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Abstract

This study examines the impact of China's dominant position among the BRIS countries, namely Brazil, Russia, India and South Africa. Particularly, by using a dynamic factor model estimated over the period 1995Q2-2009Q4, it investigates how supply and demand shocks from China are transmitted to these economies. The results show that China's supply shocks are more important than its demand shocks. Supply shocks produce positive and significant output responses in all BRIS countries. International trade is an important channel for the transmission of shocks across China and BRIS countries indicating that supply and demand shocks in China do not have similar effects on the BRIS countries and therefore they require different policy responses.

JEL Classification Numbers: C3, E32, F40, O57

Keywords: Dynamic factor model, Supply and demand shocks, Sign restrictions, BRICS

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1 Introduction

Increasing economic integration, especially through trade and financial flows among countries, has been one of the most remarkable events in the world over the last two decades. Many emerging economies have gained in prominence as their economic activities now have significant ripple effects in other countries including the developed ones (Akin and Kose, 2008). In as far as geo-politics is concerned the large emerging economies - Brazil, Russia, India, China and South Africa (SA) - are rapidly becoming integrated and important to the world economy (see Çakır and Kabundi, 2013a, b). They intended to strengthen their mutual cooperation within the form of the alliance of the BRICS group. China is obviously the dominant actor among this emerging group.

This paper therefore focuses on China, because its integration with the global economy and within BRICS is deeper than that of any other country. Our interest in this paper is to identify supply and demand shocks in China and their channels of transmission. To achieve that we use a dynamic factor model estimated over the period 1995Q2-2009Q4.

The reason for assessing the impact of China's shocks to BRIS is based on the fact that China's growth has changed the distribution of economic activities across the world. Its share of the world's GDP now stands at 14%, making it the second largest economy after the US (IMF, 2012). Its high economic growth[1] and increased openness have led to it becoming a major player in the global economy (Siklos, 2010). China has now an economic powerhouse that significantly contributes to economic recoveries after meltdowns. For example, when the US subprime crisis triggered a global financial crisis in 2008, which slowed global economic growth, China's economy grew by 9.1% in 2009. China's status as one of the most important countries in the world is not overstated, as it is the world's second largest economy, a nuclear weapons state, a permanent member of United Nations Security Council, the largest holder of foreign exchange reserves and a rising power whose influence is spreading across the globe. Thus, China's growing importance as an assembly platform for exports of manufactures, a destination for foreign investment, and a consumer of imported technology, raw materials and industrial goods is not a one-time shock; rather, it is an on-going process that continually shape the balance of global supply and demand (Eichengreen and Tong, 2005). As a strategic power that is intent on rivaling the US, China is projected to surpass the US in 2030 to become the world's largest economy (Maddison, 2006). China therefore significantly raises the status and profile of the other BRICS countries (Lo, 2008).

[1] Between 1980 and 2009, China's real GDP growth rate has averaged around 10%. As Perkins (2005) notes, this rate of growth could be sustained in the ranges of 8% to 10% a year for the next couple of decades.

There is already rich literature that focuses on China's trade and financial integration with the world (Cheung, Chinn and Fujii, 2005; Shin and Sohn, 2006; Francois and Wignaraja, 2008; Bussière and Schnatz, 2009; Ghosh and Rao, 2010, and Tokarick, 2011). However, little research has been conducted on China's economic influence on the other countries, save for Bloom, Draca and Van Reenen (2011) who have studied the impact of China on developed economies and Hsieh and Ossa (2011) who have assessed the welfare impact of the observed pattern of sector-level growth in China on fourteen major countries and four broad world regions. However, none of these studies, or any other study to date, has considered the impact of China's economic activities on the other BRICS countries.

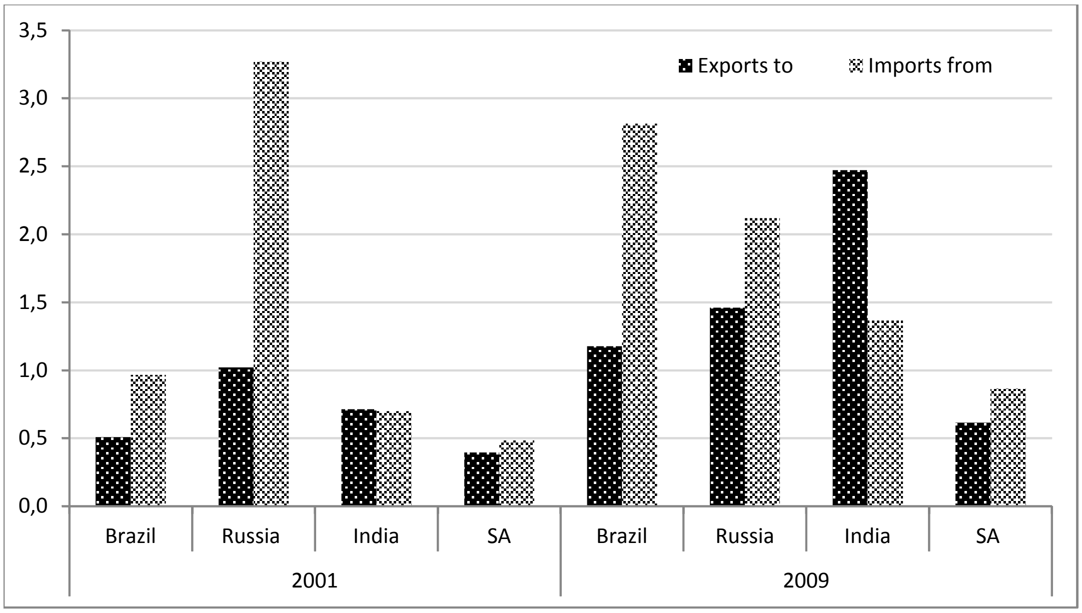
The expansion of international trade has been a particularly remarkable aspect of China's rising prominence in the world economy. Between 1995 and 2009, China's exports and imports grew at an average rate of around 20% and 18%, but in 2009 they both decreased at around 16% and 11%, respectively. China's largest trading partners in terms of total exports and imports are the US and Japan (IMF, 2012).

China's trade with Japan and the US decreased significantly over the last decade. For instance, its imports from Japan decreased from around 17.5% to 13% of total imports and exports to Japan decreased from 17% to 8%. International trade, especially exports is a major driver of economic growth of China. Taken together, exports and imports amount to over two-thirds of its GDP (IMF, 2012). This is partly due to the heavy involvement of the manufacturing sector in international production chains and its policies on technology development (Tan and Khor, 2006; Bergsten, Gill, Lardy and Mitchell, 2006, and Lemoine and Unal-Kesenci, 2007). This high growth in trade has been supported by large investment flows (Eichengreen and Tong, 2005). For instance, it received an average of around 4% net foreign direct investments (FDI) of GDP between 1995 and 2010 (WB, 2011). China's FDI is export oriented and also directed in part to investment in infrastructure. Given the significantly larger shares of private capital flows in China's GDP and its tilt towards exports and growth promoting infrastructure, it is clear that the increased integration of China into the world economy contributes to its rapid growth. Also, China's growth has benefited significantly from the world wide fragmentation of production where parts of the production chain have been moved to low cost countries (Den Butter and Hayat, 2008).

As China's trade with the rest of the world deepens, so is the shift of the composition and geographical pattern of its trade. Its imports are growing rapidly as it is now the third largest importer of developing countries' goods after the US and the European Union. China's trade with the BRIS countries is also growing rapidly and China is now among the most important export destinations for these economies. Imports from the

BRIS countries increased between 2001 and 2009, except for Russia (Figure 1). From the point of view of its source of imports among the BRIS, Russia was the main supplier of China (3.3%). But in 2009, Brazil became China's biggest import market when it supplied 2.8% of China's total imports. China's imports from India and SA increased from 0.7% and 0.5% in 2001 to 1.4% and 0.9% in 2009, respectively. In terms of total exports, in 2001, Russia was the top export market for China's goods (1%), followed by India (0.7%), Brazil (0.5%) and SA (0.4%). However, in 2009, India overtook Russia and became the leading export destination of China (2.5%), followed by Russia, Brazil and SA which received 1.2%, 1.5% and 0.6% in that order. The intensity of trade linkages between China and the BRIS countries is different for each of the countries. In 2009, Brazil, India and Russia are intensively linked to China, while SA has somewhat weak linkages with China (Figure 1).

Figure 1: China's Foreign Trade with the BRIS (Percentage of world)



Source: ITC calculations based on UN Comtrade statistics, 2012.

As a consequence, China has provided an opportunity and a market for primary commodity exporters from developing countries. This has helped raise economic growth in a number of developing countries in recent years (Jenkins, 2008). Thus, the emergence of China as a large trading nation and destination of international investment is likely to have positive spillover effects on its trading partners. Hence, one might expect China to have a significant effect on BRIS countries' economic activity.

This paper assesses the influence of China on BRIS and it identifies channels through which shocks are transmitted. It is essential to identify how positive supply shock from China affects macroeconomic variables of the BRIS countries. In addition, the question arises as to whether the demand shock is transmitted differently. To the best of our knowledge, this paper is the first attempt to investigate the impact and the transmission of China's supply and demand shocks to the BRIS countries.

The study finds three main characteristics of the transmissions. First, China's supply shocks to BRIS are transmitted more forcefully than its demand shocks. Second, the reaction of BRIS to China's shocks varies across countries. For example, positive supply shocks have positive, permanent and significant effects on Brazil's, Russia's and SA's output, while it has positive but short-lived effect on India's output. Positive demand shocks from China have positive and significant effect on Brazil's and SA's output only. Finally, the magnitude and the channels of transmission of shocks also vary from one country to another. The results based on the variance share of the common component suggest that SA and Russia are intensively linked to China, while Brazil and India have rather modest economic linkages with China. The main channels of transmission for all shocks are exports and imports between China and SA; imports and short-term interest rate between China and Brazil; exports and short-term interest rates between China and Russia, and exports, imports and short-term interest rate between China and India. The transmission channels are mainly trade channels rather than financial.

This rest of the paper is organized as follows. The next section discusses the dynamic factor model and the identification of supply and demand shocks. Section 3 analyses the data, their transformation and the estimation technique. Section 4 discusses the empirical results and the transmission channels. Section 5 concludes the paper.

2 Methodology

This section includes two main steps. It firstly introduces the dynamic factor model[2] to investigate the common components of a large number of macroeconomic variables and then the process of identification of structural shocks that explain the common components of the variables of interest.

2.1 The factor model

Factor analysis has been successfully considered in models consisting of large number of variables. Classical factor models were initiated by Sargent and Sims (1977) and

[2] More details can be found in Forni and Lippi (2001), and Stock and Watson (2002a, 2002b).

Geweke (1977). These models have been applied by Singleton (1980), Chamberlain and Rothschild (1983), and Stock and Watson (1998), among others. The main idea of factor models is that all the information included in a large dataset could be captured by a few key common factors. These factors represent the hidden forces underlying the co-movement of observable series. The co-movement of contemporaneous time series is due to the fact that they are arising largely from a relatively few key economic factors, such as productivity, monetary policy, trade linkages, financial linkages and oil price shocks. In this paper, the unobserved factors assist in the identification of supply and demand shocks within a data-rich environment framework. Various methods have been proposed to construct these common factors, the simplest is the principal component analysis introduced by Stock and Watson (2002a).

Recently, the dynamic factor model has become very popular in economics.[3] Suppose there are N number of different observable economic variables, each one consisting of T observations. It is assumed that, for each observation in time t, all the N individuals partially depend on a small number, r, of non-observable, or latent common factors. Assume that Y_t is represented as the sum of the two latent components, a common component, $X_t = (x_{1t}, x_{2t}, ..., x_{Nt})'$, and the idiosyncratic component, $\Xi_t = (\varepsilon_{1t}, \varepsilon_{2t}, ..., \varepsilon_{Nt})'$. Thus, an approximate dynamic factor model of Stock and Watson (1998, 2002a) can be represented as

$$Y_t = X_t + \Xi_t = \Lambda F_t + \Xi_t \tag{1}$$

where X is the product of a $q-$dimensional vector of common factors, and $\Lambda = \left(\lambda_1^{'}, \lambda_2^{'}, ..., \lambda_N^{'}\right)'$ is the $N \times r$ matrix of factor loadings with $r \ll N$. $F_t = (f_{1t}, f_{2t}, ..., f_{rt})'$ is a vector of r common factors. The common component of each series, which is driven by a small number of shocks common to all variables, is the part of the series that depends on the common factors. However, the effects of the common shocks are different for each variable because of the different factor loadings. The idiosyncratic component is the part of the series driven by idiosyncratic shocks that are specific to each variable and it is orthogonal to the common factors. Unlike the vector autoregressive (VAR) process, the factor model can accommodate a large number of variables. The estimation of the parameters of Equation (1) generally lies in the analysis of the variance-covariance matrix of the observable data X. All the N series depend on r factors, meaning that there is a r-dimensional matrix representing the N series. This dimension reduction matrix corresponds to the choice of the largest eigenvalues of the variance-covariance matrix

[3] It has been used by Forni, Hallin, Lippi and Reichlin (2005), Kabundi (2009), Kabundi and Nadal De Simone (2011), Doz, Giannone and Reichlin, (2011), Crucini, Kose and Otrok (2011), and Çakır and Kabundi (2013).

of Y. Therefore, the first largest eigenvalues and eigenvectors are calculated from the variance-covariance matrix $cov(Y_t)$,

$$X_t = VV'Y_t \tag{2}$$

where V' is the $N \times r$ matrix of eigenvectors corresponding to the largest r eigenvalues of the correlation matrix of Y_t. The common factors, F_t, are estimated in a consistent manner by applying standard principal component analysis to Y_t,

$$F_t = V'Y_t \tag{3}$$

where the factor loadings, Λ, is equal to V, an estimate of the matrix of factor loadings. Hence, the idiosyncratic components are

$$\Xi_t = Y_t - X_t \tag{4}$$

Then, the number of static factors, r, for the above mentioned dynamic factor model, are estimated using Bai and Ng (2002) and Alessi, Barigozzi and Capasso (2010) information criterion. Lastly, the common factors are estimated by a Vector Autoregressive representation of order 1 as in Forni, Hallin, Lippi and Reichlin (2005) and represented as

$$F_t = \Psi F_{t-1} - \mu_t \tag{5}$$

where Ψ is a $r \times r$ matrix and μ_t a $r \times t$ vector of residuals. Equation (5) characterises the dynamic of common factors. We follow the approach proposed by Chamberlain (1983) and Chamberlain and Rothschild (1983) which allows for a mild serial correlation of the idiosyncratic errors, but the weak correlation vanishes with the law of large numbers.

2.2 Identification of structural shocks

The identification of structural shocks is based on the reduced form VAR model in Equation (5). This study follows the identification scheme proposed by Faust (1998) and Uhlig (2005) based on inequality restrictions imposed on the impulse response functions of variables of interest. This identification methodology has gained significant interests in recent years. For instance, Peersman (2005) uses sign restrictions to study the slowdown of the early 2000s in the Euro region and the US by identifying demand, monetary policy and two supply shocks. Ruffer, Sanchez and Shen (2007) similarly look at the contributions of fluctuations in ten Asian countries. Sanchez (2010) also investigates the contributions to fluctuations in fifteen emerging economies. More recently, Kabundi and Nadal De Simone (2011) have identified the main shocks that cause fluctuations in French output and their channels of transmission. This study uses identification scheme proposed by Eickmeier (2007) and Kabundi and Nadal De Simone (2011), which has three main steps.

In the first step, the reduced form VAR residuals, μ_t, are orthogonalised using the Cholesky decomposition. The vector of orthogonalised residuals is $\upsilon_t = A^{-1}\mu_t$ and $E\left(\nu_t\nu_t^{'}\right) = 1$. Thus,

$$cov = \mu_t = AE\left(\nu_t\nu_t^{'}\right)A^{'} = AA^{'} \tag{6}$$

with A being the $r \times r$ lower triangular Cholesky matrix. The vector of impulse response functions of y_{it} to the identified shock in period k to ν_t is obtained as

$$\varphi_{ik} = c_i B^k A \tag{7}$$

with c_i being the i^{th} row of factor loadings of C and the corresponding variance-covariance matrix of the $k-$step ahead forecast error is $\sum_{j=0}^{k}\varphi_{ij}\varphi_{ij}^{'}$.

In the second step, the main driving forces or shocks of China's GDP are identified. This is achieved by extracting the shocks which maximize the explanation of the chosen variable of the $k-$step ahead of the forecast error variance of GDP out of the orthogonalised residuals. The vector of the main driving forces $\omega_t = \left(\omega_{1t}, \omega_{2t}, ..., \omega_{rt}\right)^{'}$ behind China's GDP growth is assumed to be linearly correlated to the identified shocks through the $r \times r$ matrix Q,

$$\upsilon_t = Q\omega_t \tag{8}$$

The objective of the procedure is to choose Q so that the first shock explains as much as possible the forecast error variance of China's GDP over a certain horizon k, and the second shock explains as much as possible the remaining forecast error variances. Hence, the forecast error variance explained by the first shock is

$$\sigma^2(k) = \sum_{j=0}^{k}\left(\varphi_{ij}q_1\right)\left(\varphi_{ij}q_1\right)^{'} \tag{9}$$

where i is the China's GDP, and q_1 is the first column of Q. Thus, Q is the matrix of eigenvectors of S, $(q_1, q_2, ...q_r)$, where q_1 $(l = 1, ..., r)$ is the eigenvector corresponding to the l^{th} principal component shock. Uhlig (2003) suggest that the column q_1 should be selected so that $q_1^{'}\sigma^2 q_1$ is maximized. That is,

$$\sigma^2(k) = \sum_{j=0}^{k} \left(\varphi_{ij} q_1\right) \left(\varphi_{ij} q_1\right)^{'}$$
$$= q_1^{'} S_{ik} q_1 \tag{10}$$

where $S_{ik} = \sum_{j=0}^{k} (k+1-j) \varphi_{ij}^{'} \varphi_{ij}$ subject to the side constraint $q_1^{'} q_1 = 1$, which is a normalization condition that can also be written as the Lagrangean,

$$L = q_1^{'} S_{ik} q_1 - \lambda \left(q_1^{'} q_1 - 1 \right) \tag{11}$$

where λ being the Lagrangean multiplier. From Equation (11), q_1 is the first eigenvector of S_{ik} and λ is the corresponding eigenvalue. Thus, the shock associated with q_1 is the first principal component shock.

In the third step, orthogonal shocks are identified by rotation. The vector of orthogonal two shocks $\omega_t = (\omega_{1t}, \omega_{2t})$ is multiplied by any 2×2-dimensional orthogonal rotation matrix R of the form:

$$R = \begin{pmatrix} \cos(\theta) & -\sin(\theta) \\ \sin(\theta) & \cos(\theta) \end{pmatrix}$$

with θ being the rotation angle, $\theta \in (0, \pi)$ which varies on a grid to produce all possible rotations. In this study, the angle of rotation is applied on the first two principal component shocks, namely the supply and demand shocks. To account for uncertainty in the factor estimation, a bootstrap technique, which is necessary in constructing confidence bands, is applied according to Kilian (1998).

The identification scheme mentioned above is used to identify China's demand and supply shocks. The identification strategy is based on aggregate demand and aggregate supply paradigm, which the core of many macroeconomic textbooks. We have adopted this procedure to avoid unrealistic identification strategy that are commonly used in VAR framework setting to zero short-term restrictions and using long-run restrictions of Blanchard and Quah (1989). Table 1 provides a summary of the sign restrictions imposed for the identification of shocks.

In line with a typical aggregate demand and aggregate supply diagram, a positive demand shock affects both output and prices positively, while a positive supply shock has a positive effect on output, but prices react negatively. Thus, the central bank is likely to react to a positive supply shock by decreasing the nominal interest rate and increasing it in case of a positive demand shock (Peersman, 2005; Fratzscher, Saborowski and Straub, 2010; Straub and Peersman, 2006, and Canova and Paustian, 2011). Other variables are left unrestricted. If these shocks are correctly identified, i.e. the output, prices, and short-term interest rates behave as expected, then we can trust their impact on other variables and the spillover to other economy.

Table 1: Sign Restrictions

Shocks	Output	Prices	Interest Rates
Positive Supply Shock	+	-	-
Positive Demand Shock	+	+	+

3 Data and Estimation

The dataset comprises a total of 161 ($N = 161$) quarterly variables, ranging from 1995Q2 to 2009Q4 which implies 59 time dimension ($T = 59$). The reason for the choice of this time span is the availability of data. Specifically, the dataset contains 32 variables for Brazil, 28 for China, 30 for India, 34 for Russia and 37 variables for SA. The data covers the real, nominal and financial variables, such as GDP, consumption, investment, consumer prices, interest rates, exchange rates, monetary aggregates, international portfolio and direct investment flows as well as international trade. The variables and their transformation are provided in Table 4. The data series are obtained from IMF's International Financial Statistics (IFS), the Organization for Economic Cooperation and Development (OECD) and the GVAR Toolbox1.0 databases.

As required in the factor model, each of the 161 macroeconomic series is transformed to comply with stationarity condition. Two unit root tests, namely the Augmented Dickey-Fuller, hereafter ADF, and Kwiatkowski, Phillips, Schmidt and Shin, hereafter the KPSS, (1992) are performed to test for the stationarity of all the series. The KPSS test differs from the ADF tests in that the data series in the former are assumed to be trend-stationary and uses different null hypothesis of stationarity as opposed to non-stationary. All variables are seasonally adjusted using $X12$ filter and transformed into logarithms, except those in percentages and those containing negative values.

We then estimate the number of factors.[4] Bai and Ng, hereafter BN, (2002) suggest six criterions for determining the number factors. All six criterions seek the number of static factors that minimizes the mean squared distance between observed data and

[4] To determine the number of factors empirically, a number of methods have recently been developed particularly by Bai and Ng (2002), Stock and Watson (2005), Hallin and Liska (2007), Bai and Ng (2007), and Alessi, Barigozzi and Capasso (2010).

common part as estimated by static principal components. The mean squared distance is computed for all the possible number of static factors r up to $r_{\max} = \min\{N, T\}$. The BN criterion can be used to consistently estimate the number of factors where the cross-section dimension, N, and the length of the observed series, T, both go to infinity. The traditional Akaike information criterion (AIC) and Bayesian information criterion (BIC), common in time series fail because they rely on the assumption $T \gg N$. Bai and Ng (2002) generalizes the C_p criteria of Mallows (1973) and obtain the Panel C_p (PC_p). In addition, they propose another class of criteria similar to the AIC and the BIC, but they use the logarithmic transformation of the error variance and obtained a panel Information Criteria (IC_p).[5] Both principle components (PC_p) and information criteria (IC_p) estimate the number of factors consistently.

Table 2 presents the estimated number of static factors and cumulated variance share by 10 principal components based on the BN test. The dimension of r is six, five and eight according to PC_{p1}, PC_{p2} and PC_{p3} criterion, respectively. Furthermore, the criteria IC_{p1}, IC_{p2} and the IC_{p3} suggest estimates for r of three, one and five, respectively. We therefore choose 3 factors, $r = 3$, following the IC_{p1} criteria. The reason is that IC_p criteria are more robust than PC_p (Bai and Ng, 2002). Another reason is that if the numbers of common factors are overestimated, the estimated results are still consistent, unlike when the common factors are underestimated (Stock and Watson, 2002b).

Table 2: Determining the Number of Factors Based on the BN Test

r	PCp1	PCp2	PCp3	ICp1	ICp2	ICp3	Cumulated Variance Share
1	0.8865	0.8897	0.8783	-0.0787	-0.0715*	-0.0968	0.14
2	0.8534	0.8599	0.8370	-0.0810	-0.0665	-0.1172	0.21
3	0.8277	0.8375	0.8032	-0.0815*	-0.0598	-0.1357	0.28
4	0.8177	0.8307	0.7850	-0.0664	-0.0375	-0.1388	0.33
5	0.8102	0.8265*	0.7693	-0.0528	-0.0167	-0.1433*	0.38
6	0.8094*	0.8290	0.7604	-0.0334	0.0100	-0.1420	0.42
7	0.8152	0.8380	0.7580	-0.0066	0.0441	-0.1332	0.45
8	0.8223	0.8484	0.7570*	0.0191	0.0769	-0.1257	0.48
9	0.8323	0.8617	0.7588	0.0466	0.1117	-0.1162	0.51
10	0.8452	0.8779	0.7635	0.0769	0.1492	-0.1041	0.54

[1]Note: The maximal number of factors for the BN criterion is 10. An asterisk indicates the ideal number of factors.

[5]See Bai and Ng (2002) for more technical details of all six information criteria.

4 Empirical Results

This section presents empirical results in the form of the impulse response functions and the variance share of the common components. The impulse response analysis shows the direction, magnitude and time path of domestic output, industrial production, exports, imports, FDI inflows and outflows. It also shows share and consumer prices and short-term interest rates from supply and demand shocks emanating from China. Figures 2-6 show the profiles of these variables for each of the BRICS countries, where the dotted lines indicate the 90% confidence intervals. They are calculated over 20 quarters in order to display the cyclical pattern associated with the structural shocks. The variance share of the common component is useful in considering the relative importance of shocks for given variables.

4.1 China's shocks

The impulse response functions of the China's supply and demand shocks and their impact on China's variables are depicted in Figure 2. The results show that the responses of output, interest rates and inflation to supply and demand shocks are consistent with the predictions of economic theory. The supply shocks increase output and lower interest rates. However, response of inflation is positive, but insignificant. In contrast to supply shocks, positive demand shocks induce an immediate increase in output, interest rates and inflation.

Positive supply shocks have permanent and long-lasting effect on output, exports, imports, inward FDI flows and share prices. They record a 1%, 0.5%, 0.8%, 1% and 0.7% increases in that order and stay high and significant. Industrial production responds strongly to supply shocks, increasing by 0.8% and stays significant until the eighth quarter. However, the effect on outward FDI flows, short-term interest rates and consumer prices is insignificant. Positive demand shocks, on the other hand, have positive but short-lived effects on output and inward FDI flows. The immediate response of these variables to demand shocks is less than 0.5% and the effect dies out after a few quarters. The effect of demand shocks on outward FDI flows, short-term interest rates and consumer prices is positive and significant and stay high over the long term. Finally, and in contrast to supply shocks, demand shocks have no effects on exports, imports and share prices.

The results show that supply shocks are more important and persistent than demand shocks. These findings are consistent with the work of Kojima, Nakamura and Ohyama (2005) who point out that the increase in the China's GDP growth rate since 1998 indicates the existence of positive supply shocks. Supply shocks attract more inflows of foreign investments into the country, while demand shocks encourage outflows of foreign investments. Supply shocks have permanent positive effects on inward FDI flows, while demand shocks; on the other hand, have positive and long-lasting impact on outward FDI flows. In addition, the effects of supply shocks on exports and imports are positive and stay high and significant over the entire period. Both exports and imports react to a positive demand shock as expected by theory. The effects are positive and short-lived on both variables. These findings are in line with the nature of China's economy that boasts significant current account surplus. The findings are further shown to be consistent with the data and the literature as the average share of international trade (exports and imports) amount to over two-thirds of China's GDP (WB, 2011). This is partly due to the heavy involvement of the manufacturing sector in the international production chains. It also reflects policies of technology adaptation through international integration (Lemoine and Unal-Kesenci, 2007; Tan and Khor, 2006, and Bergsten et al., 2006).

4.2 Transmission of China's shocks to BRIS

Figures 3-6 present the impact of China's supply and demand shocks on the BRIS variables. Positive supply shocks have permanent, positive and significant effect, as expected, on real output in all countries with the exception of India. The immediate impact, however, varies across countries, with the highest response recorded in Brazil and Russia. They both record a 1% rise immediately after the shock and increase to 1.5% and 1.7% by the fourth and fifth quarters respectively. The supply shocks are transmitted to SA's output much less forcefully than to Brazil and Russia. But, the immediate affect records an increase of 0.3% and remains positive and significant over the long term. In the case of India, positive supply shocks are positively transmitted to its output, but the effect is significant only for short horizons.

China's supply shocks have permanent and long-lasting effect on both exports and imports of all BRIS countries. It is more likely that supply shock in China is driven by an increase in productivity and a decline in cost of production, given that in the past three decades the country has experienced higher productivity with low cost of production. High productivity combined with low cost of production pushes exports up and increases imports of raw materials. This is in line with the empirical work of Liu, Wang and Wei (2001) who find that growth of exports causes the growth of imports. This, in turn, results in higher demand of raw materials from emerging markets, namely Brazil, Russia and SA. Because of higher demand of commodity as the supply shocks trigger exports from these countries (Figures 3-6). Secondly, a boost in China's exports lead to an increase in imports from BRIS. That means China's exports trigger imports from BRIS countries (Figures 3-6).

Positive supply shocks have positive and short-lived effects on SA's FDI inflows and India's FDI inflows and outflows. The shocks, however, are negatively transmitted to SA's and Russia's FDI outflows and Brazil's FDI inflows. On the other hand, China's supply shocks have positive, significant and long-lasting impact on Russia's FDI inflows. Thus, recent movement of FDI flows between China and BRIS supports the fact that foreign direct investments influence trade among countries. The increase in trade between China and BRIS is supported by rise in FDI flows. For instance, as it has been shown that the growth of China's imports causes the growth in inward FDI to a destination country (Liu, Wang and Wei, 2001).

Moreover, positive supply shocks have negative, significant and short-lived effects on short-term interest rates for all BRIS countries. Supply shocks affect SA interest rates more powerfully than the other countries. For instance, SA records a -3% response immediately after the shock and reaches -4% in the third quarter, while the rest of the countries record declines in interest rates that vary between 0.1% and 1%. Monetary policy authorities of BRIS react to positive supply shocks by decreasing the short-term interest rate as a result of low cost of production from China.

Further, positive demand shocks from China are transmitted more forcefully to Brazil, Russia and SA than India. China's demand shocks have positive but short-lived impact on Brazil's, Russia's and SA's output of about 0.05%, 0.03%, and 0.002% and the effect dies out after a few quarters. Even though the effects on India is permanent, it is very small and insignificant, reaching a maximum of about 0.0002% after four quarters. Positive demand shocks have small, positive and short-lived effects on SA exports. However, they have negative and short-lived effects on India's imports. For Brazil and Russia, the demand shocks, however, have positive and short-lived effects on both exports and imports. The effect of demand shocks on both FDI inflows and outflows is negative in all BRIS countries, except for FDI inflows in Russia. It has long-lasting effects on FDI outflows in Brazil and India, but short-lived effects on SA's and Russia's FDI outflows. The effects of demand shocks on FDI inflows are insignificant for SA and India, positive and short-lived for Russia and negative and short-lived for Brazil. Moreover, their effect on interest rates is positive and long-lasting for all the countries.

By dint of the simple fact that China has become the second greatest economic power in the world, it has seen its economic relations with BRIS significantly increase. China is the primary trading partner of BRIS countries and hence the interdependence between China and BRIS is considerably deepening. For instance, in 2001, Chinese exports to India, Russia, Brazil and SA were less than $3 billion in each country, while in 2009 its exports to these countries was $29, $17, $14 and $7 billion, respectively (IMF, 2012). Strong international trade linkages lead to high interdependence among countries. Using three dynamic factors, we obtain variance shares of the common components 48%, 58% and 63% of imports of Brazil, SA and India and 66% of exports of Russia (see Table 3). It means trade represents the main channel of transmission of shocks. The high level of dependence of SA trade variables on China's shocks is probably explained by the fact that China became SA's number one trading partner in 2009 (Çakır and Kabundi, 2013a).

Table 3: Variance Shares of the Common Components of BRIS

Variables	Brazil	Russia	India	South Africa
GDP	0.16	0.26	0.00	0.48
Consumer prices	0.27	0.30	0.02	0.09
FDI inflows	0.12	0.07	0.18	0.02
FDI outflows	0.04	0.01	0.00	0.20
Exports	0.39	0.66	0.48	0.55
Imports	0.48	0.26	0.63	0.58
Industrial production	0.48	0.03	0.20	0.53
Real effective exchange rate	0.25	0.14	0.03	0.24
Short-term interest rates	0.44	0.54	0.67	0.41

The transmission of shocks vary across countries. For instance, China's shocks are transmitted to Brazil and SA through real variables (industrial production depicts 48% and 53% variance share of common components). Hence, we can say that trade integration leads to synchronization of real variables between China and these countries. Conversely, financial and nominal variables exhibit lower variance share of common components for all BRIS countries (25%, 14%, 0.3% and 24% for real exchange rate and 27%, 30%, 0.2% and 0.9% for consumer prices of Brazil, Russia, India and SA, respectively), which means that financial markets of BRICS are less integrated. Therefore, the transmission of China's shocks to the BRIS countries is mainly due trade integration instead of financial linkages. Moreover, since the common components explains 41%, 44%, 54% and 67% of the variation of SA's, Brazil's, Russia's and India's short term interest rates in that order, it is possible that there is a coordination of policies, probably due to the fact that they are all exposed to common shocks from China and its low cost of production. It is therefore possible to examine the response of BRIS variables to monetary policy shocks from China, but this is beyond the scope of the current study.

Overall, the findings show that China's shocks do have different impacts on each of the BRIS countries. For instance, supply shocks are more forcefully transmitted to BRIS than the demand shocks. Supply shocks have permanent positive and significant effect on real output in all countries, except for India. In case of India, the effect is positive and significant only for short horizons. In addition, the main channels of transmission of all shocks are exports and imports between China and Brazil; exports, imports and inward FDI flows between China and Russia; exports and inward FDI flows between China and India as well as exports and inward FDI flows between China and SA. This shows that, across China and BRIS countries, transmission channels are mainly trade rather than financial. It is then possible to refer to the increased volume of trade and investment between China and BRIS countries as evidence of increased international economic integration.

5 Conclusions

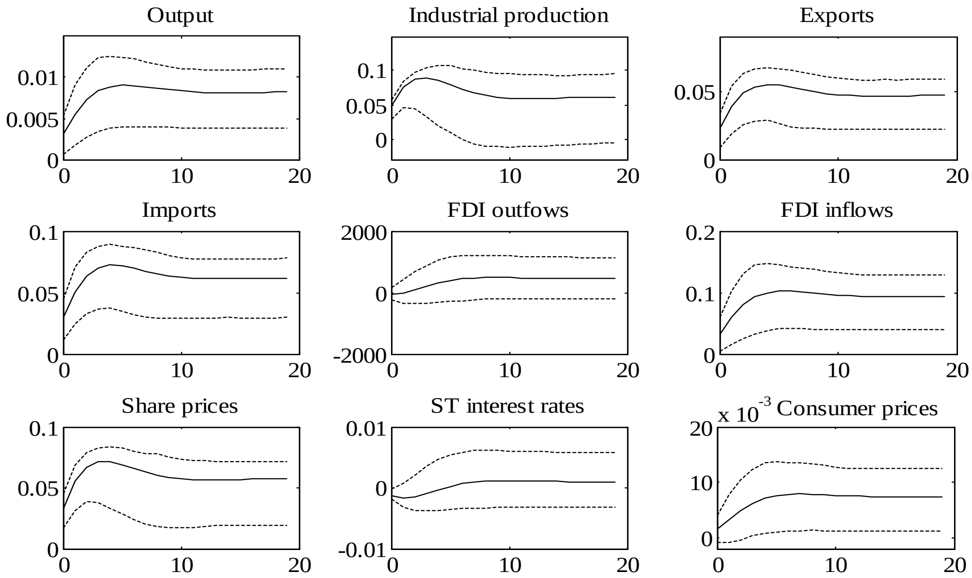
Since China's emergence as a major player into the global economy, there is an increasing interest among policymakers and academics to examine its impact on the other countries, especially developing ones. This paper investigates the impact of China's shocks on the BRIS countries. In particular, two types of shocks, namely positive supply and demand shocks are used to assess the time profile of the effects of these shocks. It uses a large-dimensional approximate dynamic factor model with quarterly data from 1995Q2 to 2009Q2.

Three main findings emerge from the results. First, China's supply shocks are more important than its demand shocks. For instance, supply shocks produce positive and significant output responses in all BRIS countries. However, their effect is significant only for short horizon in India. China's demand shocks have small effects on BRIS relative to supply shocks. Second, the intensity of economic relationship is different between China and BRIS. China has intensive economic linkages with SA and Russia, while it has rather moderate economic linkages with Brazil and India. Finally, the magnitude and the channels of transmission of shocks vary from one country to another. For instance, the main channels of transmission of all shocks are exports, imports and industrial production between China and SA; imports, industrial production and short-term interest rates between China and Brazil; exports and short-term interest rates between China and Russia, and exports, imports and short-term interest rates between China and India.

Furthermore, one key channel for the transmission of shocks across China and BRIS is international trade and its main channel of transmission is through supply shocks which dominate the dynamics and have the strongest impact on the BRICS countries. Hence, it can be argued that China's supply and demand shocks do not have similar effects on the BRIS countries and therefore they require different policy responses. This seems to suggest that China is not yet a locomotive for the world economy because it does not provide extra demand stimulus. However, China's significant demand of raw materials seems to track positive supply shocks, which explains why it seems to affect positively Brazil, Russia and South Africa.

Figure 2: Impulse-Response Functions of Chinese Variables

Supply Shock



Demand Shock

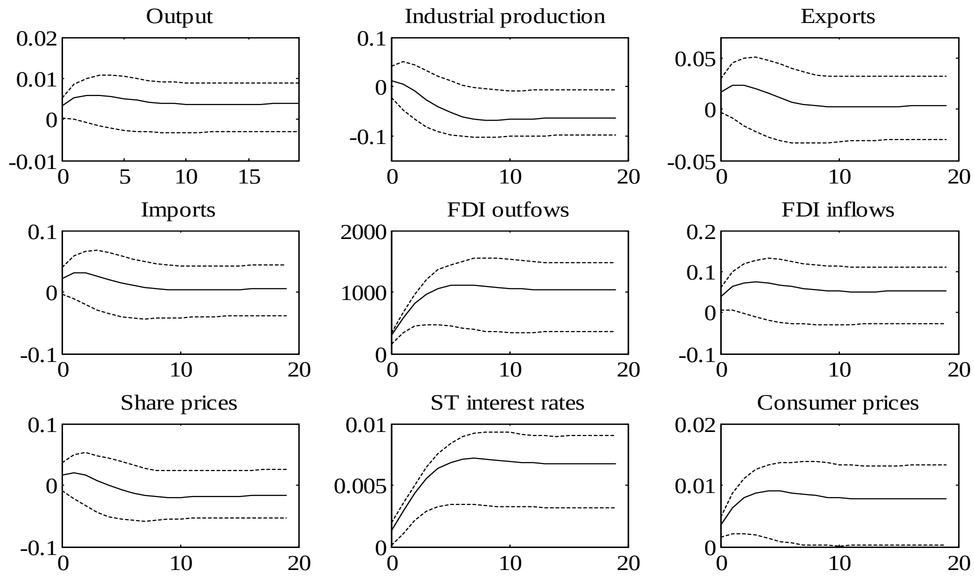
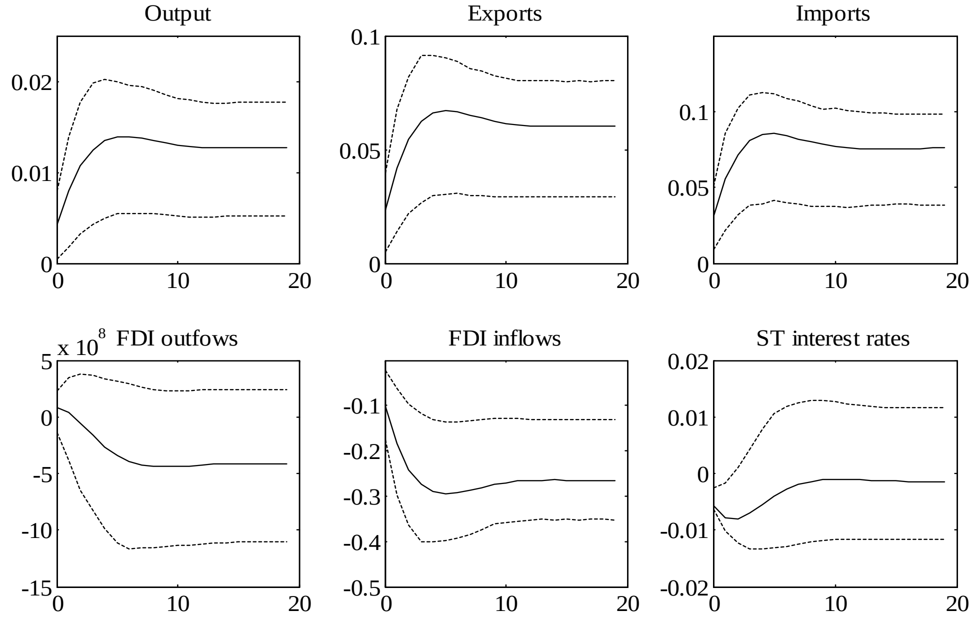


Figure 3: Impulse-Response Functions of Brazilian Variables

China's Supply Shock



China's Demand Shock

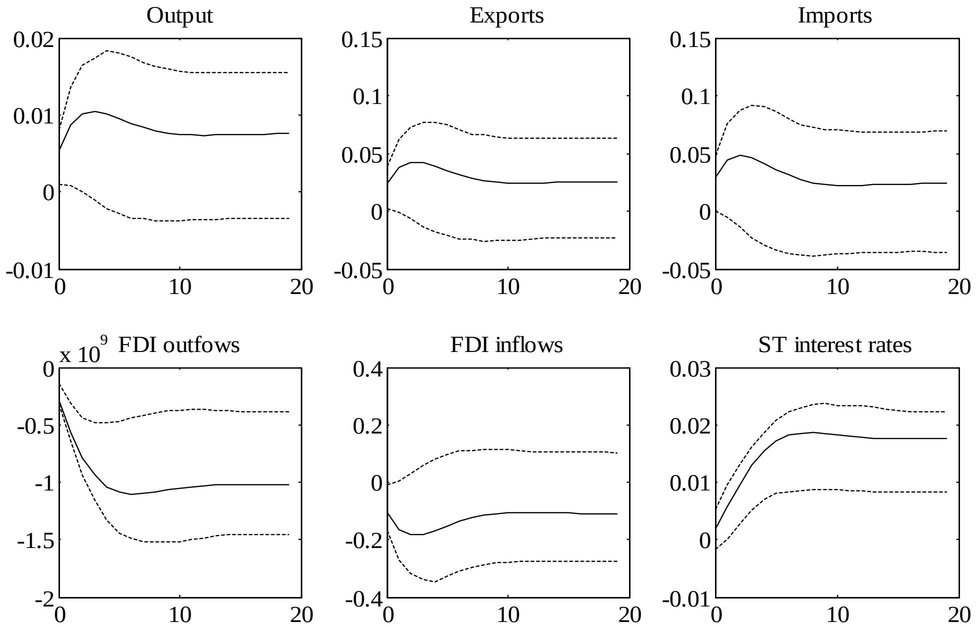
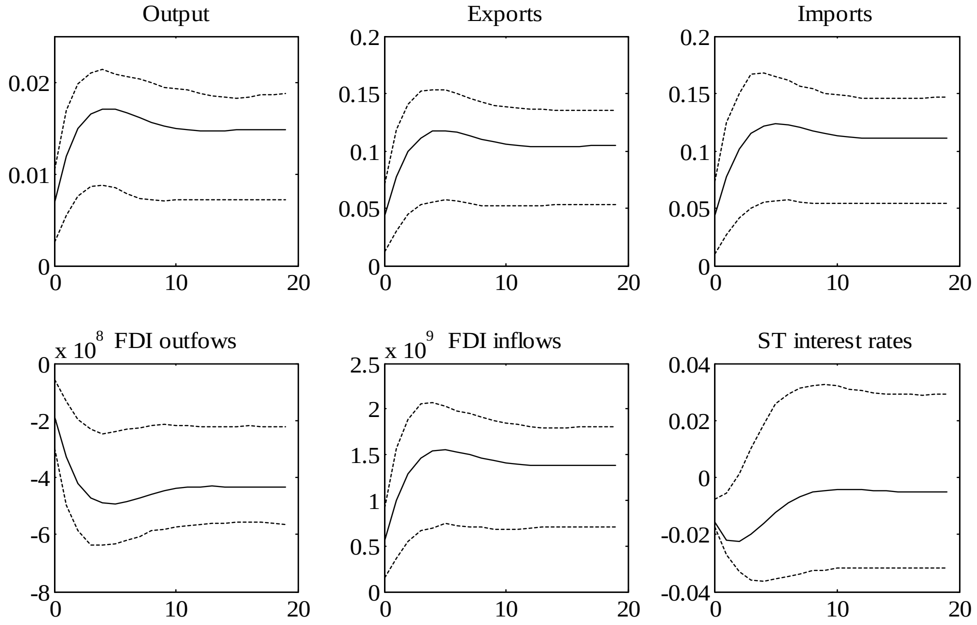


Figure 4: Impulse-Response Functions of Russian Variables

China's Supply Shock



China's Demand Shock

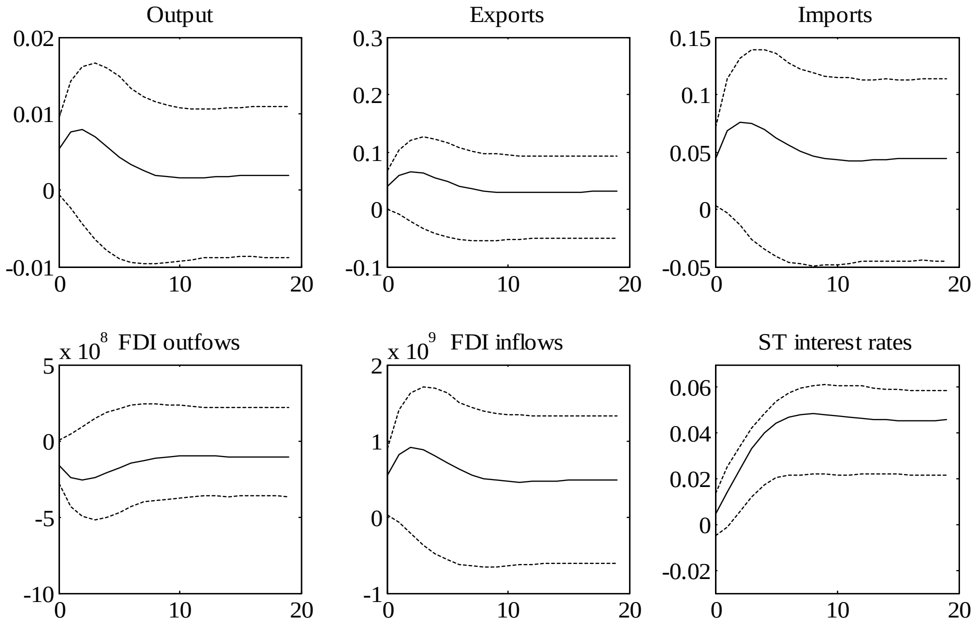
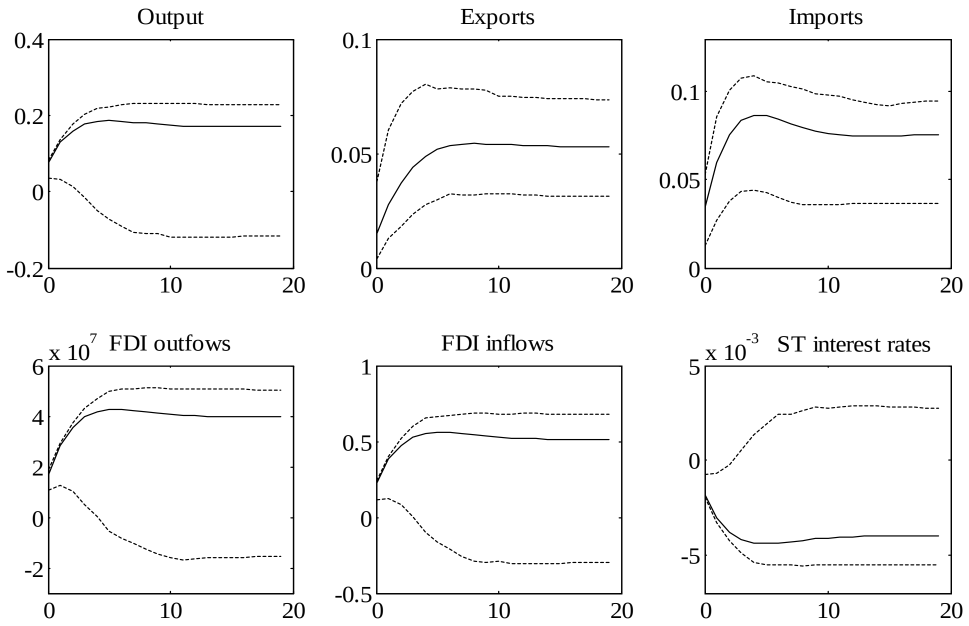


Figure 5: Impulse-Response Functions of Indian Variables

China's Supply Shock



China's Demand Shock

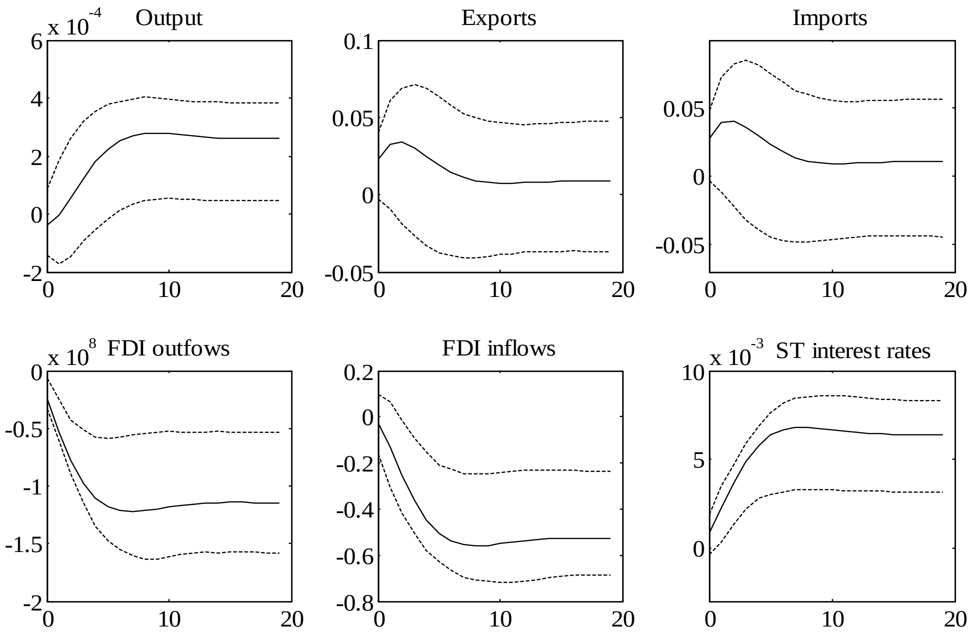
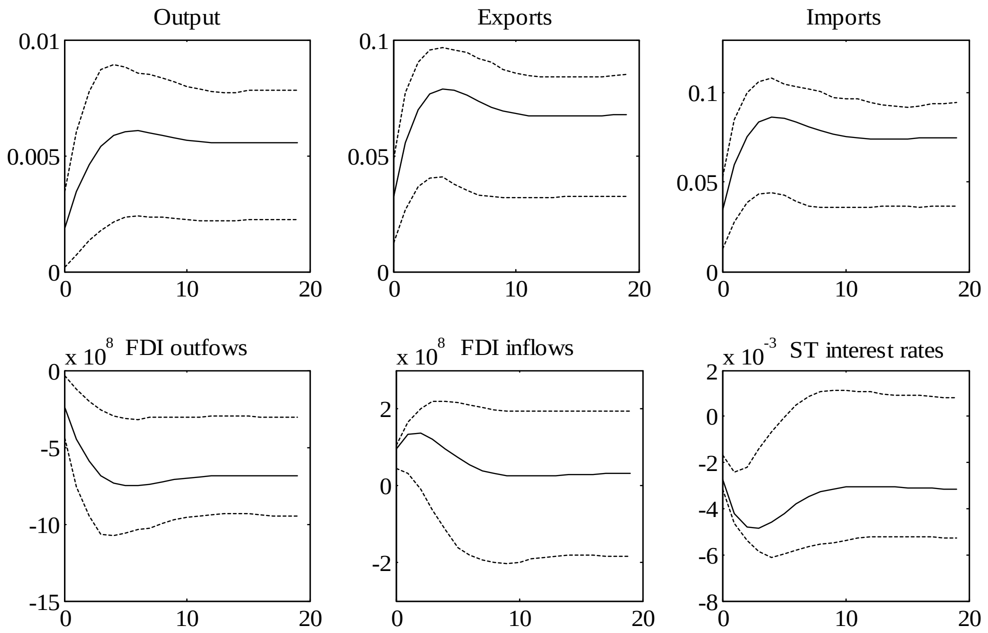


Figure 6: Impulse-Response Functions of SA Variables

China's Supply Shock



China's Demand Shock

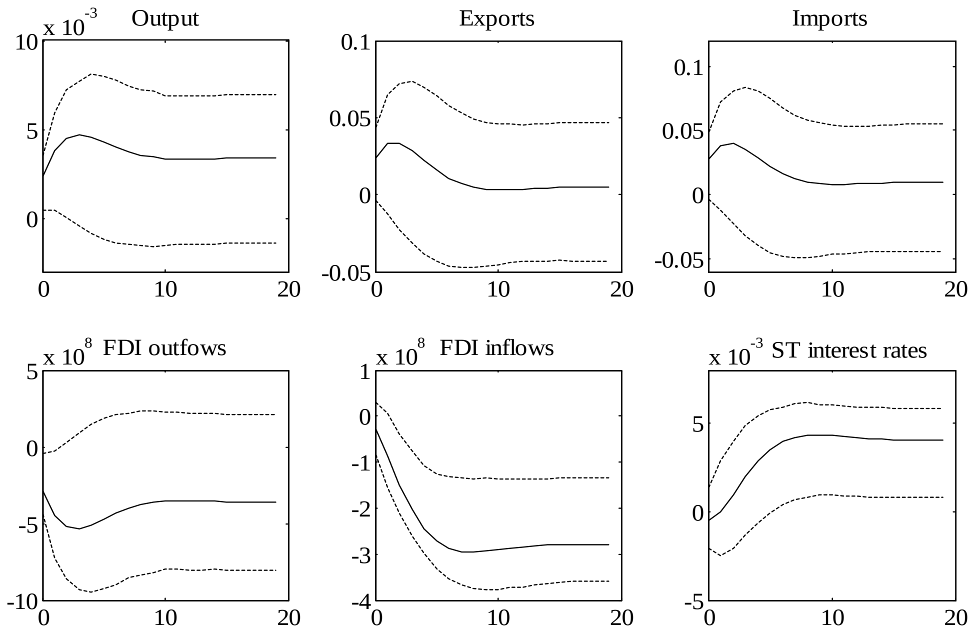


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Table 4: Macroeconomic Series

No	Country	Variable	Log	Stationarity	Treatment
1	Brazil	Monetary aggregate (M1) sa	l	1	5
2	Brazil	Monetary aggregate (M2) sa	l	1	5
3	Brazil	Monetary aggregate (M3)	l	1	5
4	Brazil	National currency per US dollar sa	l	1	5
5	Brazil	NEER from ins (index)	l	1	5
6	Brazil	REER based on rel. cpi (index) sa	l	1	5
7	Brazil	Gold in million ounces	l	1	5
8	Brazil	Savings deposits	nl	1	2
9	Brazil	Time deposits	nl	1	2
10	Brazil	Share prices (index)	l	1	5
11	Brazil	PPI / WPI (index) sa	l	1	5
12	Brazil	National CPI (index) sa	l	1	5
13	Brazil	Industrial production (index) sa	l	1	5
14	Brazil	Production of crude petroleum	l	1	5
15	Brazil	Production in total mining	l	1	5
16	Brazil	Production in total manufacturing sa	l	1	5
17	Brazil	Production of total construction sa	l	1	5
18	Brazil	Exports, f.o.b. (flow) sa	l	1	5
19	Brazil	Imports, c.i.f. (flow) sa	l	1	5
20	Brazil	Current transfers: credit (flow)	l	1	5
21	Brazil	Current transfers: debit (flow) sa	nl	1	2
22	Brazil	Direct investment abroad	nl	0	1
23	Brazil	Direct invest. in rep. economy	l	0	4
24	Brazil	Portfolio investment assets (flow)	nl	1	2
25	Brazil	Portfolio investment liabilities (flow)	nl	0	1
26	Brazil	Reserve assets (flow)	nl	0	1
27	Brazil	Government consumption expend. sa	l	1	5
28	Brazil	Gross fixed capital formation sa	l	1	5
29	Brazil	Household cons. expenditure	l	1	5
30	Brazil	GDP vol. (index) sa	l	1	5
31	Brazil	Short-term interest rates	nl	1	2
32	Brazil	Total reserves minus gold	l	1	5
33	China	Bonds (stock)	l	1	5
34	China	Capital accounts (stock)	l	1	5
35	China	Consumer prices: all items (index) sa	l	1	5
36	China	Consumer prices: food (index) sa	l	1	5
37	China	Demand deposits (stock) sa	l	1	5
38	China	Direct invest. in rep. economy	l	1	5
39	China	Direct investment abroad	nl	1	2
40	China	Exports, f.o.b. (flow) sa	l	1	5
41	China	Foreign assets (stock)	l	1	5
42	China	Foreign liabilities (stock)	l	1	5
43	China	GDP vol. (index, 2005=100)	l	1	5
44	China	Gold ac.to national valuation (stock)	l	1	5
45	China	Imports, c.i.f. (flow) sa	l	1	5
46	China	Industrial production (index)	l	1	5
47	China	Monetary aggregate (M1) sa	l	1	5
48	China	Monetary aggregate (M2)	l	1	5
49	China	Money (stock) sa	l	0	4
50	China	National currency per US dollar	l	1	5
51	China	NEER from ins (index) sa	l	1	5
52	China	Production of cement sa	l	1	5
53	China	REER based on rel. cpi (index) sa	l	1	5
54	China	Reserve money (stock) sa	l	1	5
55	China	Restricted deposits	l	0	4
56	China	Savings deposits (stock)	l	1	5
57	China	Share prices (index)	l	1	5
58	China	Short-term interest rates	nl	1	5
59	China	Time deposits (stock) sa	l	1	5
60	China	Total reserves minus gold (stock) sa	l	1	5

No	Country	Variable	Log	Stationarity	Treatment
61	India	Consumer prices: all items (index) sa	l	1	5
62	India	Demand deposits (stock) sa	l	1	5
63	India	Dir. invest. in rep. economy	l	0	4
64	India	Direct investment abroad	nl	1	2
65	India	Equity price (index)	l	1	5
66	India	Foreign assets (stock) sa	l	1	5
67	India	Foreign liabilities (stock) sa	l	1	5
68	India	GDP vol. (index, 2005=100)	l	1	5
69	India	Exports: f.o.b. total sa	l	1	5
70	India	Imports: c.i.f. total sa	l	1	5
71	India	Government deposits (stock)	l	1	5
72	India	Industrial production (index) sa	l	1	5
73	India	Lending rate (percent per annum)	nl	1	2
74	India	Monetary aggregate (M1) sa	l	1	5
75	India	Monetary aggregate (M3) sa	l	1	5
76	India	Money (stock) sa	l	1	5
77	India	National currency per US dollar, sa	l	1	5
78	India	Portfolio investment liabilities (flow)	nl	0	1
79	India	PPI / WPI (index, 2005=100) sa	l	0	4
80	India	Production in total manufacturing sa	l	1	5
81	India	Production in total mining (index) sa	l	1	5
82	India	Production of electricity (index) sa	l	1	5
83	India	REER based on rel. CPI (index) sa	l	1	5
84	India	Reserve assets (flow)	nl	0	1
85	India	Reserve money (stock) sa	l	1	5
86	India	Reserve position in the fund (US dollars)	l	1	5
87	India	Share prices (index)	l	1	5
88	India	Short-term interest rates	nl	1	5
89	India	Time deposits (stock) sa	l	1	5
90	India	Total reserves minus gold (US dollars) sa	l	1	5
91	Russia	Capital account: credit (flow)	l	0	4
92	Russia	Capital account: debit (flow)	nl	0	1
93	Russia	Consumer price index (index) sa	l	1	5
94	Russia	Consumer prices: food (index) sa	l	1	5
95	Russia	Consumer prices: services (index)	l	1	5
96	Russia	Current transfers: credit (flow) sa	l	1	5
97	Russia	Current transfers: debit (flow) sa	nl	1	2
98	Russia	Deposit rate (percent per annum) sa	l	1	5
99	Russia	Direct invest. in rep. economy	nl	1	2
100	Russia	Direct investment abroad	nl	1	2
101	Russia	Employment (index, 2005=100)	l	1	5
102	Russia	Exports, f.o.b. (flow) sa	l	1	5
103	Russia	GDP vol. (index, 2005=100) sa	l	1	5
104	Russia	Gold in million ounces (stock)	l	1	5
105	Russia	Government consumption expenditure (flow)	l	1	5
106	Russia	Gross fixed capital formation (flow)	l	1	5
107	Russia	Household cons. expenditure (flow) sa	l	1	5
108	Russia	Imports, c.i.f. (flow)	l	1	5
109	Russia	Industrial production (index) sa	l	1	5
110	Russia	Lending rate (percent per annum)	l	1	5
111	Russia	National currency per US dollar	l	1	5
112	Russia	NEER from ins (index)	l	1	5
113	Russia	Portfolio investment assets (flow)	nl	0	1
114	Russia	Portfolio investment liabilities (flow)	nl	0	1
115	Russia	Private final consumption expenditure sa	l	1	5
116	Russia	Production of coal (units, tonnes mln) sa	l	0	5
117	Russia	Production of crude petroleum (index) sa	l	1	4
118	Russia	Production of gas (units, mş bln) sa	l	0	5
119	Russia	REER based on rel. CPI (index) sa	l	1	5
120	Russia	Refinancing rate	l	1	5

No	Country	Variable	Log	Stationarity	Treatment
121	Russia	Reserve assets (flow)	nl	0	1
122	Russia	Reserve position in the fund (US dollars)	l	1	5
123	Russia	Short-term interest rates	l	1	5
124	Russia	Total reserves minus gold (stock) sa	l	1	5
125	South Africa	Capital account: debit (flow)	nl	0	1
126	South Africa	Consumer price index (index) sa	l	1	5
127	South Africa	Consumption of fixed capital sa	l	1	5
128	South Africa	Current transfers: credit (flow)	l	1	5
129	South Africa	Current transfers: debit (flow)	nl	1	2
130	South Africa	Deposit rate (percent per annum)	nl	1	2
131	South Africa	Direct invest. in rep. economy	nl	0	1
132	South Africa	Direct investment abroad	nl	0	1
133	South Africa	Discount rate (percent per annum)	nl	0	1
134	South Africa	GDP deflator (index, 2005=100) sa	l	1	5
135	South Africa	GDP vol. (index, 2005=100) sa	l	1	5
136	South Africa	Gold production (index) sa	l	1	5
137	South Africa	Exports: f.o.b. total sa	l	1	5
138	South Africa	Imports: c.i.f. total sa	l	1	5
139	South Africa	Government bond yield sa	nl	1	2
140	South Africa	Government consumption expend. sa	l	1	5
141	South Africa	Gross fixed capital formation sa	l	1	5
142	South Africa	Household cons. expenditure sa	l	1	5
143	South Africa	Lending rate (percent per annum)	nl	1	2
144	South Africa	Manufacturing production (index) sa	l	1	5
145	South Africa	Mining production (index) sa	l	1	5
146	South Africa	Monetary aggregate (M1) sa	l	1	5
147	South Africa	Monetary aggregate (M2) sa	l	1	5
148	South Africa	Monetary aggregate (M3) sa	l	1	5
149	South Africa	Money market rate (percent)	nl	1	2
150	South Africa	National currency per US dollar	l	1	5
151	South Africa	NEER from ins (index)	l	1	5
152	South Africa	Portfolio investment assets (flow)	nl	0	1
153	South Africa	Portfolio investment liabilities (flow)	nl	0	1
154	South Africa	PPI / WPI (index, 2005=100) sa	l	0	4
155	South Africa	Private final con. expend. (index) sa	l	1	5
156	South Africa	REER based on rel. cpi (index)	l	1	5
157	South Africa	Reserve assets (flow)	nl	0	1
158	South Africa	Reserve position in the fund (US dollars) sa	l	1	5
159	South Africa	Share prices: all shares (index) sa	l	1	5
160	South Africa	Short-term interest rates (percent)	nl	1	2
161	South Africa	Total reserves minus gold (stock)	l	1	5

[2]Notes: The transformation codes (treatment) are as follows: 1 - no transformation (level); 2 - first difference; 4 - logarithm (log-level); 5 - first difference of logarithm (log-first difference). sa denotes seasonally adjusted series; l stands for logarithm; nl indicates the level of the data; 0 denotes integrated of order zero; 1 represents the first difference of the series. The data are available over the 1995Q2-2009Q4 period.