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Transmission Mechanism of Monetary Policy in BRICS Countries: A Comparative Response with the USA

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Abstract

The main objective of this study is to analyze the monetary transmission mechanism in key emerging market economies: Brazil, Russia, India, China, and South Africa (BRICS). For this purpose, we have estimated benchmark VAR models with money aggregation. The time series quarterly data from 2009Q1 to 2019Q4 used for the variables include real GDP, consumer price index, short-term interest rate, money supply aggregation M2, and the real effective exchange rate. We also examined the dynamic responses of various macroeconomic variables to the policy shocks. The findings of this study can be summarized as follows: As a result of a temporary rise in the short-term interest rate, the response of output is diversified across countries. Overall, the interest rate increase hurts output. In Brazil, Russia, and India we observed a temporary fall in output that converges to baseline afterward, while it continues to show negative divergence in the case of China and South Africa. The real appreciation of the exchange rate in BRICS countries is found. Prices respond sluggishly to the monetary policy shock in countries of the BRICS association and only start to fall significantly several quarters after GDP. The comparative analysis shows that the effect of the monetary policy shock on the output in the USA is much slower as compared to the economies of BRICS. The impact on prices is also found to be slower in the US as compared to the BRICS countries. In other words, prices are found to be more sluggish in the US.

Keywords: GDP growth, Inflation, Interest rate, Board Money, Exchange rate

1. Introduction

The mechanism of monetary transmission carries great importance for the formulation and implementation of monetary policy in any country. Due to this, the monetary spread is one of the most significant areas of monetary economics. A substantial amount of literature is devoted to analyzing the monetary transmission in different areas, and countries of the developed and developing world. Macroeconomic variables are affected by the monetary policy with long legs. Therefore, monetary authorities need to be forward-looking in their approach, which requires a broad understanding of the mechanism of monetary transmission (Taylor, 2000).

The transmission mechanism of monetary is a policy of the monetary authority to control macroeconomics. The monetary policy affects the inflation rate and the output of an economy. Mishkin (2001) concluded that policy variables such as prices, inflation, and interest rate are affected by monetary action with high variability and uncertainty. So, it becomes interesting to the effects of the movement of monetary policy on macroeconomic variables. Financial sector development plays a vital role in macroeconomic variables' more stable monetary outcomes; it may also improve technological changes and the provision of new financial products. Therefore, there is a need to empirically test and reinterpret the channels of monetary transmission on a regular.

Monetary policy stance generally aims at the achievement of high economic growth in a non-inflationary manner. Economic growth beyond the potential level gives rise to inflation, which may cause sustainability risks. In other words, the monetary policy needed to keep a balance between growth and inflation. Periods of falling growth and rising inflation can also arise and, there can be many reasons for these fluctuations as domestic and external supply shocks or lagged impact of policy. The monetary policy framework in emerging economies faces several challenges from developed economies. In the past, it has seen periods of instability, where high inflation is cause to be the cause of financial instability (Taylor, 1995; Peek and Rosengren, 1997; Shahbaz, et al, 2008; Saleem & Ahmad, 2015).

In this study, we empirically analyze the traditional interest rate channel. The interest rate is the key channel of monetary transmission due to the emergence of short-term changes. Higher real interest rates occur due to an increase in nominal short-term interest rates given the nominal rigidities. Higher interest rates then affect the consumption and investment behavior of firms and individuals. They lower the current consumption by reducing disposable income and encouraging current savings. A high-interest rate may reduce the investment. Low investment may also result in the reduction of firms' production it making new investments less attractive. When prices and wages adjust over time, the real output moves to the potential level. The real exchange rate and interest rate also get back to their fundamental levels (Sims 1980; Mojon and Peersman 2001; Hung and Wade 2009).

Monetary transmission through the interest rate is enlarged by the changes in the balance sheets of the banks, firms, and exchange rates. Due to the higher interest rates, domestic financial assets become more attractive and result in the appreciation of the domestic currency. This affects domestic prices both directly and indirectly. Exchange rate appreciation leads to the reduction in domestic prices of imports, which is the direct effect. It depends upon the degree of the pass-through of the exchange rate to prices. On the other hand, it is also observed that the appreciation of the domestic currency hurts the external competitiveness of the economy. Here we witness

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the indirect effect which is visible as a reduction in net exports leading to a fall in output and aggregate demand which results in a decline in prices. Both the effects i.e. direct and indirect working in the same direction leads to a reduction in prices (Taylor 1995; Mirdala 2009; Ahmed et al, 2017; Qasim et al 2015).

This study tries to empirically investigate the impact of a monetary policy shock (an unexpected change in the rate of interest) on real macroeconomic variables. Furthermore, the exchange rate in BRICS countries and compared those results with the US economy. This exercise is the evaluation of the transmission of the monetary policy actions to the macroeconomic variables in emerging/developing economies of the world as compared to the United States, Which is considered the largest single national economy in the world. The major analyzes the impact of monetary policy on the stability of the economy and ultimate growth. There is a large amount of literature devoted to the study of the monetary transmission mechanism. Most researchers have tried to explain the heterogeneous effects of monetary policy on real variables in different countries. Researchers have applied different techniques to analyze the impact of monetary transmission.

VAR is an extensively used empirical methodology to analyze the mechanism of monetary transmission. It was first applied by Sims (1980) to analyze monetary policy. There is already extensive literature available that analyzes the monetary transmission mechanism in the US, euro area, and other countries of the world. We have chosen the BRICS association and compared the results with the US. BRICS countries are emerging economies and are of great importance due to their significant influence on regional and global economic affairs. BRICS refers to an association of emerging national economies which are: Brazil, Russia, India, China, and South Africa. This association consisted of four countries before South Africa joined it in the year 2010. The BRICS countries are the newly industrialized developing countries except for Russia. They are fast-growing economies and have a significant influence on global and regional economic affairs. It is important to investigate the monetary transmission mechanism in these emerging economies because previous studies observed that these economies improve their financial activities. While, on the other hand, they also improve the real variables' performance and rapid economic growth. We calculated the impulse response functions of the endogenous variables. It is done to find out their responses to one standard deviation shock of monetary policy. The impulse responses of the real variables for each country are compared with the US. This exercise is the evaluation of the transmission of the monetary policy actions to the macroeconomic variables in emerging/developing economies of the world as compared to the United States, which is considered the largest single national economy in the world.

2. Review of Literature

The monetary transmission mechanism was theoretically investigated by Milton (1970) after Tobin (1978) elaborates on the monetary transmission mechanism. A large number of studies, analyzing the monetary transmission mechanism in different countries of the world have been reviewed to learn from the existing literature, such as (Kashyap, 1994; Taylor, 1995; Clarida, et al. 1998; Meltzer,1995; Bernanke, and Blinder, 1992). Vector autoregressive (VAR) is the most extensively used technique to study the dynamic effects of monetary policy innovations on a large number of macroeconomic variables. Bernanke and Mihov (1998) suggested a VAR methodology to measure the monetary policy stance that includes all the policy variables as well as the non-policy variables. This approach does not assume that a single variable is the only good indicator of monetary policy. They developed a semi-structural VAR model and used the data on federal funds rate and bank reserves to extract information on monetary policy. They left the relationship among variables unrestricted. They believe that the interest rate on federal funds is a better indicator of the monetary policy stance. Bernanke and Gertler (1995) also used the VAR model to analyze the United States data and, suggested that the conventional analysis of the monetary transmission has certain shortcomings and the introduction of the credit channel would help resolve them. They discussed the facts and puzzles regarding the response of the economy to policy shocks. They also summarized the views about the credit channel and also elaborate on the role of monetary transmission.

Taylor (2000) attempted to explore the connection between the mechanism of monetary policy transmission and the monetary policy rules to guide the decision of the central bank. He analyzed the monetary transmission of the policy rules. He concluded with three major outcomes of policy: First, the mechanism of monetary transmission leads to simple monetary policy rules which are robust. Second, the complex policy rules incorporating inertial factors depend upon the specific form of the transmission mechanism of monetary policy. Third, monetary transmission through an active exchange rate channel affects the choice of the policy rule. It requires the adjustment of the interest rate in response to the exchange rate. He suggests that further research is needed to examine the effects of exchange rate fluctuations and the policy rules that take into account the forward-looking features of exchange rates (Ahmad et al, 2017; Shahid and Ali, 2015; Shahbaz et al, 2011).

Honda (2004) using the new analytic models shows that the concepts of money and the credit channel are conceptually different and it is because of the existence of government bonds. He further shows that the different regulations of bank capital affect the lending behavior of the banks and private investment differently. Mishkin (2001) analyzed the monetary transmission that works through asset prices other than the standard interest rate. He outlined the transmission mechanisms that operate through real estate prices, stock prices, and exchange rates. These transmission mechanisms affect the decisions of individuals and firms regarding consumption and

investment. He concludes that despite the active role played by the asset prices, targeting the asset price by the central bank can lead to worse economic outcomes (Bernanke and Blinder, 1992).

Peersman and Smets (2001) applied the identified VAR methodology to analyze the macroeconomic effects of changes in monetary policy in the euro area. They mainly focused on the area-wide transmission of the monetary policy. They examined the response of financial and real variables to an area-wide monetary policy impulse. After a comparison of the models (with and without money) they found that the overall results obtained were very similar. Comparing the impact of the monetary policy innovation in the euro area and the US, it was found that they have strikingly similar impulse response functions. They suggested that as there is not a common monetary policy in all euro area countries, so identifying the monetary policy innovations based on an aggregate monetary policy reaction function can create problems.

Mojon and Peersman (2001) analyzed the monetary transmission in the euro area. They used vector autoregression (VAR) models. They imposed the same identification schemes on countries with different monetary policy regimes within the European Monetary System. They showed that an increase in the rate of interest leads to a temporary fall in output, which is visible after a few quarters, while the decrease in the price level is gradual. They stressed that the impulse responses have large confidence bands around them, so the VAR models cannot be used to conclude that the effects of monetary policy in some countries are larger than in others. The other problem that they identified is the size of the estimated shocks and that the reaction functions of the central banks are different in each country.

Cecchetti (1999) analyzed the challenges regarding monetary policy among the eleven new members of the European Monetary Union. He found that the primary among those challenges is the formation of monetary policy given the fact that it would have a differential impact on the euro area countries. The introduction of the euro required adjustments in the member countries. These adjustments tend to change the relationship between central banks and the real economy. That will change the monetary transmission mechanism in member countries of the euro area and make the new European Central Bank's job more difficult. He examined the differences in the availability of nonbank sources of finance as well as in the concentration, health, and size of the national banking system. He considered the differences in financial structure as the cause of national asymmetries in the monetary transmission mechanism. He further suggested that the differences in financial structure are most probably due to the diverse legal structures of the countries of the European Union (EU).

Dedola and Lippi (2003) studied the monetary transmission mechanism in five industrialized countries. For this purpose, they used disaggregated industry data to document the heterogeneous impact of monetary policy so that they can be related to industry characteristics. They used the methodology of structural VAR to measure the impact of unanticipated monetary policy on industrial output. The economic significance of the variables (which are related to the borrowing capacity of the firms) shows a significant role in the credit frictions that confirm the predictions coming from the analysis using quantitative general equilibrium models.

For the time series analysis, Hung and Wade (2009) for Vietnam, Nakajima et al. (2011) for japan, and Peek and Rosengren (1997) for the USA studied the monetary transmission mechanism. They used the VAR approach and explored the relationships between real output, real interest rate, monetary aggregate, inflation, credit, and the real exchange rate. In the case of Vietnam, they suggested that the monetary changes affect the real GDP but the connection between inflation and money is not very clear. They found exchange rate and credit channels more active than the interest rate channel. Kashyap and Stein (2000) worked to examine the effects of monetary policy on banks' lending behavior. They studied the transmission mechanism using the quarterly data set of insured commercial banks in the US from 1976 to 1993. They found that the monetary policy has strong effects on lending for banks having less liquid balance sheets. Their results strongly support the presence of an active bank lending channel in the US at least in the sample period. But they did not give any statement about the quantitative importance of the lending channel of monetary policy transmission in the country.

Koop et al. (2009) investigated if the monetary transmission mechanism has actually changed or if the changes in it are merely due to the changes in the exogenous shocks. They also considered whether these changes are gradual or sudden. They extended the time-varying vector autoregressive models with stochastic volatility to estimate the parameter change. The variables they used included the interest rate, unemployment, and inflation. They demonstrate that there is strong evidence of parameter change and the strongest change is in error variances, error covariance, and also in the VAR coefficients and that the change is gradual, not abrupt.

For BRICS countries Kutu and Harold (2016) investigate the monetary transmission mechanism and industrial output, Salmanov et al, (2016) investigate the monetary policy and bank lending for Russia. Sengupta (2014), Das (2015), and Mishra et al, (2016) for India most recently Can et al, (2019) for turkey. There is a large amount of literature devoted to the study of the monetary transmission mechanism. Some of the work is discussed above, whereas the researchers have tried to explain the heterogeneous effects of monetary policy on real variables in different countries of the world. Researchers have applied many different techniques to analyze monetary transmission. When we review the past literature, we found hardly any study to investigate the monetary transaction mechanism of BRICS and compared it with the USA. We also found that vector auto-regression (VAR) is the most widely used technique for this purpose. This literature provides the basis for further research to help improve policy formulation and implementation.

3. Methodology, Variable, and Data Sources

Following Stock and Watson (2001), we specified two benchmark VAR models to analyze the impact of a monetary policy shock in the BRICS and the USA. The models can be represented as follows:

$$Y_t = \alpha(K)Z_{t-1} + \eta(K)X_t + \mu_t \quad (1)$$

Where Z_t is the vector of endogenous variables for BRICS and the US. X_t is a vector of exogenous foreign variables. α and η are matrices of coefficients to be estimated. μ_t is a vector of innovations. The vector of exogenous variables X_t includes the US real output(y_t^{US}), CPI of the US (cp_t^{US}) and the interest rate(i_t^{US}):

$$X_t^* = [cp_t^{US} \;\; y_t^{US} \;\; i_t^{US}] \quad (2)$$

These variables are included to account for the changes in the world output and inflation and are treated as exogenous as there is no feedback from the variables of BRICS and the USA to these foreign variables. These exogenous variables are allowed to have an impact on the endogenous variables of BRICS and the USA. The reason for the inclusion of US variables as exogenous ones is that the economy of the US is considered "the engine" of the world economy and any fluctuations in the US economy can cause spillovers to the rest of the world. Dees and Guilhem (2009) suggest that the emergence of large economies like china and the increasing economic integration is likely to have weakened the role of economy of the US as a driver of global economic growth. But at the same time, they show that the transmission of the US cyclical developments to other economies of the world fluctuates over time but remains large overall.

In the first model, the vector of endogenous variables for BRICS and the USA Z_t consists of real GDP(y_t), consumer price index (p_t), the lending rate (i_t) and the real effective exchange rate (x_t):

$$Z_t^* = [y_t \;\; p_t \;\; i_t \;\; x_t] \quad (3)$$

Matrix formulation of VAR for this model is given as:

$$\begin{bmatrix} y_t \\ p_t \\ i_t \\ x_t \end{bmatrix} = \begin{bmatrix} \alpha_{10} \\ \alpha_{20} \\ \alpha_{30} \\ \alpha_{40} \end{bmatrix} + \begin{bmatrix} A_{11}(L) & A_{12}(L) & A_{13}(L) & A_{14}(L) \\ A_{21}(L) & A_{22}(L) & A_{23}(L) & A_{24}(L) \\ A_{31}(L) & A_{32}(L) & A_{33}(L) & A_{34}(L) \\ A_{41}(L) & A_{42}(L) & A_{43}(L) & A_{44}(L) \end{bmatrix} \begin{bmatrix} y_{t-1} \\ p_{t-1} \\ i_{t-1} \\ x_{t-1} \end{bmatrix} + \begin{bmatrix} \eta_{11} & \eta_{12} & \eta_{13} \\ \eta_{21} & \eta_{22} & \eta_{23} \\ \eta_{31} & \eta_{32} & \eta_{33} \\ \eta_{41} & \eta_{42} & \eta_{43} \end{bmatrix} \begin{bmatrix} cp_t^{US} \\ y_t^{US} \\ i_t^{US} \end{bmatrix} + \begin{bmatrix} \mu_{yt} \\ \mu_{pt} \\ \mu_{it} \\ \mu_{xt} \end{bmatrix} \quad (4)$$

Where:

α_{i0} = the parameters representing intercept terms

$A_{ij}(L)$ = the polynomials in the lag operator L

For monetary transmission, we included monetary aggregate (M2) (m_t) in the vector of endogenous variables. Money developments are important to design the strategies of monetary policy and the inclusion of monetary aggregate could therefore help determine monetary policy shocks. In this case, the vector of endogenous variables can be represented as:

$$Z_t^* = [y_t \;\; p_t \;\; m_t \;\; i_t \;\; x_t] \quad (5)$$

Matrix formulation of VAR for this model is given as:

$$\begin{bmatrix} y_t \\ p_t \\ m_t \\ i_t \\ x_t \end{bmatrix} = \begin{bmatrix} \alpha_{10} \\ \alpha_{20} \\ \alpha_{30} \\ \alpha_{40} \\ \alpha_{50} \end{bmatrix} + \begin{bmatrix} A_{11}(L) & A_{12}(L) & A_{13}(L) & A_{14}(L) & A_{15}(L) \\ A_{21}(L) & A_{22}(L) & A_{23}(L) & A_{24}(L) & A_{25}(L) \\ A_{31}(L) & A_{32}(L) & A_{33}(L) & A_{34}(L) & A_{35}(L) \\ A_{41}(L) & A_{42}(L) & A_{43}(L) & A_{44}(L) & A_{45}(L) \\ A_{51}(L) & A_{52}(L) & A_{53}(L) & A_{54}(L) & A_{55}(L) \end{bmatrix} \begin{bmatrix} y_{t-1} \\ p_{t-1} \\ m_{t-1} \\ i_{t-1} \\ x_{t-1} \end{bmatrix} + \begin{bmatrix} \eta_{11} & \eta_{12} & \eta_{13} \\ \eta_{21} & \eta_{22} & \eta_{23} \\ \eta_{31} & \eta_{32} & \eta_{33} \\ \eta_{41} & \eta_{42} & \eta_{43} \\ \eta_{51} & \eta_{52} & \eta_{53} \end{bmatrix} \begin{bmatrix} cp_t^{US} \\ y_t^{US} \\ i_t^{US} \end{bmatrix} + \begin{bmatrix} \mu_{yt} \\ \mu_{pt} \\ \mu_{mt} \\ \mu_{it} \\ \mu_{xt} \end{bmatrix} \quad (6)$$

Where:

α_{i0} = the parameters representing intercept terms

$A_{ij}(L)$ = the polynomials in the lag operator L

We have used the data for BRICS countries and USA at a quarterly frequency and our samples for BRICS and USA spans from 2009Q1 to 2019Q4. Data are transformed into a natural log for econometric analysis. IMF International Financial Statistics (IFS): It provided us with the data of consumer price index CPI, Money supply M2, lending interest rate (i_t) and real effective exchange rate (x_t) (except for India, Reserve Bank of India (RBI) data source) for all countries of the BRICS association and USA. World Development Indicators (WDI): It provided us with the data of GDP for all the countries.

4. Empirical Results

Before the estimation of the VAR model, it is necessary to decide the optimal lag length of the system. The problem related to the inclusion of different numbers of lags and the degrees of freedom does not significantly contribute to the justification of the equations. If we are not able to choose the optimal lags in the estimated equation, this may lead to misspecified the required results. Several tests exist that suggest the optimal lag length of VAR systems. In this study, two optimal lags are taken as recommended by the Schwartz Information Criteria. The empirical results are presented in the table-1 for BRICS countries and the USA.

Table 1: Impulse Response

Impulse response for Brazil						**Impulse response for Russia**					
Period	**Y**	**P**	**M**	**I**	**X**	**Period**	**Y**	**P**	**M**	**I**	**X**
1	0.000 (0.000)	0.000 (0.00)	0.000 (0.000)	0.032 (0.00)	-0.041 (0.001)	1	0.000 (0.000)	0.000 (0.00)	0.000 (0.000)	0.044 (0.007)	-0.006 (0.003)
5	6.415 (0.00)	-0.031 (0.033)	0.117 (0.092)	-0.050 (0.019)	0.0382 (0.029)	5	-0.001 (0.000)	0.009 (0.02)	0.006 (0.019)	0.005 (0.008)	-0.003 (0.003)
10	0.011 (0.01)	0.027 (0.071)	-0.044 (0.102)	-0.0192 (0.031)	0.023 (0.038)	10	-0.000 (0.000)	0.004 (0.00)	0.0017 (0.001)	-0.069 (0.006)	-0.000 (0.002)
Impulse response for India						**Impulse response for China**					
1	0.000 (0.00)	0.000 (0.000)	0.000 (0.00)	0.007 (0.000)	0.003 (0.00)	1	0.000 (0.00)	0.00 (0.00)	0.000 (0.00)	0.044 (0.00)	-0.00 (0.020)
5	0.000 (0.00)	-0.049 (0.027)	0.000 (0.00)	0.000 (0.001)	-0.00 (0.00)	5	-0.000 (0.00)	-0.01 (0.07)	-0.006 (0.016)	0.006 (0.005)	0.004 (0.00)
10	7.805 (0.00)	0.003 (0.00)	0.000 (0.001)	2.605 (0.006)	0.000 (0.00)	10	-0.001 (0.05)	0.01 (0.01)	0.001 (0.013)	0.0007 (0.00)	0.000 (0.007)
Impulse response for South Africa						**Impulse response for USA**					
1	0.000 (0.00)	0.000 (0.000)	0.000 (0.00)	0.033 (0.003)	-0.026 (0.00)	1	0.000 (0.000)	0.00 (0.00)	0.036 (0.00)	0.030 (0.00)	-0.006 (0.00)
5	-0.000 (0.00)	0.070 (0.077)	0.008 (0.04)	0.036 (0.016)	-0.004 (0.012)	5	0.000 (0.00)	0.083 (0.06)	0.03 (0.04)	0.013 (0.01)	-0.003 (0.00)
10	-0.000 (0.00)	-0.073 (0.07)	0.020 (0.03)	-0.003 (0.018)	0.00 (0.00)	10	0.002 (0.000)	0.030 (0.000)	0.009 (0.03)	0.001 -0.030)	0.005 (0.00)

The results of the impulse responses of all the endogenous variables of the VAR models are different across all countries of the BRICS association and the USA. Results show that monetary policy shocks affect output in the short run. It is found that output responds significantly after two to three quarters except in Russia where it immediately responds to a positive monetary policy shock. Prices display inertial behavior and remain largely unaffected for almost three or four quarters. Responses of the variables to an unexpected temporary increase in the short-term interest rate can be summarized as follows:

(i) The response of output is diversified across countries. In Brazil, Russia, and India we observe a temporary fall in output that converges to baseline afterward. Output in China and South Africa decreases following a monetary policy shock and continues to show negative divergence from the baseline. However, in China and South Africa, a fall in output takes place after two quarters. It leads us to conclude that contractionary monetary policy hurts output in countries of the BRICS association.

(ii) Prices respond sluggishly to the monetary policy shock in countries of the BRICS association and start to fall significantly below baseline several quarters after output. Comparing the impact of monetary policy shock in BRICS and the US, it is seen that in the case of BRICS the variables respond to a monetary policy shock faster than in the US.

(iii) A positive monetary policy shock leads to the real appreciation of the exchange rate in BRICS countries. However, this appreciation of the exchange rate occurs after about two quarters in Brazil and Russia and after a year in India. While in China and South Africa it immediately starts to appreciate. We also calculated the impulse

responses of the key variables to a monetary policy shock in the United States and compared them with the results obtained for countries of the BRICS association.

A comparison shows that following the monetary policy tightening (a) the output in the US responds to the monetary policy shock after six quarters, while in the BRICS countries it starts to fall immediately or after two to three quarters. It shows that the effect of the monetary policy shock on the output for the USA is much slower as compared to the economies of BRICS (b) The impact of monetary transmission on prices is also found to be slower in the US as compared to BRICS countries. In other words, prices are found to be more sluggish in the US and they do not fall below the zero lines even after eight quarters. (c) The response of the real effective exchange rate in the US is smaller as compared to Brazil and China, but more long-lived in the US. The empirical results are reported in figures 1 (Brazil), 2 (Russia), 3 (India), 4 (china), and 5 (South Africa) reported in Appendix.

5. Conclusions

In this study, we have estimated standard VAR on quarterly data, expressed in natural logs, from 2009Q1 till 2019Q4 for countries of the BRICS association and the USA to study the macroeconomic effects of a monetary policy shock in those countries. The variables include real GDP, consumer price index, interest rate, real effective exchange rate, and the broad monetary aggregate (M2). VAR models for each country are found to be stable as the inverted roots of the models are inside the unit circle, although some roots are near unity in absolute value. Using standard identification schemes, we calculated impulse responses of the main macroeconomic variables to an unexpected monetary policy contraction in the BRICS and also compared them with that of the United States. The empirical results of impulse responses of the variables related to monetary shock in the United States and compared with the results obtained for countries of the BRICS association. After comparison we found that following the monetary policy tightening: (a) the output in the US responds to the monetary policy shock after six quarters, while in the BRICS countries and the US it starts to fall immediately or after two quarters. It shows that the effect of the monetary policy shock on the output of the US is much slower as compared to BRICS countries. (b) The impact on prices is also found to be slower in the US as compared to BRICS countries. In other words, prices are found to be more sluggish in the US and they do not fall below the zero line even after eight quarters. (c) The response of the real effective exchange rate in the US is smaller as compared to Brazil and China, but more long-lived in the US.

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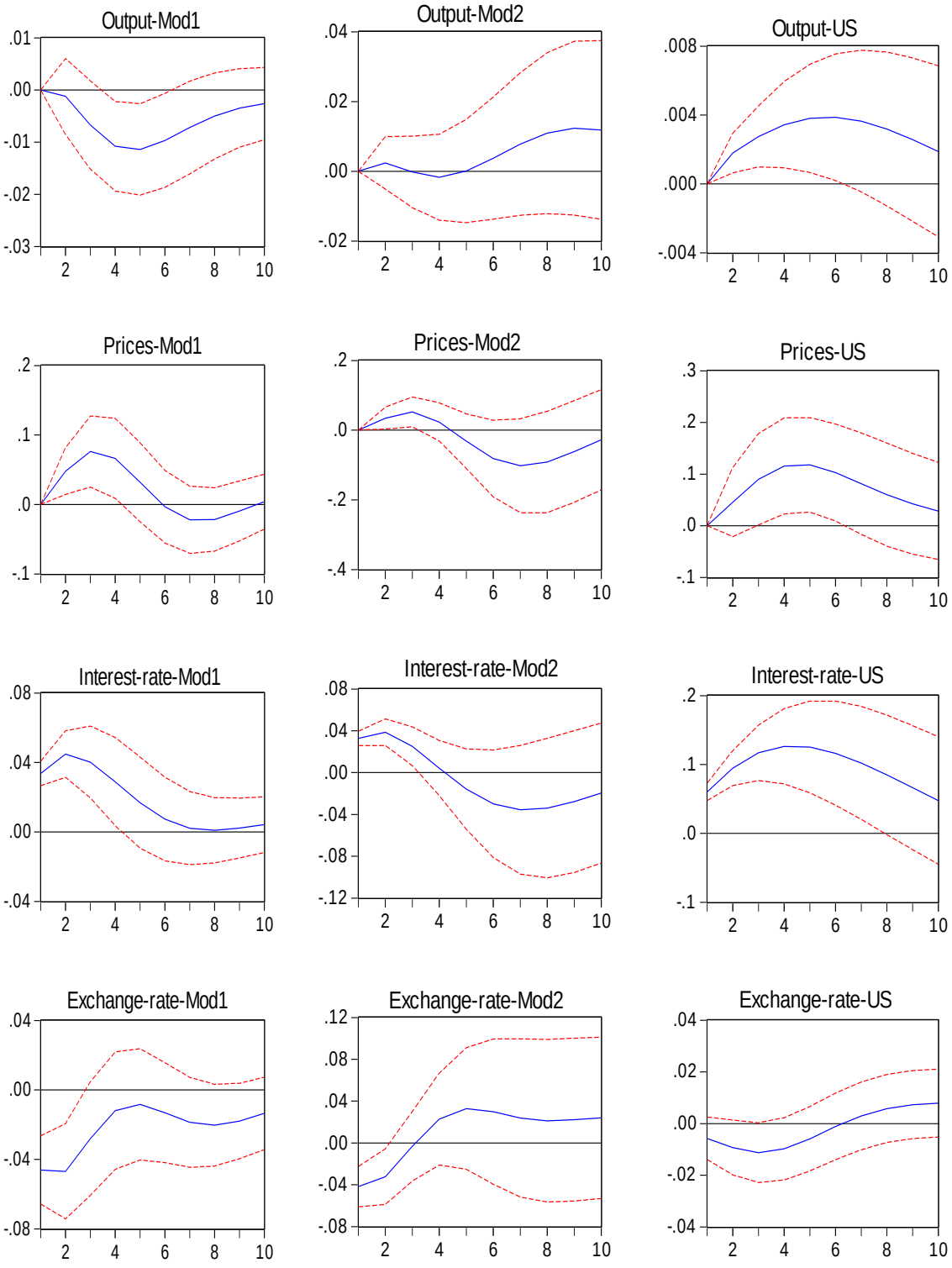
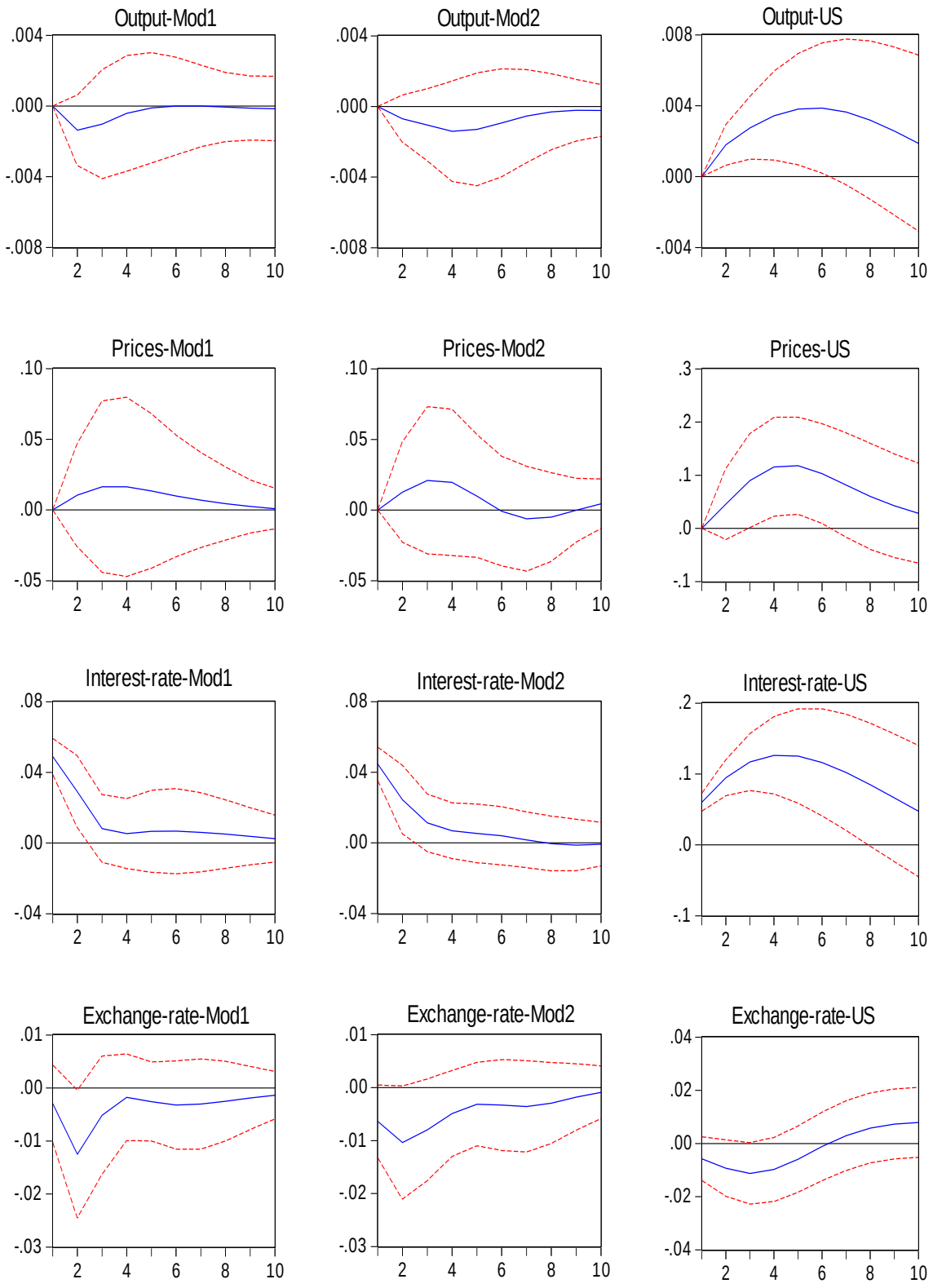
Appendix

Figure 1: The effects of a monetary policy shock in Brazil and the United States
(Estimation Period:2009Q1-2019Q4)



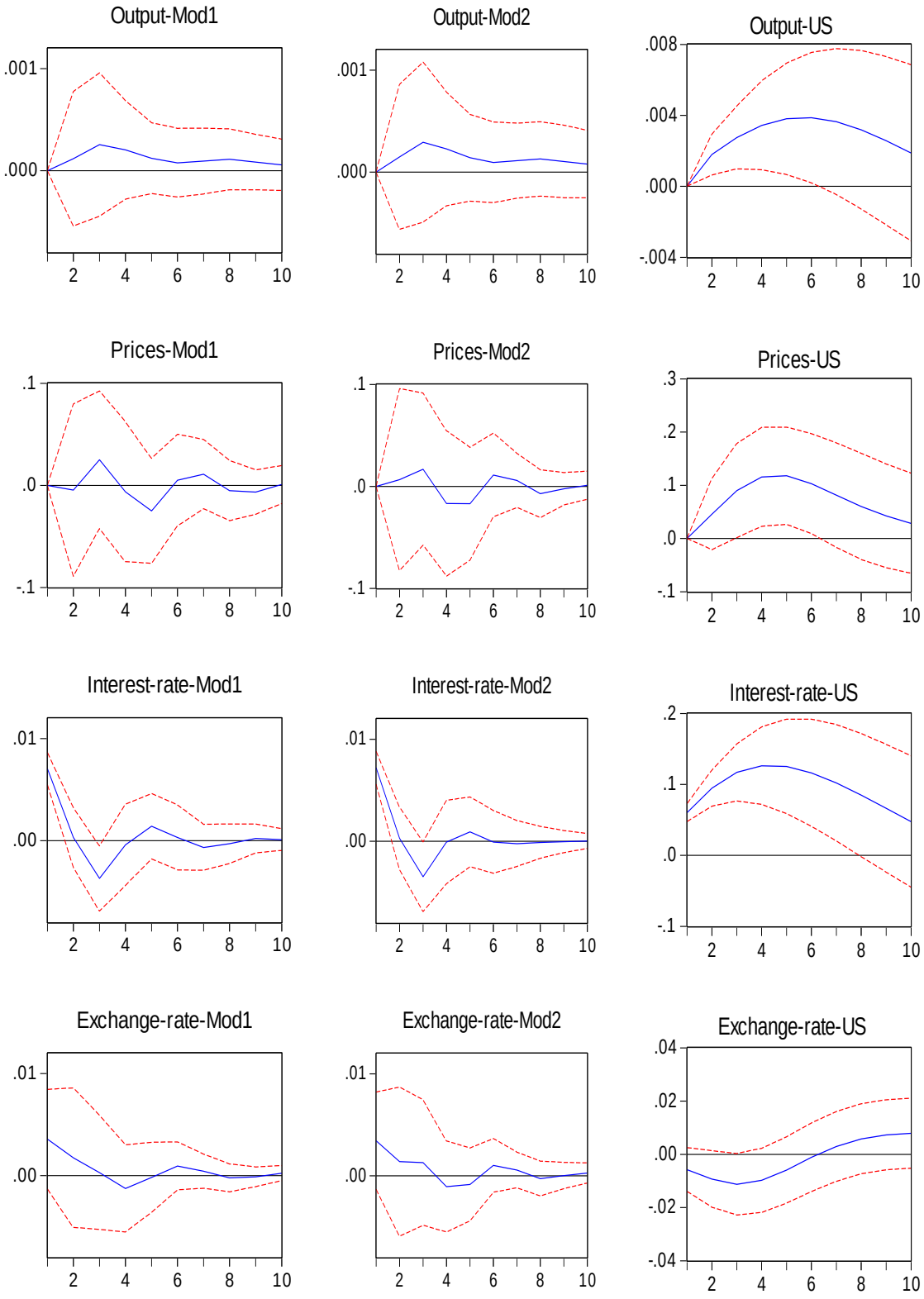
Note:95% confidence bands

Figure 2: The effects of a monetary policy shock in Russia and the United States
(Estimation Period: 2009Q1-2019Q4)



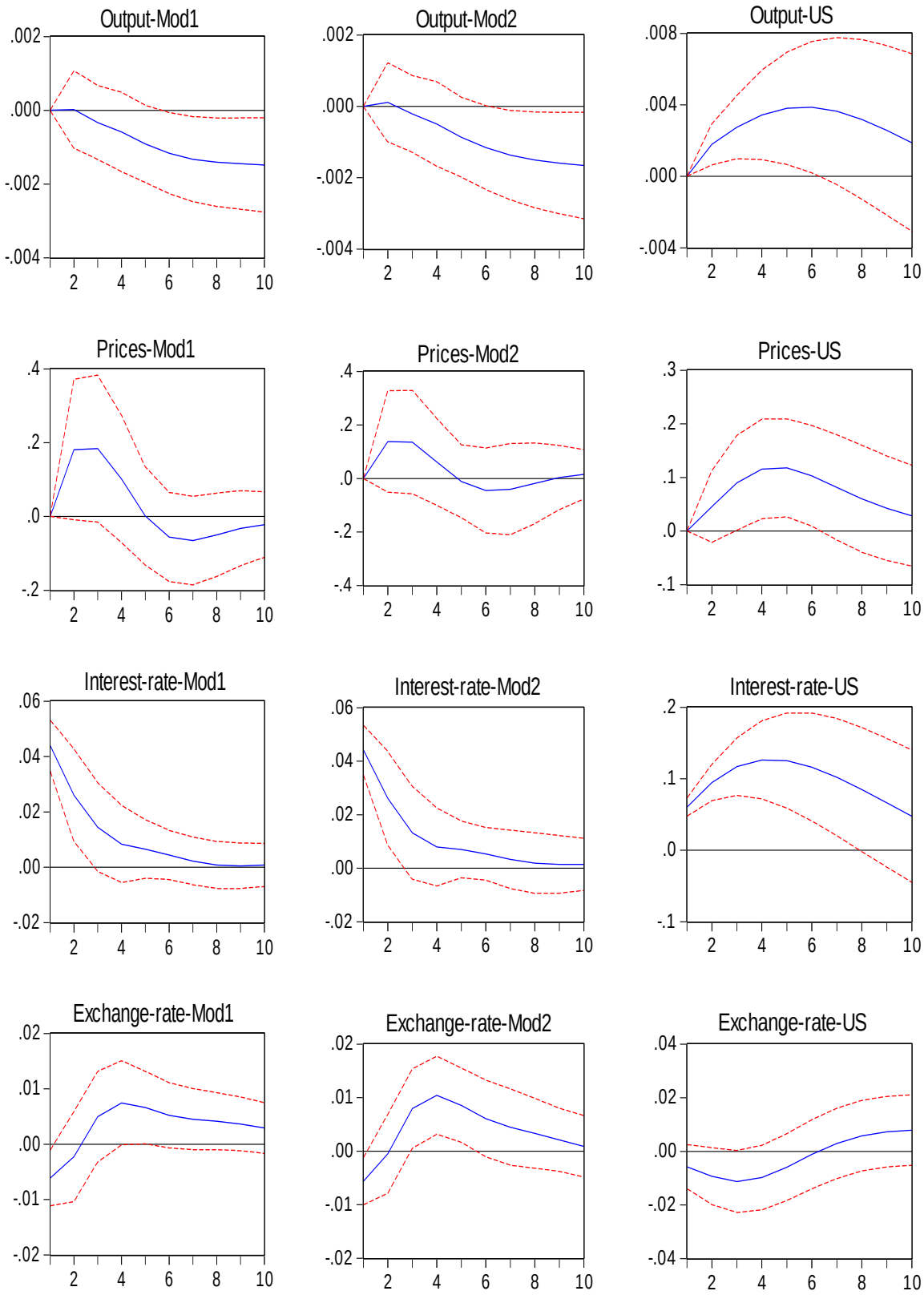
Note: 95% confidence bands

Figure 3: The effects of a monetary policy shock in India and the United States
(Estimation Period: 2009Q1-2019Q4)



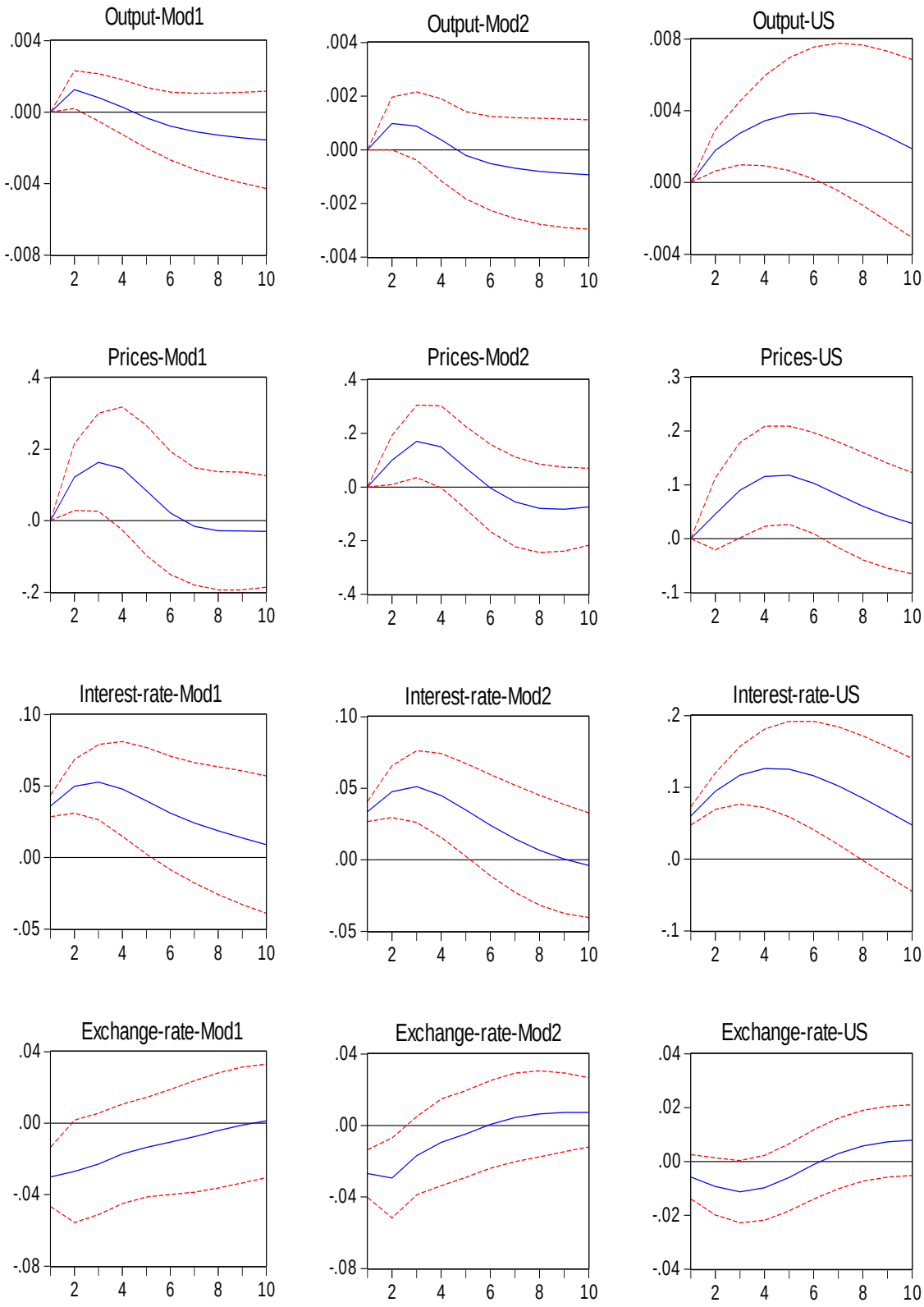
Note: 95% confidence bands

Figure 4: The effects of a monetary policy shock in China and the United States
(Estimation Period: 2009Q1-2019Q4)



Note: 95% confidence bands

Figure 4.5: The effects of a monetary policy shock in South Africa and the United States
(Estimation Period: 2009Q1-2019Q4)



Note: 95% confidence bands