expected negative sign for Belgium and France and statistically
significant and positive sign for Italy, Spain and Finland. The estimated results for all
countries, in general, support the alternative specification of the exchange market
pressure.

Tanner (2001) estimates an exchange market pressure (EMP) model using
monthly data from 1990 to 1998. A vector autoregression (VAR) approach is used to
estimate the EMP model for Brazil, Chili, Mexico, Indonesia, Korea, and Thailand.
Unlike other studies Tanner (2001) construct EMP variable in the following way:

\[ EMP = e_t - r_t = \delta_t - m_t, \]
\[ \delta_t = \Delta D_t / M_{t-1}, \]
\[ m_t = \Delta M_t / M_{t-1} - \pi_t, \]

Where, \( e_t \) represents the rate of growth of the nominal exchange rate, \( r_t = \Delta R_t / M_{t-1}, \)
\( M_t \) is nominal money at time \( t, \) \( R_t \) is international reserves, \( \pi_t \) is the rate of inflation, \( D_t \) is
domestic credit, \( r_t \) is the rate of growth of the international reserves scaled by
monetary base, and \( \delta_t \) is the rate of growth of the domestic credit scaled by monetary
base.

The growth rates of domestic credit and the interest rate differential between
domestic and U.S. interest rates are used to examine the impact of the monetary
policy on the exchange market pressure. The response of the EMP is positive and
significant as expected due to shock to domestic credit for all countries except for
Korea. The response of EMP Korea is statistically significant and negative. The
response of the EMP due to shock to the interest rate differential is weaker than that
of the shock to domestic credit. The response of EMP due to a shock to the interest
rate differential is statistically significant and negative for Indonesia, Thailand, Brazil
and Mexico.

From the above review of literature, the monetary model of exchange market
pressure seems to be an appropriate for both developed and developing countries. The current study uses the same model for Bangladesh, a developing country, to examine the impact of monetary policy on the Girton and Roper’s version of EMP. This study also investigates the factor sensitivity of the EMP with respect to reserves and nominal exchange rate by introducing a new variable Q (=e/r).

Model Variables

Quarterly data from 1976:2 to 2003:1 are employed to estimate Engle and Granger’s (1987) two-step single equation error correction model (ECM) and a vector error correction model (VECM) containing the following variables:

- \( d \) = percentage change of domestic credit scaled by the monetary base;
- \( e \) = percentage change of nominal exchange rate (Taka-Dollar or Taka-Rupee);\(^9\)
- \( r \) = percentage change of international reserves scaled by the monetary base;
- \( P_i^* \) = percentage change of foreign consumer price index (India and the U.S.);
- \( y \) = percentage change of industrial production;
- \( \text{mm} \) = percentage change of the money multiplier;
- \( Q_i = (e/r) = Q_i \) is included to examine whether the EMP is sensitive whether monetary authority absorb pressure by either depreciating currency or loosing reserves.

Seasonally adjusted data are used for all the variables except for the exchange rate. All the variables are in log-differenced form. A description of the variables is given in detail in the Appendix-D.

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\(^9\) The U.S. and India’s exchange rate are included because the USA and India are the two major trading partners of Bangladesh. \( i=1(USA) \) and \( 2(India) \).

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Before estimating the model, the statistical properties of each variable are analyzed. A series of Dickey-Fuller (1981) unit root tests are used to examine each series up to two unit roots. Log level data are used to run the test for the presence of one unit root, while first differenced data are used to run the test for the presence of a second unit root, given that the first unit root is present. Two sets of the unit root tests are performed using the Taka/Dollar and the Taka/Rupee exchange rates. The augmented Dickey-Fuller (ADF) unit root tests suggest that the log of the domestic credit scaled by the monetary base, the log of the foreign (the U.S. or India) price level, the log of real output, and the log of money multiplier contain one unit root and therefore need to be differenced once to attain stationarity. The composite value of EMP in level also fails to reject the null hypothesis of unit root for both Taka/Dollar and Taka/Rupee exchange rate.

According to Engle and Granger (1987), an equation estimated with differenced data will be mis-specified if the variables are cointegrated and cointegration is ignored.\textsuperscript{50} Therefore, cointegration among the I (1) variables is tested using the techniques developed by Johansen (1988) and Johansen and Juselius (1990). Both the trace and maximum eigenvalue tests suggest two cointegrating vectors for each EMP model using Taka/Dollar and Taka/Rupee exchange rates. The presence of co-integration in the integrated series suggests that the model should be estimated using an error correction model (ECM).

This paper uses a two-step procedure suggested by Engle and Granger (1987) to estimate the model. In this approach, first, a long-run equilibrium EMP model in

\textsuperscript{50} Variables are cointegrated if each variable is \( I(d) \), but a linear combination of the variables is \( I(d-b) \), \( b>0 \).
log levels is estimated by ordinary least square (OLS). Then the lagged value of the calculated residuals from step one is used in an error correction model. This lagged value of the residual specifies the short-run dynamics of the second model; the coefficient on the lagged residual is the speed of adjustment. The significance of the coefficient of the lagged residual implies that the variables are cointegrated. The larger the coefficient is, the greater the responses of the variables to fill the gap of the deviation from long-run equilibrium (Enders 1995).

Error Correction Model (ECM)

Two sets of equations are estimated in this paper. First, two U.S. variables and four domestic variables are used to estimate the model (growth rate of Taka/Dollar exchange rate and growth rate of domestic international reserves are used to construct EMP) and three domestic variables (domestic credit, real income, money multiplier) and a foreign variable (U.S. inflation) are used to estimate the long-run equilibrium model and a short-run dynamic model. Engle and Granger’s (1987) two-step procedure is used to estimate the model. In the first step, a long-run equilibrium model is estimated with OLS using log levels of the variables. In the second step, the lag value of the residual derived from the first step is used in the second equation to estimate the short-run dynamic model. The same procedure is repeated with the second set of equations containing growth rate of Taka/Rupee exchange rate and domestic international reserves to construct EMP. India’s inflation and the same three domestic variables are used as independent variable.

Following Girton and Roper (1977) a new variable $Q_i = e/r$ is also included in the model to examine whether the EMP is sensitive to its components i.e., monetary authority in Bangladesh absorb pressure either by loosing reserves or by
depreciating currency. A significant positive coefficient of $Q_i$ will imply that the monetary authority in Bangladesh responds to EMP by depreciating currency. A significant and negative coefficient of $Q_i$ will imply that the monetary authority in Bangladesh responds to exchange market pressure by reserve losses. In that case, the central bank sells foreign currency instead of currency depreciation. The insignificance of the $Q_i$ will imply that the EMP is not sensitive to its components whether monetary authority absorbs more pressure either by the depreciating currency or by loosing reserves.

Empirical Results

**Error Correction Model**

The results from the short-run dynamic models are reported in Tables 10 and 11. Table-10 shows the estimated results from Engle and Granger’s (1987) two-step single equation model containing U.S. variables. The coefficient of the growth rate of the domestic credit is significant at 1% level. The coefficient of domestic credit (-0.96) implies that a 10% increase in the domestic credit causes the exchange rate to depreciate by $(e=-0.96\times10=-9.6\%)$, or a loss of reserves by $(r=-0.96\times10=-9.6\%)$, or a combination of the two (Girton and Roper 1977, p.544).

The coefficient of the lagged value of the error term also appears to be significant. A significant error correction term implies that the variables are cointegrated. However, the coefficients on U.S. inflation and real income and money multiplier are not significant, which implies that U.S.’s inflation and domestic real income and money multiplier do not have an impact on EMP in Bangladesh. The results remain the same when estimating the model adding a new variable $Q_1$. $Q_1$ is

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$Q_1$ is USA, $Q_2$ is India.
added to see whether EMP is sensitive to its components. The coefficient of $Q_1$ turns out to be insignificant, implying that the monetary authority is not sensitive to the components of EMP. They adjust both, international reserves and the exchange rate to reduce EMP. This paper estimates the model using the Taka/dollar nominal exchange rates as a dependent variable. The estimated coefficients are all insignificant when Taka/dollar exchange rate is used as a dependent variable. This paper also estimates the model using international reserves as a dependent variable. In that case, the coefficient of domestic credit is statistically significant and negative at 1% level.

Table-11 shows the estimated single equation results using India's variables. The coefficient of domestic credit is negative and significant at 1% level. India's inflation and error correction terms are also significant at 5% and 1% levels, respectively, with the expected signs. A significant and positive coefficient of India's inflation implies that an increase in the India's inflation increases foreign exchange market pressure in Bangladesh and a significant error correction term implies that the variables are cointegrated. However, the money multiplier and real income are not statistically significant. The results do not change when the $Q_2$ variable is added to the model. The coefficient of $Q_2$ turns out to be insignificant.
Table 10

Dependent Variable: EMP (Taka vis-a-vis U.S. Dollar)

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>r-e</th>
<th>r-e</th>
<th>r</th>
<th>e</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-9.38 (-1.57)</td>
<td>-9.35 (-1.56)</td>
<td>-4.85 (-0.79)</td>
<td>4.52*** (3.49)</td>
</tr>
<tr>
<td>d</td>
<td>-0.96*** (-6.53)</td>
<td>-0.96*** (-6.52)</td>
<td>-0.94*** (-6.22)</td>
<td>0.01 (0.46)</td>
</tr>
<tr>
<td>p₁*</td>
<td>0.0008 (0.00)</td>
<td>-0.03 (-0.03)</td>
<td>-0.07 (-0.06)</td>
<td>0.06 (0.29)</td>
</tr>
<tr>
<td>y</td>
<td>-0.10 (-0.48)</td>
<td>-0.12 (-0.57)</td>
<td>-0.07 (-0.30)</td>
<td>0.03 (0.81)</td>
</tr>
<tr>
<td>mm</td>
<td>0.47 (1.51)</td>
<td>0.48 (1.54)</td>
<td>0.48 (1.51)</td>
<td>0.01 (0.25)</td>
</tr>
<tr>
<td>Qᵢ</td>
<td>--</td>
<td>-1.45 (-0.43)</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Lagged e-hat</td>
<td>-64.15*** (-3.18)</td>
<td>-64.74*** (-3.19)</td>
<td>-61.63*** (-2.96)</td>
<td>2.52 (0.58)</td>
</tr>
<tr>
<td>Adj-R²</td>
<td>0.34</td>
<td>0.33</td>
<td>0.31</td>
<td>0.005</td>
</tr>
</tbody>
</table>

(***) Implies significant at 1% level, while (**) implies significant at 5% level.
Table 11
Dependent Variable: EMP (Taka vis-a-vis India’s Rupee)

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>r-e</th>
<th>r-e</th>
<th>r</th>
<th>e</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-25.58*** (-2.81)</td>
<td>-25.92*** (-2.81)</td>
<td>-25.62*** (-2.89)</td>
<td>-0.02 (0.44)</td>
</tr>
<tr>
<td>d</td>
<td>-1.06*** (-7.05)</td>
<td>-1.05*** (-6.97)</td>
<td>-1.06*** (-7.21)</td>
<td>0.003 (0.07)</td>
</tr>
<tr>
<td>( p_2^* )</td>
<td>2.79** (2.78)</td>
<td>2.80*** (2.78)</td>
<td>2.66** (2.72)</td>
<td>-0.12 (-0.41)</td>
</tr>
<tr>
<td>y</td>
<td>-0.01 (-0.06)</td>
<td>-0.008 (-1.51)</td>
<td>-0.04 (-0.19)</td>
<td>-0.02 (-0.42)</td>
</tr>
<tr>
<td>mm</td>
<td>0.53 (1.67)</td>
<td>0.54 (1.68)</td>
<td>0.44 (1.42)</td>
<td>-0.09 (-0.90)</td>
</tr>
<tr>
<td>Q2</td>
<td>--</td>
<td>0.53 (0.26)</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Lagged e-hat</td>
<td>-47.75*** (-2.42)</td>
<td>-47.64*** (-2.40)</td>
<td>-54.54*** (-2.83)</td>
<td>-6.79 (-1.10)</td>
</tr>
<tr>
<td>Adj-R2</td>
<td>0.34</td>
<td>0.33</td>
<td>0.35</td>
<td>0.07</td>
</tr>
</tbody>
</table>

(***)) Implies significant at 1% level, while (**) implies significant at 5% level.
This paper also estimates the model using Taka/Rupee exchange rate and the international reserves as dependent variables. The estimated coefficients from using Taka/Rupee exchange rate are all insignificant, while the estimated coefficients from international reserves as a dependent variable have two significant coefficients. Domestic credit is statistically significant and negative at 1% level, while India’s inflation is statistically significant and positive at 5% level.\textsuperscript{52}

Vector Error Correction Model (VECM)

In order to see the robustness of the results from the ECM, this paper derives impulse response function (IRFs) and variance decomposition (VDCs) from vector error correction models (VECM) using both exchange rates: Taka/Dollar and Taka/Rupee. The VDCs show the portion of the variance in the forecast error for each variable explained by innovations to all variables in the system. This study is mostly interested in the portion of the forecast error variance of exchange market pressure that is explained by shocks to the domestic credit (d), foreign price levels (p_i*), domestic real income (y), and the money multiplier (mm). If these factors explain a significant portion of the forecast error variance in the EMP then we can say these factors have significant impact on EMP.

The IRFs show the dynamic response of each variable in the system to shocks from each variable in the system. If the response of the exchange market pressure is significant and negative due to shocks to domestic credit and money multiplier then we can say that domestic credit and money multiplier have a significant impact on

\textsuperscript{52} This paper also estimates the model with OLS using growth rates (excluding error correction terms) of U.S. and India’s variables with and without the Q_i variable. This time only the domestic credit variable appears to be significant at 5% level with the expected sign in the U.S. equations. In the India’s equations, domestic credit and India’s inflation appear to be significant at the 5% level with the expected negative and positive signs respectively.
EMP. On the other hand, we expect a significant and positive impact of domestic real income and foreign inflation on the EMP. If the response of EMP is significant and positive we can say that, an increase in the domestic real income and the foreign inflation would increase EMP.

Hafer and Sheehan (1991) argue that VAR results can be very sensitive to the choice of lag length. Therefore, Akaike's Information Criterion (AIC) and Schwartz's Information Criteria (SIC) are used to select the lag length for the VECM model. Lag orders of one through eight are tested. A lag order of four produces the minimum AIC and SIC in each case. Q-statistics are used to see if VECM residuals in each equation are white noise at this minimum AIC and SIC. The Q-statistics show white noise residuals for each equation at lag order four. Therefore, a lag of four is used to derive VDCs and IRFs from the VECM. To see the robustness of the results, a lag of eight is also used to estimate the model. This paper reports the estimated results using optimal lag 4 in upper portions of Tables 12 and 13 and estimated results using lag 8 in the lower portions of Tables 12 and 13.

To estimate VDCs and IRFs, orthogonalization of the VECM residuals is required. A Cholesky decomposition is used to orthogonalise the residuals. The Cholesky decomposition requires the variables to be ordered in a particular way such that variables placed higher in the ordering have a contemporaneous impact on all variables lower in the ordering, but the variables lower in the ordering do not have a contemporaneous impact on the variable higher in the ordering. 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" (Wheeler 1999, page 277).

53 A maximum lag length of eight is used to preserve degrees of freedom.
Therefore, it is important to decide a proper ordering of the variables. The Cholesky ordering of the variables for this study is: \( p^* \), mm, d, y, and EMP.\(^{54}\) The foreign inflation variable is placed first in the ordering according to small country assumption; foreign inflation is exogenous. Placing foreign inflation higher in the ordering implies that foreign inflation has a contemporaneous impact on money multiplier, domestic credit, domestic real income, and EMP, while these variables have no contemporaneous impact on foreign inflation. EMP is placed last in the order allowing all other system variables to have a contemporaneous impact on EMP. This assumption is consistent with previous single-equation studies that treat EMP as an endogenous variable, while treating all other system variables as exogenous.

The money multiplier is assumed to remain constant within a given quarter. Hence, the money multiplier is placed above other domestic variables. This assumption allows the money multiplier to have a contemporaneous impact on other domestic variables, but domestic variables have no contemporaneous impact on the money multiplier. As a policy variable, domestic credit is placed above real income in the ordering. This allows monetary policy to have a contemporaneous impact on real income. However, policy decisions respond with a lag to changes in real income.\(^{55}\)

Variance Decomposition (VDCs) of Exchange Market Pressure (EMP) using Taka/U.S. Dollar Nominal Exchange Rate

In order to know the impacts of a shock, VDCs for time horizons of 4, 6, 12, 16 and 20 are computed. 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.

\(^{54}\) This paper also estimates VECM models adding the Qi variable, but the IRFs and VDCs of EMP due to shocks to Qi are never significant.

\(^{55}\) This study also estimates VECM by switching the order between domestic real income and money multiplier and domestic credit and money multiplier. Major policy conclusions do not change due to switching the ordering between real income and money multiplier and switching the ordering between domestic credit and money multiplier.
Twenty-five hundred Monte Carlo simulations are used to calculate the standard errors. Because this study is most concerned with the forecast error variance in the exchange market pressure (EMP) explained by the foreign (U.S. and India) price level, money multiplier, domestic credit, and real income, VDCs of EMP derived from using the VECM model are reported in Tables 12 and 13. Table-12 shows the VDCs derived from estimating VECM model using Taka/U.S. dollar nominal exchange rate, and Table-13 shows the VDCs derived from estimating VECM model using Taka/India’s Rupee nominal exchange rate.

Table-12 indicates that domestic credit can explain a significant portion of the forecast error variance in EMP at time horizons 4, 8, and 12, while estimating at lag length 4 using Taka/Dollar exchange rate. The forecast error variance explained by the domestic credit at time horizon 12 is 30.56%. None of the other variables is significant. The results change if we change the lag length. At lag 8, the forecast error variance explained by domestic credit is significant at time horizons 4, 8, 12, 16, and 20. Domestic credit is the only significant variable regardless of the lag length.
Table 12

Variance Decomposition of Exchange Market Pressure using Taka/Dollar Nominal Exchange Rate and Cholesky Ordering as: $p_t^*$, mm, d, y and EMP

<table>
<thead>
<tr>
<th>VECM Lag Length</th>
<th>Time Horizon</th>
<th>$p_t^*$</th>
<th>mm</th>
<th>d</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>4</td>
<td>1.24</td>
<td>4.04</td>
<td>41.33**</td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(4.19)</td>
<td>(6.54)</td>
<td>(11.75)</td>
<td>(4.06)</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>10.21</td>
<td>3.29</td>
<td>36.71**</td>
<td>4.24</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(12.03)</td>
<td>(8.20)</td>
<td>(13.32)</td>
<td>(5.61)</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>21.42</td>
<td>2.86</td>
<td>30.56**</td>
<td>5.84</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(17.14)</td>
<td>(8.52)</td>
<td>(13.51)</td>
<td>(6.13)</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>29.48</td>
<td>2.16</td>
<td>25.53</td>
<td>6.58</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(19.16)</td>
<td>(8.08)</td>
<td>(13.39)</td>
<td>(6.37)</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>33.83</td>
<td>1.63</td>
<td>22.13</td>
<td>6.75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(19.98)</td>
<td>(7.66)</td>
<td>(13.30)</td>
<td>(6.52)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VECM Lag Length</th>
<th>Time Horizon</th>
<th>$p_t^*$</th>
<th>mm</th>
<th>d</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>4</td>
<td>2.44</td>
<td>1.92</td>
<td>33.88**</td>
<td>3.62</td>
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<td></td>
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<td>(5.18)</td>
<td>(5.85)</td>
<td>(12.17)</td>
<td>(5.75)</td>
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<tr>
<td></td>
<td>8</td>
<td>13.66</td>
<td>1.41</td>
<td>34.34**</td>
<td>10.89</td>
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<td></td>
<td></td>
<td>(11.66)</td>
<td>(6.39)</td>
<td>(13.35)</td>
<td>(10.17)</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>16.63</td>
<td>5.24</td>
<td>34.81**</td>
<td>11.49</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(13.35)</td>
<td>(9.17)</td>
<td>(13.72)</td>
<td>(10.81)</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>17.44</td>
<td>6.47</td>
<td>32.69**</td>
<td>12.99</td>
</tr>
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<td></td>
<td></td>
<td>(14.37)</td>
<td>(9.94)</td>
<td>(13.42)</td>
<td>(11.46)</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>16.96</td>
<td>6.04</td>
<td>32.18**</td>
<td>12.68</td>
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<td>(14.79)</td>
<td>(9.75)</td>
<td>(13.47)</td>
<td>(11.59)</td>
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Notes: Figures in the parenthesis are Monte Carlo simulated standard errors. The point estimates are considered significant if the point estimates are at least twice as large as their standard errors.
Variance Decomposition (VDCs) of Exchange Market Pressure (EMP) using Taka/India’s Rupee Nominal Exchange Rate

Table-13 shows the variance decomposition of EMP due to shock to foreign inflation, money multiplier, domestic credit, and real income estimated for VECMs estimated at lags 4 and 8. The Taka/Rupee exchange rate is used to construct EMP. In order to know the magnitude of the shock, variance decompositions at time horizons 4, 8, 12, 16, and 20 are reported. The upper portion of Table-13 shows that domestic credit can explain a significant portion of the forecast error variance in EMP at time horizons 4 and 8, when estimating the VECM at lag 4. The forecast error variance explained by domestic credit at time horizon 8 is 34.42%. None of the other variables explains a significant portion of the forecast error variance in the EMP. These results hold if we change the lag length to 8. At lag 8, domestic credit can explain a significant portion of the forecast error variance of EMP at all time horizons.
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<td>(7.59)</td>
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Notes: Figures in the parenthesis are Monte Carlo simulated standard errors. The point estimates are considered significant if the point estimates are at least twice as large as their standard errors.
Impulse Response Function (IRFs) of the Exchange Market Pressure (EMP) using Taka/Dollar Nominal Exchange Rate

The IRFs show the dynamic response of each variable in the system to shock from each variable in the system. The Cholesky ordering of the variables for this study is: $p_i^*, mm, d, y$ and EMP. A two-standard-deviation confidence interval is reported for each IRF. A confidence interval containing zero indicates lack of significance. The confidence interval for each IRF is computed from twenty-five hundred Monte Carlo simulations. The IRFs of EMP due to shocks to foreign price level, money multiplier, domestic credit, and real income are shown in Figures 9 to 12. In Figures 9 and 11 the optimal lag length of 4 is used to derive the IRFs estimating the VECM using Taka/Dollar and Taka/Rupee exchange rates. To see the robustness of the results, the IRFs derived from VECM using lag length 8 are also estimated and reported in Figures 10 and 12.

In Figures 9 and 10, the Taka/Dollar exchange rate is used to construct the EMP variable. Figure-9 shows the IRFs of EMP due to shocks to domestic credit, U.S. inflation, real income and the money multiplier. In Figure-9, the response of EMP due to shock to domestic credit is significant and negative initially, remaining significant up to time horizon 13, and becomes insignificant thereafter. The IRFs of EMP due to shocks to U.S. inflation is insignificant initially, becomes significant and negative at time horizon 7, and remains significant thereafter. The impulse response function of EMP due to shock to the U.S. inflation appears with the wrong sign. None of the other variables is significant in Figure-9. As Figure-10 shown, the results

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56 $i=1$(USA) and 2(India).
57 VECMs with $Q_1$ and/or $Q_2$, included also estimated. The IRFs of EMP due to shocks to $Q_1$ and $Q_2$ were never significant.
remain the same when the lag length is increased to 8.\textsuperscript{58}

**Impulse Response Function (IRFs) of Exchange Market Pressure (EMP) using Taka/India’s Rupee Nominal Exchange Rate**

Figures 11 to 12 show the IRFs of EMP due to a shock to the domestic credit, foreign inflation, real income and money multiplier when Taka/Rupee exchange rate is used. Figure-11 shows the response of EMP due to shocks to domestic credit, foreign inflation, and the money multiplier estimated at lag 4 using Taka/Rupee nominal exchange rate. In Figure-11, the response of EMP declines sharply due to shock to domestic credit and remains negative and significant for the rest of the periods. The response of the EMP due to innovation to India’s inflation is significant and positive for the first two quarters, which becomes insignificant thereafter. None of the other variables appears to be significant in Figure-11. As Figure 12 shown, the results remain the same when the lag length of 8 is used.

\textsuperscript{58} At lag 8, the response of the EMP due to shock to income becomes significant only for the 5\textsuperscript{th} quarter and the response of EMP to a shock to U.S. inflation is significant for time horizons 6 to 9.
Figure-9: Responses of EMP due to Shocks to $d$, $mm$, $p_t^*$, and $y$ estimated at lag 4 using Taka/Dollar Exchange Rate and Cholesky Ordering: $p_t^*$, $mm$, $d$, $y$ and EMP
Figure-10: Responses of EMP due to Shocks to d, mm, p₁*, and y estimated at lag 8 using Taka/Dollar Exchange Rate and Cholesky Ordering: p₁*, mm, d, y and EMP.

Response of EMP to d

Response of EMP to mm

Response of EMP to p₁*

Response of EMP to y

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Figure-11: Responses of EMP due to Shocks to d, mm, p₂*, and y estimated at Lag 4 using Taka/India's Rupee Exchange Rate and Cholesky Ordering: p₂*, mm, d, y and EMP
Figure-12: Responses of EMP due to Shocks to d, mm, p2*, and y estimated at Lag 8 using Taka/India’s Rupee Exchange Rate and Cholesky Ordering: p2*, mm, d, y and EMP.
The results derived from VECM are better than single equation ECM because VECM takes into account endogeneity of the variables where a single-equation ECM considers each right-hand side variable as exogenous. This potentially creates a simultaneity bias in the coefficients. The results from VECM are more reliable because it takes into account the simultaneity problem.

The significance of the coefficient of domestic credit in terms of ‘t’ ratio from ECM and IRFs and VDCs from VECM show that domestic credit has a significant impact on EMP for both exchange rates. However, domestic real income is never significant for any case. The estimated coefficient of foreign inflation (India) from ECM and IRFs estimated at lag 4 show significant and positive impacts on EMP. The response of EMP due to shock to the U.S. inflation is significant and negative. However, the coefficient of the U.S. inflation from ECM and VDCs of EMP due to shock to U.S. inflation is not significant. The estimated coefficient of the money multiplier is never significant either using Taka/Dollar or Taka/Rupee exchange rate.

Conclusion

This paper provides evidence supporting the claim that an increase in the domestic credit results either in exchange rate depreciation or reserves losses while using either the Taka/U.S. Dollar or the Taka/India’s Rupee exchange rate. Domestic credit has a significant impact on EMP in each model estimated. We do not find evidence of the impact of domestic real income on EMP for either of the two cases. The impact of the growth rate of the money multiplier on EMP is not significant in

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59 At lag 8, the response of EMP due to shock to income becomes significant only for the 5th quarter.
any of the cases. However, the IRFs estimated in this paper show a significant and positive response of EMP due to a shock to India’s inflation and significant and negative impact due to shock to the U.S. inflation. The ECM also supports the significant and positive coefficient of India’s inflation. However, the coefficient of EMP from ECM and VDCs of EMP due to shock to the U.S. inflation does not support the significant impact of the U.S. inflation on EMP. The coefficient of $Q_i$ is never significant in the VDCs or IRFs. This implies that the monetary authority in Bangladesh responds to EMP by depreciating currency and losing international reserves. This is true for both exchange rates (Taka/U.S. Dollar or Taka/India’s Rupee). Therefore, as a policy prescription, we can say that the monetary model of exchange market pressure can be used to determine the level of intervention needed to achieve an exchange rate target for Bangladesh.
PART V

OVERALL CONCLUSION

Based on the results from first essay we can conclude that India’s monetary policy as a foreign monetary policy has a significant impact on macroeconomic variables in Bangladesh. Therefore, the monetary authority in Bangladesh should keep an eye on the monetary policy in India to prevent negative effect on Bangladesh output. For example, if India pursues expansionary monetary policy to avoid currency appreciation vis-à-vis Bangladeshi Taka, Bangladesh should also devalue their currency relative to India to avoid currency appreciation due to expansionary policy in India.

In the first essay, from the IRFs and VDCs we find that foreign (India) monetary policy has a significant impact on output, real exchange rate (Taka/Rupee), and the interest rate in Bangladesh. The impact of foreign monetary policy on the domestic money supply is inconclusive. Domestic monetary policy, measured by $M_1$, shows that domestic monetary policy has a significant impact in altering domestic macroeconomic variables, especially the price level, the real exchange rate, and the interest rate.

Based on the second essay, we conclude that monetary policy measured by the monetary base does not have an impact on banks’ portfolios. Therefore, we conclude that neither a ‘money channel’ nor a ‘credit channel’ exist in Bangladesh. This result is plausible in the sense that commercial banks in Bangladesh have large amounts of...
excess reserves. Hence, banks are not dependent on the central bank for liquidity. The lack of dependence of commercial banks, on the central bank for liquidity may contribute to the ineffectiveness of monetary policy in altering bank portfolios in Bangladesh.

In the second essay, IRFs and VDCs derived from the structural (Bernanke, 1986) VAR and a VAR with Cholesky decompositions, are used to examine the monetary policy transmission mechanism in Bangladesh. IRFs and VDCs of deposits and credit derived from a structural (Bernanke 1986) VAR and VDCs derived from Cholesky decompositions indicate that monetary policy measured by the monetary base does not have a significant impact on deposits and credit.

IRFs and VDCs of output derived from the structural VAR show contradictory results from a shock to bank deposits. IRFs of output derived from the structural VAR show that deposits have a significant and positive impact on output. However, VDCs from structural and Cholesky decompositions show that deposits do not have a significant impact on output. Therefore, even though a ‘money channel’ does not exist in Bangladesh, whether bank deposits have an independent effect on economic activity in Bangladesh is not clear. The IRFs and VDCs of the price level derived from the structural VAR and VDCs from Cholesky decompositions show that innovations to deposits have a significant and positive impact on the price level. This shows that no ‘price puzzle’ in the model. The differences in results are due to differences in their contemporaneous relationships. The Cholesky decompositions imposes recursive structure on the contemporaneous relationship, while the in the SVAR contemporaneous relationship is imposed by the theory.

The IRFs and VDCs of the price level derived from the structural VAR, and

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As of June 2001, the excess reserves of the commercial banks in Bangladesh stood at Tk.3271 crores, which is 49.10% of total reserves. (Economic Trends, Bangladesh Bank)
VDCs from Cholesky decompositions show that credit does not have a significant impact on the price level. IRFs and VDCs of output derived from structural VAR show that innovations to credit do not have a significant impact on output. However, VDCs derived from the Cholesky decomposition show that an innovation to credit can explain a significant portion of the forecast error variance in output at time horizons 12 and 16. So, we can conclude that even though there is no evidence of the existence of a 'credit channel' in Bangladesh, whether bank total credit plays a role in the transmit in monetary policy into the economy is inconclusive due to the different results of the IRFs and VDCs.

In the third essay, Engle and Granger's (1987) two-step single-equation estimator is used to examine Girton and Roper's (1977) monetary model of the EMP. IRFs and VDCs derived from a vector error correction model (VECM) are also used to examine the robustness of the impact of the monetary policy. The estimated coefficient of domestic credit derived from the ECM shows that monetary policy, measured by domestic credit, has a significant negative impact on EMP. The IRFs and VDCs derived from the VECM also indicate that monetary policy has a significant and negative impact on EMP as expected. This implies that contractionary monetary policy reduces exchange market pressure either by reducing foreign reserves or by depreciating domestic currency.

Domestic real income is never significant in any of the cases. The impact of growth rate of the money multiplier is not significant using either Taka/Rupee exchange rate or Taka/Dollar exchange rate. The coefficient of India's inflation from the ECM and IRFs of the VECM show that India's inflation has a significant and positive impact on the EMP. The IRF of the U.S. inflation shows that the response of the EMP due to shock to U.S. inflation is significant and negative. However, the
coefficient of U.S. inflation from ECM and VDCs of EMP due to shock to U.S. inflation does not support the statistical significance of inflation.
Appendix A

Description of the Variables used in Essay I
The data period for this paper is 1975:1 to 2001:4.
The descriptions of the variables used in essay-1 appear below

**CPI** = Price level Bangladesh (1995=100) = the log of domestic consumer price index (CPI); the cost of living index of the Dhaka middle income families is used as a price variable. The seasonally unadjusted data on consumer price index are seasonally adjusted using the X11 procedure in SAS. Then the log of CPI is used as a price variable. The seasonally unadjusted quarterly data on consumer price index are available from various issues of *Economic Trends*, a Bangladesh Bank publication.

**CPI_India** (1995=100) = the log of foreign (India) consumer price index (CPI_I); the cost of living index for the industrial workers of seventy industrial centers in India is used as a foreign consumer price index. The weights used are based on a household expenditure survey. The seasonally unadjusted data on the consumer price index are seasonally adjusted using the X11 procedure in SAS. Then the log of the seasonally adjusted data on consumer price index is used as a foreign CPI_I. The seasonally unadjusted quarterly data on consumer price index of India are available from international financial statistics (IFS) CD-ROM.

**MB** = Real Money Balances Bangladesh (In Crore Taka) = the seasonally adjusted log of the real money supply (MB) is used as a domestic money variable. To get the seasonally adjusted real money supply, seasonally unadjusted data on M1 and consumer price index (CPI) are seasonally adjusted using the X11 procedure in SAS. Seasonally adjusted M1 is divided by the seasonally adjusted CPI to get the seasonally adjusted real money supply. Finally, the log of real money supply is used as a domestic money variable. The seasonally unadjusted quarterly data on domestic narrow money supply (M1) are available from various issues of *Economic Trends*, a publication of the Bangladesh Bank.
\textbf{MI} = Real Money Balances India (In Crore Taka) = the log of real money supply ($M_1$) is used as a foreign money supply (MI); the data on foreign (India) money supply ($M_1$) is calculated by adding data on seasonally unadjusted currency outside banks (COB) and seasonally unadjusted demand deposits (DD). The data on seasonally unadjusted foreign (India) money supply is seasonally adjusted using the X11 procedure in SAS. The data on COB and DD were initially in national currency (Billions Rupee). Therefore, to get the foreign money in domestic monetary terms, the data on foreign $M_1$ (COB+DD) is first transformed into crore rupees (dividing billion rupee by hundred). Then the seasonally adjusted data on foreign money supply (crore rupee) is transformed into crore taka dividing by Taka/Rupee seasonally unadjusted nominal exchange rate. To get the real money supply, $M_1$ is divided by CPI$_I$. Finally, the log of real foreign money supply is used as a foreign money variable ($M_i$).

\textbf{RER} = Exchange rate (TK/RU.) = the log of real exchange rate (RER) is used as an exchange rate variable. To get the real exchange rate the Taka/Rupee nominal exchange rate is calculated dividing Tk./U.S.$ by Ru/U.S.$$. Then the real exchange rate is calculated by multiplying seasonally unadjusted nominal exchange rate by the ratio of seasonally adjusted foreign (India’s) CPI$_I$ and domestic CPI. Finally, the log of real exchange rate is used as an exchange rate variable. The data on nominal exchange rates are available from international financial statistics (IFS) CD-ROM.

\textbf{Y} = Output (1995=100) = the log of real output is used as the output (y) variable. The seasonally unadjusted data on industrial production has been seasonally adjusted using the X11 method in SAS. Seasonally unadjusted quarterly data on industrial production are available from international financial statistics (IFS) CD-ROM.
\[ \text{LR} = \text{Interest rate-the seasonally unadjusted lending rate of commercial banks on individual and business loans is used as an interest rate (LR) variable. The data on the lending rates are available from international financial statistics (IFS) CD-ROM.} \]
Appendix B

Description of the Variables used in Essay 2
The data period for this paper is from 1975:1 to 2000:4. Descriptions of the variables used in essay-2 appear below.

**CPI** (1995=100) = the log of domestic consumer price index (CPI); the cost of living index of middle income families in Dhaka is used as a price variable. The seasonally unadjusted data on consumer price index are seasonally adjusted using the X11 procedure in SAS. Then the log of CPI is used as a price variable. The seasonally unadjusted quarterly data on consumer price index are available from various issues of *Economic Trends*, a Bangladesh Bank publication.

**MB** (In Crore Taka) = the seasonally adjusted log of real monetary base (MB) is used as a monetary policy variable. The seasonally unadjusted data on monetary base are seasonally adjusted using the X11 procedure in SAS. To get the seasonally adjusted real monetary base, the seasonally adjusted CPI divides the seasonally adjusted monetary base. Finally, the log of real monetary base is used as a monetary policy variable. The seasonally adjusted quarterly data on monetary base (MB) are available from various issues of *Economic Trends*, a Bangladesh Bank publication.

**Y** (1995=100) = the log of real output is used as the output variable. The seasonally unadjusted data on industrial production has been seasonally adjusted using the X11 method in SAS. Seasonally unadjusted quarterly data on the industrial production are available from international financial statistics (IFS) CD-ROM.

**Dep** (Taka in Crore) = the log of seasonally adjusted real total banks’ deposits (demand deposits plus time deposits) is used as the liability variable. The seasonally unadjusted data on total bank deposits are seasonally adjusted using the X11 method in SAS. The seasonally unadjusted quarterly data on the total banks’ deposits are available from the international financial statistics (IFS) CD-ROM.

**Dcps** (Taka in Crore) = the log of seasonally adjusted real domestic credit to
the private sector is used as an asset variable. The seasonally unadjusted data on the
domestic credit to the private sector are seasonally adjusted using the X11 method in
SAS. The seasonally unadjusted quarterly data on the domestic credit to the private
sector are available from the International Financial Statistics (IFS) CD-ROM.

R= lending rate on credit (R) is used as an interest rate variable. The
seasonally unadjusted data of the lending rate are available from the monetary survey
of Bangladesh bank.
Appendix C

Data plot on Excess Reserves as a Percent of Total Reserves
Excess Reserves as a percent of Total Reserves
Appendix-D

Descriptions of the Variables used in Essay 3
The data period for this paper is from 1976:2 to 2003:4. The descriptions of the variables used in essay-3 appear below.

**Foreign Inflation** \( (p_{t}^*) \) (1995=100) = the percentage change of foreign (India and the U.S.) consumer price index; the seasonally unadjusted data on each consumer price index are seasonally adjusted using the X11 procedure in SAS. Then the percentage change of CPI is used as a foreign inflation variable. The seasonally unadjusted quarterly data on consumer price index are available from IMF CD-ROM.

**Real Income** \( (y) \) (1995=100) = the percentage change of real income is used as the real income \( (y) \) variable. The seasonally unadjusted data on industrial production has been seasonally adjusted using the X11 method in SAS. Seasonally unadjusted quarterly data on the industrial production are available from international financial statistics (IFS) CD-ROM.

**International Reserves** \( (r) \) (in Million Taka) = the percentage change of foreign assets \( (r) \) of the monetary authorities are used as an international reserves variable. The seasonally unadjusted data on the international reserves are seasonally adjusted using the X11 method in SAS. Seasonally unadjusted quarterly data on the international reserves are available from international financial statistics (IFS) CD-ROM.

**Domestic Credit** \( (d) \) (in Million Taka) = the percentage change of central bank domestic credit to the government and the private sector is used as a monetary policy variable. The seasonally unadjusted data on domestic credit are seasonally adjusted using the X11 method in SAS. The seasonally unadjusted quarterly data on the
domestic credit are available from the International Financial Statistics (IFS) CD-ROM.

**Exchange rate (e)** = the percentage change of the nominal exchange rate (Taka/Dollar and Taka/Rupee). Here, Taka/Rupee rate is the cross rate derived from dividing Taka/Dollar by Rupee/Dollar nominal exchange rate. The seasonally unadjusted data of the nominal exchange rate are available from the International Financial Statistics (IFS) CD-ROM.

**Money Multiplier (mm)** = the percentage change of the money multiplier (mm); the money multiplier is calculated dividing M₂ by the monetary base. The seasonally unadjusted data on the M₂ and the monetary base are seasonally adjusted using the X11 method in SAS. The seasonally unadjusted data of M₂ and the monetary base are available from IMF CD-ROM.

\[ Q = \frac{e}{r} = Q \] is calculated dividing the percentage change of the exchange rate by the percentage change of the international reserves.
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