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Fiscal Policy in the BRICs

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Abstract

This paper assesses the macroeconomic impact of fiscal policy shocks for four key emerging market economies - Brazil, Russia, India and China (BRICs) – using a Bayesian Structural Vector Auto-Regressive (BSVAR) approach, a Sign-Restrictions Vector Auto-Regressive framework and a Panel Vector Auto-Regressive (PVAR) model. To get a deeper understanding of the government's behaviour, we also estimate fiscal policy rules using a Fully Simultaneous System of Equations and analyze the importance of nonlinearity using a smooth transition (STAR) model. Drawing on quarterly frequency data, we find that government spending shocks have strong Keynesian effects for this group of countries while, in the case of government revenue shocks, a tax hike is harmful for output. This suggests that there is no evidence in favour of 'expansionary fiscal contraction' in the context of emerging economies where spending policies are largely pro-cyclical. Our findings also show that considerations about growth (in the case of China), exchange rate and inflation (for Brazil and Russia) and commodity prices (in India) drive the nonlinear response of fiscal policy to the dynamics of the economy. All in all, our results are consistent with the idea that fiscal policy can be a powerful stabilization tool and can provide an important short-term economic boost for emerging markets, in particular, in the context of severe downturns as in most recent financial turmoil.

Keywords: fiscal policy, emerging markets, fully simultaneous system of equations, sign-restrictions VAR, smooth transition regression model.
JEL classification: E37, E62.

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1. Introduction

The financial crisis of 2008 and the increase in fiscal intervention that came with it has renewed attention on the role of fiscal policy in macroeconomic stabilisation, as the current policies of fiscal consolidation and austerity threaten output recovery (Fontana and Sawyer, 2011). The literature is pretty much divided, with different views on the impact of discretionary fiscal policy. The proponents of austerity argue that high fiscal deficits threaten to crowd out private spending and undermine market confidence. Fiscal consolidation can be expansionary as it could have a positive effect on growth by stimulating private demand and confidence in the financial markets.

The Keynesian perspective on the other hand argues that fiscal contraction at a time of recession will not aid output recovery.[1] Besides, the role fiscal policy becomes even more important when interest rates hit a zero bound. Given this scenario, an expansionary fiscal policy is the way forward. The present paper therefore makes an empirical contribution to examine whether unexpected fiscal shocks have counter-cyclical impact, focusing on four key emerging market economies for which there is limited evidence in the fiscal policy literature, providing evidence of a threshold effect in relation to the factors driving endogeneity of fiscal policy.

The global nature of the current downturn implies that external demand for developing country exports cannot be relied upon to jumpstart a recovery process. Given that interest rate is already at its lowest level in most countries, there is very little room for monetary policy to aid recovery. The alternative stimulus to support recovery could come through fiscal policy as many governments are currently engaged in. But there is no single instrument for fiscal policy, as fiscal policy surprises can be described either in terms of tax cuts or increase in expenditures by a fiscal authority. Hence it is important to know the effectiveness of these two types of policy shocks and accordingly we will know which type of fiscal policy can help support recovery.

At the same time, the ability of countries to respond can vary considerably depending on the size of the government. The issue of whether fiscal policy enhances or retards long-run economic activity has been long-debated in the literature.[2] By carrying out a meta-analysis of a sample of 93 published studies, Nijkamp and Poot (2004)

[1] As we saw in the aftermath of the Asian financial crisis, fiscal consolidation was not successful and IMF-supported stabilization programmes, in particular fiscal austerity measures, contributed to output collapse in the first year of the programme (Mallick, 2006).

[2] For an early literature on the role of fiscal policy in the process of economic development, see Easterly and Rebelo (1993).

provide evidence that on balance the positive effect of conventional fiscal policy on growth is rather weak.

Double-digit or high single-digit inflation continues to be a major policy concern in many developing countries, but fiscal policy appears to be highly pro-cyclical instead of being counter-cyclical as it is in developed countries. In fact, one typically finds that these developing economies have excess productive capacity. Given that emerging market economies are growing well below their potential level of output, fiscal policy has been playing an important role in output expansion, by stimulating private investment via infrastructural spending by the public sector.

As a result, understanding the role that fiscal policy can play in these four key emerging countries - namely, Brazil, Russia, India, and China, the so called BRICs – is crucial, because different fiscal policy instruments may respond either pro-cyclically or counter-cyclically. In this context, the task requires a deep knowledge of the models that describe fiscal transmission and the extent to which fiscal policy can be used as a stabilizing tool. In these countries, there is also a conflict between achieving fiscal stabilization and fiscal reforms simultaneously (Toye, 2000); it is therefore even more important to understand the effects of unexpected fiscal shocks in this group of key emerging markets. While monetary policy has become firmly based on the use of interest rate as the key policy instrument in a one instrument–one target framework (Arestis and Sawyer, 2008), there is no such single instrument in the case of fiscal policy and it is therefore important to uncover the adverse impact of a positive tax shock relative to the favourable effect of a positive spending shock.

In this paper, however, we use alternative empirical approaches to analyse the dynamic effects of shocks in government spending and revenues on economic activity in the key emerging countries. We do so by using Bayesian Structural and Sign-Restrictions Vector Auto-Regressive (VAR) models via identifying tax shocks and spending shocks. The basic intuition is that structural shocks can be identified by checking whether the signs of the corresponding impulse responses are in line with theoretical priors. Here we examine the impact of an unexpected fiscal shock on output in an economy, which can be different across countries. The channel is either direct government spending or tax cut leading to higher private consumption or whether both type of fiscal shocks stimulates private investment and thereby output recovery.

Our results consistently show that positive government revenue shocks (tax increases) do have a significant adverse effect on output, whereas positive spending shocks have significant positive effect.

In addition, we show that a positive spending shock: (i) generates a strong increase in the commodity price, but does not seem to impact significantly on the price level; (ii) rises the interest rate and, thereby, may "crowd-out" private spending, which explains the short-lived effect on GDP; and (iii) has a negative impact on equity markets, as markets foresee the deterioration of the fiscal stance.

We also carry out a panel Vector Auto-Regressive (PVAR) exercise, which confirms the previous findings about the expansionary effect of fiscal policy, even after controlling for the presence of crisis episodes.

Then, we look at the response of the fiscal authority to several economic and financial developments, via the estimation of fiscal policy rules. This analysis is supported through the estimation of a Fully Simultaneous System of Equations (linear model) and a Smooth Transition Auto-Regressive framework (nonlinear model).

The evidence suggests the existence of some nonlinearities, in particular, for tax rules (in the cases of Brazil, Russia and India) and spending rules (in the cases of Russia and China).

Additionally, considerations about the economic growth (in the case of China), the exchange rate and inflation (for Brazil and Russia) and commodity prices (in India) explain such nonlinear pattern of fiscal policy.

Finally, fiscal authorities seem pursue a target range for the threshold variable rather than a specific point target. In fact, the exponential smooth transition regression (ESTR) model seems to be the best description of the systematic reaction of fiscal policy to the dynamics of the economy.

The paper is organized as follows. Section 2 reviews the literature on fiscal policy. Section 3 describes the econometric methodologies used to identify the fiscal policy shocks and to estimate the fiscal policy rules. Sections 4 and 5 present the data and discuss the empirical results. In Section 6, we conclude.

2. A Brief Review of the Literature

The conduct of fiscal policy in emerging market economies confronts important challenges. In fact, the past fiscal policy experience can be typically associated with extreme episodes of monetary instability, swinging from very high inflation to financial

instability (Mishkin, 2000). However and despite its importance, the literature on fiscal policy for emerging markets is rather inexistent as research has been typically confined to the analysis of monetary policy (Mallick and Sousa, 2011).

In this context, the literature on the identification of fiscal policy shocks is wide and incorporates different approaches. For the US, Ramey and Shapiro (1998) use a "narrative approach" to isolate political events, and find that, after a brief rise in government spending, nondurable consumption displays a small decline while durables consumption falls. Following the same approach, Edelberg *et al.* (1999) show that episodes of military build-ups have a significant and positive short-run effect on U.S. output and consumption, and that the sign of the response does not change when anticipation effects are taken into account. Fatás and Mihov (2001) use a Cholesky ordering to identify fiscal shocks and show that increases in government expenditures are expansionary, but lead to an increase in private investment that more than compensates for the fall in private consumption. Blanchard and Perotti (2002) use information about the elasticity of fiscal variables to identify the automatic response of fiscal policy, and find that expansionary fiscal shocks increase output, have a positive effect on private consumption, and a negative impact on private investment. More recently, using sign restrictions on the impulse-response functions and identifying the unexpected variation in government spending by a positive response of expenditure for up to four quarters after the shock, Mountford and Uhlig (2009) find a negative effect in residential and non-residential investment.

Regarding other countries, Perotti (2004) investigates the effects of fiscal policy in Australia, Canada, West Germany, U.S. and the U.K., and finds a relatively large positive effect on private consumption and no response of private investment. Biau and Girard (2005) find a cumulative multiplier of government spending larger than one, and positive reactions of private consumption and private investment in France. For Spain, Castro and Cos (2006) report that, while there is a positive relationship between government expenditure and output in the short-term, in the medium and long-term expansionary spending shocks only lead to higher inflation and lower output. Heppke-Falk *et al.* (2006) use cash data for Germany, and find that a positive shock in government spending increases output and private consumption, although the effect is relatively small. Giordano *et al.* (2007) show that, in Italy, government expenditure has positive and persistent effects on output and on private consumption.

In what concerns the role of economic policy for stock prices, the attention has been normally targeted towards the role played by monetary policy. Rigobon and Sack (2003) use a heteroskedasticity-based estimator and find a significant response of the stock market to shocks in the interest. Bernanke and Kuttner (2005) show that a hypothetical unanticipated 25-basis-point cut in the Federal funds rate target is associated with about a 1% increase in broad stock indexes. More recently, Ardagna (2009) reports that fiscal adjustments based on expenditure reduction and signalling sounder fiscal behaviour are related with increases in stock market prices. Using a panel of OECD countries, the author also shows that fiscal consolidation that lead to a permanent and substantial fall in government debt are linked to a stronger increase in stock market prices. For emerging markets, Calvo and Mishkin (2003) suggest that central banks should be subject to "constrained discretion" through inflation targeting, making it harder for them to follow an "overly expansionary monetary policy". The authors argue that financial crises are strongly determined by weak institutional credibility.

In terms of interest rates, according to Gale and Orszag (2003) there are two important reasons for why budget deficits may raise nominal interest rates: (i) they reduce aggregate savings when private savings do not increase by the same amount (no Ricardian equivalence) and if there are no compensating foreign capital inflows, which leads to a decrease in the supply of capital; and (ii) they increase the stock of government debt and, consequently, the outstanding amount of government bonds (relative to other financial assets). In this case, there is a "portfolio effect", as a higher interest rate on government bonds would be required in order to incentive investors to hold the additional bonds.

While some studies find that interest rates tend to increase after a rise in the deficit, others do not (Engen and Hubbard, 2004). The empirical findings seem to depend on whether expected or current budget deficits are used as explanatory variables (Upper and Worms, 2003; Brook, 2003; Laubach, 2009), and also on whether yield differentials in Europe with respect to Germany (Codogno *et al.*, 2003) or interest rate swap spreads are used as the dependent variable (Goodhart and Lemmen, 1999). For Europe, the existing evidence points either to a significant (although small) effect (Codogno *et al.*, 2003; Faini, 2006), or to the absence of impact (Heppke-Falk and Hüfner, 2004). For the U.S., the effect seems to be substantially larger (Gale and Orszag, 2003). For OECD countries, Ardagna (2009) shows that long-term government

bond rates fall in periods of budget consolidation and rise when the fiscal position deteriorates.

Regarding the link between fiscal policy and exchange rates, Morón and Winkelried (2003) highlight that emerging market economies are incapable of smoothing out large external shocks, due to the large and abrupt swings in the real exchange rate generated by sudden capital outflows. Kim and Roubini (2003) show that a budget deficit shock leads to an improvement in the trade balance. Corsetti and Müller (2006) assess the response of the trade, while Monacelli and Perotti (2010) focus on the joint response of trade balance, consumption and real exchange rate. The authors find that a rise in government spending induces real exchange rate depreciation and a trade balance deficit. Batini *et al.* (2010) show that financial frictions, especially when coupled with liability dollarization, severely increase the costs of a fixed exchange rate regime.

Finally, looking at the interaction between monetary and fiscal policy, Ferrero (2006) analyzes optimal monetary and fiscal policy setting in a currency union with two countries. The author includes a role for distortionary taxation and government debt, which leads to a modified optimal targeting rule for the union as a whole. Beetsma and Jensen (2005) and Gali and Monacelli (2008) have analyzed the role of fiscal stabilization policy in the context of a monetary union. Monetary policy is conducted by a common central bank, while fiscal policy is implemented at the country level. The authors show that there is a stabilizing role for fiscal policy that goes beyond the efficient provision of public goods.

3. Econometric Methodology

3.1. Assessing the Macroeconomic Impact of Fiscal Policy

3.1.1. The Bayesian Structural Vector Auto-Regression (BSVAR)

We estimate the following Structural VAR (SVAR)

$$\underbrace{\Gamma(\boldsymbol{L})}_{\boldsymbol{n}\times\boldsymbol{n}}\underbrace{\boldsymbol{X}_{\boldsymbol{t}}}_{\boldsymbol{n}\times 1} = \Gamma_0 \boldsymbol{X}_{\boldsymbol{t}} + \Gamma_1 \boldsymbol{X}_{\boldsymbol{t}-1} + ... = \boldsymbol{c} + \varepsilon_{\boldsymbol{t}} \quad (1)$$

$$v_t = \Gamma_0^{-1}\varepsilon_t \ , \quad (2)$$

where $\varepsilon_t \mid X_s, s < t \sim \mathrm{N}(\underline{0}, \Lambda)$, *Γ(L)* is a matrix valued polynomial in positive powers of the lag operator *L*, *n* is the number of variables in the system, ε_t are the fundamental economic shocks that span the space of innovations to X_t, and v_t is the VAR innovation.

Fiscal policy can be characterized as

$$gi_t = f(\Omega_t) + \varepsilon_t^i \tag{3}$$

where, g_t is the fiscal policy instrument, f is a linear function, Ω_t is the information set, and ε_t^i is the policy shock.

We consider a recursive identification scheme and assume that the variables in X_t can be separated into 3 groups: (i) a subset of n_1 variables, X_{1t}, which do not respond contemporaneously to the fiscal policy shock; (ii) a subset of n_2 variables, X_{2t}, that respond contemporaneously to it; and (iii) the policy instrument in the form of the government spending, g_t, or government revenue, t_t. In accordance with the studies of Christiano *et al.* (2005) and Sousa (2010a), we include real GDP and inflation among the set of variables belonging to X_{1t}. We also add the commodity price to X_{1t} and the equity price to X_{2t}, which allow us to account for the importance of these variables while assessing the effects of a fiscal policy shock.

The recursive assumptions can be summarized by $X_t = \left[X_{1t}, t_t, g_t, X_{2t}\right]'$ and

$$\Gamma_0 = \begin{bmatrix} \underbrace{\gamma_{11}}_{n_1 \times n_1} & \underbrace{0}_{n_1 \times 1} & \underbrace{0}_{n_1 \times n_2} \\ \underbrace{\gamma_{21}}_{2 \times n_1} & \underbrace{\gamma_{22}}_{2 \times 1} & \underbrace{0}_{2 \times n_2} \\ \underbrace{\gamma_{31}}_{n_2 \times n_1} & \underbrace{\gamma_{32}}_{n_2 \times 1} & \underbrace{\gamma_{33}}_{n_2 \times n_2} \end{bmatrix}. \tag{4}$$

Finally, the impulse-response function to a one standard-deviation shock under the normalization of $\Lambda = \boldsymbol{I}$ is given by:

$$\boldsymbol{B}(\boldsymbol{L})^{-1}\Gamma_0^{-1}, \tag{5}$$

We use a Monte Carlo Markov-Chain (MCMC) algorithm to assess uncertainty about its distribution. We construct probability intervals by drawing from the Normal-Inverse-Wishart posterior distribution of *B(L)* and Σ

$$\beta|_\Sigma \sim \mathrm{N}(\hat{\beta}, \Sigma \otimes (X'X)^{-1}) \tag{6}$$

$$\Sigma^{-1} \sim \mathrm{Wishart}((T\hat{\Sigma})^{-1}, T-m) \tag{7}$$

where *B(L)* is a matrix valued polynomial in positive powers of the lag operator *L* associated with the regression coefficients, β is the vector of regression coefficients in the VAR system, Σ is the covariance matrix of the residuals, the variables with a hat are the corresponding maximum-likelihood estimates, *X* is the matrix of regressors, *T* is the

sample size and *m* is the number of estimated parameters per equation. The selected optimal lag length is 1 (Brazil and Russia) and 2 (China and India), in accordance with the standard likelihood ratio tests.

3.1.2. The Sign Restrictions Vector Auto-Regression

In this section, we describe our method in estimating the effects of fiscal shocks by means of sign restrictions, following Uhlig (2005). Unlike the traditional VAR approach, in order to completely identify the system, Uhlig (2005) proposed imposing sign restrictions on the impulse response functions. Identification via sign restrictions is relevant in this context, as our objective is to investigate the effect of shocks due to surprise movements in interest rates. We use the reduced-form of a vector autoregressive (VAR) model of order *p* with the following standard representation:

$$Y_t = B(L)Y_{t-1} + u_t \qquad (8)$$

where the vector *Y* includes the endogenous variables, *B(L)* is a lag polynomial of order *p*, and the covariance matrix of the vector of reduced-form residuals *u* is denoted as Σ. Identification in the structural VAR literature amounts to providing enough restrictions to uniquely solve for the following decomposition of the $n \times n$ estimated covariance matrix of the reduced-form VAR residuals Σ. The identification approach here is to represent the one-step ahead prediction errors into economically meaningful or fundamental shocks that there are n fundamental shocks which are mutually orthogonal and normalised to be of variance one, $\Sigma = E[u_t, u_t^{'}] = AE[\varepsilon_t \varepsilon_t^{'}]A^{'} = AA^{'}$, where this equation can be described as the Cholesky decomposition of Σ.

After having estimated the reduced form VAR model, in the first step, we randomly draw from the posterior distributions of the matrix of reduced form VAR coefficients, the variance covariance matrix of the error term, Σ. The usual structural VAR approach assumes that the error terms, u_t, are related to structural macroeconomic shocks, ε_t, via a matrix A, hence $u_t = A\varepsilon_t$. This defines a one-to-one mapping from the vector of orthogonal structural shocks ε to the reduced-form residuals *u*, $u=A\varepsilon$. The j^{th}-column of the identifying matrix *A*, a_j, is called an impulse vector, as it maps the innovation to the j^{th} structural shock ε_j into the contemporaneous, impact responses of all the *n* variables. With the structural impulse vector a_j in hand, the set of all structural impulse responses of the *n* variables up to the horizon *k* can then be computed using the estimated coefficient matrix *B(L)* of the reduced-form VAR. Thus the sign restriction

approach amounts to simultaneously estimating the coefficients of the reduced-form VAR and the impulse vector.

Uhlig (2005) identification method searches over the space of possible impulse vectors, $A_i\varepsilon^i$ to find those impulse responses that agree with standard theory. The aim is to identify an impulse vector, *a*, where $a \in \Re^n$, if there is some matrix A, such that $AA' = \Sigma$, where $A = [a_1, ..., a_n]$, so that *a* is a column vector of A. As a result, *a*, is an impulse vector if and only if there is an n-dimensional vector α of unit length so that $a = A'\alpha$ and, hence, $\Sigma = AA' = \sum_{i=1}^{n} a_i a_i'$. Once the impulse vector *a* has been appropriated, the impulse response is calculated as $\varepsilon_a(k) = \sum_{i=1}^{n} \alpha_i \varepsilon_i(k)$, where $\varepsilon_i(k) \in \Re^n$ is the vector response at horizon k to the i^{th} shock in a Cholesky decomposition of Σ (Uhlig, 2005). This way, we obtain a range of impulse responses that are compatible with the sign restrictions.

3.1.3. The Panel Vector Auto-Regression (PVAR)

We also use a panel-data vector autoregression (PVAR) methodology, which: (i) relies on the traditional vector autoregression (VAR) approach, and, therefore, treats all variables in the system as endogenous; (ii) combines it with the panel-data approach - consequently, allowing for unobserved individual heterogeneity; and (iii) increases the efficiency of statistical inference, avoiding the potential bias coming from a small number of degrees of freedom of the country level VAR.

We specify a first-order VAR model as follows:

$$Y_{i,t} = \Gamma_0 + \Gamma(\boldsymbol{L})\boldsymbol{Y}_{i,t} + \nu_i + \boldsymbol{d}_{\boldsymbol{c,t}} + \varepsilon_{\boldsymbol{i,t}} \quad i = 1, ..., N \quad t = 1, ..., T_i \qquad (9)$$

where $Y_{i,t}$ is a vector of endogenous variables, Γ_0 is a vector of constants, $\Gamma(L)$ is a matrix polynomial in the lag operator, ν_i is a matrix of country-specific fixed effects, and $\varepsilon_{i,t}$ is a vector of error terms. Our model also allows for country-specific time dummies, $d_{c,t}$, which capture aggregate, country-specific macro shocks. These dummies are eliminated by subtracting the means of each variable calculated for each country-year.

Given that the correlation between the fixed effects and the regressors (due to the lags of the dependent variables) implies that the mean-differencing procedure creates biased coefficients (Holtz-Eakin *et al.*, 1988), we use a two-stage procedure in

which: 1) we forward mean-difference the data (the 'Helmert procedure'), thereby removing only the mean of all future observations available for each country-year (Arellano and Bover, 1995); and 2) we estimate the system by GMM using the lags of the regressors as instruments (Blundell and Bond, 1998). In our model, the number of regressors is equal to the number of instruments.

Another issue that deserves attention refers to the impulse-response functions. Given that the variance-covariance matrix of the error terms may not be diagonal, one needs to decompose the residuals so that they become orthogonal. We follow the usual Choleski decomposition of variance-covariance matrix of residuals, in that after adopting the abovementioned ordering, any potential correlation between the residuals of two elements is allocated to the variable that comes first.

3.2. Estimating Fiscal Policy Rules

3.2.1. The Fully Simultaneous System of Equations

We also identify fiscal policy shocks using a Fully Simultaneous system of equations approach in a Bayesian framework. Therefore, we take into consideration the automatic response of fiscal policy to economic activity. Moreover, we do not assume that the government reacts only to variables that are predetermined relative to policy shocks, and assume that there are no predetermined variables with respect to fiscal policy shock.

In the structural VAR approach, we use Bayesian inference to assess the posterior uncertainty about the impulse-response functions in the Fully Simultaneous system of equations (Sims and Zha, 1999), and consider a Monte Carlo importance sampling weight algorithm.

We consider the following set of variables $X_t = [sp_t, g_t, t_t, y_t, p_t, i_t, cp_t]'$, where sp_t represents the stock price index, g_t, the government spending, t_t, the government revenue, y_t, the GDP, p_t, the GDP deflator, i_t, the central bank rate, and cp_t, the commodity price index. In particular, we partition the data such that $X_t = [X_{1t}', g_t, t_t, X_{2t}']$, where:

$$X_{1t} = [sp_t]; \qquad X_{2t} = \begin{bmatrix} y_t \\ p_t \\ i_t \\ cp_t \end{bmatrix}$$

The economy is divided into three sectors: a financial, a public and a production sector. The financial sector – summarized by the stock prices index, sp_t – reacts contemporaneously to all new information, in recognition of the fact that stock prices are determined in markets characterized by a continuous auction structure. The public sector – that allows for simultaneous effects –, comprises the equations for government spending and government revenue, and links them with the log real GDP, y_t, the GDP deflator, p_t, and the average cost of financing debt, i_t. The production sector consists of log real GDP, y_t, the GDP deflator, p_t, the average cost of financing debt, i_t, and the commodity price index, cp_t. The orthogonalization within this sector is irrelevant to identify fiscal policy shocks correctly. All these variables are not predetermined relative to the fiscal policy shocks but it is assumed that the policy shock can influence them contemporaneously.

Additionally, we adopt an identification of the fiscal policy shocks based on Blanchard and Perotti (2002) and Perotti (2004). This identification scheme consists of two steps: (i) institutional information about taxes and transfers and the timing of tax collections is used to identify the automatic response of taxes and government spending to economic activity, that is, to compute the elasticity of government revenue and spending to macroeconomic variables; and (ii) the fiscal policy shock is then estimated.

The identifying restrictions on the matrix of contemporaneous effects, Γ_0, can be defined as:

$$\Gamma_0 = \begin{bmatrix} \gamma_{11} & \gamma_{12} & \gamma_{13} & \gamma_{14} & \gamma_{15} & \gamma_{16} & \gamma_{17} \\ 0 & \gamma_{22} & 0 & -\xi_{G,Y}\cdot\gamma_{22} & -\xi_{G,\pi}\cdot\gamma_{22} & -\xi_{G,i}\cdot\gamma_{22} & 0 \\ 0 & 0 & \gamma_{33} & -\xi_{T,Y}\cdot\gamma_{33} & -\xi_{T,\pi}\cdot\gamma_{33} & -\xi_{T,i}\cdot\gamma_{33} & 0 \\ 0 & 0 & 0 & \gamma_{44} & 0 & 0 & 0 \\ 0 & 0 & 0 & \gamma_{54} & \gamma_{55} & 0 & 0 \\ 0 & 0 & 0 & \gamma_{64} & \gamma_{65} & \gamma_{66} & 0 \\ 0 & 0 & 0 & \gamma_{74} & \gamma_{75} & \gamma_{76} & \gamma_{77} \end{bmatrix} \begin{bmatrix} sp_t \\ g_t \\ t_t \\ y_t \\ p_t \\ i_t \\ cp_t \end{bmatrix} \quad (10),$$

where the parameters ξ_{ij} can be identified using external information. For instance, $\xi_{G,Y}$, $\xi_{G,\pi}$, and $\xi_{G,i}$ are the elasticities of government spending respectively to GDP, the GDP deflator, and the long-term interest rate. The description of the elasticities used in the identification procedure is reported in Table 1.

Table 1: Elasticities of Government Spending and Revenue.

	Elasticities of Government Spending			Elasticities of Government Revenue		
	$\xi_{G,Y}$	$\xi_{G,\pi}$	$\xi_{G,i}$	$\xi_{T,Y}$	$\xi_{T,\pi}$	$\xi_{T,i}$
Brazil	0	-0.5	0	1.85	1.25	0
Russia	0	-0.5	0	1.85	1.25	0
India	0	-0.5	0	1.85	1.25	0
China	0	-0.5	0	1.85	1.25	0

Note: The estimates of the elasticities are based on Blanchard and Perotti (2002), Perotti (2004), and Favero and Giavazzi (2007).

3.2.2. The Smooth Transition Regression (STAR) Model

Allowing for the case of fiscal authorities being responding differently to deviations of financial variables or output from their targets, a nonlinear specification can be formulated to account for such a behaviour. We employ a Smooth Transition Regression (STR) model to control for that possibility. While allowing for smooth endogenous regime switches, it is also able to explain when a fiscal authority changes its policy behaviour.

A standard STR model for a nonlinear fiscal rule can be de.ned as follows:

$$FI_t = \psi' z_t + \omega' z_t G(\eta, c, s_t) + \varepsilon_t \qquad (11)$$

where FI_t denotes the fiscal policy instrument and $z_t = (1, z_{1t}, ..., z_{kt})$ is the vector of k explanatory variables. The vectors $\psi = (\psi_0, \psi_1, ..., \psi_k)$ and $\omega = (\omega_0, \omega_1, ..., \omega_k)$ represent the parameter vectors in the linear and nonlinear parts of the model, respectively. In total, we have $k+1$ parameters to estimate, and some of these may be zero a priori. The disturbance term is assumed to be independent and identically distributed with zero mean and constant variance. The transition function $G(\eta,c,s_t)$ is continuous and bounded between zero and one in the transition variable s_t.

We start by considering $G(\eta,c,s_t)$ as a logistic function of order one:

$$G(\eta, c, s_t) = [1 + \exp\{-\eta(s_t - c)\}]^{-1}, \quad \eta > 0. \qquad (12)$$

This kind of STR model is called logistic STR model or LSTR1 model. In this case, the transition function is a monotonically increasing function of s_t, where the slope parameter, η indicates the smoothness of the transition from one regime to another, i.e. it shows how rapid the transition from zero to unity is, as a function of s_t. Finally, the location parameter, c, determines where the transition occurs. Considering this framework, the LSTR1 model can describe relationships that change according to the

level of the threshold variable and, consequently, an asymmetric reaction of the government to, for example, a high and a low debt regime.

The STR model is equivalent to a linear model with stochastic time-varying coefficients and, as so, it can be rewritten as:

$$FI_t = [\psi' + \omega' G(\eta, c, s_t)]z_t + \varepsilon_t \Leftrightarrow FI_t = \zeta' z_t + \varepsilon_t, \qquad t = 1,...,T. \quad (13)$$

The combined parameters, ζ, will fluctuate between ψ and $\psi + \omega$ and change monotonically as a function of s_t. The more the transition variable moves beyond the threshold, the closer $G(\eta,c,s_t)$ will be to one, and the closer ζ will be to ψ. Similarly, the further *st* approaches the threshold, c, the closer the transition function will be to zero and the closer ζ will be to ψ.

Given that a monotonic transition may not be a satisfactory alternative, we will also consider (and test for) the presence of a non-monotonic transition function. This can be the case where governments consider not a simple point target for the transition variable, but a band or an inner regime where the transition variable is considered to be under control. Consequently, the reaction of the fiscal authority will be different from the situation where transition variable is outside that regime.

We consider the following logistic function of order two:

$$G(\eta, c, s_t) = [1 + \exp\{-\eta(s_t - c_1)(s_t - c_2)\}]^{-1}, \quad (14)$$

where $\eta>0$, $c=\{c_1,c_2\}$ and $c_1 \geq c_2$. This transition function is symmetric about $(c_1+c_2)/2$ and asymmetric otherwise, and the model becomes linear when $\eta \rightarrow 0$. This model is called the quadratic logistic STR or LSTR2. If, for example, output (or wealth) is the transition variable, this model allows us to estimate separate lower and upper bands for output growth instead of a simple target value.

Finally, we also consider the case of the exponential STR model (also known as ESTR model). This corresponds to the situation where the transition function is exponentional, that is

$$G(\eta, c, s_t) = 1 - \exp\{-\eta(s_t - c)^2\} \qquad \eta > 0, \quad (15)$$

which corresponds to the particular case of the LSTR2 model where $c_1=c_2$. Therefore, the transition function is symmetric. This specification enables to capture the behaviour of fiscal policy in the extreme regimes (when the government defines its policy according to economic, financial and commodities variables) as well in the central regime for which fiscal authorities are more independent. In practice, even though

several tests enable the choice between exponential and logistic models, the first specification is invariably used for financial data than logistic one.

4. Data and Summary Statistics

We use data for the BRICS (Brazil, Russia, India and China). The data are available at quarterly frequency and the sample covers the period 1990:1-2008:3.

The variables and data definitions are as follows:

- Raw materials: *Real Commodity Price Index* (cp_t). Used as a proxy for changes in the global demand and to control for the price puzzle, and provided by Haver Analytics.
- Real GDP: *GDP* (GDP_t). Used as a proxy for economic activity and business cycle and provided by Haver Analytics.
- Inflation rate: *Inflation Rate* (π_t). Computed from the GDP deflator and provided by Haver Analytics.
- Interest rate: *Nominal Central Bank Rate* (i_t). Provided by Haver Analytics.
- Exchange Rate: *Real bilateral exchange rate versus the U.S. Dollar* (er_t). Provided by Haver Analytics.
- Equity Price: *Real Stock Price Index* (sp_t). Compiled from Haver Analytics (Brazil, China, India) and Global Financial Database (Russia).
- Government Spending: *General Government Final Consumption Expenditure* (g_t). Used as a fiscal policy instrument and compiled from the World Bank and the OECD National Accounts.
- Government Revenue: *General Government Tax Revenue* (t_t). Used as a fiscal policy instrument and compiled from the World Bank and the OECD National Accounts.

5. Empirical Results

5.1 The Macroeconomic Impact of Fiscal Policy

5.1.1. The Bayesian Structural Vector Auto-Regression (BSVAR)

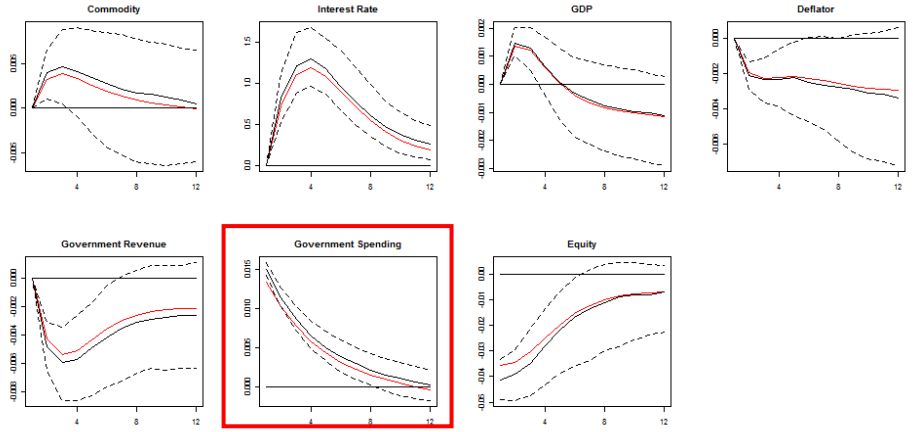
We start by estimating a B-SVAR based on a partial recursive identification scheme. Figures 1 to 4 plot the impulse-response functions to a fiscal policy shock. The solid and dashed lines correspond to the average response and the 68 percent posterior probability bands (constructed using a Monte Carlo Markov-Chain algorithm based on

10000 draws), while the red line denotes the median response. The results can be summarized as follows:

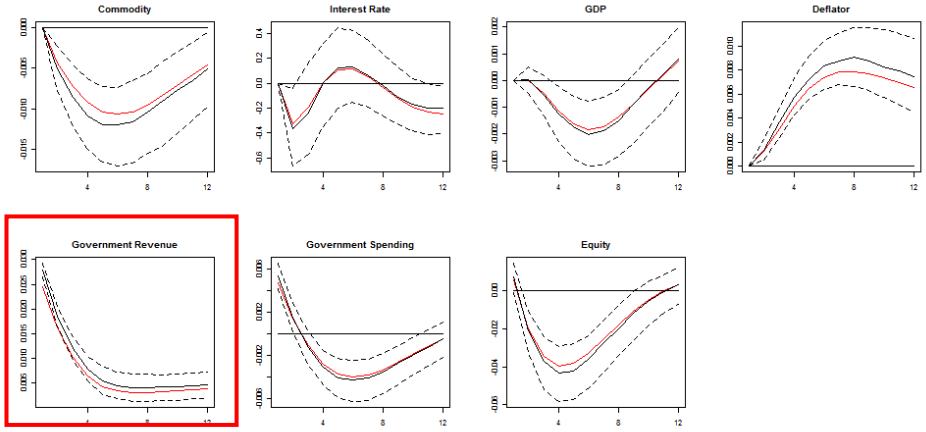
1) We show that government spending has an expansionary effect on GDP (in particular, for Brazil and China) which lasts for about 6 quarters, while a positive tax shock has a contractionary impact which is generally persistent. This, in turn, gives support to the existence of important Keynesian effects of fiscal policy in the BRICs.
2) The interest rate tends to rise following a spending shock and this effect is rather persistent, a feature that highlights the possibility of important "crowding-out" effects. This also helps explaining why the impact of fiscal policy on output is typically short-lived.
3) The price level is not significantly affected by government spending shocks or its response is small in magnitude.
4) Commodity prices rise sharply in the outcome of a fiscal expansion, in particular, for Brazil, Russia and China, and remain at a higher than initial level for a relatively long period.
5) Interestingly, while a positive spending shock is typically followed by a fall in taxation, a positive tax shock tends to be associated with a rise in government spending. Putting it differently, episodes of fiscal expansion tend to have an amplified effect on the economy because of the increase in spending and the fall in taxation. In contrast, periods of restrictive policies via increases in taxes generally fail to lead to fiscal consolidation because of the subsequent boost in government spending.
6) Equity prices fall in response to a positive spending shock, giving rise to the idea that markets interpret the expansion of government spending as a deterioration of public finances.

Figure 1: IRFs using a Partial Recursive Identification – Brazil.

1a – spending shock



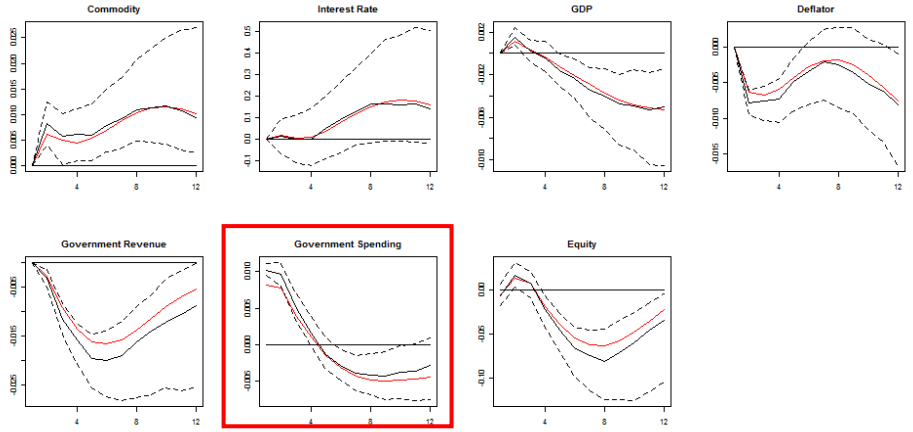
1b – tax shock



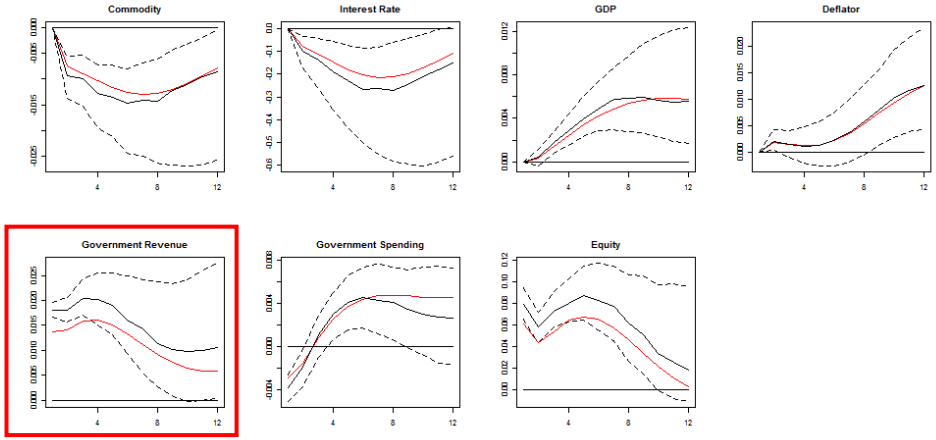
Solid and dotted lines – average response and 68% posterior probability intervals; Red solid line – median response.

Figure 2: IRFs using a Partial Recursive Identification – Russia.

2a – spending shock



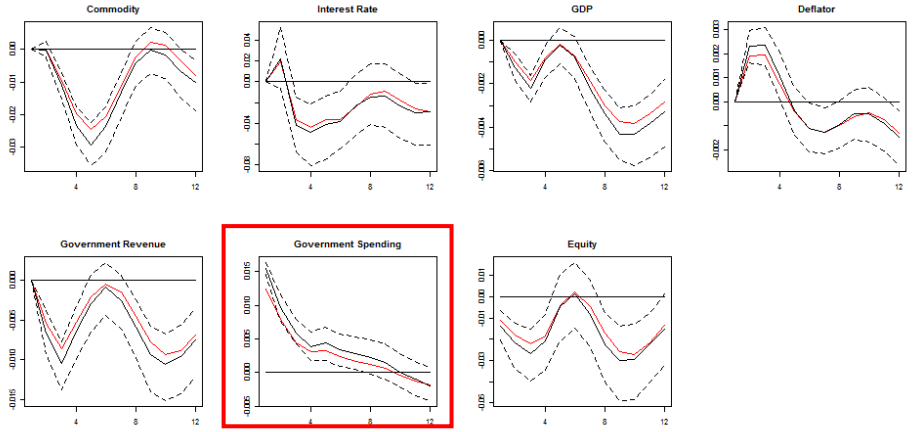
2b – tax shock



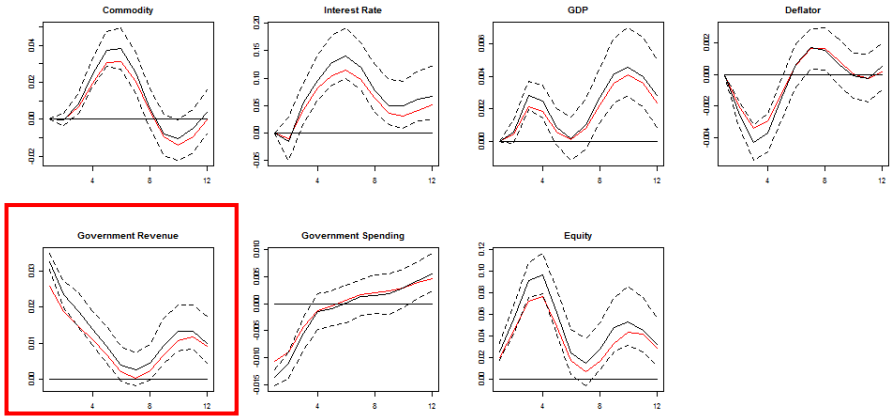
Solid and dotted lines – average response and 68% posterior probability intervals; Red solid line – median response.

Figure 3: IRFs using a Partial Recursive Identification – India.

3a – spending shock



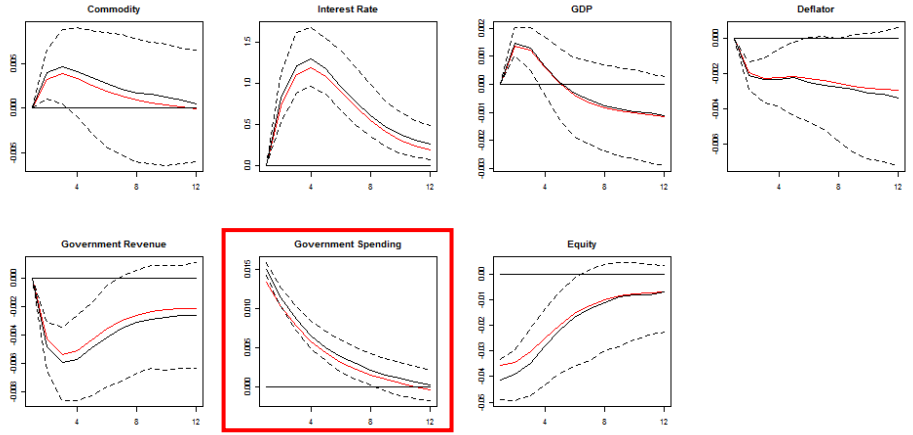
3b – tax shock



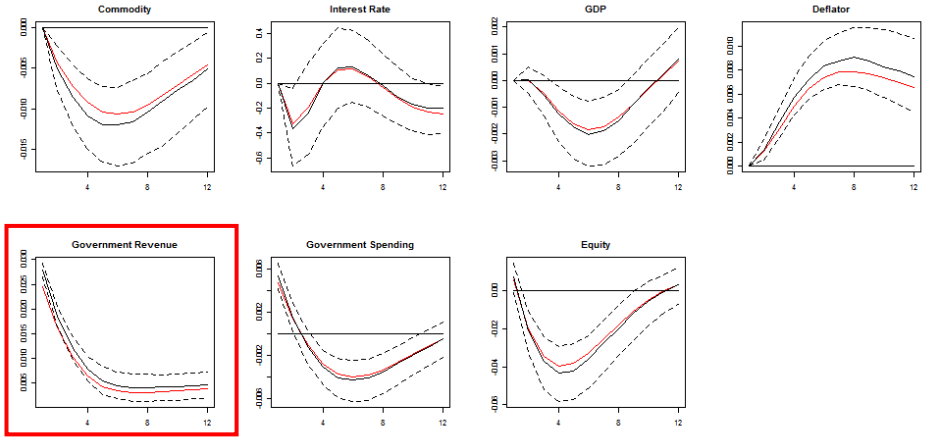
Solid and dotted lines – average response and 68% posterior probability intervals; Red solid line – median response.

Figure 4: IRFs using a Partial Recursive Identification – China.

4a – spending shock



4b – tax shock



Solid and dotted lines – average response and 68% posterior probability intervals; Red solid line – median response.

5.1.2. The Sign Restrictions Vector Auto-Regression

In order to further validate our BVAR results, we carry out the above 'pure sign restriction' identification strategy due to Uhlig (2005) using the following sign restrictions, not only upon impact, but for a few periods after the shock's impact. The sign restrictions imposed are the same as the signs observed earlier in the BVAR exercise. Three restrictions are imposed to identify a tax shock – an increase in interest rate, a reduction in inflation, and a reduction in money growth. In addition, we also identify a government spending shock. We identify a tax shock first and then the spending shock as defined in Table 2.

Table 2: Identifying Sign Restrictions.

	TAX	GEX	GDP	INF	CBR	MON	RER	REQ
Contractionary tax shock (increase in taxes)	+	?	–	–	?	?	?	?
Expansionary spending shock (increase in government spending)	?	+	+	+	?	?	?	?

The responses in Figures 5 to 11 satisfy the sign restrictions for $k = 1,..., K$ quarters. The responses of these three variables have been restricted for the first 2 quarters, following the shock. The error bands based are illustrated as the dotted lines above and below the response line (the thick line), which are composed of the 16^{th}, 84^{th} and median percentiles of the impulse responses for each shock, and are based on 10000 draws. The results can be summarized as follows:

1) We show that fiscal policy can play a stabilising role, as fiscal policy shocks generally have Keynesian effects in our empirical exercise. India seems to have experienced the largest fall in real output following a contractionary tax policy shock, followed by Brazil and China. All countries seem to demonstrate pro-cyclicality of government expenditure, while tax policy shocks lead to a fall in output, showing a counter-cyclical effect.
2) Inflation declines in all three countries reacting almost immediately to a tax policy shock, but the effect seems smallest and mostly short-lived, as it quickly goes back to its initial level. Inflation gets reduced, but at the

cost of reduction in output. Both FX and equity market responses remain negatively related to the response of inflation following a fiscal shock.

3) As a spending shock is likely to give rise to an increase in market borrowing by the government, interest rate changes in these countries remain accommodative, slowly receding back to zero.

4) The contractionary tax shock has a negative effect on output. Overall, the results indicate that government consumption shocks have strong Keynesian effects for this group of key emerging market economies, while in the case of tax shocks, a rise in tax reduces output in all three countries, which suggests that there is no evidence in favour of 'expansionary fiscal contraction' in the context of emerging economies where spending policies were assumed to be pro-cyclical.

5) For Russia, we carried out impulse responses for spending shocks only, as the tax series is only available for a limited period, which reduces the time dimension considerably for the 8-variable VAR. The Keynesian argument still holds for the impact of unexpected government spending shocks (see Figure 11).

Figure 5: IRFs of Tax shocks using Sign Restriction approach - Brazil.

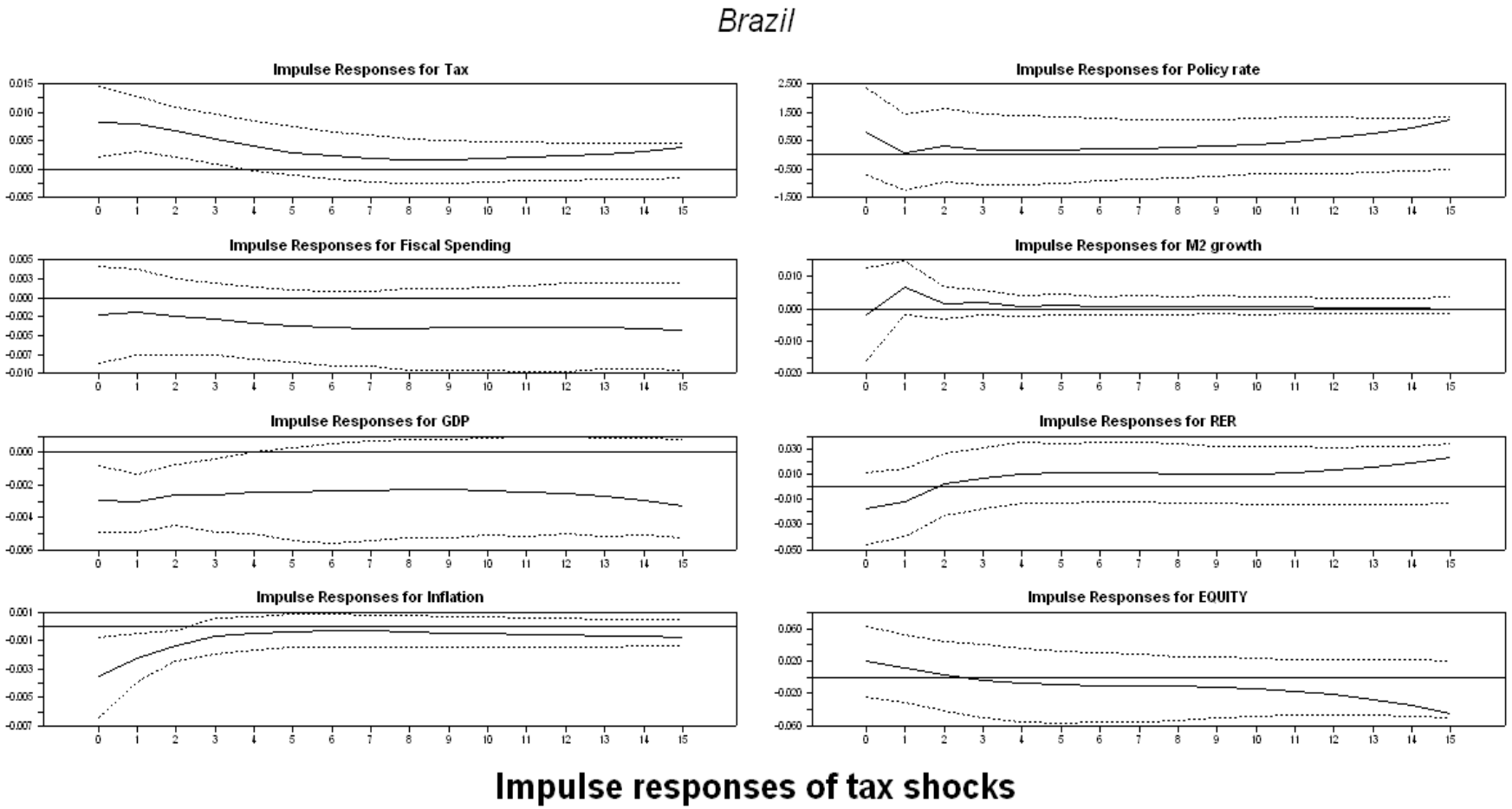


Figure 6: IRFs of Spending shocks using Sign Restriction approach - Brazil.

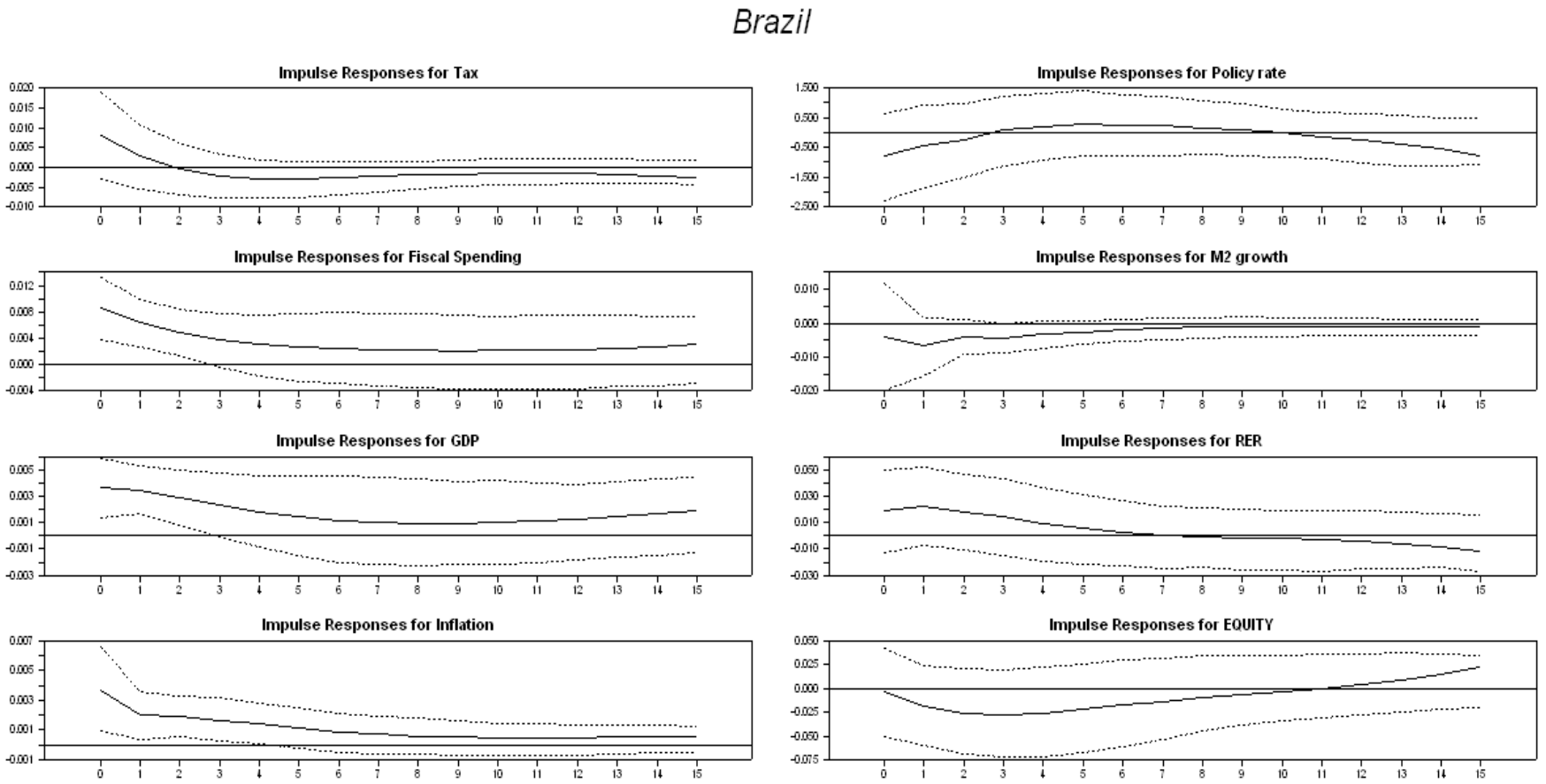


Figure 7: IRFs of Tax shocks using Sign Restriction approach - India

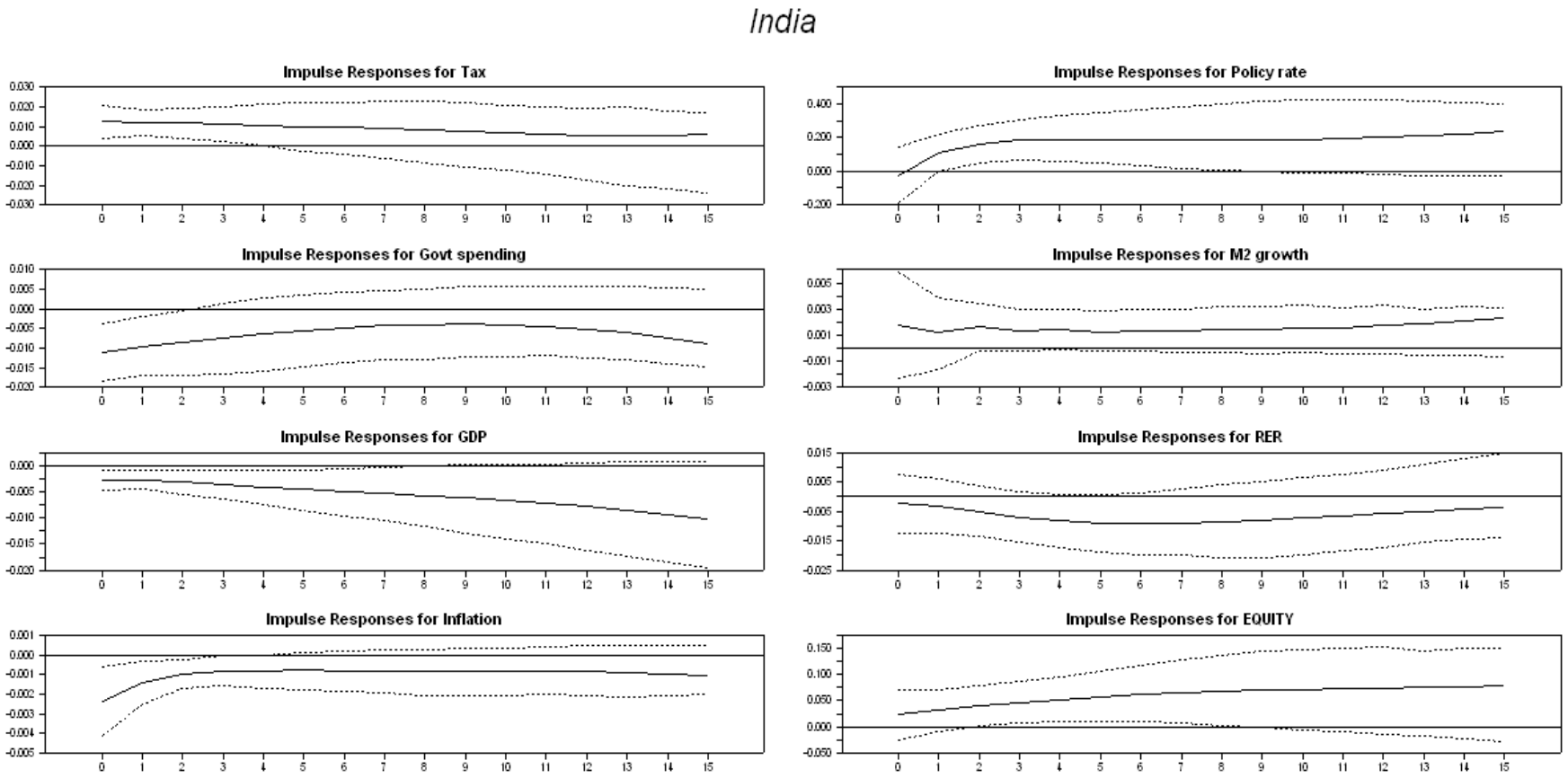


Figure 8: IRFs of Spending shocks using Sign Restriction approach - India.

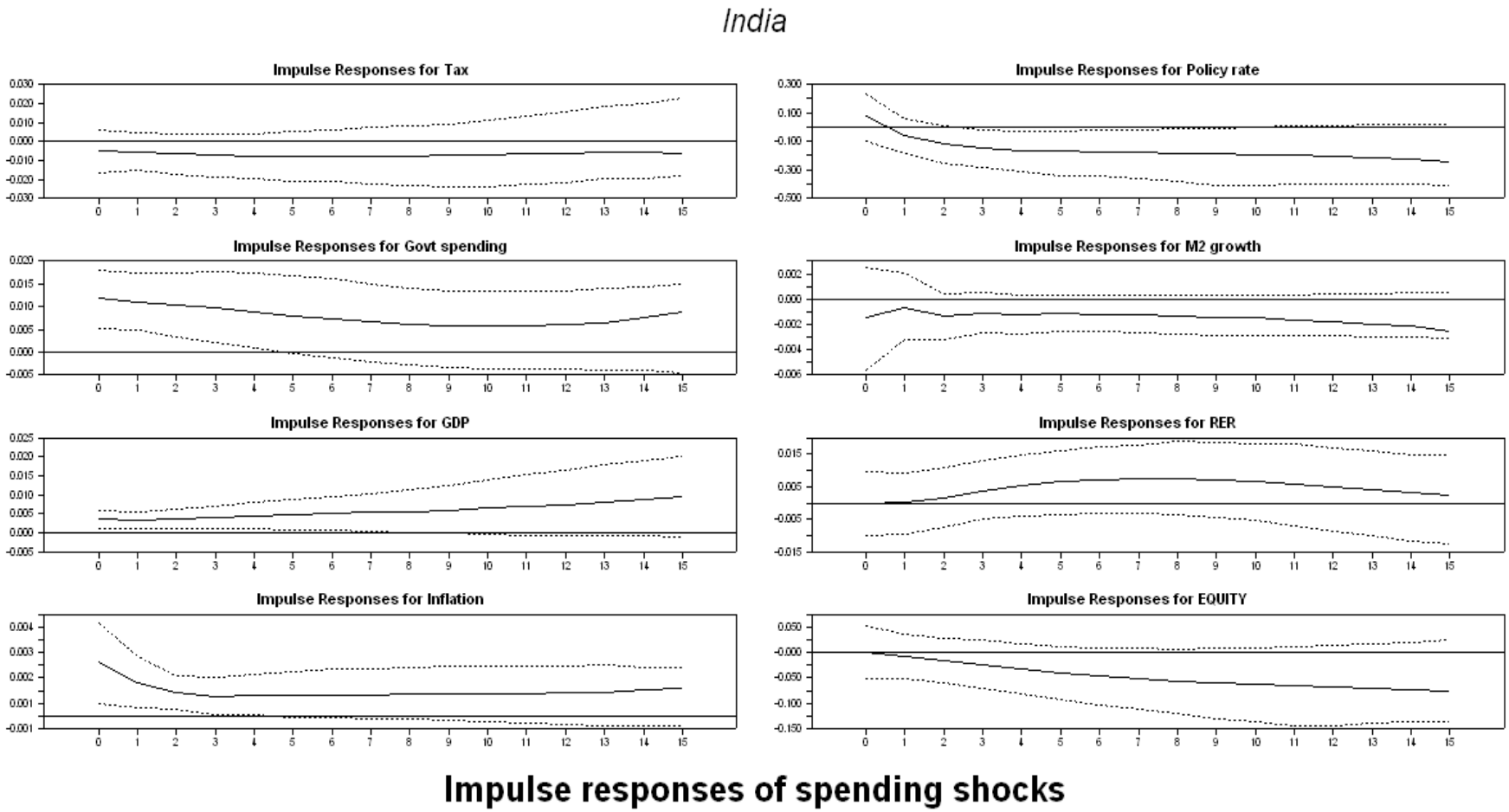


Figure 9: IRFs of Tax shocks using Sign Restriction approach - China

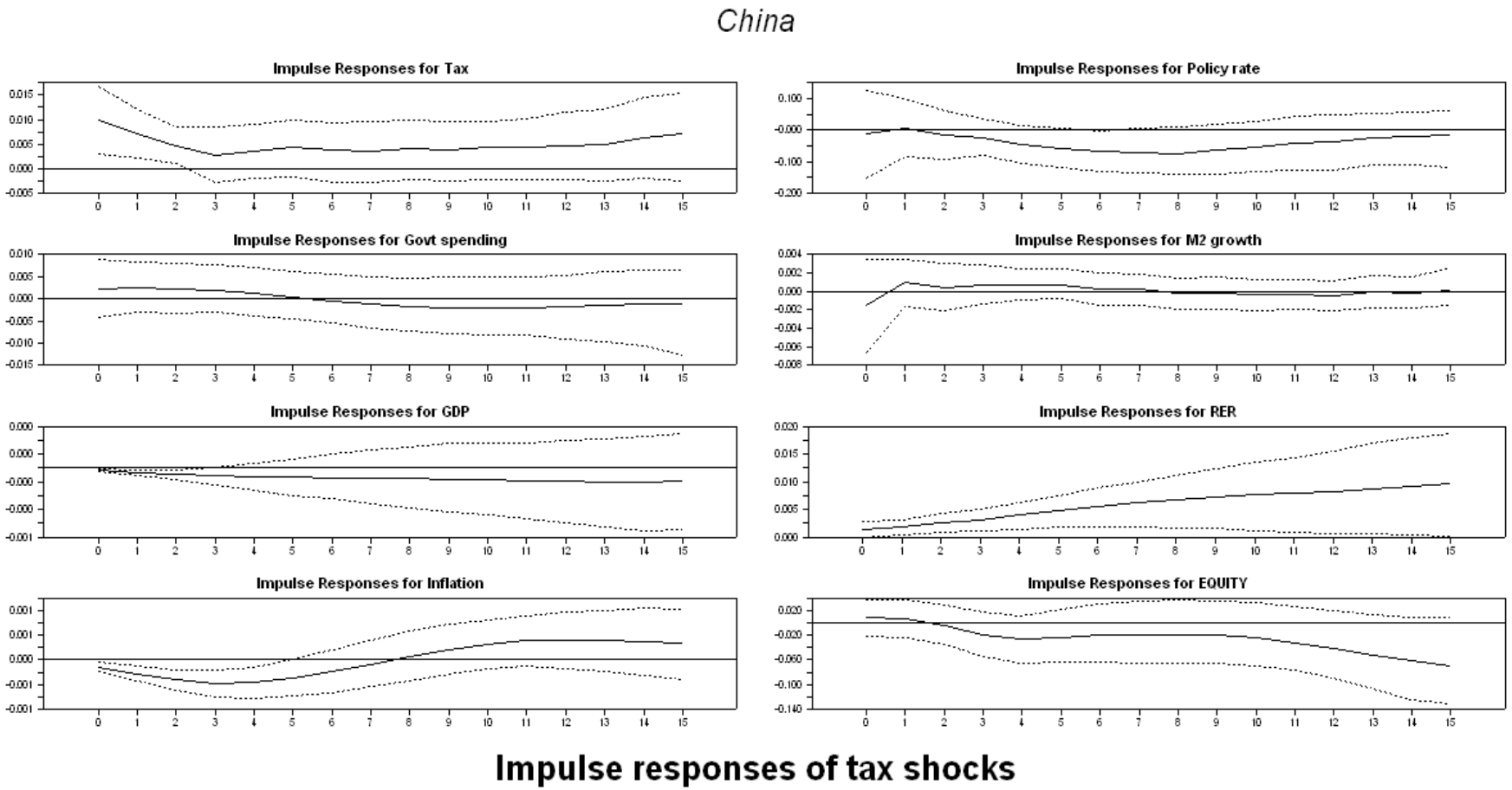


Figure 10: IRFs of Spending shocks using Sign Restriction approach - China

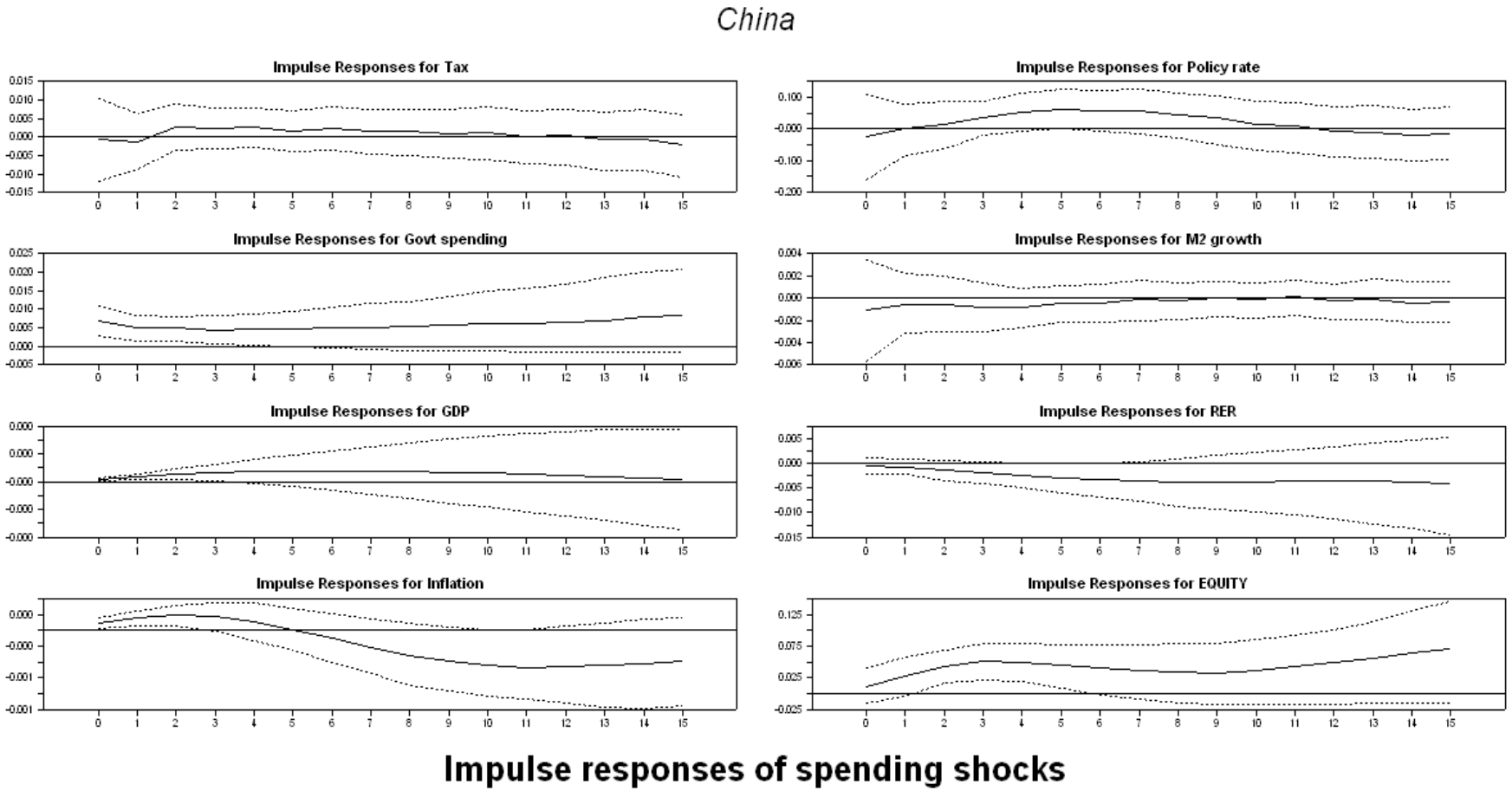
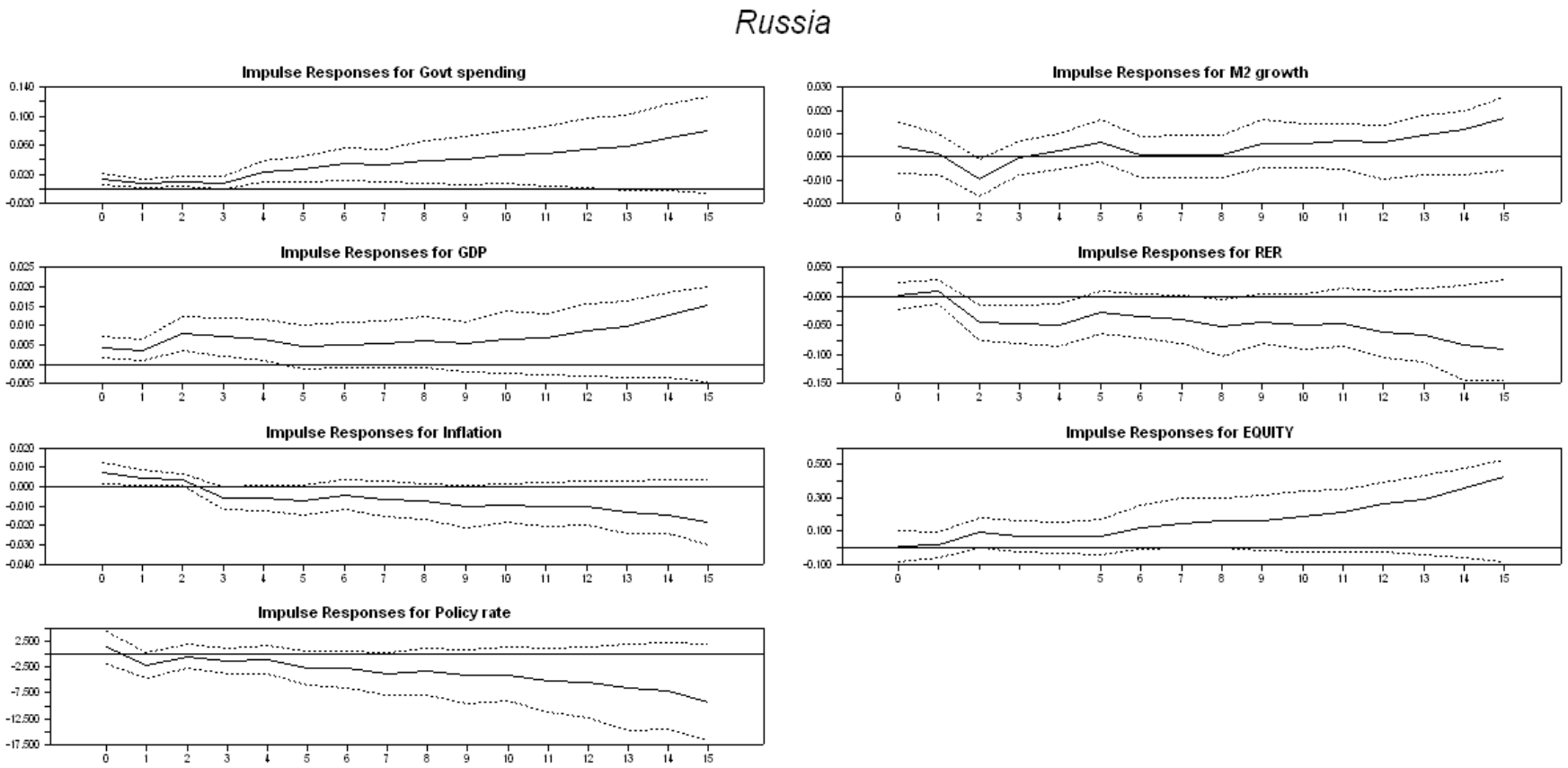


Figure 11: IRFs of Spending shocks using Sign Restriction approach - Russia



5.1.3. The Panel Vector Auto-Regression (PVAR)

In this Sub-Section, we report the results from the estimation of the PVAR. We transform the system in a "recursive" VAR (Hamilton, 1994) and impose a triangular identification structure, therefore, assuming that the shocks to the policy instrument affects the GDP, the price level, the interest rate and the commodity price only with a lag. The ordering of the variables in the system is, therefore, common in the literature on fiscal policy.

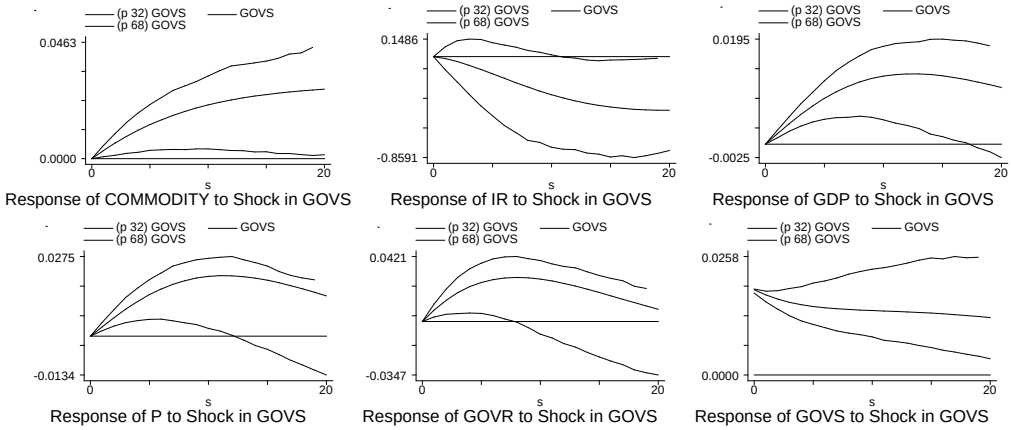
Given that emerging markets have frequently been the stage for episodes of economic, financial and/or currency crises and that the anticipation of these events may affect lending and market default premia (Dell'Ariccia *et al.*, 2006), we create two dummy variables, $\boldsymbol{D}_{i,t}^{CRISIS}$ and $\boldsymbol{D}_{i,t}^{NO\,CRISIS}$. We define the dummy variable $\boldsymbol{D}_{i,t}^{CRISIS}$ as follows: it takes the value of 1 if either the change (year-on-year) of real GDP or real equity price index is more than two times the country-specific standard deviation of the variable; and 0, otherwise. In addition, the quarters before and after the peak of crisis are also marked with 1, and all other periods (normal periods) are marked with 0. By its turn, the dummy variable $\boldsymbol{D}_{i,t}^{NO\,CRISIS}$ takes the value of 1 in case of absence of episodes of crises and 0 otherwise. Then, we estimate a dummy variable augmented PVAR model of the form:

$$\mathrm{Y}_{\mathrm{i,t}} = \Gamma_0 + \Gamma_{\boldsymbol{CRISIS}}(\boldsymbol{L})\boldsymbol{Y}_{\mathrm{i,t}} \bullet \boldsymbol{D}_{\boldsymbol{I,T}}^{\boldsymbol{CRISIS}} + \Gamma_{\boldsymbol{NO\,CRISIS}}(\boldsymbol{L})\boldsymbol{Y}_{\mathrm{i,t}} \bullet \boldsymbol{D}_{\boldsymbol{I,T}}^{\boldsymbol{NO\,CRISIS}} + \nu_{\mathrm{i}} + \boldsymbol{d}_{\boldsymbol{c,t}} + \varepsilon_{\boldsymbol{i,t}} \quad \mathrm{i} = 1,...,\mathrm{N} \quad \mathrm{t} = 1,...,\mathrm{T_i} \qquad (16)$$

This robustness test checks whether the previous findings were biased because the episodes of crises were not appropriately controlled for.

Figure 12 corroborates the results of the B-SVAR and the sign restriction approaches. In fact, it can be seen that a positive government spending shock leads to: (i) an expansionary effect on GDP that peaks after 12 quarters; and (ii) a boost in the price of commodities and the price level. In addition, the findings show that, in the absence of periods of extreme instability (that is, in "normal" periods), fiscal policy still has a strong and positive impact on GDP.

Figure 12: IRFs using a PVAR approach – Spending shock.



5.2. Fiscal Policy Rules

5.2.1. The Fully Simultaneous System of Equations

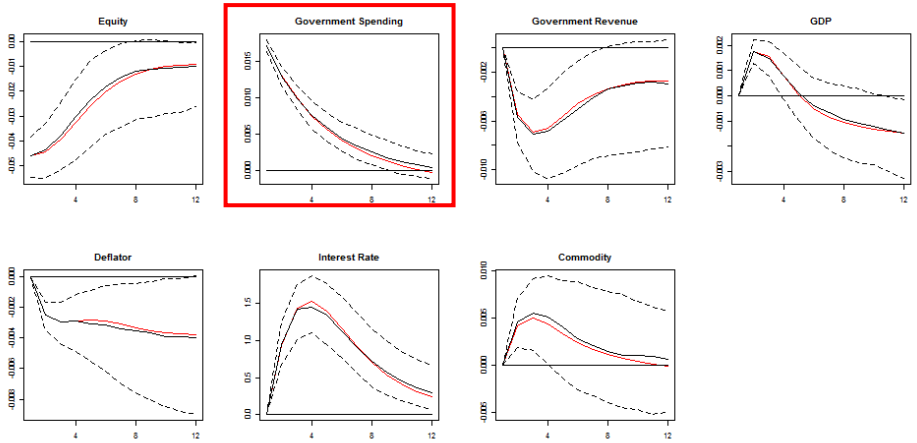
We now look at the result provided by the estimation of the Fully Simultaneous System of Equations.

Figures 13 to 16 plot the impulse-response functions to a fiscal policy shock. The solid and dashed lines correspond to the average response and the 68 percent posterior probability bands constructed by using a Monte-Carlo importance sampling normalized weights algorithm, and based on 50000 draws. The red line denotes the median response. The results can be summarized as follows:

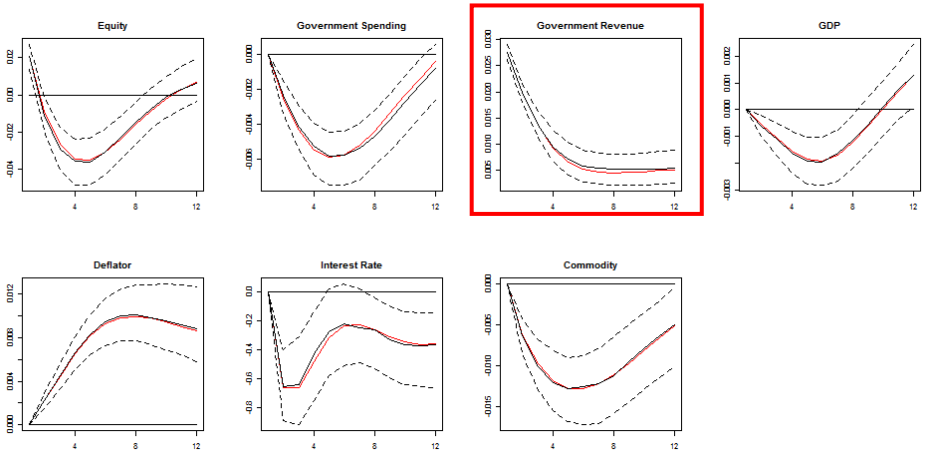
1) Government spending seems to generate strong Keynesian effects, reflected in the expansionary effect on output, while a positive tax shock leads to a contraction of economic activity.
2) The borrowing costs rise after the shock in government spending, thereby, "crowding-out" private spending.
3) Inflation does not seem to be significantly impacted by spending shocks, but the price of commodities rises dramatically.
4) Episodes of fiscal expansion via the spending side tend to be followed by tax cuts, while episodes of fiscal contraction via the revenue side are typically associated with a subsequent rise in government spending.
5) Markets interpret the rise in government spending as a signal of a deterioration of the fiscal stance or as a future increase of risk premium (Sousa, 2010b). As a result, equity prices fall after a positive spending shock.

Figure 13: IRFs using a Fully Simultaneous System of Equations – Brazil.

13a – spending shock



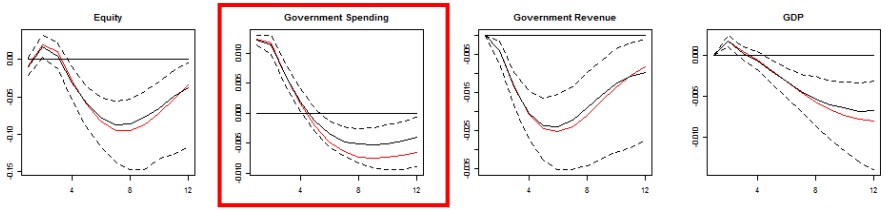
13b – tax shock



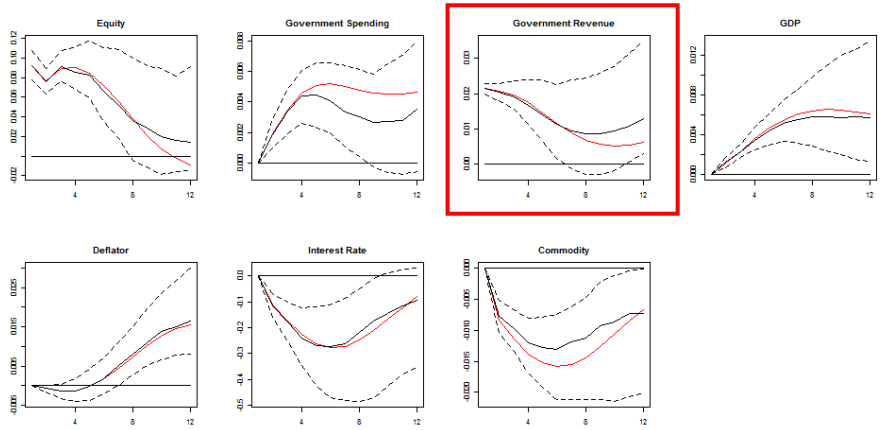
Solid and dotted lines – average response and 68% posterior probability intervals; Red solid line – median response.

Figure 14: IRFs using a Fully Simultaneous System of Equations – Russia.

14a – spending shock



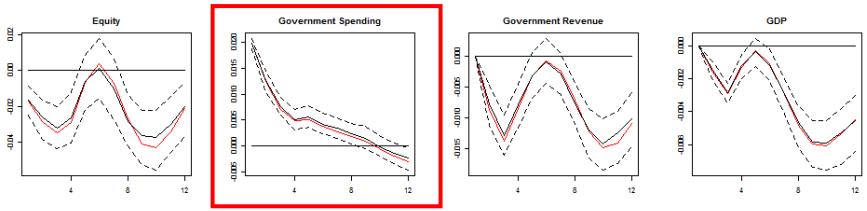
14b – tax shock



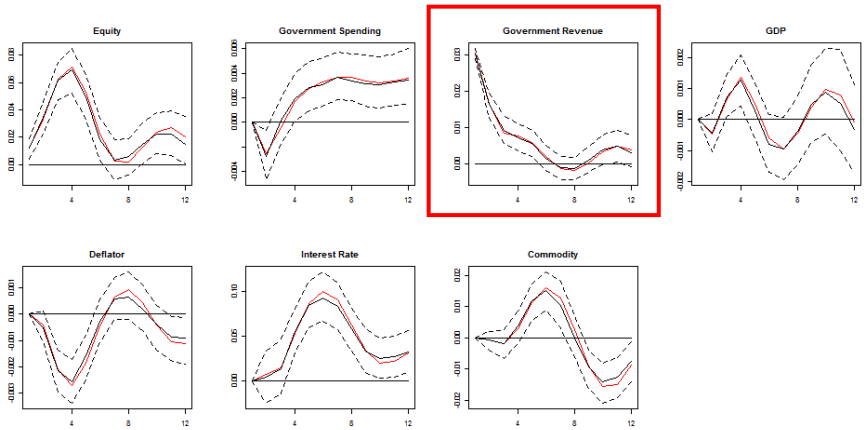
Solid and dotted lines – average response and 68% posterior probability intervals; Red solid line – median response.

Figure 15: IRFs using a Fully Simultaneous System of Equations – India.

15a – spending shock



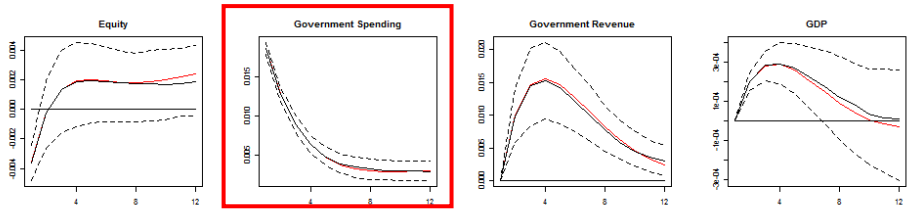
15b – tax shock



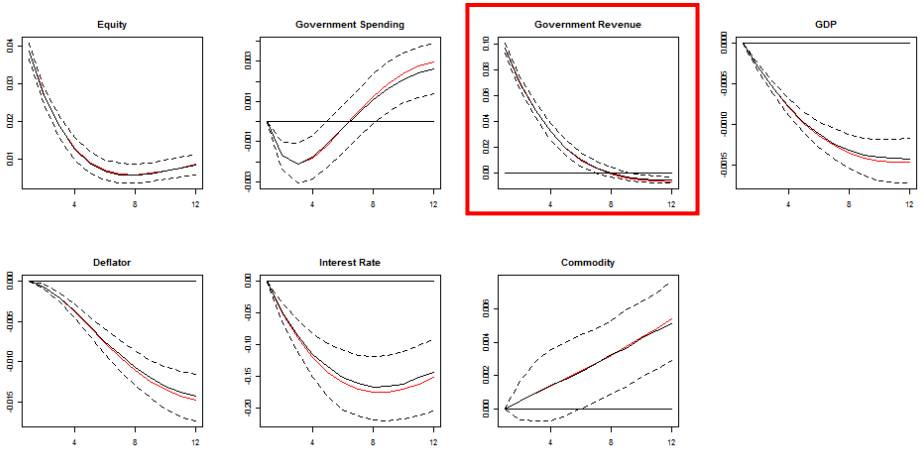
Solid and dotted lines – average response and 68% posterior probability intervals; Red solid line – median response.

Figure 16: IRFs using a Fully Simultaneous System of Equations – China.

16a – spending shock



16b – tax shock



Solid and dotted lines – average response and 68% posterior probability intervals; Red solid line – median response.

5.2.2. The Smooth Transition Regression (STAR) Model

This section aims to study the effect the macroeconomic impact of fiscal policy shocks for the BRICs in a nonlinear framework using STR model. The introduction of nonlinearity can be justified by the potentially asymmetric effect of fiscal policy according to the phase of a business cycle. Furthermore, we expect that the determinants of fiscal policy also vary according to regimes. The main advantage of STR modelling is to the enable the dynamics to be time-varying and to define it according to regime.

In practice, we carried out the STR modelling in several steps according to Granger and Teräsvirta (1993), Teräsvirta (1998) and Van Dijk *et al.* (2002). First of all, we specify the linear model for the government consumption and government revenue. In particular, we have included *Real Commodity Price Index* (cp_t), Real GDP, Inflation rate: *Inflation Rate* (π_t), Interest rate: *Nominal Central Bank Rate* (i_t), Exchange Rate (er_t), Equity Price (sp_t), the money growth as explanatory variables. Second, we have tested the linearity hypothesis using Lagrange Multiplier Tests of Luukonen *et al.* (1988) that test the linearity against the nonlinearity of STR type.[4] Tests of linearity are carried out for several transition variables and the optimal variable is that for which the rejection of linearity is the strongest. From the empirical results reported in Table 3, we note that linearity is strongly rejected for Russia for both government consumption and tax variables, for Brazil and India only for tax variable and for China at 10% level only for government consumption. These results are interesting as they suggest some nonlinearity in the transmission of fiscal shocks. Third, we apply a list of Fisher Tests introduced by Teräsvirta (1998) to specify the transition function: logistic or exponential. According to the results,[5] the exponential is a priori more appropriate to reproduce the transition between regimes for the most series for which linearity is rejected.

Table 3: Linearity Tests (LM_3 Test).

Country	Series	LM Test (P-value)
Brazil	Spending	0.56
	Tax	0.02
Russia	Spending	0.0
	Tax	0.0
India	Spending	0.35
	Tax	0.03
China	Spending	0.08
	Tax	0.27

[4] For more details about these tests, see Van Dijk *et al.* (2002).
[5] We do not report these results in order to save space, but results are available upon request.

Table 4: Nonlinear fiscal policy rules.

	Brazil		Russia		India		China	
Linear part (ψ)	g_t	t_t	g_t	t_t	g_t	t_t	g_t	t_t
Constant	-	0.023 [1.61]	0.007 [0.65]	0.05 [1.14]	-	0.012 [0.57]	-0.03 [-0.51]	-
cp_t	-	-0.121 [-0.56]	0.139 [0.83]	-0.49 [-0.58]	-	0.68* [2.06]	-0.912 [-0.70]	-
sp_t	-	-0.12 [-0.64]	0.074* [2.9]	-0.117 [-1.19]	-	0.02 [0.04]	-0.023 [-0.40]	-
er_t	-	0.30* [2.11]	0.262 [1.5]	-1.05 [-1.37]	-	-0.131 [-0.56]	0.194 [0.33]	-
y_t	-	0.53 [0.61]	1.39* [3.4]	0.121 [0.11]	-	1.31* [1.99]	9.20 [0.66]	-
π_t	-	0.44* [2.15]	0.072 [0.47]	-2.64* [-3.0]	-	0.312 [0.55]	-0.362 [-0.09]	-
m_t	-	0.47* [2.3]	0.137 [0.76]	-1.06 [-1.52]	-	-0.284 [-0.46]	-0.434 [-0.89]	-
i_t		-	-	-		-	-	
Nonlinear part (ω)								
Constant	-	-0.01 [-0.52]	-0.005 [-0.22]	-0.04 [-1.06]	-	-0.102** [-1.77]	0.07 [1.47]	-
cp_t	-	0.263 [0.91]	-0.40 [-1.5]	0.287 [0.32]	-	-0.966** [-1.79]	0.78 [0.57]	-
sp_t	-	0.223 [1.07]	-0.385* [-3.9]	0.164 [1.44]	-	-0.012 [-0.08]	-0.03 [-0.62]	-
er_t	-	-0.325** [-1.77]	-0.679* [-3.0]	1.47* [2.03]	-	-0.034 [-0.05]	-0.46 [-0.58]	-
y_t	-	-0.612 [-0.52]	-3.80* [-3.4]	1.88 [1.19]	-	-0.056 [-0.15]	-20.9 [-1.57]	-
π_t	-	-0.545* [-2.52]	0.619* [2.33]	3.19* [3.71]	-	-4.15* [-2.25]	-3.94 [-0.92]	-
m_t	-	-0.828* [-3.01]	1.20 [1.5]	0.71 [0.95]	-	3.72** [1.65]	0.40 [0.59]	-
i_t		-	-	-		-	-	
η	-	38.4** [1.93]	1.84* [2.1]	6.43** [1.85]	-	10.5** [1.93]	200.6 [1.4]	-
C	-	-0.20* [-20.6]	-0.065 [-6.3]	0.012* [2.6]	-	0.05* [4.2]	0.02* [30.9]	-
Obs.	-	57	52	54	-	49	46	-
R^2	-	0.46	0.79	0.93	-	0.65	0.47	-
Model	-	ESTR	ESTR		-	ESTR	ESTR	-
s_t	-	sp_t	cp_t	cp_t	-	cp_t	cp_t	-

Notes: * statistically significant at 5% level; ** at 10% level. All variables are in log differences. The *t*-ratio statistics are in square brackets. s_t denotes the transition variable.

Fourth, we estimated the STR models by the Nonlinear Least Squares Method after initializing the parameters. We report the main important results in Table 4. Accordingly, we note for Brazil strong evidence on nonlinearity in tax rules dynamics. Indeed, our findings show significant time varying dynamic and transition between regimes. Also, we note strong interaction between fiscal shock, exchange rate, inflation and the money growth. Interestingly, the interactions between these variables seem to be

asymmetrical as these effects are positive in the first regime but negative and significant in the second regime.

For China, the nonlinearity characterizing the government consumption seems to be less significant as suggested by the linearity test (rejection at 10% level). Also, our finding capture a significant nonlinear relationship only between with the GDP and government consumption (at 12% level). Even though the threshold parameter is significant, the non rejection of omitted nonlinearity in the residual suggests the presence of other type nonlinearity notably because the transition speed is higher suggesting rather an abrupt adjustment.

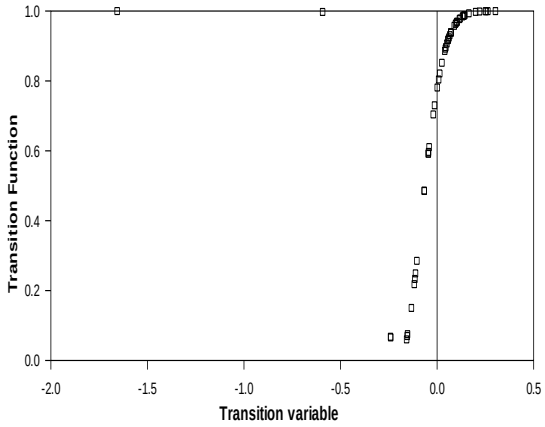
Regarding India, we note significant linear relationship between tax rules, GDP and commodity prices, while nonlinearity characterizes much more the relationship between tax and inflation. Also, the exponential function seems to appropriately characterize the transition between Tax regimes even though the transition speed is rather less than for Brazil. Also while for Brazil, the transition between tax rule regimes is determined by equity markets, the transition is rather associated with commodity market.

For Russia, both government consumption and tax variables are characterized by nonlinear dynamics. Regarding the government consumption, we note several important results. On the one hand, nonlinearity and smoothness significantly characterize its dynamic. On the other hand, we have noted several significant and positive effects between government consumption and other macroeconomic variables such as equity price, GDP. The same variables as well as the exchange rate also affect negatively and in a nonlinear manner the government consumption dynamics, suggesting strong evidence of nonlinear time-varying relationships. For tax rules, they seem to be nonlinear and significantly governed by inflation, exchange rate. The relation within inflation alternate from negative to positive according to the regime.

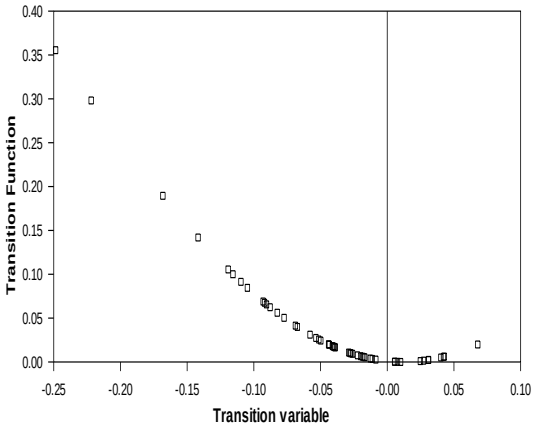
Overall, these findings highlights evidence of nonlinearity and time varying in the dynamics of fiscal rules and the transmission of fiscal shocks. We also note that these relationships vary according to regimes. In order to illustrate this switching, we have reported in Figure 17 and 18 the estimated transition functions.

Figure 17: Transition Functions for Tax in Brazil, Russia and India.

Brazil



Russia



India

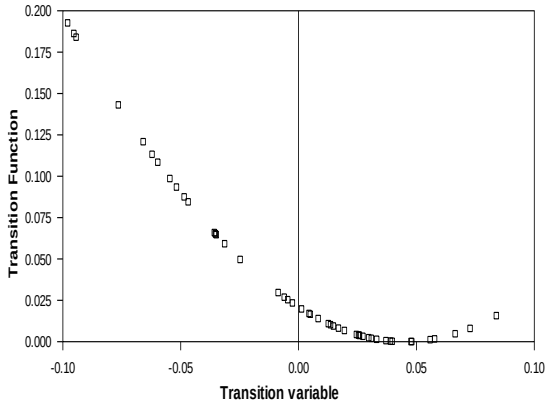
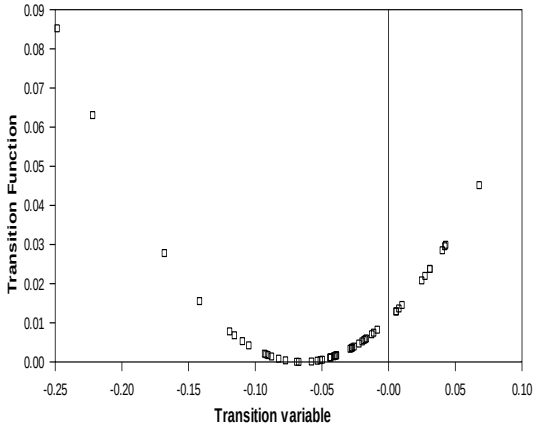
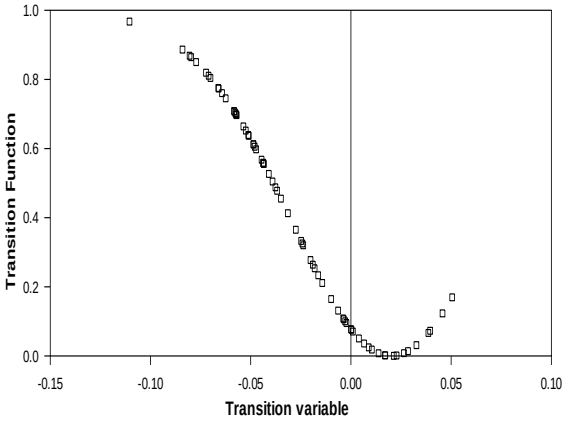


Figure 18: Transition Functions for Spending in Russia and China.

Russia

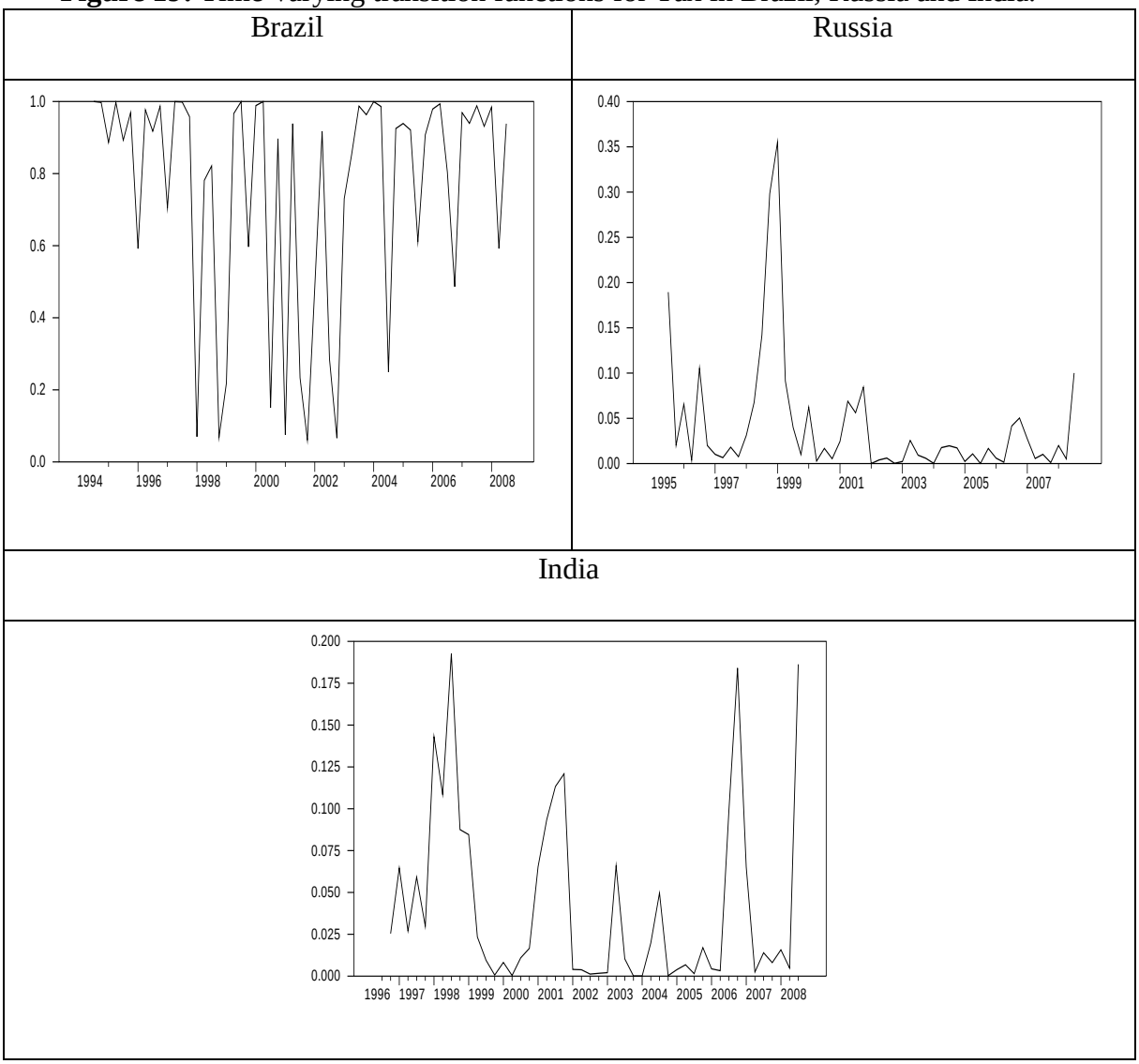


China



The analysis of these Figures provides several interesting findings. First, for tax, the dynamics of the transition function shows significant smoothness and persistence for India and Russia. The profile of the transition function for Brazil is different, which can mean that the transmission of tax shock is more abrupt, confirming our analysis of the transition speed. Also, the persistence associated with the government consumption is more significant for Russia than for China. Second, the transition function reaches the unity only for China and Brazil, which can indicate a faster speed in the transmission of fiscal shock and can also be supported for China by its high growth.

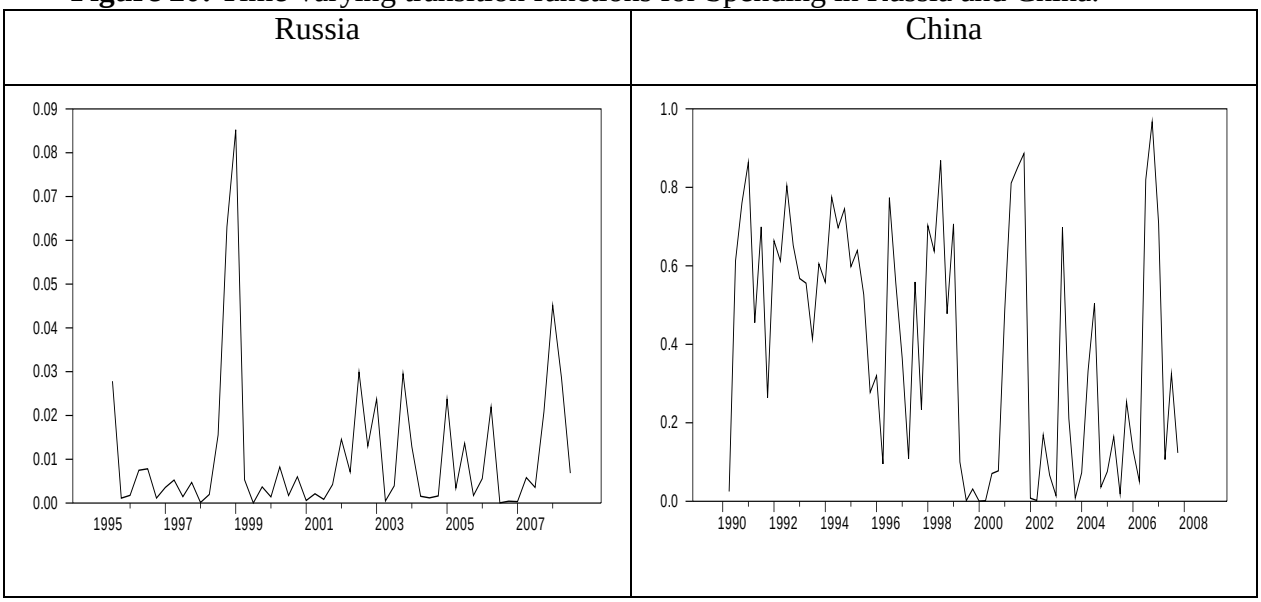
Figure 19: Time-varying transition functions for Tax in Brazil, Russia and India.



We also report the dynamic profile of the transition function for the sample under consideration (Figures 19 and 20). This should inform about the intensity of adjustment and the transition between fiscal regimes. In particular, we note the high

volatility of transition and adjustment notably for Brazil and China suggesting important dynamic associated with the fiscal rules. These effects are less significant for the other countries.

Figure 20: Time-varying transition functions for Spending in Russia and China.



Finally, in order to check the validity of nonlinear estimation, Table 5 reports several misspecification tests. Accordingly, we point out several important findings. First, we note the high superiority of nonlinear modeling in relation to linear model to reproduce the effect of fiscal shock notably for Russia for which the residua variance is significantly reduced after the introduction of nonlinearity. Second, the residuals do not show any ARCH effect. They are stationary and indicate omitted nonlinearity for China and Brazil.

Table 5: Misspecification tests.

	Brazil		Russia		India		China	
	g_t	t_t	g_t	t_t	g_t	t_t	g_t	t_t
$\frac{\sigma_{STR}}{\sigma_L}$	-	0.81	0.32	0.17	-	0.70	0.74	-
ADF Test	-	-5.25	-5.17	-3.55	-	-5.43	-5.71	-
ARCH Test (P-Value)		0.34	0.65	0.65	-	0.73	0.77	-
DW		1.84	2.31	2.13	-	2.15	2.14	-
Fisher Test (P-value)	-	0.159	0.0	0.02	-	0.02	0.149	-
LM^{ONL} *Test (P-value)*	-	0.91	0.17	0.32	-	0.03	0.08	-
Normality Test (JB)		0.00	0.0	0.25	-	0.0	0.23	-

Notes: ADF, DW, JB, LM^{ONL} respectively denote Dickey-Fuller Test, Durbin-Watson Test, Jarque-Bera test and nonlinear omitted test.

6. Conclusion

This paper provides time-series and panel evidence on the fiscal policy transmission for four key emerging market economies: Brazil, Russia, India and China (BRICs).

We use modern estimation techniques – namely, the Bayesian Structural Vector Auto-Regressive (B-SVAR) and the panel VAR (PVAR) - to identify the fiscal policy shock along with the more recent Sign-Restrictions approach.

We show that an expansion of government spending: (i) has a strong and positive effect on output; (ii) leads to a sharp rise in the commodity price, but does not seem to impact significantly on the price level; (iii) rises the interest rate and, thereby, can "crowd-out" private spending; and (iv) has a negative impact on equity markets in light of the expectations about a deterioration of the fiscal stance.

In the case of an increase in government revenue, a rise in tax reduces output in all countries, which suggests that there is no evidence in favour of 'expansionary fiscal contraction' in the context of emerging economies.

To summarize the response for this group of key emerging market economies, we carry out a panel VAR exercise, which provides further robustness of our finding that expansionary fiscal policy has a positive effect on output. These results remain robust even after controlling for the presence of crisis episodes.

Then, we assess the reaction of the fiscal authority to several economic and financial developments, via the estimation of fiscal policy rules. To do so, we estimate a Fully Simultaneous System of Equations and analyze the importance of nonlinearity using a smooth transition autoregressive (STAR) model.

We find strong evidence that the fiscal policy followed by governments in the BRICs exhibits nonlinearity. In particular, such nonlinearity is more relevant for tax rules (in the cases of Brazil, Russia and India) and for spending rules (in the cases of Russia and China).

In addition, we show that considerations about the economic growth (in the case of China), the exchange rate and inflation (for Brazil and Russia) and commodity prices (in India) seem to be the major drivers of such nonlinear pattern of fiscal policy.

Moreover, the findings suggest that the fiscal authorities pursue a target range for the threshold variable rather than a specific point target. In fact, the exponential smooth transition regression (ESTR) model seems to be the best description of the fiscal policy rule in these countries.

The current work provides the basis for forecasting future government's policy behaviour in the major emerging market economies. As a result and from a policy perspective, it provides important insights about the major economic and financial developments to which the fiscal authority reacts in a systematic manner.

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