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EXTERNAL SHOCK, MONETAR POLICY AND THE DOMESTIC ECONOMY: A STRUCTURAL VAR APPROACH FOR BANGLADESH

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ABSTRACT: The Paper examines the impact of external shock and the monetary policy on the domestic price and output of Bangladesh using a Structural Vector Autoregression (SVAR) model estimated with quarterly data of the sample period from 1989 to 2013. Impulse response function shows innovation in reserve money has a positive impact on price and output, although impact on price level is less significant. On the other hand external shocks seem to have more prominent impact on the domestic economy. Shocks in foreign price have an immediate positive impact on domestic prices. Innovation in OECD GDP also has significant positive impact on domestic output of Bangladesh. Effectiveness of monetary policy in the open economy model of Bangladesh economy seems to be lower compared to that in a closed economy version of the economy.

JEL Classification: E5, F4

Keywords: Monetary policy, Price level, GDP, External Shock

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INTRODUCTION

Effectiveness of monetary policy in the economy has been studied extensively, particularly in the context of developed world. Since the beginning of the 1990s, analysis of monetary policy transmission in emerging countries has gained substantial importance due to structural and economic policy reforms and subsequent transition to new policy regime. Consequently studies on effectiveness of monetary policy in the emerging economies also got momentum. Most of the studies on the effectiveness of monetary policy were made in the framework of a closed economy. However, the world has experienced a rapid trend in globalization in the last few decades. Countries around the globe are now interlinked in terms of economic activities. There are some shocks which may affect the countries of the world together. Policy changes in one country may have implications for other countries as well. Hence, domestic policies can hardly work independent of external factors. Keeping these in view, a large body of literature has developed to address the impact of external shock on domestic economy. Effectiveness of monetary policy also has been examined in the context of an open economy in many studies.

In the early days, economic institutions in Bangladesh were not developed enough to be conducive for a market economy. Bangladesh started to implement economic policy reforms in late 1980s, and the country now functions under a more liberalized environment. It has proceeded long in terms of trade and exchange liberalization. Trade openness ratio increased from around 15% in the early 80s to close to more than 40% in the recent years. In addition, there is impressive growth of remittance inflow. However, its capital account is not open yet, and the exchange rate regime moved to a "floating" one only lately. Nevertheless, the economy of Bangladesh is now well integrated with rest of the world. At the same time, there had been considerable reforms in financial sector including interest rate liberalization and enhancing role of private sector in the banking industry. The waves of

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reform spilled over to conduct of monetary policy as well. There have been significant changes in Bangladesh Bank's (BB) legal, institutional and policy frameworks including development of money market instruments, open market operations of various government treasury bills (TBs) auction, adoption of floating exchange rate, etc. These changes allow BB to conduct monetary policy relying on market based instruments. Such changes obviously raise the importance of systematic study on effectiveness of monetary policy. Unfortunately, only a few studies have been conducted in this field in Bangladesh (i.e., Ahmed and Islam 2004, Yunus 2004, Rahman and Ahmed 2014), and all these studies are made in a closed economy framework. Moreover, except some partial studies on exchange rate pass-through (i.e., Yunus 2014, Haque and Razzaque, 2004) there is no studies to formally examine the impact of external shock in Bangladesh.

On this backdrop, the present paper makes an attempt to simultaneously consider the impact of external shock and monetary policy on the economy of Bangladesh. It builds up a structural vector autoregression (SVAR) model of Bangladesh in an open economy set up. The paper examines importance of monetary policy and external shocks in explaining variation in domestic price level and output using SVAR model estimated with quarterly data ranging from the year 1989 to 2013.

Structure of the paper is as follows: Section 2 briefly reviews the issues related to external shock. Section 3 builds up a structural VAR model for Bangladesh and describe the identification scheme. Section 4 presents the results in details. Section 5 concludes the paper

EXTERNAL SHOCKS AND THE DOMESTIC ECONOMY: A REVIEW OF ISSUES AND EVIDENCE

There is now a huge literature explaining inter-linkages among policy and performance of countries and importance of external shock shaping the domestic economy. We will make a very partial review of these just to have an idea of the issue.

One of the earlier works in the field of inter-linkage is Dornbush (1985), which develops a framework where performance of OECD countries has impact on the debtor LDCs. The paper focuses on three channels of influence from OECD to LDCs: commodity prices, real interest rate and quantity effects of export of LDCs. Theoretically, net results of debtor LDC may be conflicting depending on exogenous source of OECD expansion. Empirical evidence of the paper, among others, reports that there is a positive relation between growth of OECD countries and their import from LDCs. Later on empirical literature on growth finds that there may be even growth spillover from developed to developing country, particularly through trade. For example, Aurora and Vambakidis (2006) find that there is a significant positive impact of US economic growth on the growth of rest of the world, especially developing countries. The paper asserts that such impact of US economic growth on other countries can be explained by the significance of US as a global trading partner.

One of the important external shocks discussed in the literature is the oil price shock. Brown & Yueel (2002) identifies several transmission channels through which oil price can affect macroeconomic variables of a country. The direct impact is a negative supply shock as the increase in oil price has direct impact on output due to the change in marginal cost of producing goods. In addition to direct increase in oil price in the economy, there is indirect impact of oil price shock on prices of other goods as well. There may also be sectoral adjustment affect of oil price shock that arise out of asymmetry in oil price shock impact on different sectors of the economy. There are now a large number of studies assessing impact of oil shock on domestic economy, particularly on inflation and output. (Hooker 2002, Cunedo & Garcia 2005, Blanchard and Gali, 2009 are few well cited examples in this regard).

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Financial markets in the world are now well integrated. United States having the largest financial market, its impact on the rest of the world is obvious. A good number of studies found that US interest rate shock has impact on interest rate and economic activity of other countries including the emerging ones. Kim and Rubini (2000) show that external shock such as shocks in FED funds rate and world petroleum price explain a large variation in output of a group of developed countries. Rinehart (2001) and Frankel and Rubini (2001) reports negative impact of US interest shock on GDP of developing countries. Urbie and Yoe (2006) and Neumeyer and Perri (2005) emphasize the importance of foreign interest shock in explaining business cycle of developing countries. Importance of US interest rate and world petroleum is recorded even in explaining monetary policy transmission in India (Aleem, 2010).

There are several recent studies examining impact of external shocks on the emerging economies. For example, Mackowiak (2007) finds that US monetary policy shock not only affects exchange rate and interest rate of emerging countries, it has significant impact on price level and output of these countries as well. Allegret et al. (2012) finds that external shocks viz. oil price, US output and US monetary policy have an increasing importance stimulating domestic price, output and exchange rate of the East Asian Countries. In the same line Nguyen et al. (2014) finds that Oil price and US monetary shocks are more important in explaining variation in domestic variables of East Asian Countries compared to that of US output.

Thus, we cam sum up at least three sources of external shock that has an impact on the emerging and developing economies: shocks in monetary policy or interest rate of the developed country, economic performance of the developed country and external price (mostly oil price).

MONETARY POLICY, EXTERNAL SHOCK AND THE ECONOMY OF BANGLADESH: THE MODEL AND THE IDENTIFICATION SCHEME

Monetary policy transmission has been well explored both theoretically and empirically. Empirical studies on effectiveness of monetary policy in the developing countries have shown mixed results (Misra et al, 2012). However, most of the studies on monetary policy transmission have been conducted in a closed economy set up. In a globalised world monetary policy should rather be studied in an open economy frame work. In an open economy, external shocks not only propagate to have impact on domestic price and output, but also have impact on the effectiveness of monetary policy transmission. Literature in this field identified at least three factors viz external price, foreign interest rate and GDP of the relevant foreign countries to have impact on the domestic economy. In addition, exchange rate which works as the link between domestic and foreign prices also affects domestic price and output.

Relevance of external shock should be carefully considered for Bangladesh. First, interest rate of a large country may affect that in the small one through the uncovered interest rate parity. However, as the capital account of Bangladesh is not open, this channel of transmission is not relevant in Bangladesh. Secondly, existing studies on impact of external price shock mostly used world petroleum price shock to have an impact on domestic price and output. But, energy price is administered by the government in Bangladesh and it has no direct relationship with world price. Thus, shocks in world petroleum price would have minimum direct impact on the economy of Bangladesh. However, Bangladesh is an import dependent economy; import GDP ratio is more than 20%. The country is heavily dependent on import for both capital good and intermediate good for investment and production. It has also high dependence on import for consumer goods and food items. Importable goods count about 34% weight in the basket of goods calculating consumer price index (Yunus 2014). Hence, we take import price index as the relevant foreign price whose shock may have impact on domestic price and output. Third, although export from Bangladesh is growing over time, more than ninety percent of export from Bangladesh goes to the OECD countries. Hence, economic performance of the OECD countries may affect that of Bangladesh through its impact on export

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demand from Bangladesh. Thus, we take shocks in import weighted foreign price index and shocks in OECD output as the relevant external shock for Bangladesh.

We assume that the economy of Bangladesh can be described by a structural form equation

$$G(L)y_t = e_t \quad (1)$$

Where, G(L) is a matrix of polynomials in the lag operator L, y_t is an nX1 data vector and e_t is an nX1 structural disturbance error. Value of an economic variable in a time period depends potentially on both contemporaneous and lagged values of all other variables in a stochastic manner. The stochastic error term et is serially uncorrelated and var(e_t) = Π; Π is a diagonal matrix where diagonal elements are the variance of structural disturbance. Structural disturbances are assumed to be mutually uncorrelated.

We can estimate a reduced form equation (VAR) as

$$Yt=B(L)y_t + u_t \quad (2)$$

Where, B(L) is a matrix of polynomials (without constant term) in lag operator L and var(u_t) = Ω

There are several ways of recovering the parameters in the structural form equations from the estimated parameters in the reduced form equation. A popular and convenient method is to orthogonalize the reduced form disturbance by Cholesky decomposition as in Sims (1980) which is known as VAR in standard form. In this identification scheme we can assume only a recursive structure which is somewhat "mechanical" as it has very little economic content (Enders and Wilks, 2010). Blanchard and Watson (1986), Bernake (1986), and Sims (1986) suggest a generalized method (Strucural VAR or SVAR) where non-recursive restrictions are allowed while still giving restrictions only on contemporaneous structural parameters (Kim and Rubini, 2000). Imposition of appropriate restrictions on the structural model may be guided by economics.

Let Go be the coefficient matrix (non-singular) on L^0 in G(L), that is, the contemporaneous coefficient matrix in the structural form., and let $G^0(L)$ be the coefficient matrix in G(L) without contemporaneous coefficient Go, i.e., G(L) = G_0 + $G^0(L)$). The parameters in the structural form and that of reduced form equation are related by

$$B(L) = -G_0^{-1}G^0(L) \quad (3)$$

In the same line, the structural disturbance and the reduced form residuals are related by $e_t = G_0u_t$, which implies

$$\Omega = G_0^{-1}\Pi\, G_0^{-1} \quad (4)$$

Maximum likelihood estimation of Π and G_0 can be obtained only through sample estimate of Ω. The right hand side of equation (4) has n(n+1) free parameter to be estimated , whereas Ω contains n(n+1)/2 parameters. By normalizing n diagonal elements of G_0 each to be to 1, we need at least n(n-1)/2 restrictions on G_0 to have the model identified.

In our model, data vector is MP, P, GDP, FP, FGDP and ER where MP is monetary policy variable measured by reserve money, P is the price level measured by CPI, GDP is gross domestic product, FP is the foreign price measured as an index of CPI of major import partners of Bangladesh, FGDP is the foreign GDP represented by the GDP of OECD countries, and ER is the exchange rate which is an index of nominal effective exchange rate constructed from bilateral exchange rate of Bangladesh with its major trading partners[1]. First three variables are standard variables analyzing effectiveness of monetary policy in a closed economy. Last three variables are added in the vector to have an open economy version of the economy. We explained how shocks in foreign price and

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foreign GDP may have impact on domestic price and GDP. Finally, the nominal effective exchange rate is introduced to consider the effects of our identified monetary shocks and other changes on the value of domestic currency.

Although our identification scheme lies in the spirit of Shims and Zha (1995) and Kim and Rubini (2000), we modify their scheme in the light of Bangladesh economy where list of variables are somewhat different from them. Moreover, we estimate our model using quarterly data instead of monthly data, which has implication for contemporaneous relations. The following equations summarize our identification scheme based on equation (4).

$$\begin{bmatrix} e_{MP} \\ e_{P} \\ e_{GDP} \\ e_{FP} \\ e_{FGDP} \\ e_{ER} \end{bmatrix} = \begin{bmatrix} 1 & g_{12} & g_{13} & g_{14} & 0 & g_{16} \\ 0 & 1 & g_{23} & g_{24} & 0 & 0 \\ 0 & 0 & 1 & g_{34} & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ g_{61} & g_{62} & g_{63} & g_{64} & g_{65} & 1 \end{bmatrix} \begin{bmatrix} u_{MP} \\ u_{P} \\ u_{GDP} \\ u_{FP} \\ u_{FGDP} \\ u_{ER} \end{bmatrix} \quad (5)$$

Where, e_{MP}, e_P, e_{GDP}, e_{FP}, e_{FGDP}, e_{ER} are the structural disturbances, that is , money supply shock, CPI shock, output shock, foreign price shock, OECD GDP shock and exchange rate shocks respectively and u_{MP}, u_P, u_{GDP}, u_{FP}, u_{FGDP}, u_{ER} are the residuals in the reduced form equations. Money supply equation is assumed to be the reaction function of the central bank, which sets the reserve money target after observing current trend in domestic price, domestic production and the foreign price. Data on domestic and foreign price is available within a quarter and some judgments about GDP trend can also be made within such time. Actually, half yearly monetary policy statement of Bangladesh Bank sets the money and credit growth target by considering overall economic condition in the recent past and contemporary development in the external and internal economic scenario. Short term changes in monetary policy is taken with judgments of the authority based on the information on short term interest rate, foreign currency reserve, trend in bank credit, liquidity situation, trend in inflation and exchange rate etc. As price stabilization is one of the objectives of the central bank, we expect g_{12} to be negative. Exchange rate stabilization target implies a negative sign of g_{16} as monetary tightening is needed to increase the value of taka while currency is depreciating. If authority wants to minimize the price hike due to supply shock out of global inflation through a contractionary monetary policy, then g_{14} will have a negative sign.

Identification restriction for the price equation simply assumes that contemporary output and foreign price may affect the price level. However, monetary policy has a lagged impact on price and it has no contemporaneous relation with price level. As the studies find a lag in the exchange rate pass through effect, exchange rate also does not have any concurrent impact on price as well. We assume that Foreign GDP simply does not have any contemporaneous impact on domestic price. Identifying restrictions on the GDP equation assert that this variable is contemporary exogenous to all variables except foreign price, because the later may affect output through production cost. Bangladesh is a small country compared to the rest of the world or OECD countries combined. Hence, the identifying restrictions for foreign price and foreign GDP take these variables as being contemporaneously exogenous to any variable of the domestic economy. Finally, exchange rate is an arbitrage equation that describes financial market equilibrium. Hence, it is assumed that both domestic and external variable may have contemporaneous impact on exchange rate. The coefficient matrix is a 6X6, so we need (6X5)/2 = 15 restrictions. However we have 18 zero restrictions making the system apparently over identified.

EMPIRICAL EVIDENCE

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In this section we report results of estimate of the contemporaneous coefficients, impulse response out of the SVAR model and the variance decomposition of the forecast error of the model. We also make a comparison of the effectiveness of monetary policy of our open economy model to tat in a closed economy model of Bangladesh.

Estimates of Contemporaneous Coefficients

Table 1 reports the estimated coefficients of the contemporaneous relations along with their standard errors. Quarterly data from FY 1989 to FY2013 has been used for estimation. All variables are seasonally adjusted and are used in logarithms. Following most of other literature on Estimation of VAR in quarterly data, we took lag length of 2. Estimated value of g_{12} is negative with a very low standard error. This implies that monetary authority takes tight monetary policy during positive shocks in price. Similarly, estimated g_{16} is negative, although the standard error is not that small. Thus, in a situation of depreciating currency, central bank also attempts to monetary tightening. Negative sign of estimated g_{13} is indicative of a tendency of monetary tightening during positive output shock. However, sign of estimated coefficient g_{14} is positive with relatively large standard error implying that central bank fails to take contractionary policy during positive shock in foreign price. Most of the other coefficients come with right sign, although standard errors in some cases are large mostly because of the collinearity problem among variables. Lower part of table 1 reports likelihood ratio test of the over-identification restrictions. Identification restrictions are not rejected at 5% level i.e. statistically the model is not over-identified.

TABLE 1: ESTIMATES OF CONTEMPORANEOUS COEFFICIENTS IN THE STRUCTURAL MODEL

Coefficients	Estimate (standard Error)
g_{12}	-0.8083 (0.3344)
g_{13}	-0.4119 (0.2935)
g_{14}	1.1489 (0.9514)
g_{16}	-0.4717 (0.4847)
g_{23}	-0.0941 (0.0882)
g_{24}	-0.9917 (0.2893)
g_{34}	-0.8994 (.3250)
g_{61}	0.1497 (0.1750)
g_{62}	-0.2706 (0.2204)
G_{63}	-0.2229(0.1607)
g_{64}	0.1434(0.5122)
g_{65}	-2.1418 (0.6902)
Test of Over identifying Restrictions	Likelihood Ratio: 1643.355 Chi-Square: 6.585 P-value: 0.0864

Impulse Response Analysis

Figure 1 shows impulse response function of shocks in reserve money, external shocks and exchange rate shocks on the endogenous variables. It is evident that an innovation in reserve money that indicates an expansionary monetary policy has a positive impact on price level. Monetary policy shock creates an initial small negative spike in GDP, but shortly the impact is reversed. Thus, monetary policy shock works in the expected direction in

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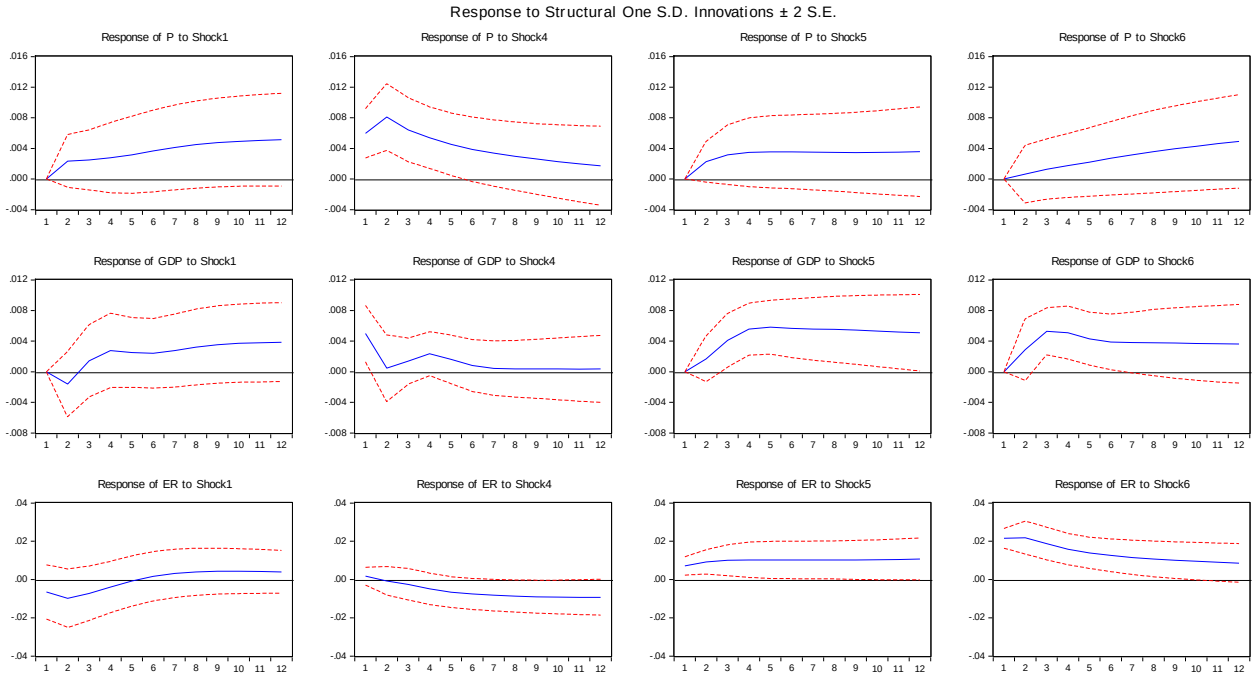
effecting price level and GDP. However, impact of reserve money shock on price and output are not statistically that significant. Impulse response of monetary shock on exchange rate shows that innovation in reserve money has an initial negative impact on exchange rate which is reversed after few quarters. However, overall impact of monetary policy shock on exchange rate is insignificant. Impulse response of foreign price shows that a positive shock in foreign price has a significant impact on domestic price level within first few quarters, but eventually the impact gets weaker. Foreign price shock also has negative impact on exchange rate which becomes significant within few quarters. An increase in foreign price level probably reduces import demand which eventually strengthens domestic currency. Foreign price shock has an insignificant impact on GDP without any trend. Impulse response of foreign GDP shows that, a positive shock in foreign GDP has a significant positive impact on domestic GDP. Thus, Economic performance of OECD countries has some impact on growth performance of Bangladesh. Foreign GDP shock also has positive impact on domestic price level and exchange rate. Innovation in exchange rate has a significant positive impact on GDP that is consistent with open economy macroeconomics that currency depreciation may increase GDP through an increase in AD due to increase in net export. Innovation in exchange rate also gradually enhances domestic price level as expected.

FIGURE 1: IMPULSE RESPONSE OF MONETARY POLICY AND EXTERNAL SHOCKS ON DOMESTIC PRICE, OUTPUT AND EXCHANGE RATE



1= Reserve money (MB), 4 = Foreign price (FP), 5 = Foreign GDP (FGDP), 6 = Exchange rate (ER)

Central bank of Bangladesh attempts to control reserve money to achieve particular target of broad money (M2) growth with the assumption of a stable money multiplier. However, unit root test of money multiplier suggests that, money multiplier in Bangladesh is non-stationary. Thus, there may not be a stable relationship between reserve money and money supply. As a sensitivity test of monetary and other shocks in the economy we also estimate the SVAR model and the corresponding impulse response using M2 as the monetary policy variable. Impulse responses are shown in the appendix A2. Impulse responses show that shocks in money supply has significant positive impact on both price and output. Impact of shock of foreign price on domestic price level is positive and even more significant compared to that in the estimated model with reserve money as the monetary policy variable. As before, foreign price has no significant impact on domestic GDP. However, foreign price has a

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stronger negative impact on exchange rate. Impact of foreign GDP shock on domestic price level, GDP and exchange rate remains same as before. However, impact of exchange rate shock on GDP and price level is now insignificant. On the whole, shock in monetary aggregate has stronger impact on the economy and the external shocks also shows somewhat stronger impact on the relevant variable when monetary aggregate is used as the monetary policy variable. Thus, if the monetary authority can control money supply using different instruments, it can achieve stronger policy outcome in the expected direction.

Comparison with Impact of Monetary Policy Shock in a Closed Economy

Figure (2) compares the impulse response of reserve money shock on price and output in an open economy to those of a closed economy. The closed economy SVAR model is estimated with reserve money, price level and output treating foreign price and foreign GDP as exogenous variables[2]. Impulse responses of the monetary policy shock in the closed and open economy SVAR models are shown together in Figure 2. It is quite evident that monetary shock produces much smaller response in price in the open economy model compared to that in the closed economy model. Monetary shock produces an initial negative spike in GDP in the closed economy model whereas response of GDP is positive in the open model right after the monetary shock. Similar to impact on price level, overall response of monetary shock on output is smaller in the open economy model compared to that in the closed economy model. Appendix table also shows that impulse response of shocks in reserve money on price is significant in the closed model. Similarly, impulse response on GDP becomes significant with a short lag. In contrast, we have seen in the figure (1) that although monetary policy has a stimulating effect on both price and output, they lack statistical significance. Thus, the responses of monetary policy in stimulating price and output in the closed economy model controlling for external shocks are much stronger compared to that in the open economy model. This is also consistent with textbook results of open economy macroeconomics where open economy multiplier impact of domestic shock is smaller to that in the closed economy under fixed exchange rate. In Bangladesh there was fixed exchange rate regime until 2003. Although the country then moved to "floating" exchange rate regime, exchange rate was not totally flexible because of the intervention of the central bank. Consequently open economy just reduces the effectiveness of monetary policy to some extent.

FIGURE (2A): IMULSE RESPONSE OF RESERVE MONEY SHOCK ON PRICE LEVEL

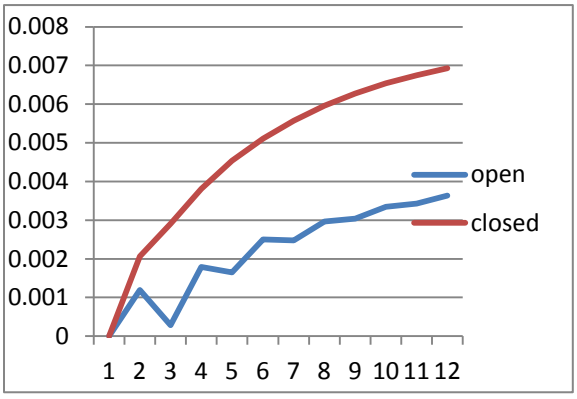
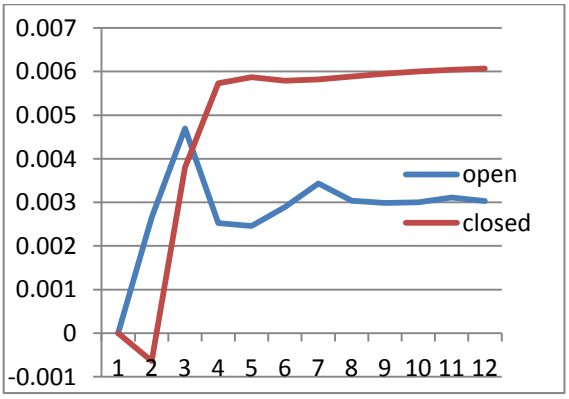


FIGURE (2B): IMULSE RESPONSE OF RESERVE E MONEY SHOCK ON GDP



Variance Decomosition of Forecast Error

Table 2 shows the relative importance of external and internal shocks in explaining variations in domestic price and output in terms of variance decomposition of forecast error out of the estimated SVAR model. It is quite evident that foreign price has the most important weight in domestic price variation. Weight of monetary base

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increases with time but it remains lower than that of foreign prices. Exchange rate variation play marginal role in variation of price level. On the other hand, variations in both monetary base and exchange rate have reasonable weights in explaining variation of GDP and these weights increase with time. Weight of foreign GDD in explaining variation in domestic GDP increase with time and after one year it appears as the dominant shock explaining variation in output. Foreign price shock is important for short term impact on GDP variation, but it loses its weight with time horizon. External shocks out of foreign GDP and Foreign price level appear as more important than the shocks in monetary policy in variation of domestic price level and output.

TABLE 2: VARIANCE DECOMPOSITION OF FORECAST ERROR

Variance decomposition of Price (%)

Quarter	MB	P	GDP	FP	FGDP	ER
2	1.22	73.13	1.87	22.54	1.13	0.09
4	2.66	64.38	5.05	23.47	3.73	0.71
8	6.70	51.63	12.92	18.97	6.43	3.35
12	10.82	40.49	18.97	14.88	7.62	7.22

Variance Decomposition of GDP (%)

Quarter	MB	P	GDP	FP	FGDP	ER
2	0.63	0.16	90.28	6.19	0.69	2.05
4	2.19	3.26	68.67	5.79	9.02	11.06
8	4.51	2.38	56.95	3.85	19.03	13.29
12	7.51	1.78	52.05	2.81	22.20	13.70

CONCLUSSION

The paper estimates a structural VAR model to examine the impact of monetary policy and external shocks in the economy of Bangladesh using quarterly data of 25 years. Estimated monetary policy reaction function finds that monetary authority rightly tightens monetary policy with positive shocks in price level and exchange rate. Impulse response functions show that monetary policy and exchange rate shocks affect price level and output in right direction. An innovation in reserve money and exchange rates has a positive impact on price and output. However, impact on price level is less significant. Impact of exchange rate shock becomes more important only with time. On the other hand external shocks seem to have more prominent impact on the domestic economy. Shocks in foreign price have an immediate positive impact on domestic prices. Innovation in OECD GDP also has significant impact on domestic output. Variance decomposition exercise shows that external shocks weight more in explaining variation in domestic price and output compared to the monetary policy. Furthermore, effectiveness of monetary policy in our open economy version seems to be lower compared to that in a closed economy version of the economy. Hence, impact of domestic (monetary) policy shock is partly diluted in the open economy version of the SVAR model of Bangladesh.

Thus, while monetary policy has its impact on desired direction, external shocks are of much importance in explaining variation in domestic price and output. While monetary tightening would be the right policy in controlling inflation, this may not always bring high success if the external factors are not favorable. Bangladesh has very recently moderated its inflation which is somehow credited to tight monetary policy. However, our study has the implication that recent fall in international prices also had positive impact in this regard. Similarly, innovation in

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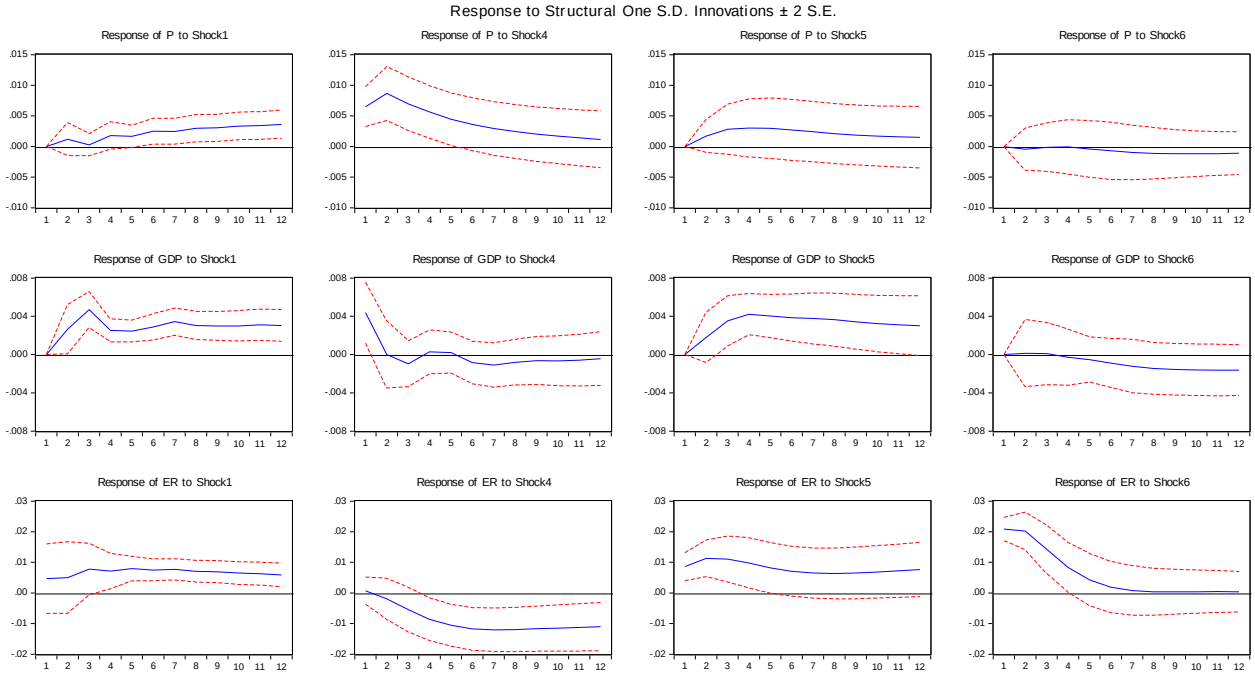
OECD GDP has positive impact on GDP of Bangladesh. Thus, global recovery may have a positive stimulus to GDP growth of the country.

APPENDIX

Appendix A1: Data and Construction of Variables

In the recent years various money market instruments have been introduced to control money supply, and interest rates on these instruments are important in controlling monetary base. However, data on these 'policy rates' are available for relatively short span of time. Hence we use monetary base or reserve money as the monetary policy variable. We use CPI (1995-96 base) as the index of price level. Foreign price index is constructed as the weighted average of CPI of the major import partners. A measure of nominal effective exchange rate has been be constructed by taking trade weighted measure of bilateral exchange rate of Bangladesh with major trading partner. The study used quarterly data of all the required variables to examine impact of monetary policy and external shocks in the domestic economy. However, quarterly data on GDP is not available. An measure of quarterly GDP is constructed using the following procedure. Monthly data on quantum index of industrial production is available from BBS. By applying quarterly growth of this index to the annual data on industrial GDP, we figured out quarterly data on industrial GDP. In the service sector, there is not much reason for existence of seasonality. However, there may be cyclical effect on this sector related to the overall economic condition of the economy. Using the background input-output model of the SAM 2007, we calculated the backward linkage factor of the industrial sector with the service sector. We then assume that quarterly variation in industrial production will be transmitted to service sector in proportion to backward linkage factor. Agricultural production is least effected by cyclical behavior and it has its own seasonal pattern. Moreover, it has lag period between production decision and actual production. Agriculture counts only less than one fifth of GDP. Considering all these, we just divide the annual agricultural production among the four quarters using the quarterly growth factor estimated from its annual growth. We then combine these estimates of quarterly data on sectoral disaggregates to have estimate of quarterly GDP. Data sources are IMF, Bangladesh Bank and the BBS.

Appendix A2: Impulse Response of SVAR model with money supply (m2) as the monetary policy variable



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Appendix A3: SVAR estimate for the Closed Economy

Structural VAR Estimates
Date: 02/16/15 Time: 12:57
Sample (adjusted): 1990Q3 2013Q4
Included observations: 94 after adjustments
Estimation method: method of scoring (analytic derivatives)
Convergence achieved after 6 iterations
Structural VAR is just-identified

Model: Ae = Bu where E[uu']=I
Restriction Type: short-run pattern matrix

A =

1	C(1)	C(2)
0	1	C(3)
0	0	1

B =

C(4)	0	0
0	C(5)	0
0	0	C(6)

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	-0.782222	0.277665	-2.817140	0.0048
C(2)	-0.424862	0.243977	-1.741402	0.0816
C(3)	-0.142188	0.089434	-1.589870	0.1119
C(4)	0.044199	0.003224	13.71131	0.0000
C(5)	0.016418	0.001197	13.71131	0.0000
C(6)	0.018935	0.001381	13.71131	0.0000

Log likelihood	652.2023

Impulse Response of Monetary Policy Shock in

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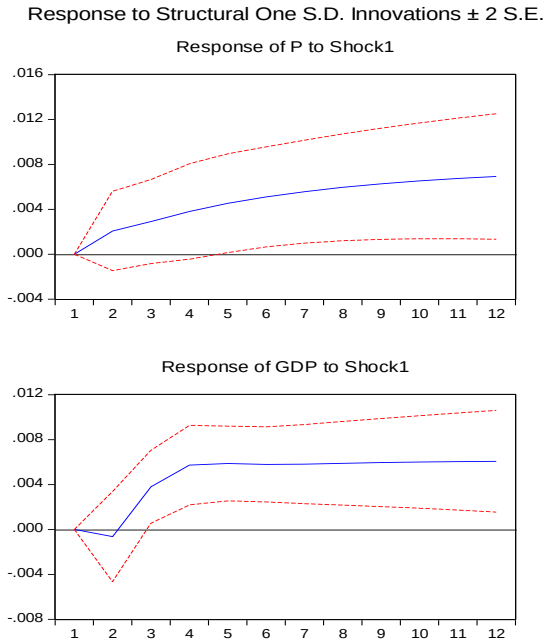
Closed Economy



Shock 1 = Shock in reserve money

END NOTES

[1] Data sources and construction of variables are described in Appendix

[2] Closed economy version of SVAR model takes reserve money, price and GDP as the data vector. Identification scheme with these three variables gives a 3X3 principal sub-matrix out of the above 6X6 matrix of contemporaneous coefficients and restrictions. See appendix A3.

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