Output Decomposition and the Monetary Policy Transmission Mechanism in Bangladesh: A Vector Autoregressive Approach

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Abstract

This paper investigates the output composition of the monetary policy transmission mechanism for Bangladesh. Vector Auto-regression (VAR) models are used to analyse the data from 1973 to 2015. Although the central bank's policy interest rate shock does not significantly affect the major compositions of the output, investment channel still works better than consumption. However, exchange rate shock effects more significantly on the real economy mainly through consumption than investment. This research, on one hand, demonstrates the potential channels of the monetary policy transmission mechanism. On the other hand, methodologically, it proposes a minor modified model that suite for economy of the developing countries like Bangladesh where the net export component of output is negative which creates some complexity in using the standard model used for developed countries like the USA, the EU, Japan and Australia.

1. Introduction

The central bank of Bangladesh, the Bangladesh Bank (BB) focuses on the "Star Model" of monetary policy that concerns about inflation, growth, exchange rate, interest rate and money supply (BB, 2016). Bhuiyan (2013) argues that in Bangladesh a contractionary policy shock increases the real interest rate, appreciates domestic currency, and decreases both inflationary expectations and output. Alam (2015) reveals that increasing the policy interest rate decreases output, and appreciates local currency, however, pushes the price level to increase. According to his findings, the above-mentioned impacts are statistically insignificant, meaning that,

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monetary policy cannot control short run economic fluctuations for the economy. He also claims that 'prevalence of microcredit' and 'government domestic borrowing' may deteriorate the effectiveness of this policy. On the other hand, Maroney et al. (2004) claim that monetary policy plays a better role than fiscal policy in accelerating the economic growth of Bangladesh. This statement is supported by other research conducted by Hasan et al. (2016).

Although some research works on the monetary transmission mechanism of Bangladesh is available in the literature, no research has paid attention to the output composition method for finding out the major channel of that mechanism in Bangladesh. Therefore, to fill this gap, the research question of this paper is: *What is the more effective channel between the consumption and the investment for the monetary policy transmission mechanism?*

There are various kinds of unavoidable complexities to be faced in conducting research about the transmission mechanism in lower income countries (Mishra and Montiel, 2013). However, as in developed countries, output decomposition technique would still help to explain the insight of the country-specific empirical economic traits and could demonstrate the effective channel of monetary policy transmission mechanism in Bangladesh. This kind of analysis would also help to identify the effective underlying procedures of the monetary policy shocks to the particular real sectors of the country.

The remainder of the paper is arranged as follows: Section 2 reviews the available literature; Section 3 explains about the data with statistical description; Section 4 describes the methodology used in this research along with short reviews of the methodological literature; Section 5 analyses results and discusses with economic intuition, and Section 6 concludes.

2. Literature review

Monetary policy affects the real economy mainly through the interest rate and exchange rate (Obstfeld & Rogoff, 1995). Supporting this views, Bhuiyan (2013) asserts that monetary policy shocks transmits to the real output through both interest rate and exchange rate in Bangladesh. The central bank's policy interest rate is the major instrument of the monetary policy in inflation-targeting central banks and its increase push GDP to decline (Sims, 1980; Bernanke & Blinder, 1992; Eichenbaum, 1992; Leeper & Gordon, 1992; Christiano et al., 1999). On the demand side of the goods and services market, this policy instrument works

with two major channels: consumption and investment. The first indicates to decline in current private consumption due to wealth effects or inter-temporal substitution by consumers (Boivin et al., 2010). Whereas, the later channel is linked with the cost of capital increasing, or a fall in the market value of firms, followed by a decline in the private investment level.

Theories regarding the consumption smoothing and investment volatility advocate that compared with consumption, investment is more powerful to changes in monetary policy. Investment is likely to react more strongly to a monetary policy shock than consumption, and therefore the investment channel is stronger than the consumption channel. However, empirical evidence on the relative importance of the consumption and investment channels seem to vary by country. Using VAR and dynamic stochastic general equilibrium (DSGE) models Angeloni et al. (2003) assert that the main transmission channel in the Euro area is the investment on the contrary consumption channel plays the major role in the USA. They place emphasis on the 'output composition puzzle' for the USA case. Still in the USA household spending is the main contributor to real GDP growth (Fischer, 2016).

Using similar VAR models, Fujiwara (2004) demonstrates that the situation of Japan lies somewhere between the Euro area and the US cases, but the investment channel works better for the transmission mechanism of monetary policy shocks. Considering the size effects, Phan (2014) also finds that in Australia investment channel plays a more important role than the consumption channel, while the contributions of the two channels are indistinguishable in the Euro area and the USA.

3. Data and statistical descriptions

Canova (1995) strongly recommends that variable choices must be verified and substantiated before the results are discussed. With a similar view, Amisano and Giannini (1997, p.136) argue that in the VAR analysis of transmission mechanisms, choosing a variable set is a major problem however, this choice should reflect the institutional features of the economy. Therefore, this institutional setting of the monetary economics of Bangladesh, which like the rules of the game, effects the agents' strategies and therefore have effect on the payoff of the market. It is very difficult considering the time and scope constraints to accumulate the quarterly consistent data of the consumption and investment. Therefore, in this research yearly data from 1973 to 2015 is used.

Considering the theoretical grounds, literature and the base economic sectors of GDP growth of Bangladesh, eight variables are used for the two baseline specifications and other two alternative specifications. The household consumption (cons), investment (i), import (im), GDP deflator(p), total bank credit (tc) and central bank's policy rate (r) are collected from International Financial Statistics, (International Monetary Fund (IMF) 2016) while exchange rate (ex) is from World Bank (2016). Other remaining output (y) is calculated by deducting the consumption and investment while adding the import with GDP. There is no seasonally adjusted data available in the IMF or other sources for Bangladesh whereas consumption and investment data is available only on a yearly basis. Consumption data usually contains some seasonality effects however to address this issue and for easy to interpretation data in logarithm form is use.

The data sample "Gross Capital Formation, Gross Fixed Capital Formation, Corporations, Households, and Non-profit Institutions Serving Households Nominal, National Currency" (IMF, 2016) is used as the "investment". The trends of the "Gross Capital Formation" of IMF as a percentage of the GDP is almost same as central bank's historical data (Bangladesh Bank, 2016 (a)) available from 1989-90. However, as the consumption data is on average 5 percent lower than the central bank's data. For maintaining consistency IMF's consumption data are used.

It is found that the nature of the output decomposition data of Bangladesh is quite different from Australia, Japan, and the USA's data. For these three countries, the "other GDP" component (after deducting "cons" and "i") which is used in the literature is positive. However, for Bangladesh, it becomes negative for some years with a very large standard deviation. Due to the bigger volume of the import compared to the export, net export becomes negative. However, the current account is still positive due to the higher remittance as it is included as the other income in the balance of payments. Considering the issues of the negative value, which generates missing figure when it transformed in logarithm, the import (im) is used in the model.

4. Methodology

In the macroeconomic research after the initiation of Sims (1980), VAR, is a broadly used model to assess the impact of independent monetary policy shocks on other macroeconomic variables such as output, inflation, and exchange rate. The structured VAR is used for

developed countries such as USA in a study by Christano et al. (2000), for G7 countries by Kim and Roubini (2000), and for Euro region by Peersman and Smets (2003). Leeper et al. (1996) allow a non-recursive formation while Christiano et al. (1999) and others utilise recursive arrangements in the identification of monetary policy shocks. Some summaries of the literature of using parametric restrictions in identifying shocks for VAR models can be found in papers by Canova (1995), Bagliano and Favero (1998) and Christiano et al. (1999). A recent non-parametric strategy in identifying shocks emerges using sign restrictions, of which a review can be found in Fry and Pagan (2011). The early monetary policy literature of Bangladesh including Chowdhury (1995), Younus (2004), Ahmed and Islam (2006) use the VAR approach.

With Japanese data, Fujiwara (2004) investigates about effective channel for the monetary transmission mechanism with five VAR models separated based on the literature of Leeper et al. (1996), Christiano et al. (2001), Erceg and Levin (2002), and Peersman and Smets (2003). Whereas Phan (2014) investigates with four models used in the works of Peersman and Smets (2003), Christiano et al. (2005) and Erceg and Levin (2006).

Considering the scope and data availability for Bangladesh, this paper uses two unrestricted VAR models in order to examine the effectiveness of the particular channel of the monetary transmission mechanism each for interest rate and exchange rate shocks. This unrestricted model assumes that the system is recursive and hence the Cholesky decomposition is employed for identification. Two non-recursive identification strategies that are recommended by Sims and Zha (1998) and Kim and Roubini (2000) are also used by imposing restrictions on the contemporaneous parameters considering the conditions of a small open economy of Bangladesh. All models are also used to check the robustness of the impulse responses with different ordering. For panel data Stata works better however, for time series data Eviews is also handy hence this paper used later statistical software.

4.1 Baseline models: recursive identification

Following the reviewed literature it is assumed that consumption is not contemporaneously affected by the any other variables while investment is affected contemporaneously by the consumption (*cons*) shock. Import is affected contemporaneously by consumption and investment (*i*). The remaining part of the output (*y*), mainly the export is contemporaneously affected by the consumption investment and import whereas GDP deflator (p) as a proxy variable of the price index is affected by the all aforementioned variables' shock. Central

bank's policy interest (*r*) along with consumption, investment, remaining output (export and government expenditure) and GDP deflator contemporaneously affects the credit market. However, except the total credit (tc), all other variables' shocks are contemporaneously effects central bank's policy interest rate. Therefore, using the Cholesky decomposition, the relationship between the reduced form errors and the structural disturbances for the baseline recursive VAR specification-1 would be shaped as the following matrix form:

$$\begin{bmatrix} U_{lcons} \\ U_{li} \\ U_{lim} \\ U_{ly} \\ U_{lp} \\ U_{r} \\ U_{tc} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ t_{21} & 1 & 0 & 0 & 0 & 0 & 0 \\ t_{31} & t_{32} & 1 & 0 & 0 & 0 & 0 \\ t_{41} & t_{42} & t_{43} & 1 & 0 & 0 & 0 \\ t_{51} & t_{52} & t_{53} & t_{54} & 1 & 0 & 0 \\ t_{61} & t_{62} & t_{63} & t_{64} & t_{65} & 1 & 0 \\ t_{71} & t_{72} & t_{73} & t_{74} & t_{75} & t_{76} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{lcons} \\ \varepsilon_{li} \\ \varepsilon_{lim} \\ \varepsilon_{ly} \\ \varepsilon_{lp} \\ \varepsilon_{r} \\ \varepsilon_{tc} \end{bmatrix}$$

The second baseline model (specification-2) is used for exchange rate shock. The exchange rate (ex) variable will place at the last order of the variables after bank's total credit (tc) in the similar matrix as aforementioned matrix of specification-1. All the variable is used in logarithm term except the interest rate. The underling logic is that as x is close to the zero, log (1+x) ≈ x. Moreover, interest rate change would be interpreted in the percentage point change as well.

4.2 Non-recursive Identification

The non-recursive identification strategy recommended by Sims and Zha (1998), and Kim and Roubini (2000), imposes restrictions on the contemporaneous parameters T, which are modified in light of the macroeconomic context.

Following the macroeconomic condition of the Bangladesh two non-recursive identifications are structured. The structural matrix for the specification-4 (Short run pattern matrix of the identification 3 and 4 are explained in Appendix) is then constructed as follows:

$$\begin{bmatrix} U_{lcons} \\ U_{li} \\ U_{lim} \\ U_{ly} \\ U_{lp} \\ U_{r} \\ U_{tc} \\ U_{ex} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ t_{21} & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ t_{31} & t_{32} & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & t_{42} & 0 & 1 & 0 & 0 & 0 & 0 \\ t_{51} & t_{52} & t_{53} & 0 & 1 & 0 & 0 & t_{58} \\ t_{61} & t_{62} & t_{63} & t_{64} & 0 & 1 & 0 & t_{68} \\ 0 & t_{72} & t_{73} & 0 & 0 & t_{76} & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & t_{87} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{lcons} \\ \varepsilon_{li} \\ \varepsilon_{lim} \\ \varepsilon_{ly} \\ \varepsilon_{lp} \\ \varepsilon_{r} \\ \varepsilon_{tc} \\ \varepsilon_{ex} \end{bmatrix}$$

For example, since the depreciation of the Bangladeshi currency causes an inflationary pressure, and a key objective of the Bangladesh Bank is to maintain a stable price level, like Bhuiyan (2013), this paper also assumes that the central bank contemporaneously responds to the exchange rate. Furthermore, following the arguments of Akhtaruzzaman (2005), it is assumed that exchange rate fluctuation effects the inflation in Bangladesh. Therefore, t_{58} and t_{68} are identified.

4.3 Unit root test

It reveals that the model satisfies the stability condition as all the eigenvalues lie inside the unit circle and that reveal that both VAR models satisfy the stability condition.

4.4 Lag selection

Usually Akaike Information Criterion (AIC) or Schwartz Bayesian Information Criterion (SBIC) is used to decide about lag length. However, considering the sample size and its frequency (yearly basis), this paper uses one lag following the SBIC. Because, the SBC chooses the most parsimonious model (Enders, 2010) and for low order VAR processes, the SBC does quite well in terms of choosing the correct VAR order and providing good forecasting models (Lutkepohl,1985).

5. Main findings

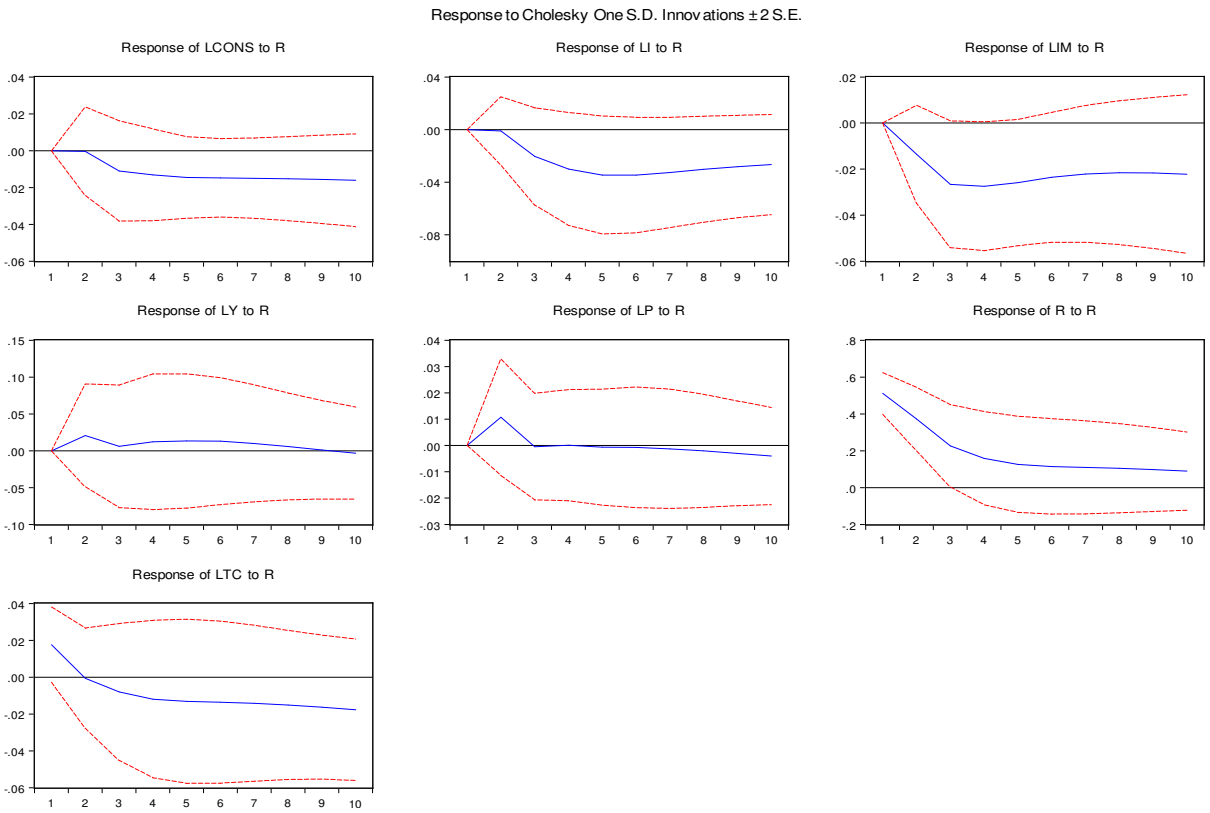
Although all variables (except the interest rate) are in logarithm form that are nonstationary however, the shocks are stationary (Figure 5 in Appendix).

5.1 Baseline model: recursive identification

It is found that for both the central banking policy rate and the exchange rate, as the "Star Model" of monetary policy shocks, both have a negative impact on consumption while interest rate shock leads consumption decrease very slowly, exchange rate shock effects rapidly. As per the interest rate shock (see in Figure 1), 0.51 percentage point increase in interest rate leads to decrease in both consumption and investment. Investment decreases by approximately 3.5 to 7.9 percent at peak whereas consumption deceases by approximately 1.6 to 4.1 percent at peak. Hence, in the sense of elasticity, interest rate shock works through the investment channel better than through the consumption channel.

Central bank's policy interest shock impacts on output through the investment channel is on average more than 2 times bigger than consumption channel. However, if we consider the "size effect" that is, weight of these two components, the total impact on the consumption within the economy would be higher than investment as the volume of consumption is on average 3 times weighted than investment in Bangladesh.

Figure 1: IRFs of the VAR Model Specification-1



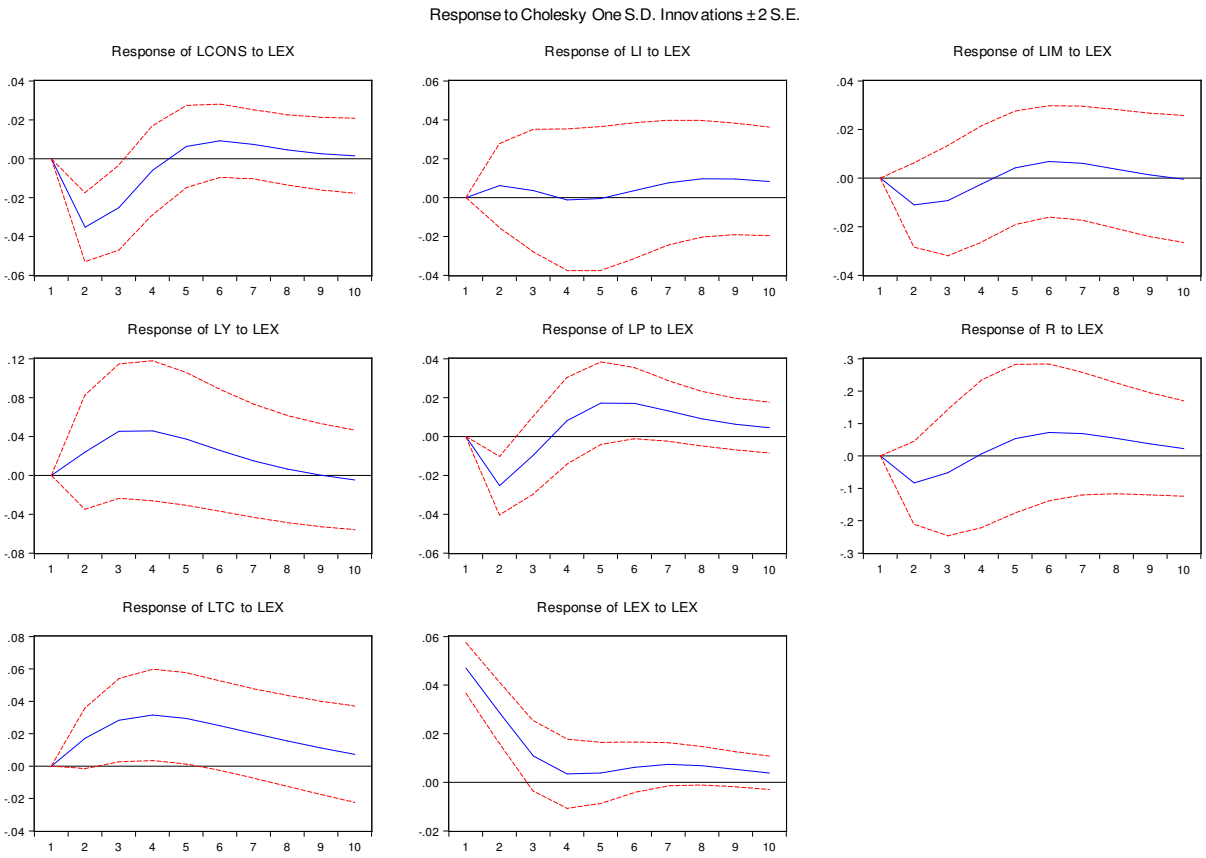
The response of the GDP deflator indicated that price increases in the short run by 1.1 to 3.3 percent in the second year and returns to the steady state level by end of the year. Import decreases by 2.7 percent in peak which may explain with economic intuition. The major economic foundation of the output in Bangladesh is manufacturing sector which needs huge import technology, machinery, equipment as well as materials and semi produced goods. Import also liked with the consumption as the major urban-household goods are imported. However, initially bank credit increases but starts to decrease from the following year of the shock. It indicates some underling linking with the lagging responses of the consumption and investment which would indicate that the cost of continuing same level of the consumption and investment, in the context of instant increase in the price (GDP deflator) as a response of

the interest rate shock, may adjusted with initially by increasing credit. However, it is also theoretically intuitive as credit returns back to the steady state and further decreases starts from the second years.

For checking the robustness of the results, 4 lags, that referred by other information criteria, has been imposed in the specification-1. Results (Figure 6, Appendix) reveals that fluctuation of the investment is still higher than that of the consumption however it variables are converse to the steady state.

It has to be mentioned that the interest rate shock does not have any statistically significant impact on the fluctuation of the other variables except the import. However, Granger causality test confirms that exchange rate shock is statistically significant (means reject the H_0) for the fluctuation in the consumption, price level both at 0.1 percent significant level while for the total credit null hypothesis is rejected at 10 percent significant level (details in Table 1 in the Appendix).

Figure 2: IRFs of the VAR Model Specification-2



On the other hand, an increasing in USD rate (see in Figure 2) meaning that depreciation of the local currency makes it depreciated by 4.7 percent initially (first year), leads decreases in the consumption rapidly started from first year peaked at 3.5 to 5.3 percent in the middle of the following second year but returned to the steady state level with slower pace. Investment slightly increases in the following year and comes back at its steady state level. Since the unrestricted VAR is on a reduced form, therefore, uninterpretable without "reference" to theoretical economic structures (Bjornland, 2000). Following this argument, the effects on investment would be explained with the underlining economic theories. The short term positive increases of the investment intuitively indicates that increasing in the export due to the depreciation of the local currency requires some more investment in the short run. This shock also leads import, GDP deflator and interest rate to fall but credit increases by 3.2 percent in peak. It effects hugely to the remaining GDP (y), which includes export, by 4.6 to 11.8 percent in peak. Following the literature (for example, Paul, 2015), the output of India is used as an exogenous variable to check the robustness of the result but results (Figure 9 in Appendix) are almost same as of the Speciation-2.

Overall, the exchange rate policy shock works better through the consumption channel compared to the investment channel. As data is on a yearly basis, and as the central bank's policy interest rate is set on a half yearly basis, however, after 2003 it remains constant at 5 percentage level, therefore, comparatively, exchange rate shock would be better interpreter.

Although present research also founds similar results like the other researchers' (Bhuiyan, 2013; Alam, 2015) claims that central bank policy shock effect on the real economy very insignificantly, however, comparing the two major channels, the investment channel still responds better. Exchange rate affects consumption, which is statistically highly significant.

5.2 Variance decomposition

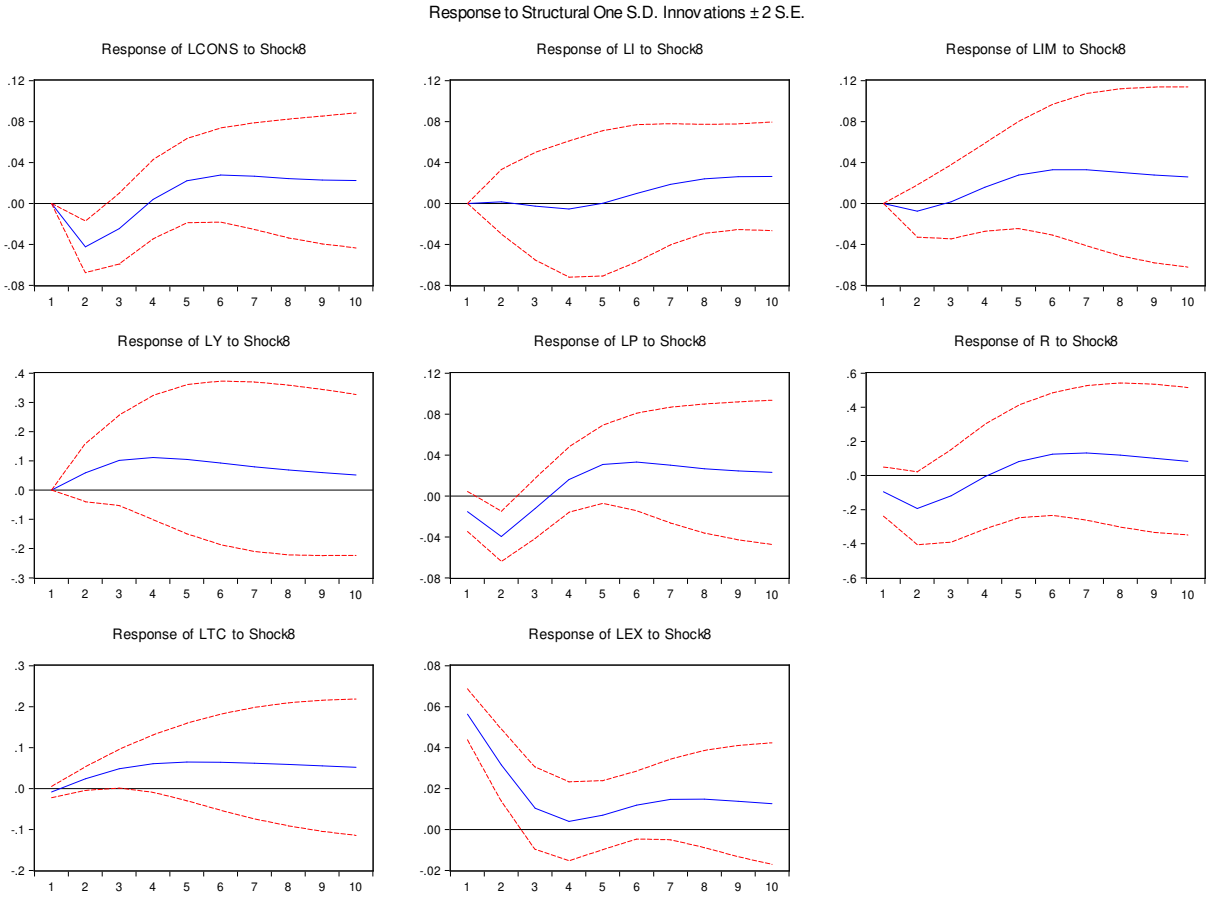
The variance decompositions show that the interest rate and the exchange rate consumption contributes in comparatively bigger. In the model specification-2 the fluctuation in consumption, investment, consumption and other remaining part of GDP are explained mostly by consumption (Figures 6 & 7 in Appendix).

5.3. Alternative model: non-recursive identification

The alternative non-recursive model also used with variables in a changed order as well modifying the baseline VAR model to check the robustness of the models.

The results of the non-recursive identifications do not provide any additional major results. For the alterative specification of the first specification for policy rate shock, specification-3 (Figure 10 in Appendix) provides almost similar result however, as an alternative specification of specification 2, specification-4 (see Figure 3 and in Appendix, table 2) also provides similar result with interest rate and price is more sensitive while investment and imports are less responsive compare to in the specification 2.

Figure 3: IRFs of the VAR Model Specification-4



6. Conclusion

Output decomposition technique still helps to explain the insight of the country-specific empirical economic traits and to demonstrate the effective channel of monetary policy transmission mechanism in Bangladesh. Although the central bank's policy interest rate shock could not significantly impact on the major compositions of the output, investment channel still works better than consumption. However, exchange rate shock effects more significantly on the real economy mainly through consumption channel then investment

channel. The sensitivity of the major GDP components to the both interest rate and exchange rate in Bangladesh, which are uncovered in this research, may recommend to consider for more effective “Star Model” of the monetary policy.

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Appendix:

Table 1: VAR Granger Causality/Block Exogeneity Wald Tests results

		Excluded Chi-sq	df	Prob.
Dependent var: LCONS				
	R	0.339024	1	0.5604
	LEX	19.38114	1	0.0000
Dependent var: LIM				
	R	3.787237	1	0.0516
Dependent var: LP				
	R	0.003337	1	0.9539
	LEX	13.17924	1	0.0003
Dependent vare: LTC				
	R	1.849694	1	0.1738
	LEX	3.488216	1	0.0618

Figure 5: Residuals of the variables

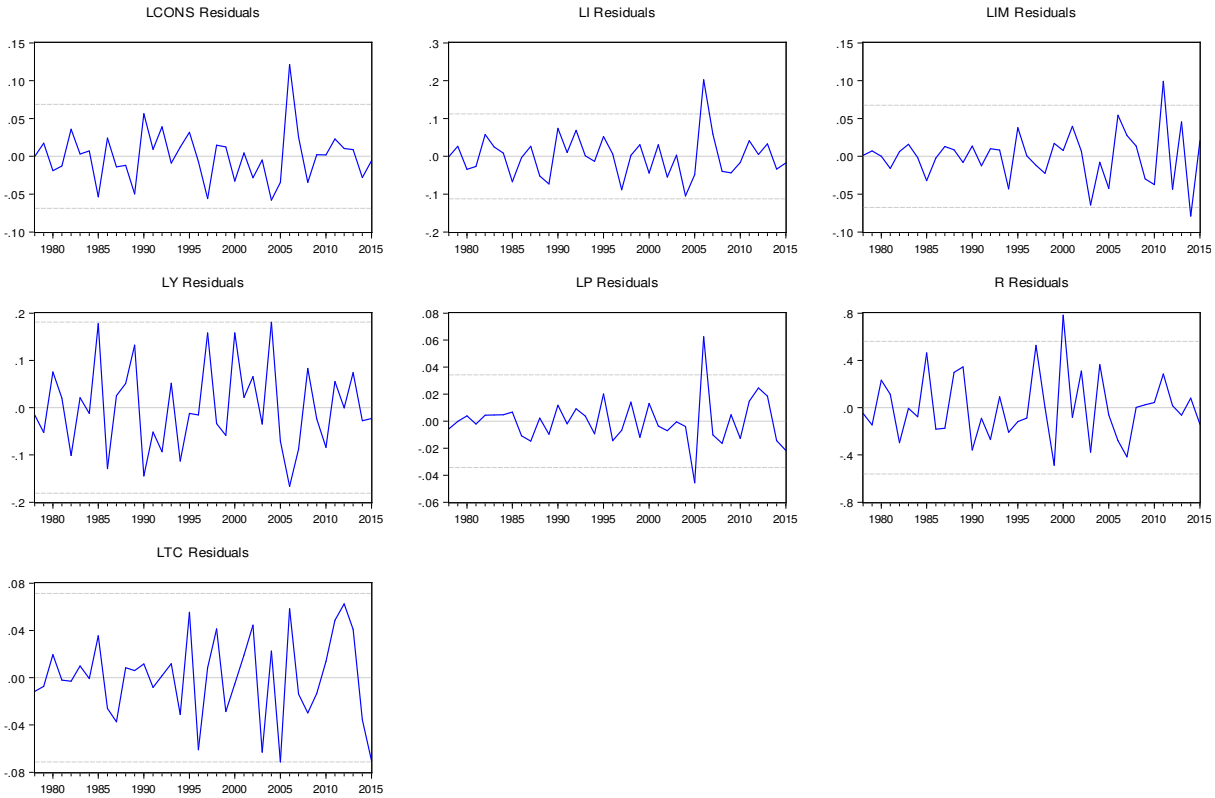

Figure 6: IRFs of the Model Specification 1 with 4 lags

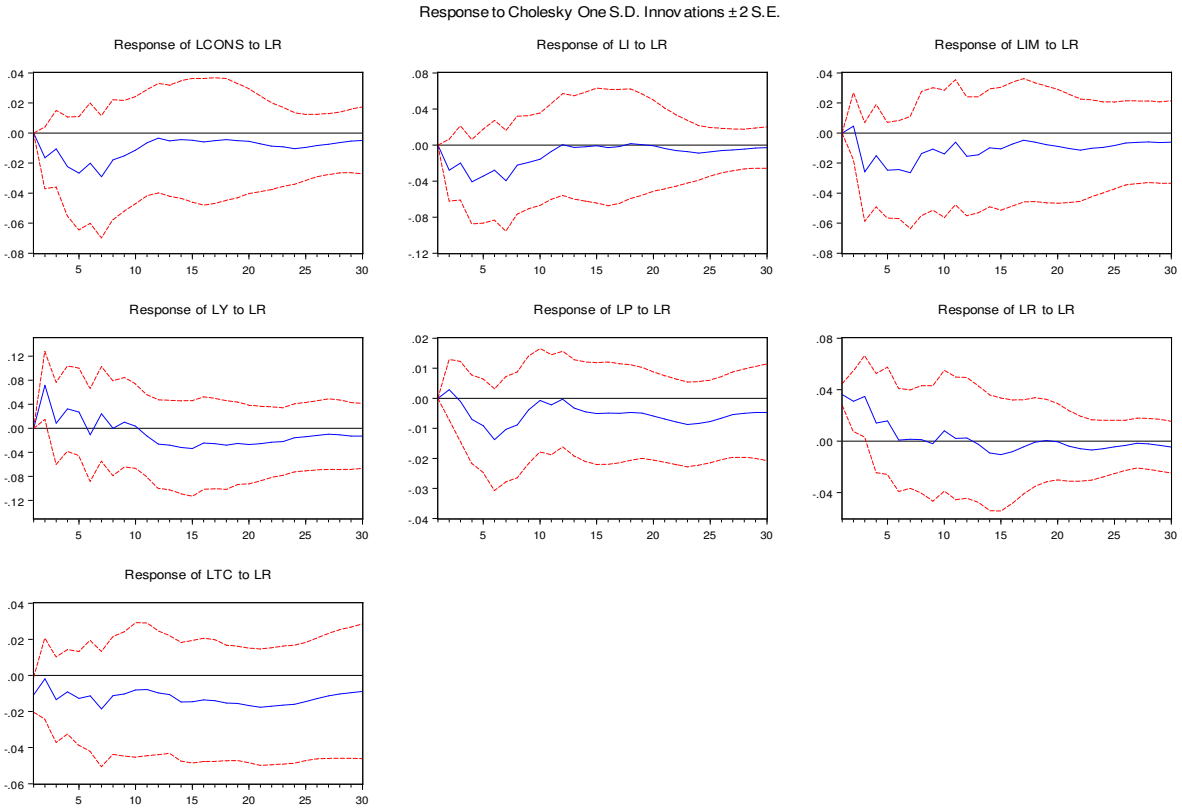

Figure 7: Variance Decomposition of the Model Specification-1

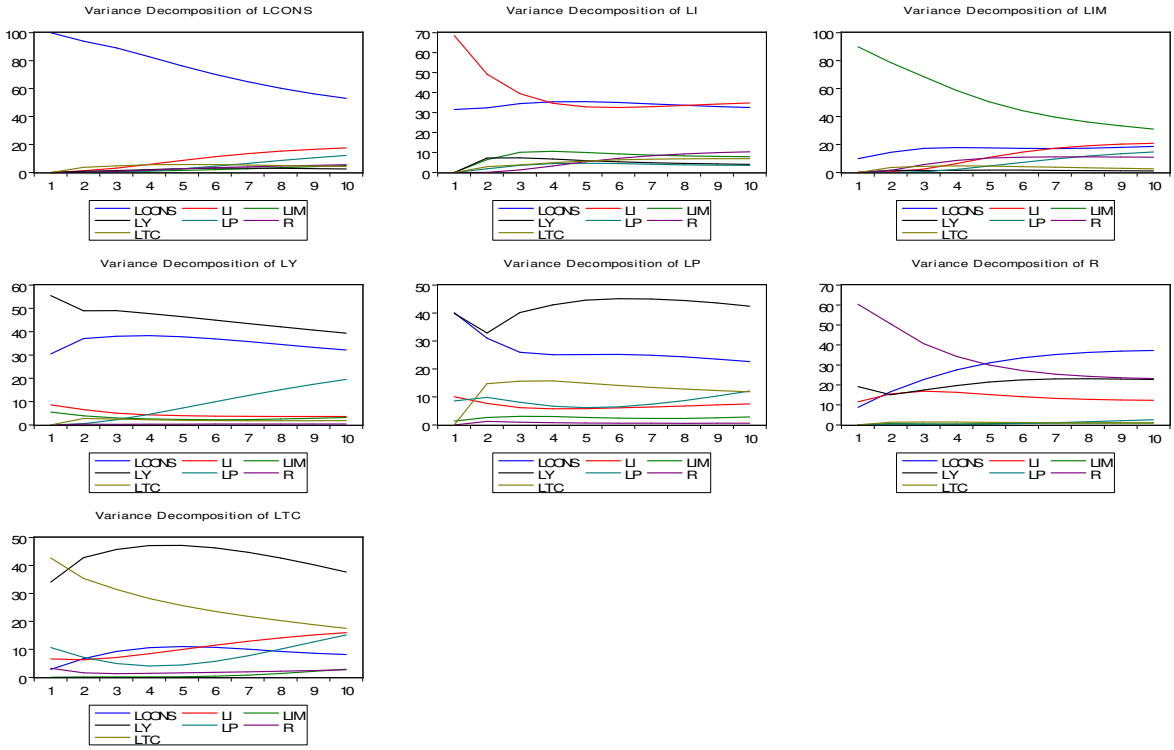

Figure 8: Variance Decomposition of the Model Specification-2

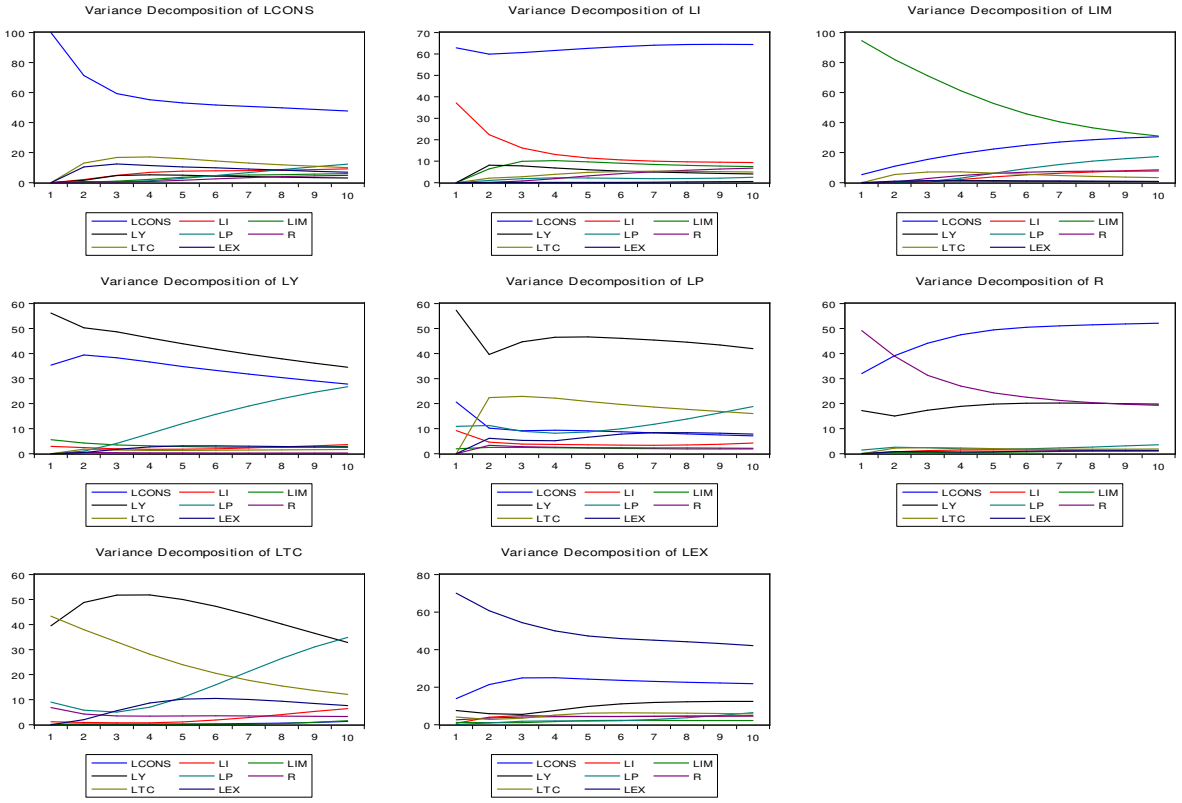

Figure 9: IRFs of Model Specification 2 with India's GDP as an exogenous variable

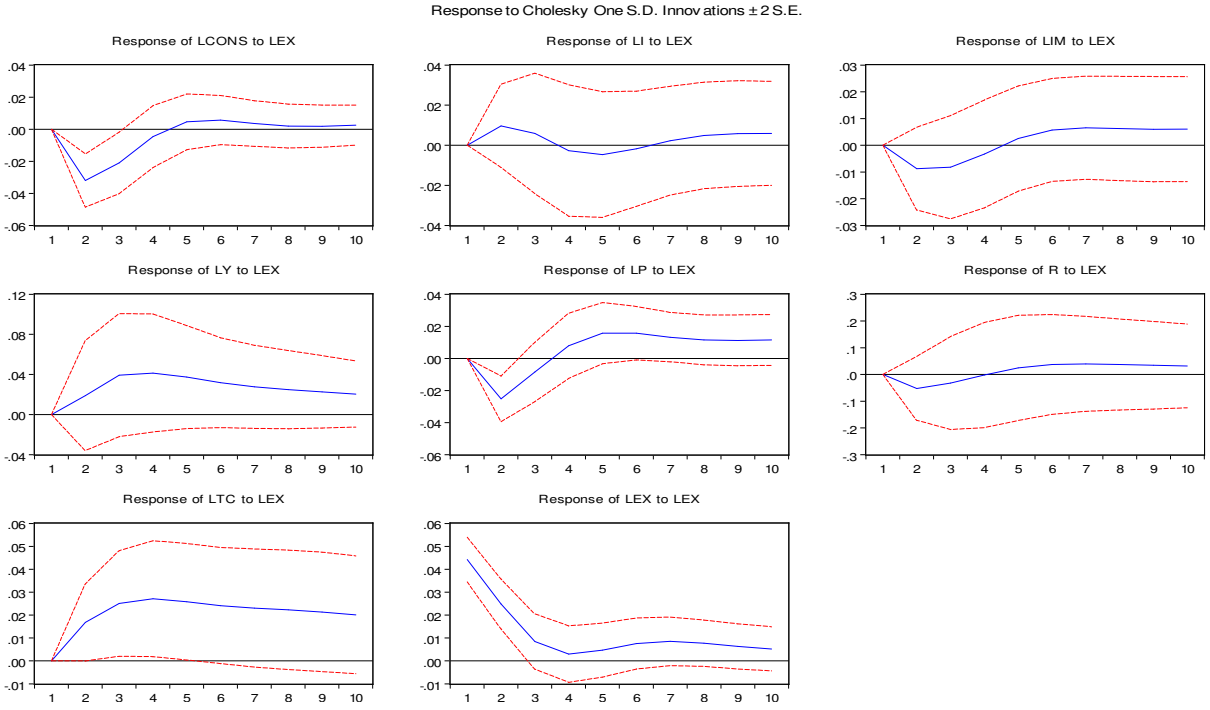

Figure 10: IRFs of the VAR Model Specification-3

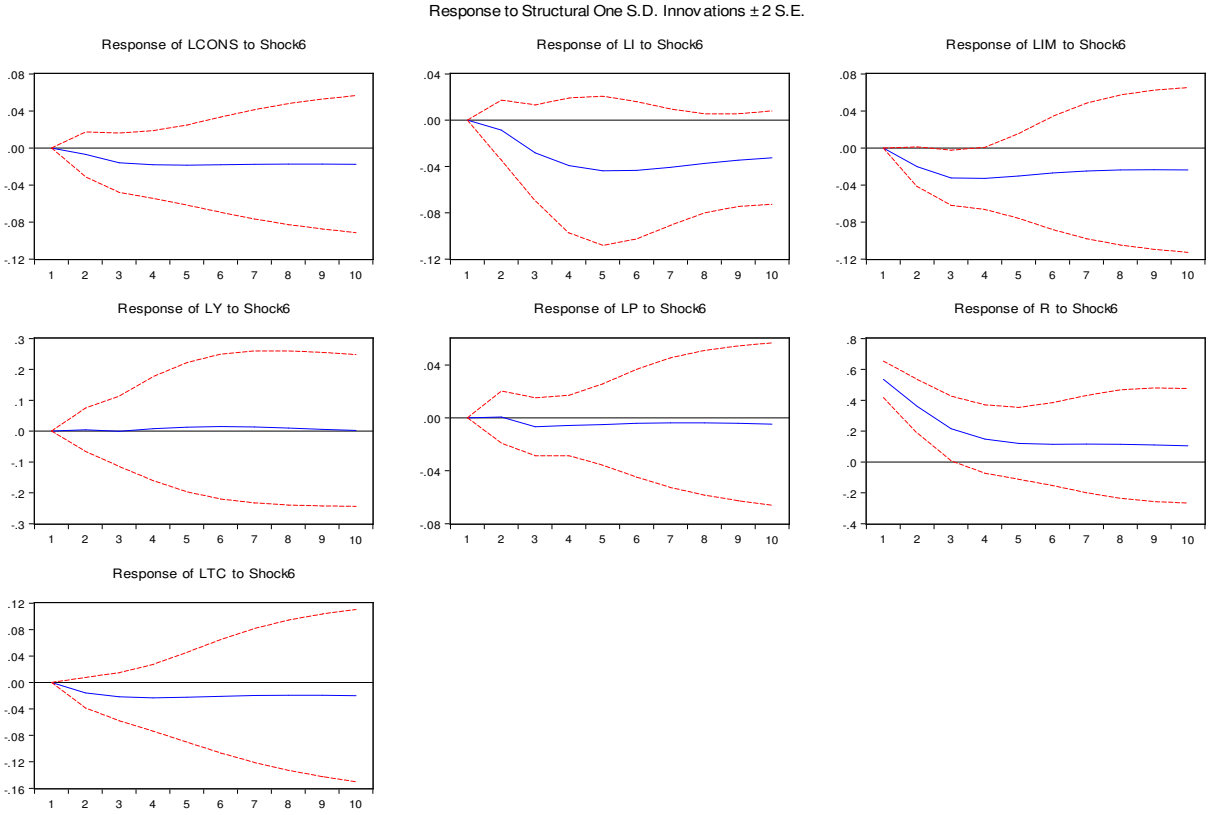

Table 2: SVAR estimation for Model Specification 4

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

A =

1	0	0	0	0	0	0	0
C(1)	1	0	0	0	0	0	0
C(2)	C(5)	1	0	0	0	0	0
0	C(6)	0	1	0	0	0	0
C(3)	0	C(9)	0	1	0	0	C(14)
C(4)	C(7)	C(10)	C(12)	0	1	0	C(15)
0	C(8)	C(11)	0	0	C(13)	1	0
0	0	0	0	0	0	0	1

B =

C(16)	0	0	0	0	0	0	0
0	C(17)	0	0	0	0	0	0
0	0	C(18)	0	0	0	0	0
0	0	0	C(19)	0	0	0	0
0	0	0	0	C(20)	0	0	0
0	0	0	0	0	C(21)	0	0
0	0	0	0	0	0	C(22)	0
0	0	0	0	0	0	0	C(23)