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Monetary Policy Shocks and Macroeconomic Variables: Evidence from Fast Growing Emerging Economies

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Abstract
This paper investigates both the effects of domestic monetary policy and external shocks on fundamental macroeconomic variables in six fast growing emerging economies: Brazil, Russia, India, China, South Africa and Turkey—denoted hereafter as BRICS_T. The authors adopt a structural VAR model with a block exogeneity procedure to identify domestic monetary policy shocks and external shocks. Their research reveals that a contractionary monetary policy in most countries appreciates the domestic currency, increases interest rates, effectively controls inflation rates and reduces output. They do not find any evidence of the price, output, exchange rates and trade puzzles that are usually found in VAR studies. Their findings imply that the exchange rate is the main transmission mechanism in BRICS_T economies. The authors also find that that there are inverse J-curves in five of the six fast growing emerging economies and there are deviations from UIP (Uncovered Interest Parity) in response to a contractionary monetary policy in those countries. Moreover, world output shocks are not a dominant source of fluctuations in those economies.

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Keywords Monetary policy; inflation; international trade; exchange rate; SVAR

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1. Introduction

The BRICS_T (Brazil, Russia, India, China, S. Africa and Turkey) economies have enjoyed a remarkable record of high and persistent economic growth over the 1995-2012 period. We seek to answer two key questions regarding monetary policy in these BRICS_T emerging economies -"what role does monetary policy play in those economies?" and "what are the effects of monetary policy on the macroeconomic variables such as inflation, output, the exchange rate, the money supply and the trade balance?" These questions are significant to monetary economists, monetary policy makers and researchers in both monetary economics and financial markets. Unfortunately, there is no consensus in either the theoretical or empirical literature on the answers.[1] Moreover, the empirical evidence is generally based on an individual countryôs experiences and experiences of economies at differing stages of development. The reaction of macroeconomic variables to a contractionary policy may depend on whether the economy is a developed or emerging country[2].

Reasons for differences in the response of macroeconomic variables to monetary policy include differences in the development level of financial markets, in the accountability and priority of the central banks, in the openness of economies, and in price and wage rigidities. Moreover, emerging countries have ample excess capacity with regards to labor, and thereby have a tendency to intervene in their markets to create higher employment[3]. Therefore, in analyzing the real effects of monetary policy shocks on the macroeconomic variable we find that rapidly developing BRICS_T economies may reveal crucial information for policy makers and researchers. In that regard, this paper provides some evidence regarding the effects of monetary policy and external shocks on BRICS_T countriesô macroeconomic variables.

A large body of empirical literature investigating the effects of monetary policy on macroeconomic variables is based on multivariate models such as the vector autoregressive model (VAR), structural VAR (SVAR), vector error correction model (VECM), structural VECM (SVECM) and the impulse responses derived from them. To identify monetary policy shocks in the above mentioned models, some restrictions have to be imposed on the

[1] See Ivrendi (2007) for the effectiveness of monetary policy on stock price and exchange rate.
[2] See Cushman and Zha (1997) for the discussion of the effects of monetary policy in large closed and small open economies.
[3] See Mallick and Sousa (2011, 2013) for the discussion of monetary policy in BRICS economies.

relationships between monetary policy and macroeconomic variables. Controversial results found in empirical studies are partially due to restrictions imposed on monetary policy models while others are due to a subsequent economic analysis and misspecification of the relationships among variables of interest in the models. The identification of monetary policy shocks is crucial and based on the assumptions of the identification procedure - one of the widely used identification procedures is the "Cholesky approach". The identification procedure is based on recursive ordering and hence precludes simultaneous interactions among some of the variables, leading to a lower triangular matrix. Each variable in the lower triangular matrix is contemporaneously affected by the variables that precede it and is not affected by the variables that succeed it. In some empirical work, the monetary policy variable is ordered before the exchange rate such as in Sims (1992), Grilli and Roubini (1995) and Eichenbaum & Evans (1995). This implies that the monetary policy variable does not simultaneously react to the exchange rate. Cushman and Zha (1997) argue that such a restriction may be acceptable for the U.S. because it is a large and relatively closed economy and therefore movements in monetary policy in the U.S. are less likely to reflect foreign shocks, suggesting that the reaction of monetary policy to foreign shocks would be relatively small. However, the movement in monetary policy in small open economies is likely to be quite sensitive to both foreign and domestic macro shocks as emphasized by Kim and Roubini (2000). It is a known empirical regularity that for countries other than the U.S. identiýcation schemes that do not allow the exchange rate to respond immediately to the interest rate, and vice versa, tend to produce price and exchange rate puzzles.

The Cholesky approach may seem reasonable for large closed economies but not for small open economies. To take the differences in the response of monetary policy in large closed and small open economies into account, Cushman and Zha (1997) use a structural VAR with block exogeneity to identify the monetary policy shock and to analyze the effects of external shocks on the Canadian economy. A similar model is adopted by Sato, Zhang and McAleer (2009) to investigate if external shocks originating from the U.S. played a dominant role in influencing macroeconomic fluctuations in East Asia economies during the period 1978-2007 and by Gosse and Guillaumin (2013) to study the effects of external shocks on East Asian countries. Our model is similar to the aforementioned models. Firstly, we identify monetary policy shocks and external shocks in each BRICS_T economy and then subsequently investigate the effects of those shocks on their macroeconomic variables.

There are two key reasons for reviewing and researching the issues in this paper. The first one is empirical. From an empirical perspective, there is very little empirical work in the literature on identifying monetary shocks in the fast growing economies of BRICS_T countries with the aim of assessing the reaction of macroeconomic variables to monetary policy and external shocks. One goal of this paper is to fill this gap in the existing empirical literature and to stimulate future research on the experience of fast developing economies. The second reason is theoretical. From a theoretical perspective, there are at least two hypotheses with regards to monetary policies affecting macroeconomic variables, especially exchange rates and trade balances in open economics. The first hypothesis is the concept of "overshooting". The overshooting hypothesis emphasizes that a contractionary monetary policy (i.e. an increase in the policy interest rate) shock leads to a large initial appreciation both in nominal and real exchange rates followed by subsequent depreciations. This argument is based on the assumption that exchange rates respond immediately to a monetary policy shock but the response of price to the shock is slow and thus these values stick in the short-run. Therefore, the short-run effect of a monetary shock on the exchange rate is greater than the long-run effect of the shock on the price of goods and services, which leads to exchange rate overshooting in the short-run[4]. The empirical evidence regarding the overshooting hypothesis is mixed. Grilli and Roubini (1995) and Eichenbaum and Evans (1995) analyze the effects of contractionary monetary policy shocks for the U.S. and the G-7 countries. They find empirical evidence that is inconsistent with the overshooting hypothesis while Jang and Ogaki (2004) and Llaudes (2007) provide evidence that is consistent with the prediction of overshooting for Japan and for 15 OECD countries.

The second hypothesis is "the J-curve hypothesis". The J-curve hypothesis emphasizes that a currency depreciation, due to expansionary monetary policy for example, leads to an increase in export volume, a decrease in import volume (the volume effect) and an increase in import prices (the import value effect). If the volume effect is weaker than the import value effect, then the trade balance moves towards a deýcit; if the volume effect is stronger than the import value effect, then the trade balance moves towards a surplus. The J-curve hypothesis emphasizes that the volume effect is weaker than the import value effect in the short-run and it is stronger than the import value effect in the long-run. Therefore, at least theoretically, the effect of an expansionary monetary policy on the trade balance gives the impression of a J-

[4] See Dornbusch (1976) and Romer (2005) for overshooting hypothesis.

curve (initially causes a trade deýcit and then leads to a trade surplus in the long-run). The reason for J-curve behavior in trade balances is that import and export demand elasticities are expected to be low initially after the exchange-rate-change shock, and higher in the long-run.

Empirical findings regarding this hypothesis are also mixed. Using vector error correction models, Gupta-Kapoor and Ramakrishnan (1999) provide evidence of a J-curve for Japan's economy. Similarly, Lal and Lowinger (2002) find indications of a J-curve for six out of seven East Asian countries. In the same vein, Hacker and Hatemi-J (2004) test for the trade J-curve for three transitional central European countries ï the Czech Republic, Hungary and Poland ï in their bilateral trade with respect to Germany. Their impulse response functions reveal that there is some evidence of a J-curve effect. Similarly, Nadenichek (2006) provides evidence of a J-curve pattern in ýve of six G-7 country pairs by employing a partially identiýed SVEC model. Conversely, Lee and Chinn (1998, 2006) find that monetary policy shocks have substantial effects on the current account and exchange rates of industrial countries in the short-run but do not have any effects on either the current account or exchange rates in the long-run, which is inconsistent with the J-curve hypothesis. Also, Prasad and Gable (1998) argue that monetary expansions in most industrial economies tend to result in short-run improvement in trade balances and have signiýcant effects on þuctuations in their trade balances. Their ýnding is inconsistent with the J-curve hypothesis.

This paper investigates the effects of changes in monetary policy on macroeconomic variables in the rapidly growing BRICS_T economies, especially the transmission mechanism of monetary policy in those economies.

It is known that the original BRICS acronym, formed from the first letter of Brazil, Russia, China, India and South Africa, is an association of five large and fast growing developing countries in last two decades. Even though Turkey is not a member of the BRICS countries, its economy has experienced very rapid growth similar to the BRICS countriesô growth rates. Since our purpose is to analyze the reaction of macroeconomic variables to monetary policy in fast developing countries, we thought Turkeyôs experience may provide some useful evidence regarding the aforementioned relationships and therefore included it in this study. Therefore, we call those fast growing countries BRICS_T.

The remainder of the paper is organized as follows. Section 2 discusses the methodology and structural identification of the VAR system used in this paper. Section 3 describes the variables and data used for each country. Section 4 discusses the theoretical expectations regarding the relationships among the variables in the SVAR model and provides the empirical findings of the model. Section 5 concludes.

2. SVAR with block exogeneity for identifying Monetary Policy Shocks

Our model is similar to those in Cushman and Zha (1997) and Sato, Zhang and McAleer (2011). Cushman and Zha (1997) examine different measures of monetary policy shocks in Canadaôs small open economy and investigate the dynamic responses of macroeconomic variables to a monetary policy and external shocks while Sato, Zhang and McAleer (2011) ask whether external shocks originating from the U.S. played a dominant role in the macroeconomic variables of East Asian Countries. Our paper extends their analysis to the BRICS_T countries and explores the dynamic responses of macroeconomic variables to monetary policy and external shocks in those economies.

By omitting constants and other deterministic terms, the structural VAR can written as[5]

$$A(L)y(t) = \hat{U}(t) \qquad \textbf{(0.1)}$$

y(t) is an mx1vector of observations, A (L) is an m x m matrix polynomial in the lag operator L, and $\varepsilon(t)$ is an m x 1 vector of structural disturbances with

$$y(t) = \begin{bmatrix} y_1(t) \\ y_2(t) \end{bmatrix}, \quad A(L) = \begin{bmatrix} A_{11}(L) & A_{12}(L) \\ 0 & A_{22}(L) \end{bmatrix} \quad and \ \varepsilon(t) = \begin{bmatrix} \varepsilon_1(t) \\ \varepsilon_2(t) \end{bmatrix} \qquad \textbf{(0.2)}$$

The first block $y_1(t)$ is a vector of macroeconomic variables in the domestic country and the second block $y_2(t)$ is a vector of variables exogenous to the domestic country. The block exogeneity restriction that we impose is $A_{21} = 0$. It implies that the second block $y_2(t)$ is exogenous to the first block of domestic variables both contemporaneously and for lagged values of variables. A vector of structural shocks, $\varepsilon_t = \begin{bmatrix} \varepsilon_1(t) \\ \varepsilon_2(t) \end{bmatrix}'$ is assumed to be uncorrelated

[5]See Cushman and Zha (1997), Sato, Zhang and McAleer (2011) and Maĺkowiak (2005) for an analysis using VAR model with block exogeneity.

with $y(t-s)$ for s>0 and to satisfy $E\left[\varepsilon(t)\varepsilon'(t) \mid y(t-s), s>0\right] = I$ and $E\left[\varepsilon(t) \mid y(t-s), s>0\right] = 0$ where $\varepsilon_1(t)$ is a vector of structural shocks to domestic endogenous variables and $\varepsilon_2(t)$ is a vector of structural shocks to exogenous variables. The model is estimated separately for each BRICS_T economy.

Our choice of variables in the VAR model is based on small open economies with a New-Keynesian framework similar to those discussed in Svensson (2000), Clarida et al. (2001) and Bjørnland and Halvorsen (2013). Formally, for each BRICS_T economy, the variables in the endogenous and exogenous blocks are $y_{1,t}$ =[REXCR, M, R, P, Y, EXP, IMP] and $y_{2,t}$ =[Y*, P*, R*, OIL*], respectively. There are no restrictions on the block of endogenous variables $y_1(t)$. The block of exogenous variables $y_2(t)$ is in reduced form with normalization in the lower-triangularized order, $y_2(t)$ =[Y*, P*, R*, OIL*].

Identification ordering is recursive in $y_2(t)$: each variable in the ordering bracket is contemporaneously affected by the variables that precede and not affected by the variables that succeed it. There are no other restrictions on the coefficients of lagged variables in $y_2(t)$. In our ordering design, for example, the last variable OIL* in the bracket is affected by all the preceding three variables but it does not contemporaneously affect them.

Cushman and Zha (1997) RATS program is used for estimation[6]. Six lags are chosen for the VAR system due to the small sample size.

3. Data and Variables

The main source of data is the IMF's International Financial Statistics. However, some variables are obtained from different sources. Monthly data on money (M) is obtained from the IFS for Brazil, Russia, India, China, S. Africa and Turkey and from the OECD Main Economic Indicator (MEI) dataset for India. Treasury bill rates (R), exports (EXP), imports (IMP), consumer price index (P), producer price index (Y), advanced economies industrial production index (Y*), advanced economies consumer price index (P*), the world interest rate (R*) and oil prices (OIL*) are all from IFS. The real effective exchange rates (REXCR)

[6]We would like to thank to Cushman and Zha for making their program available.

are from IFS for Brazil, Russia, China, and South Africa; from the Central Bank of Turkey (CBT) for Turkey and from the Bank of International Settlement (BIS) dataset for India.

The logarithmic transformation is applied to all variables in the data set except the treasury bill and world interest rates which are in decimal percentage.

The estimation periods are 1995: M01-2012:M08 for Brazil, 1997:M01-2012:M08 for Russia, 1995:M01-2012:M08 for India, 1999:M01-2012:M08 for China, 1995:M01-2012:M08 for S. Africa and 1995:M01-2012:M08 for Turkey. The empirical models are estimated separately for each of the BRICS_T countries.

A structural VAR model with exogenous variables is estimated using monthly data for each BRICS_T economy. The monetary supply (M) is measured by the log of M2 for Brazil and Turkey, M1 for China, M3 for Russia and India, and M0 for South Africa. The choice of monetary aggregate (M) for each country is determined purely by the availability of data; the short term interest rate (R) is measured by Treasury bill rates for Brazil, Russia, South Africa, Turkey and by lending rate for India; the price level (P) is measured by the log of consumer price index (2005=100); output (Y) is measured by the log of the industrial production index (2005=100); the real effective exchange rate (REXCR) is the nominal effective exchange rate- a measure of the value of domestic currency against a weighted average of several foreign currencies- divided by a price deflator or index of costs. EXP and IMP are the log of export and import, respectively. The trade balance (TB) is the logarithm of the ratio of nominal exports to nominal imports as is commonly defined in the empirical literature[7] and the world interest rate (R*) is the simple arithmetic average of G-7 countries' short term interest rates; advanced countries consumer price index (P*) is in the logarithmic form; oil price (OIL*) is the log of the world crude oil prices index; world production is advanced economies industrial production index (Y*). Y*, P*, OIL* and R* are exogenous variables in each SVAR model.

4. Empirical Results and Theoretical Expectations

The empirical approach here follows Cushman and Zha's 1997 paper in which they used Canadian data from 1974 to 1993 to identify monetary policy in a small open economy. We use recently fast growing small open economiesô(the BRICS_T countries) monthly data from

[7] See Ivrendi & Guloglu (2010), Singh (2002) and Koray and McMillin (1999).

1995-2012 except Chinaôs data which run from 1999-2012 and Russiaôs data which run from 1997-2012. We decided against using an earlier starting point because it would be difficult to identify a stable monetary policy regime since many countries were part of a fixed exchange rate regime until the mid-90's. Consistent with most other related studies, the variables are specified in logarithmic levels[8]- with the exception of interest rates.

Since all BRICS_T countries are considered small open economies, with the exception of Russia, we expect a reasonable effect of exchange rate on monetary policy and therefore on the macroeconomic variables in those economies. This may not be the case for large closed economies such as the U.S. Cushman and Zha (1997), Manamperi (2013) and Carleroy (2013) used M1 as a measure of monetary policy; however, Bernanke and Blinder (1992), Sims (1992), Christiano et al. (1996), Bernanke and Mihov (1998) and Mihov (2001) argue that the short term interest rate is a better measure of monetary policy. Following Cushman and Zha (1997), Manamperi (2013) and Carleroy (2013), we use a monetary aggregate (M) as a measure of monetary policy in the SVAR model[9]. A monetary policy shock is modeled as a standard deviation disturbance in the monetary policy equation as in Cushman and Zha (1997). Finally, the SVAR model with exogenous variables is ýtted with 6 lags in log levels, with a time trend.

The identification of monetary policy shock for all BRICS_T economies can be characterized by three markets as in Cushman and Zha:

i. a money market
ii. an information market
iii. a production market

In the money market we have two equations. They are as follows:

$$d_{22}\left(M-P\right)-d_{22}Y+\ a_{23}R=\varepsilon_d \qquad \textbf{(2.1)}$$

[8]See Bjørnland and Halvorsen (2013), Cushman and Zha (1997), Uhlig (2005) and Hamilton (1994) for the discussion of VAR at level versus first difference.
[9] Manamperi (2013) shows that money supply is the most effective monetary policy tool for BRIC countries. Thus, he also considers a monetary aggregate as the main policy tool. Similarly, Carleroy (2013) employs money supply as proxy of the central bankôs monetary policy for BRICS countries.

$$d_{33}R + a_{32}M + a_{31}REXC + b_{33}R^{*} + b_{34}\left(OIL^{*}\right) = \varepsilon_{s} \quad \textbf{(2.2)}$$

Equation (4.1) is the textbook money demand equation. Equation (4.2) is the money supply equation which represents contemporaneous monetary policy and includes all information that is available within the month to the monetary policy makers. The policy makers observe immediately the changes in the exchange rate, money stock, both domestic and world interest rates, world commodity prices and oil prices.

The information market equation is similar to Sims and Zha (1995) and Cushman and Zha (1997) and it includes all contemporaneous variables:

$$d_{11}REXC + a_{12}M + a_{13}R + a_{14}P + a_{15}Y + a_{16}EXP + a_{17}IMP + b_{11}Y^{*} + b_{12}P^{*} + b_{13}R^{*} + b_{14}\left(OIL^{*}\right) = \varepsilon_{\inf} \quad \textbf{(2.3)}$$

Notice that in this specification, exchange rates can possibly respond within the month to all relevant information in the world and domestic economies. This equation implies that the data on exchange rate reflect indirectly other sources of information that may not be available to policy makers within the month.

The production market includes exports (EXP), imports (IMP), domestic output (Y) and prices (P). The imports and exports may be contemporaneously related to output and prices yet the exogenous variables such as contemporaneous world variables and the exchange rate are excluded from this market. Cushman and Zha (1997) argue that the external variables are related to production not simultaneously but with lags due to contracts and production planning. The equations of this sector are normalized in the order of import, export, output and prices (EXP, IMP, Y and P).

The estimated results for contemporaneous coefficients of the money demand, money supply and information equations are shown in Table 1.

Table 1: Estimated contemporaneous coefficients and standard errors

Market	Eq.	Variables	BRAZIL	RUSSIA	INDIA	CHINA	S. AFRICA	TURKEY
Money Market	Money Demand Equation	*M-P*	*0.073 (0.66)*	***4.957*** *(1.435)*	*0.549 (0.614)*	*0.552 (0.739)*	***1.137*** *(0.548)*	***2.395*** *(0.784)*
		Y	*-0.073 (0.66)*	***-4.957*** *(1.435)*	*-0.549 (0.614)*	*-0.552 (0.739)*	***-1.137*** *(0.548)*	***-2.395*** *(0.784)*
		R	***0.586*** *(0.028)*	***0.221*** *(0.011)*	***3.441*** *(0.161)*	***9.831*** *(0.544)*	***-2.849*** *(0.146)*	***0.251*** *(0.012)*
	Money Supply Equation	*R*	***0.082*** *(0.043)*	*0.003 (0.037)*	*0.114 (0.269)*	***1.419*** *(0.871)*	*-0.002 (0.198)*	*0.028 (0.031)*
		M	*-29.185 (35.491)*	***99.375*** *(8.289)*	***-304.50*** *(39.26)*	***-2.285*** *(1.331)*	***62.216*** *(7.839)*	***-23.626*** *(14.608)*
		REXCR	***29.517*** *(3.210)*	***-34.366*** *(9.675)*	*30.467 (27.557)*	***112.353*** *(5.819)*	*-7.08 (9.296)*	***41.748*** *(13.407)*
		R^*	*-0.500 (0.859)*	*-0.684 (0.855)*	*0.954 (0.767)*	*0.030 (0.782)*	***1.851*** *(0.635)*	***1.465*** *(0.923)*
		OIL^*	*-0.998 (1.497)*	*-0.608 (1.341)*	*-0.133 (1.133)*	*-0.905 (1.091)*	*0.740 (1.002)*	*1.795 (1.481)*
Information Market	Information Market Equation	*REXCR*	***11.09*** *(7.80)*	***80.62*** *(5.82)*	***90.60*** *(10.03)*	***-21.41*** *(9.08)*	***44.65*** *(3.10)*	*-29.17 (19.27)*
		M	***143.81*** *(11.02)*	***61.55*** *(15.29)*	*124.90 (95.35)*	***-97.85*** *(4.82)*	***31.90*** *(15.51)*	***-33.12 (11.27)***
		R	*-0.05 (0.05)*	***0.21*** *(0.02)*	***-0.59*** *(0.23)*	*0.59 (0.86)*	*-0.13 (0.19)*	*-0.07 (0.02)*
		P	***2.96*** *(1.27)*	***-4.57*** *(2.18)*	***-2.00*** *(1.23)*	***6.25*** *(1.84)*	*-0.97 (1.24)*	***-4.75*** *(2.77)*
		Y	*1.27 (1.36)*	***-3.36*** *(2.15)*	*-0.87 (1.41)*	*-3.87 (2.04)*	***-6.36*** *(1.03)*	*-2.00 (2.09)*
		EXP	***-18.87*** *(5.87)*	***9.78*** *(5.09)*	***-8.97*** *(3.87)*	***-0.72*** *(0.43)*	*11.03 (5.85)*	***6.22*** *(3.88)*
		IMP	***-71.10*** *(35.95)*	***9.06*** *(1.12)*	*-7.67 (12.85)*	***-98.34*** *(5.06)*	***101.24*** *(32.68)*	*18.10 (14.04)*
		Y^*	*-3.38 (9.97)*	***-16.65*** *(10.41)*	*-3.33 (10.12)*	*1.13 (8.33)*	*-2.85 (9.29)*	*11.35 (11.20)*
		P^*	*-117.00 (88.79)*	***161.61*** *(86.75)*	*57.02 (84.41)*	*-60.61 (56.71)*	*-74.75 (78.99)*	*49.88 (96.16)*
		R^*	***-1.163*** *(0.77)*	***1.28*** *(0.89)*	***1.35*** *(0.79)*	*-0.70 (0.80)*	*-0.60 (0.75)*	*0.58 (0.93)*
		OIL^*	***-2.70*** *(1.53)*	***-6.93*** *(1.68)*	*1.79 (1.39)*	***2.73*** *(1.08)*	*0.70 (1.33)*	*-1.03 (1.72)*

Note: Statistically significant coefficients are shown in bold font. The number in parentheses are standard errors

Letôs begin the analysis of results with the contemporaneous coefficients and their standard errors. Note that the maximum likelihood estimation of each equation is invariant to the normalization. Therefore we can discuss the precision of all the individual estimates based on the usual statistical interpretation.

The large number of significant coefficients in the money demand, money supply and information market equations that reflect simultaneity justifies the use of the SVAR with block exogeneity. It is clear that the contemporaneous coefficients are not triangular. The money demand has a positive relationship with income (y) in all the BRICS_T countries. Moreover it has a negative and statistically significant relationship with the interest rate in all the countries without any exceptions. These results are consistent with text book explanations of money demand. The money supply equations (Monetary Policy Equation) for Brazil, India, S. Africa and China reveal that the signs of the money stock and home interest rate are opposite -which imply that the central banks increase the money stock to offset high interest rates in those countries. This is consistent with interest rate smoothing in the conduct of monetary policy for the current period and known as interest rate smoothing in general. Moreover, the money stock (M) enters significantly at least at the 0.01 level in the money supply or policy reaction function in all the BRICS_T countries except India.

The opposite signs of the money stock (M) and the exchange rate (REXC) indicate that all the BRICS_T countries raise the money stock to offset appreciation of the domestic currency, consistent with our theoretical expectations. As we discussed in the introduction, monetary policy in a small open economy is likely to be quite sensitive to changes in the exchange rate. Our estimates support this effect. This kind of policy is known as "leaning against the wind." Moreover, Manamperi (2013) finds similar results for the BRIC countries (Brazil, Russia, India and China). He analyzes the reaction of BRIC countriesô central banks to different financial stress conditions (exchange rate stress, banking stress, and security market stress). The author shows that the BRIC countries' central banks respond strongly to exchange rate stress. Furthermore, he emphasizes that the exchange rate stress seems to be the most influencing stress on monetary policy settings in BRIC economies. The statistically insignificant coefficients of P* and R* mean that the central banks of the BRICS_T countries do not respond quickly to information on advanced countriesô consumer price index (P*) and

indicator of the world interest rate (R*). But, this does not indicate that the central banks of the BRICS_T countries do not react to the lags of those external variables.

The coefficients of money supply, exchange rate, imports, exports and oil prices in the information equation are generally significant, which indicates that there is a quick response of exchange rates in the BRICS_T countries to these macroeconomic variables.

4.1. Theoretically Expected Response of Macroeconomic Variables to a Contractionary Monetary Policy Shock

First, let's discuss the theoretically expected movements of macroeconomic variables to a contractionary monetary policy and then compare our theoretical expectations with the estimated impulse responses. In a monetary contraction, we expect a rise in exchange rates (appreciation) under flexible exchange rates[10]. Both þexible price models with liquidity effects and overshooting models with short-run price stickiness emphasize that a monetary contraction lead to an appreciation of the domestic currency, at least in the short-run. This also implies that there will be overshooting in the economy in response to a contractionary monetary policy.

Second, in a monetary contraction we expect a rise in interest rates and a fall in monetary aggregates initially. This expectation is based on mainstream theories which are generally accepted by most researchers. The initial rise in interest rates is expected to be short-lived and disappear in the short-run because of deflationary pressure. However, the initial impacts are expected to be a rise in interest rates and a fall in monetary aggregates.

Third, in a monetary contraction, we expect a fall in the price level as all theoretical models predict.

Fourth, we do not expect an increase in output, however we do expect a fall or no changes in output in response to a monetary contraction.

[10]See Ivrendi and Pearce (2013) for the discussions and empirical findings on contractionary monetary policy and the exchange rate in the U.S.

Fifth, a monetary contraction is generally expected to cause a fall in exports and a rise in imports but the net effect of a contractionary monetary policy on the trade balance depends on the magnitude of the expenditure switching effect and the income absorption effect. These two effects work in opposite directions. According to the expenditure effect, a contractionary monetary policy appreciates the domestic currency due to capital inflows which in turn makes foreign goods and services cheap and therefore increases imports and decreases exports. Therefore, it leads to a deterioration of the trade balance. According to the income absorption effect, a contractionary monetary policy decreases real output and therefore reduces a countryôs imports resulting in an improved trade balance. Accordingly, the reaction of the trade balance to a contractionary monetary policy shock depends on whether the expenditure switching effect is larger than the income absorption effect. If it is, then the trade balance gets worse; if it is not, then the trade deficit gets better. Therefore, we do not have any pre-determined expectation regarding the effect of a contractionary monetary policy on the trade balances in the BRICS_T economies. Finally, we do not expect a long deviation from uncovered interest parity (UIP) in response to a contractionary monetary policy.

4.2. Predictions of our model for each country

We report the estimated impulse responses of macroeconomic variables to a contractionary monetary policy for each BRICS_T country in Figure 1. We put the name of the country at the top of each column and the name of each responding variable to the contractionary monetary policy at the left of each row. Each column reports the impulse responses of a countryôs macroeconomic variables to a one standard-deviation money supply shock (a monetary contraction).

Letôs look at our estimated impulse responses in Figure 1 and compare them with our aforementioned theoretical expectations. First, in response to contractionary monetary shocks, the nominal exchange rates (the first row) initially rise signiýcantly in all countries without exception, which is consistent with our aforementioned theoretical expectation. We also calculate the real exchange rate response (reported in the tenth row in Figure 1) for BRICS_T countries. The results show that the real values move very similarly to the nominal ones. Our findings of the exchange rate appreciation following a contractionary monetary policy shock is consistent with results found in Anderson et al. (2003), Zettelmeyer (2004), Kearns and Manners (2006), Faust et al. (2007) and Mallick and Sousa (2009, 2013), among others.

Consequently, there is no puzzle here about the relationships between a contractionary monetary policy shock and an exchange rate response. This is one of the most important findings of this study. Our models reveal that contractionary monetary policy shocks have significant effects on exchange rates in all BRICS_T countries. Furthermore, all the countries examined in this study demonstrate some evidence of overshooting behavior in response to a contractionary monetary policy.

Second, the responses of real interest rates to a contractionary monetary policy are significantly positive in all the BRICS_T economies except Russia. Theoretically we expect a positive and significant response of real interest rates to a contractionary monetary policy shock. The findings reported in the first row and third column of Figure 1 are consistent with our theoretical expectations. The responses of nominal interest rates are generally insignificant. This suggests that inflation falls offsetting the effect on nominal rates but strengthening the effects on real rates

Third, monetary contraction shocks reduce price indexes in the all BRICS_T countries except Russia. These findings are consistent with the predictions of main stream theories and our aforementioned theoretical expectations as well as the recent empirical findings regarding the effects of monetary policy on prices[11]. Our findings imply that monetary policies are effective in controlling inflation in BRICS_T economies except for Russia. This is consistent with the findings of Mallick and Sousa (2009, 2013) who analyze monetary policy transmission for BRICS countries by using a sign restricted VAR model. The authors find that a contractionary monetary policy tends to stabilize inflation in those countries.

The only country in which monetary policy has no effect on the price level in the BRICS_T countries is Russia. Granville and Mallick (2010) find very similar results for Russia. They argue that Russian monetary policy has failed to achieve sustained low inþation during the 1995-2009 period. In their paper they argue that the monetary authoritiesô failure to control double-digit inþation in Russia was driven by the policy of exchange rate targeting adopted in the aforementioned period. Furthermore, our findings reveal that the contractionary monetary policy reduces inflation by causing a significant appreciation in the exchange rate in all the

[11] See Domaç and Yücel (2005), Wynne and Kersting (2007), Ball and Sheridan (2005) for the examples of how monetary policies succeed to control inflation in both developing and developed countries since the late 1980s.

BRICS_T countries except Russia. Impulse response analyses indicate that the appreciation after the contractionary monetary policy does not persist for long in Russia. In contrast, the appreciation in the exchange rate is strong and persistent in the other countries. Thus, we conclude that appreciation has helped to dampen inflation in BRICS_T countries. This is consistent with the expected effects of a tight monetary policy: a contractionary monetary policy is expected to appreciate the domestic currency and reduce inflation (see, IMF country reports). However, as discussed in OECD Economic Surveys: Russian Federations (2011), the appreciation of ruble after a contractionary monetary policy is considerably weak and temporary because of the CBRôs interventions in foreign exchange markets to restrain nominal appreciation of the ruble. The interventions create inflationary pressures by inducing a rapid expansion in the money supply. Hence, the contractionary monetary policy has failed to control inflation in Russia.

Fourth, the effects of contractionary monetary policy shocks on output are negative in India, S. Africa, Russia and China in the short-run, which is consistent with most theoretical models and our expectations. Raýq and Mallick (2008) find a roughly similar response of output to a contractionary monetary policy for Germany and France. Our findings suggest that monetary policy is a potentially useful instrument in reducing output þuctuations in the short-run in those economies. However, the effect of contractionary monetary policy on output is positive but not significant in Brazil and Turkey. The findings regarding the reactions of Turkey and Brazil output to contractionary policy are called output puzzles in the literature and are inconsistent with our theoretical expectations. Raýq and Mallick (2008) find similar response of output to a contractionary monetary policy for Italy.

Fifth, monetary contraction shocks have negatively significant effects on exports in Russia, China and Brazil consistent with our theoretical expectations. The shocks have positive yet insignificant effects on exports in S. Africa, Turkey and India. With the exception of China and S. Africa - the response of imports to a contractionary monetary policy is significantly positive in the all BRICS_T countries, which is consistent with our expectations. The effect on import in China and S. Africa is negative but insignificant.

As we discussed above, the net effect of a contractionary monetary policy on the trade balance depends on the magnitude of the expenditure switching effect and the income

absorption effect. Our findings reported in the second column and fourth row of Figure 1 reveal that the net effect of a contractionary monetary policy on the trade balance is negative in Brazil, Turkey, India, Russia and China. These findings reveal that the expenditure switching effects are larger than the income absorption effects in five out of six BRICS_T countries. This means that contractionary monetary policy initially worsens the trade balances in those economies and confirms the hypothesis that there are inverse J-curves in five out of six BRICS_T economies in response to a contractionary monetary policy. This finding is a crucial component in our research.

Finally, as in Cushman and Zha (1997), we investigate uncovered interest parity (UIP) by calculating the response path of deviations from UIP. The deviation is defined as D = R - R * + 4 (Excf-Exc), where Excf is the forecasted three-month-ahead exchange rate response. The third column and row in Figure 1 disclose that there are significant negative deviations from zero for at least 5 months in the entire forty-eight horizon. This finding contrasts with most theoretical literature arguments but is consistent with most empirical data on UIP. Cushman and Zha (1997) find similar results for Canada and they refer to McCallum's (1994) research in which he shows how regressions that ignore endogenous monetary policy reactions to interest rates and exchange rates may exhibit serious UIP violations, despite the fact that UIP actually holds. Recently, Heinlein and Krolzig (2012) analyze the possible presence of a ñdelayed overshooting puzzleò in the dynamic reaction of the exchange rate (the US dollar/UK pound) to monetary policy shocks. They find strong evidence for delayed overshooting and violations of uncovered interest rate parity (UIP) in response to monetary policy shocks.

As a final point, Figure 2 reveals that there is no clear pattern regarding the effects of world output shocks on the macroeconomic variables in BRICS_T economies. This implies that world output shocks are not a dominant source of fluctuations in macroeconomic variables of BRICS_T economies.

5. Conclusion

The literature on monetary policy reveals a broad consensus that a contractionary monetary policy shock leads to important effects on macroeconomic variables in the short-run. In some

sense, we test this consensus view in the context of fast growing, small open emerging countries, named BRICS_T.

Our findings reveal that the effects of contractionary monetary policy on macroeconomic variables in BRICS_T economies are largely consistent with mainstream theories and our expectations. We find that a contractionary monetary policy shock appreciates the domestic currency (both in real and nominal terms) in all BRICS_T countries consistent with mainstream theories and recent empirical findings that we discussed above. We did not find any exchange rate puzzles in the responses of the exchange rates to a contractionary policy in the BRICS_T economies.

In response to a contractionary money supply shock, the monetary aggregates fall and interest rates rise as expected. With the exception of Russia, our findings reveal that monetary policies are effective in controlling inflation in the BRICS_T economies. Russian monetary policy has failed to control inþation during the period we studied.

Furthermore, we find that contractionary monetary policy shocks are effective in reducing output in India, S. Africa, Russia and China but not in Brazil and Turkey.

The anomalies in our empirical analysis suggest there are inverse J-curves in five out of six BRICS_T economies and there are deviations from UIP in response to a contractionary monetary policy in BRICS_T economies. These anomalies are also found in previous empirical studies.

Finally, our findings reveal that world output shocks are not a dominant source of fluctuations in BRICS_T economies.

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Brazil monetary policy shock

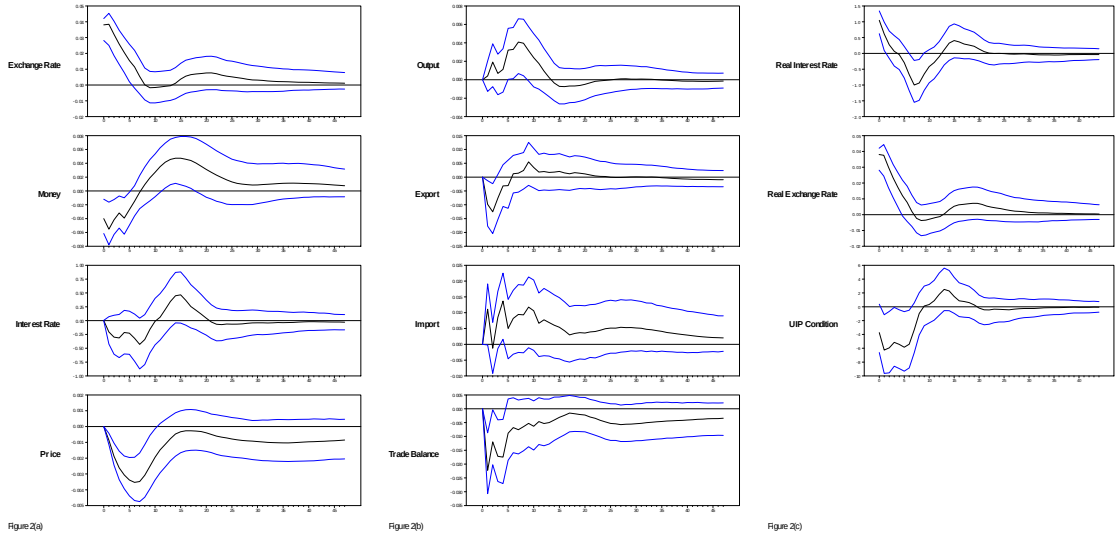


Fig. 1. Dynamic responses to a contractionary monetary policy

World output shock

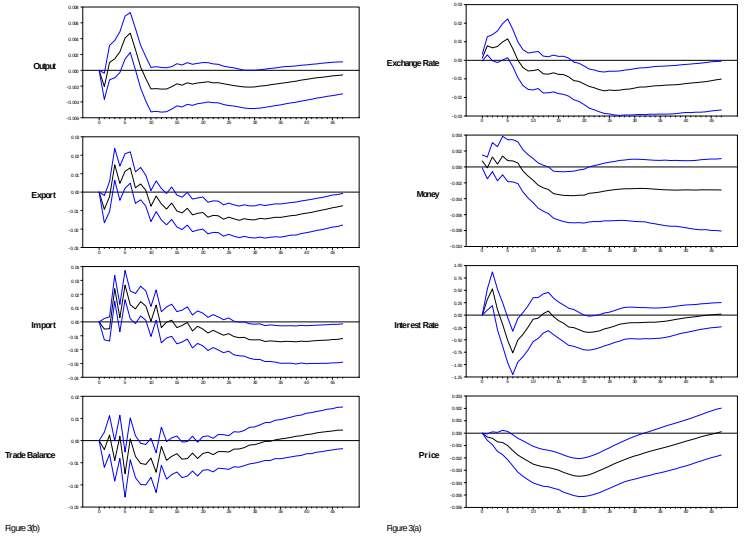


Fig. 2. Dynamic responses to an expansionary World output k.

South Africa monetary policy shock

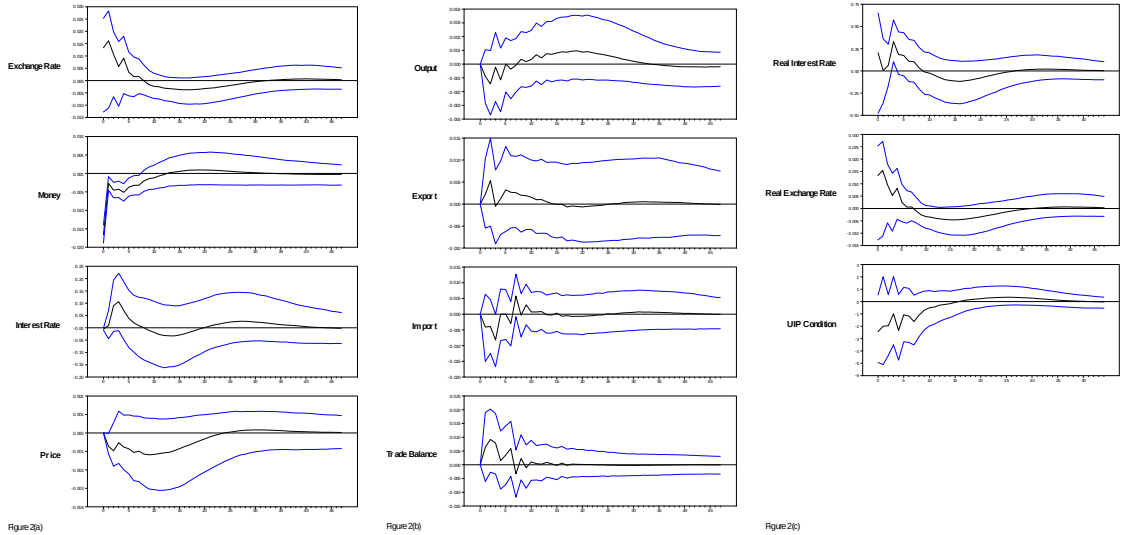


Fig.1.(Continued)

World output shock

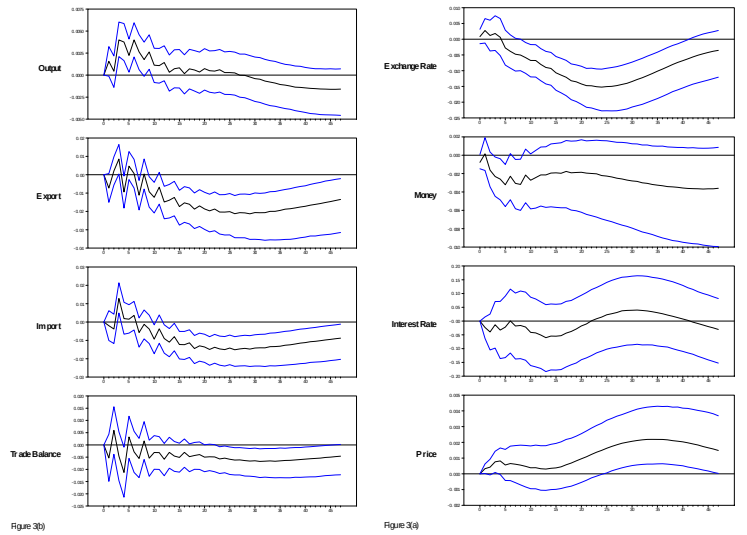


Fig. 2.(Continued)

Turkey monetary policy shock

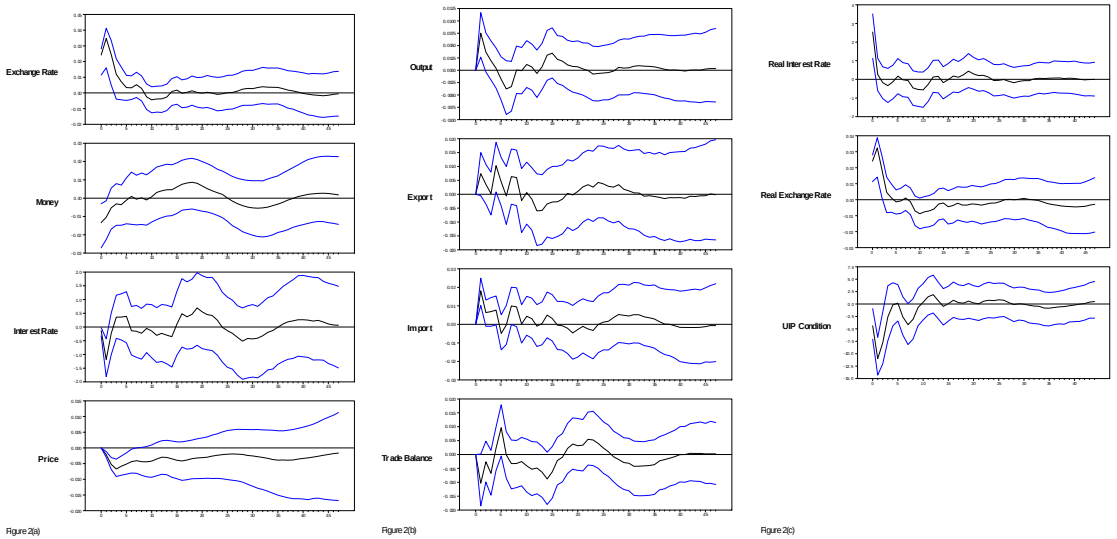


Fig.1.(Continued)

World output shock

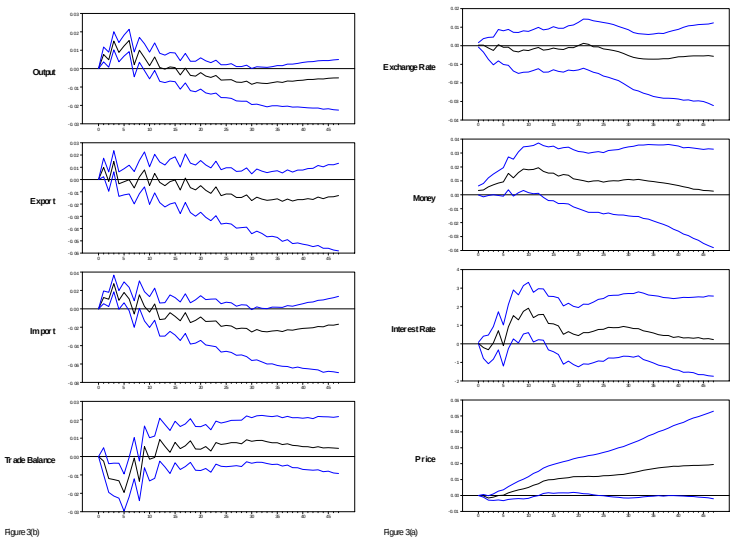


Fig.2.(Continued)

India monetary policy shock

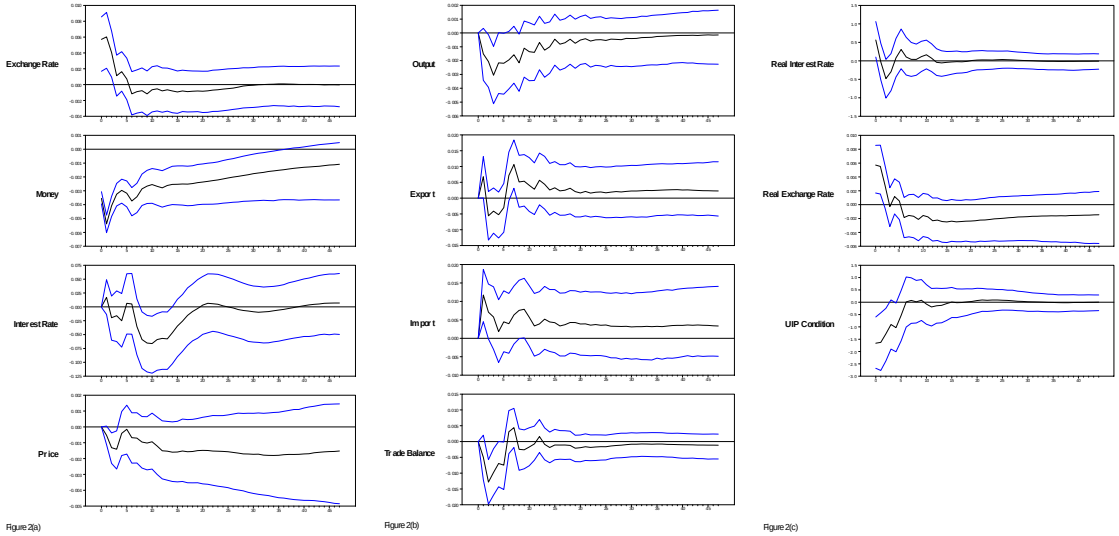


Fig.1.(Continued)

World output shock

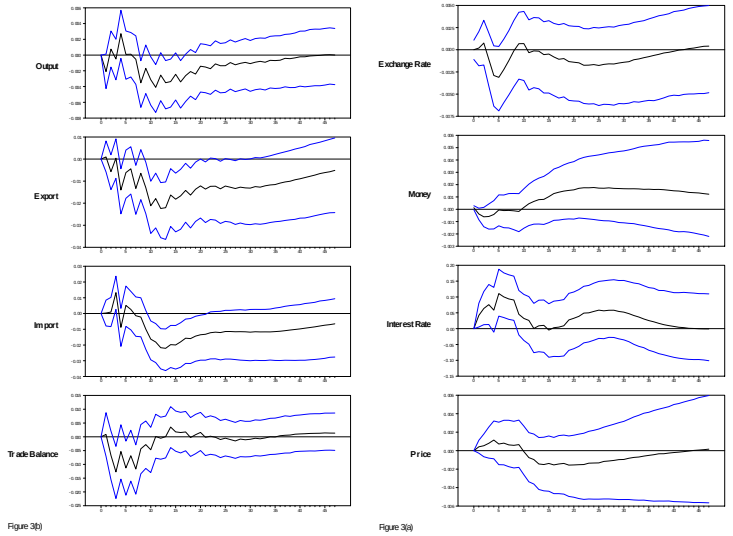
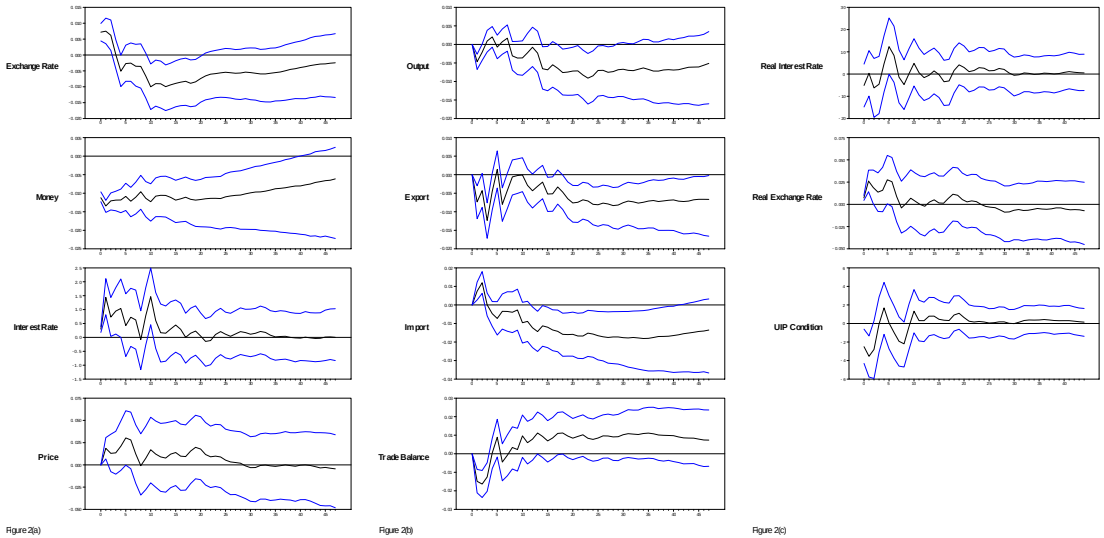


Fig. 2.(Continued)

Russia monetary policy shock



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World output shock

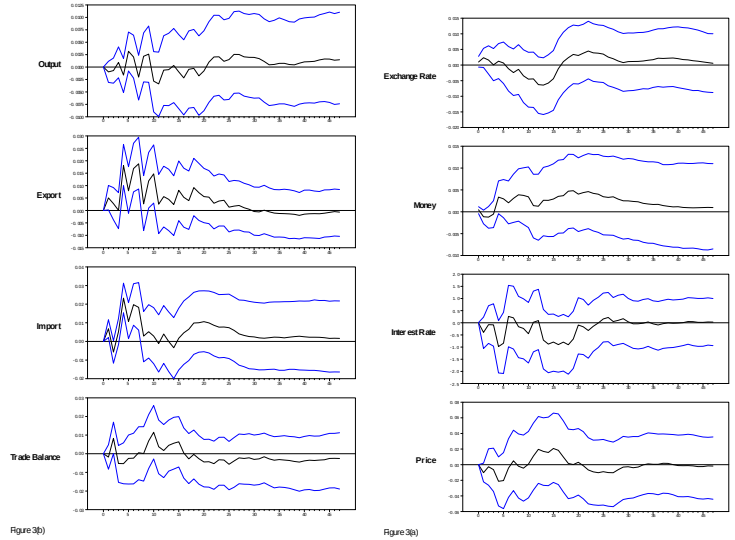

Fig.2. (Continued)

China monetary policy shock

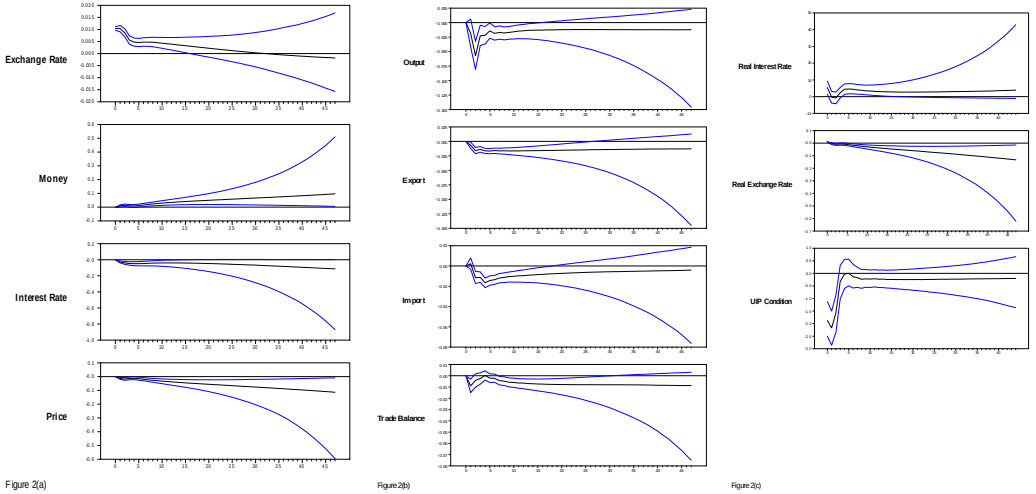

Fig.1.(Continued)

World output shock

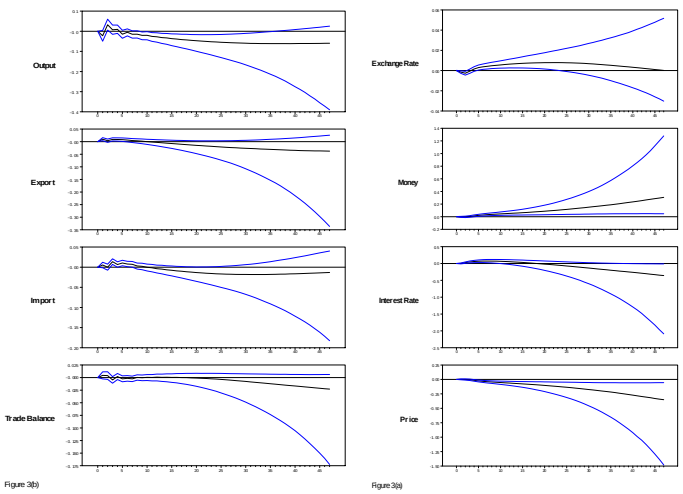

Fig.2.(Continued)