Policy Transmissions, External Imbalances, and Their Impacts: Cross-Country Evidence from BRICS

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ABSTRACT

This paper provides an empirical exploration of the interaction between fiscal policy, monetary policy, exchange rates, and external balances as well as their impacts on real economic growth and inflation for the BRICS countries. A panel VAR model is employed to assess the dynamic relationships. Our results generally confirm the significant impacts of a monetary shock on real economic activity but the effect of fiscal policy appears to be much weaker from the cross-country perspective. We do not find evidence supporting the "twin deficits" hypothesis but the positive interaction between inflation and interest rates – the "price puzzle" – is documented. When bilateral exchange rates and trade deficits (vis-à-vis the US) are used, we find that the BRICS–US bilateral trade balances do not react considerably to currency depreciation shocks, indicating that exchange rates may not play a critical role in the adjustment of large trade deficits for the U.S.

JEL classification: F31, F32, F41, F42.

***Keywords*:** Fiscal Policy; Monetary Policy; External Imbalances; BRICS; Panel VAR.

1. Introduction

The emergence of massive global imbalances has long been at the forefront of academic research and policymaking discussions. Particularly in the wake of the recent financial crisis, global imbalances are largely viewed a critical threat to economic and financial stability in the world as any disorderly unwinding of global imbalances may have serious adverse impacts on world economic growth (e.g., Blanchard and Milesi-Ferretti, 2010). While controversial debates remain ongoing about the origins and causes of large current account imbalances, many scholars and policymakers have given central stage to understanding the dynamic relationships between policy transmissions and external imbalances so as to suggest policies that could lead the global economy to more sustainable and balanced growth. Recent notable studies in this line include, for example, debates on the "twin deficit" hypothesis (e.g., Kim and Roubini, 2008; Monacelli and Perotti, 2010; Ali Abbas et al., 2010), the role of monetary transmission (e.g., Bini Smaghi, 2007; Ferraro et al., 2010), and the dynamics of exchange rates and current accounts (e.g., Obstfeld and Rogoff, 2005; Lee and Chinn 2006; Fratzscher et al., 2010), among others.

This paper provides an empirical exploration of the interaction between fiscal policy, monetary policy, exchange rates, and external balances as well as their impacts on real economic growth and inflation for the BRICS countries (Brazil, Russia, India, China and South Africa). The BRICS countries were among the fastest growing emerging markets in the past two decades and have become an important force in the world economy as producers of goods and services, and potentially large consumer markets in the near future.[1] With BRICS quickly emerging as an economic giant and the world economy increasingly globalized, domestic policies in these leading emerging economies have had significant global repercussions. Meanwhile, China and Russia have run large current account surpluses, with the former widely seen as the most serious source of global imbalances on the surplus side. The other BRICS

[1] According to Wilson and Purushothaman's (2003) projection, the BRICs (Brazil, Russia, India, and China) economies as a whole could be larger than the G6 (US, Japan, UK, Germany, France and Italy) by 2039 with China being the largest single-country economy as early as 2041.

countries also experienced substantial external imbalances periodically during their rise as an economic force. As such, it is important to understand the dynamic relationships between policy transmissions and external imbalances and their linkages to economic performance in the BRICS countries as it could shed light on the orderly unwinding of global imbalances.

Our work considers the transmissions of both fiscal and monetary policies in one framework which allows for endogenous interactions of external balances with fiscal and monetary policies. Conventional wisdom admits that fiscal and monetary authorities each have their own priorities over economic growth, price stability, or other policy targets. This perception is reflected in some studies in which only the role of fiscal or monetary policy is considered in adjusting external balances (e.g., Monacelli and Perotti, 2010; Ali Abbas et al., 2010; Ferraro et al., 2010). Nevertheless, monetary and fiscal policies are interdependent in nature as fiscal policies, for example, may change the long-run economic conditions on which monetary policies rely to achieve policy goals while monetary policies can be accommodative or counteractive to fiscal policies. Di Giorgio and Nisticò (2008) indeed using a two-country dynamic stochastic general equilibrium (DSGE) model show that any attempt by monetary policy alone to stabilize external balances may be somehow effective but painful, at the cost of excessive volatility of the exchange rate, inflation, and output. In this regard, our paper shares the same spirit with Di Giorgio and Nisticò's work and contributes to literature by depicting the dynamics of both fiscal and monetary policy transmissions and external balances in large emerging economies.

The paper closely connects with today's lively debates about the role of exchange rate realignment in redressing the imbalances. Blanchard et al. (2005) show that the alarmingly high U.S. current account deficit is not likely to reverse itself without changes in the dollar exchange rate and thus to rebalance the U.S. external position one would expect a large dollar depreciation against primarily the Asian currencies but also the euro. Fratzscher et al. (2010), however, find that asset price developments in equity and housing markets rather than the exchange rate have been the major driver of the U.S. current

account imbalances and suggest that a substantially weakened dollar is not a panacea for the deficit. Emerging market economies have often been criticized for their currency misalignment resulting in large global imbalances. Particularly, China's allegedly undervalued renminbi is in the crossfire from not only the academic communities but also the political circles. Some economists propose an "Asian Plaza" to achieve worldwide realignment of exchange rates and thus to help improve the imbalances (e.g., Cline, 2005; Bergsten, 2008). But McKinnon (2007) argues that such realignment is unlikely to bring the world back to equilibrium but rather it may cause serious problems in the developing countries. Similarly, Bagnai (2009) and Benassy-Quere et al. (2013) also concludes that China's currency policy stance would not be decisive in the adjustment of the U.S. external deficit. In this paper, we present empirical assessment of the effectiveness of exchange rate adjustment in affecting external balances from the perspective of the BRICS countries.

The dynamic relationships revealed in the paper between policy variables, external position, exchange rate as well as GDP growth and inflation also complement the empirical literature on several important economic phenomena by providing new evidence from these largest emerging market economies. For example, the interaction between fiscal balances and current account balances particularly the link between fiscal and external deficits—the "twin deficits" hypothesis—is one of the most impassioned debates and has been extensively studied. Results in the empirical literature are nevertheless very mixed and inconclusive. Notably, Kim and Roubini (2008) show that shocks that worsen the government deficit improve the current account, a divergence from "twin deficits", while Monacelli and Perotti (2010) find evidence in favor of the "twin deficits" hypothesis. In addition, our work also lays some ground in assessing some long-standing puzzles or anomalies recorded in empirical international macroeconomics, such as the "price puzzle" (e.g., Sims, 1992), the "forward discount bias puzzle" (e.g., Engel, 1996) and the "delayed exchange rate overshooting puzzle" (e.g., Eichenbaum and Evans, 1995).

The paper employs a panel vector autoregressive (VAR) model with fixed effects to perform the empirical analysis. The VAR model provides a flexible and tractable framework in which all variables in the system are treated as endogenous, and it has become a standard tool in analyzing the effects of policy transmissions as well as other interactive behaviors among economic variables. The application of the standard VAR model to panel data has gained a lot of popularity recently (e.g., Love and Zicchino, 2006; Assenmacher-Wesche et al., 2008; Goodhart and Hofmann, 2008). The panel VAR specification can benefit from both the advantage of the VAR approach dealing with endogeneity and the panel data techniques in improving estimation efficiency. From an econometric perspective, it is especially important when individual-country data series are not long enough as in our case of the BRICS countries. Dynamic relationships are summarized primarily in the impulse response functions. To properly identify the effect of one particular policy shock while holding other shocks constant, innovations in dynamic variables are orthogonalized through Cholesky decomposition. Importantly, our empirical results are largely data-oriented in a sense that the specification employs minimal identifying restrictions which do not rely on strong assumptions or follow specific theoretical models. Since many developments in emerging market economies like China and India are not readily explained by standard macroeconomic theories, the data-oriented specification without imposing specific structural restrictions allows us to avoid introducing extra uncertainties into our analysis.

The rest of the paper is organized as follows. Section 2 presents the econometric methodology. We discuss issues including unobserved individual heterogeneity, Cholesky decomposition, and recursive restrictions on the order of endogenous variables. In section 3, we describe the data sources and variable definitions. We provide a preliminary analysis on the data, depicting the general economic performance of the BRICS countries. A battery of panel unit root tests and panel cointegration tests are also performed. Section 4 reports the empirical results. We interpret both the coefficient estimates and the impulse response functions of the panel VAR model. To better understand the economic and policy nexus of

BRICS-U.S, we also carry out the exercise using bilateral variables in Section 5. Finally, Section 6 concludes.

2. Methodology

We consider a panel VAR model with fixed effects as follows,[2]

$$Z_{it} = \varphi_0 + \sum_{j=1}^{p} H_j Z_{it-j} + \Gamma_i + \varepsilon_{it} \quad (1)$$

where Z_{it} is a vector of endogenous variables and ε_{it} is a vector of errors. Γ_i is a vector of country-fixed effects which accounts for unobserved individual heterogeneity. H_j is the *j*-th order polynomial matrix where the lag length p is determined by the Akaike information criterion (AIC) considering orders up to four due to the quarterly data.[3] The endogenous variables included in the panel VAR model are the log difference of real GDP, $\triangle gdp_{it}$, the log difference of price level, $\triangle cpi_{it}$, the log difference of nominal broad money, $\triangle m_{it}$, the difference of fiscal balance, $\triangle fb_{it}$, the level of the short-term nominal interest rate, ir_{it}, the log difference of real effective exchange rate, $\triangle e_{it}$, and the difference of current account, $\triangle ca_{it}$. In order to fully account for the nexus between the BRICS countries and the United States, we also employ this set of endogenous variables replacing the real effective exchange rate and current

[2] Fixed effects models are generally preferred to random effects models for many macro datasets because a typical macro panel is less likely to be a random sample from a much larger universe of countries under consideration (Judsona and Owenb, 1999).

[3] A time dummy variable, d_t, can be included in the model. According to Goodhart and Hofmann (2008), however, a panel dataset like ours with few cross-sections but a relatively large time dimension would involve a considerable loss in efficiency. Thus, we estimate the panel VAR without the time dummies.

account with bilateral exchange rates (vis-à-vis the US dollar), $\triangle s_{it}$, and trade balance, $\triangle tb_{it}$.[4] As such, the vector Z_{it} is given by either

$$Z_{it} = \left[\triangle gdp_{it},\ \triangle cpi_{it},\ \triangle m_{it},\ \triangle fb_{it},\ ir_{it},\ \triangle e_{it},\ \triangle ca_{it}\right]' \tag{2}$$

or

$$Z_{it} = \left[\triangle gdp_{it},\ \triangle cpi_{it},\ \triangle m_{it},\ \triangle fb_{it},\ ir_{it},\ \triangle s_{it},\ \triangle tb_{it}\right]' \tag{3}$$

Specifically, a reduced-form of external balances with two lags,[5] for example, is given as follow,

$$\begin{aligned}\triangle ca_{it} = {} & \alpha_0 + \gamma_1 \triangle ca_{it-1} + \gamma_2 \triangle ca_{it-2} + \lambda_1 \triangle gdp_{it-1} + \lambda_2 \triangle gdp_{it-2} + \theta_1 \triangle cpi_{it-1} \\ & + \theta_2 \triangle cpi_{it-2} + \phi_1 \triangle m_{it-1} + \phi_2 \triangle m_{it-2} + \rho_1 \triangle fb_{it-1} + \rho_2 \triangle fb_{it-2} + \kappa_1 ir_{it-1} + \kappa_2 ir_{it-2} \\ & + \zeta_1 \triangle e_{it-1} + \zeta_2 \triangle e_{it-2} + \eta_i + \varepsilon_{it}^{ca}\end{aligned} \tag{4}$$

Other equations are defined in the same way. Note that the disturbances (ε_{it}^{gdp} , ε_{it}^{cpi} , ε_{it}^{m} , ε_{it}^{fb} , ε_{it}^{ir} , ε_{it}^{e} , ε_{it}^{ca}) are generally correlated with each other and also tend to correlated with lagged dependent variables. This endogeneity arises largely because shocks may transmit across countries in an increasingly globalized world. A sudden tightening monetary policy in China, for instance, would depress foreign direct investment from multinational firms that may shift their investment to other emerging markets economies such as India. This shock can also be transmitted through trade channels if China's exporting sectors do not get sufficient credit support and fail to meet the rising global demand which would then look for goods in other markets.

VAR models have many attractive attributes such as the minimum of identifying restrictions and the ease of implementation. However, it is found that they often fail to provide precise estimation of coefficients, usually statistically insignificant, and tend to generate large confidence intervals for the impulse response functions and variance decompositions, which generally makes inferences economically

[4] The fiscal balance, current account, and trade balance are measured as a share of GDP.

[5] Lag length selection is based on the Akaike information criterion (AIC).

uninteresting (e.g. Runkle, 2002). This problem may be attributed partly to the so-called the curse of dimensionality as in practice, a typical VAR model in macroeconomic research involves a large number of parameters, and the sample size is often not large enough compared to the size of the VAR model to justify the use of asymptotic theory. The problem is even more pronounced in emerging market economies where consistent data collection and maintenance provide only a relatively short history. In our case, Z_{it} contains seven endogenous variables, and most of our sample data from the BRICS start in the mid-1990s. Estimating such a 7-dimensional VAR model at the individual country level would generally suffer substantial loss in degrees of freedom, and it would be hard to uncover accurately the dynamic relationships among variables. In this regard, a panel modeling framework is warranted as it can substantially increase the degrees of freedom and help improve the efficiency of econometric estimates (e.g. Hsao, 2007).

Applying the VAR framework to panel data nevertheless, we are imposing the restriction that there are no cross-country differences in the estimated dynamic relationship. This constraint is often violated in practice. Goodhart and Hofmann (2008), for instance, indicate that the validity of the restriction that the underlying structure is homogenous across 17 industrialized countries is consistently rejected. Similarly, Gavin and Theodorou (2005) find no supporting evidence of the homogeneity assumption of the panel model based on individual OECD country data. The rejection, however, does not invalidate the panel specification as these testing results are severely affected by idiosyncratic events and complete elimination of the effects of idiosyncratic factors calls for very long macroeconomic time series which are usually unavailable in reality (e.g., Gavin and Theodorou, 2005). Indeed, Goodhart and Hofmann (2008) find that the panel VAR analyses help to uncover economically meaningful dynamic interactions among macro variables while the dynamic relationships in country-specific results are insignificant in general and implausible in some cases.

To better describe the underlying dynamic relationships and to overcome the aforementioned restriction, we introduce the fixed effects, Γ_i, to account for unobserved country-specific heterogeneity. In a dynamic panel model, the fixed effects however are correlated by construction with lagged dependent variables (e.g., Arellano, 2003). The mean-differencing procedure that is commonly used to remove fixed effects will induce a correlation between the lagged dependent variables and the error term and lead to inconsistent coefficient estimates (e.g. Ahn and Schmidt, 1995). In this paper, we follow Love and Zicchino (2006), using the Helmert transformation to eliminate the fixed effects originally which is originally suggested by Arellano and Bover (1995). The transformation is forward mean-differencing, that is, each observation is subtracted by the mean of the remaining future observations available in the sample. Formally, the transformed variables and error term are given as below:

$$z_{it}^{*} = w_{it}\left[z_{it} - \frac{1}{T_i - t}\sum_{j=1}^{T_i - t} z_{i(t+j)}\right] \tag{5}$$

and

$$\varepsilon_{it}^{*} = w_{it}\left[\varepsilon_{it} - \frac{1}{T_i - t}\sum_{j=1}^{T_i - t} \varepsilon_{i(t+j)}\right] \tag{6}$$

where z_{it} is any given variable in Z_{it}, T_i is the size of the time series for a given country, and $w_{it} = \sqrt{(T_i - t)/(T_i - t + 1)}$ is a weighting value to equalize the error term variance. It is easy to check that this simple transformation preserves the orthogonality of the error terms but effectively removes the fixed effects, Γ_i, in the model.[6]

[6] See Andrews et al. (2008) for more discussion concerning sweeping out the individual effects.

We estimate the model using the generalized method of moment (GMM). The standard OLS estimation methods are liable to lead to seriously biased coefficients in dynamic models (e.g., Nickell, 1981). In contrast, GMM is well suited for obtaining efficient estimators in a panel data context where a model like ours contains lagged dependent variables along with unobserved effects (e.g., Arellano and Bond, 1991).[7] The impulse response functions and error variance decompositions are often centered in VAR analyses, which allow us to gain a vivid picture of the dynamic relationships among variables of interest. Particularly, the impulse response functions describe how one variable responds over time to the innovations in other endogenous variables which are assumed to be uncorrelated with other shocks in the system. The variance decomposition shows how much of the error variance of each of the variables can be explained by shocks to the other variables. Thus, the variance decomposition provides information about the relative importance of each random innovation in affecting the variables in the system. To better understand the implications of the impulse response functions, confidence bands are warranted. We use Monte Carlo simulations to generate 1000 impulse responses based on the estimated coefficients and their standard errors. The confidence bands are thus given by 2.5^{th} and 97.5^{th} percentiles of the 1000 simulated impulse responses.

It is important to note that the impulse response functions and error variance decompositions are readily interpretable only after the residuals of the VAR have been orthogonalized. In practice, it is often found that error terms are contemporaneously correlated, which makes the impacts of an innovation in one particular variable indistinguishable from that of another variable. One commonly used method to orthogonalize the covariance matrix of residuals is the well-known Cholesky decomposition, which essentially recovers a diagonal matrix of covariances in a recursive manner. One has to keep in mind, however, that the orthogonalization by applying Cholesky decomposition imposes a particular causal

[7] See, for example, the applications of GMM on the dynamic employment in UK (e.g., Arellano and Bond, 1991)), the impacts of technological innovations on wage (e.g., van Reenen, 1996), company investment rates (Bond et al., 2004), and financial development and firm investment (e.g., Love and Zicchino, 2006).

structure on the data. The recursive ordering of variables in Z_{it} implicitly assumes that variables that come later respond contemporaneously to those that come earlier and to their lags while variables that come earlier are affected only by those that come later with lags.

The identifying restrictions on the order of variables specified in (2) or (3), albeit somewhat arbitrary, are based on the rationale suggested by the literature on the mechanism of monetary/fiscal transmission and the determination of exchange rate and the current account. The ordering of real GDP, consumer prices, money stock, and short-term interest rate represents a benchmark model of monetary policy employed by Peersman and Smets (2001). When fiscal policy is considered, we follow Kim and Roubini's (2008) rationale to order the fiscal balance before the interest rate in that fiscal adjustments are likely to be endogenously affected by the current level of economic activity within a quarter but do not respond instantaneously to monetary policy shocks. This setup shares the same spirit with van Aarle et al. (2003) in modeling monetary and fiscal policy transmission together. The exchange rate is often assumed to be more endogenous, allowing for an immediate reaction to policy shocks and other economic variables (e.g., Peersman and Smets, 2001; Kim and Roubini, 2008), which hinges on the insights provided by canonical models of exchange rate determination such as Dornbusch's overshooting model and the monetary models of Frenkel and Mussa. In this study, we nevertheless order the current account after the exchange rate, in line with Lee and Chinn (2006). With the current account being the most endogenous variable, however, we are not fully convinced that the current account innovation has no contemporaneous effect on the exchange rate as well as other variables, but rather it is of particular interest to understand the impacts of the country characteristics and policy shocks on external balances.

It is noteworthy that our specification discussed above is, of course, not an undebatable description of the underlying structure of the economic activities and policy shocks. For instance, some studies model price level most exogenous (e.g., Assenmacher-Wesche et al., 2008) and money stock more endogenous (e.g., Christiano et al., 1999). Blanchard and Perotti (2002) introduce a model of U.S. fiscal

policy in which economic activity does not contemporaneously affect policy variables. In the wake of these controversies, we experiment the exercises under different recursive orderings. The results essentially do not provide qualitatively different insights than those reported into the dynamic relationships under study.[8]

Also, one may keep in mind that the unrestricted VAR model often comes at the expense of theoretical consistency although it is an effective tool to investigate the dynamic response of the system to shocks without imposing strong identifying restrictions. To remedy the atheoretical nature, economists have devised various structural approaches to VAR modeling. Pioneered by Blanchard and Quah (1989) who use restrictions on long-run impact of shocks to identify the impulse responses, for example, structural VARs rely explicitly on some economic rationale to define the covariance matrix in estimation so as to avoid the use of arbitrary or implicit identifying restrictions. However, structural VARs have also been criticized as they deliver reliable estimation results of long-run parameters only under restrictive conditions, according to Faust and Leeper (1997), and the results are often sensitive to the identifying assumptions. Other scholars like Pesaran and Smith (2006) formulate the model based on the long-run steady state relations of the macro variables derived from the dynamic stochastic general equilibrium models (DSGE). Macroeconometric modelling equipped with the theoretical underpinnings of the DSGE models ensures that the model has an internal consistency and a relationship with economics theory that may be lost in unrestricted VAR models. This approach, nevertheless, makes strong assumptions on the form of the utility and cost functions, the formation of agents' expectations and the process of technological change. Particularly, it assumes that the DSGE model remains stable into the indefinite future. In this study, imposing a long-run steady state relationship for the BRICS countries may not be realistic as these emerging market economies have different growth paths and their economic patterns

[8] The results are available upon request.

may change substantially along the path. Therefore, we use the unrestricted panel VAR model and rely exclusively on the data themselves to identify the underlying structure.

3. Data

3.1 Sources and Definitions

Our analysis utilizes the dataset available from the IMF's International Financial Statistics (IFS) for the BRICS countries—Brazil, Russia, India, China, and South Africa, supplemented by the World Economic Outlook (WEO) database.[9] We collect quarterly data on GDP (in 2005 constant prices), consumer price index (2005=100, and the same hereafter), M1, short-term interest rate,[10] real effective exchange rate, bilateral exchange rate (national currency per US dollar), and current account balances. Bilateral trade balances are obtained from the U.S. Census Bureau. Quarterly data on fiscal balances are not available, which are interpolated linearly from WEO's annual series following the procedure suggested by Dees et al. (2005). Fiscal balances, current account balances, and bilateral trade balances are scaled to nominal GDP. Since figures of current account and trade balance are denominated in US dollars, like Lee and Chinn (2006), we convert them into respective national currencies using the period-average bilateral exchange rate.[11] The dataset is sampled up to the last quarter of 2010 while the starting periods vary across countries—mostly depending on the earliest availability of the fiscal balance—1996:Q4 for Brazil,

[9] We also cross-check or update, if appropriate, the data using resources from official websites of relevant countries, including the Banco Central do Brasil (www.bcb.gov.br), the Bank of the Russia (www.cbr.ru), the Reserve Bank of India (dbie.rbi.org.in), the National Bureau of Statistics of China (www.stats.gov.cn), and the South African Reserve Bank (www.resbank.co.za).

[10] Depending on the data availability, interest rates used are the short-term time deposit rate for Brazil, money market rate for Russia, Treasury bill rate for India and South Africa, and central bank discount rate for China, respectively.

[11] IFS itself reports current account in the percent of GDP denominated in dollars. We find that there is no substantial difference between the current account to GDP ratio series reported in IFS and the one we convert in national currency denomination. Since we do not find the ratio series for bilateral trade balance, for consistency, we opt to use the converted series.

1995:Q4 for Russia, 1994:Q4 for India, 1998:Q4 for China, and 2000:Q4 for South Africa, respectively. The data series are seasonally adjusted using EViews based on the U.S. Census Bureau's X12 program if seasonally adjusted values would be more appropriate but the original series have not been adjusted.

While the real GDP growth, consumer price, and the money supply represent indicators of general economic performance, we use the short-term interest rate and structural fiscal balance to examine the transmissions of monetary and fiscal policy in the BRICS countries. Short-term nominal interest rates are traditionally used as the instrument of monetary policy to curb inflation and promote economic growth. It hinges on the fact that monetary policy works for the most part through financial markets. The decisions such as quantitative easing and Operation Twist, for example, initiated recently by the Federal Open Market Committee (FOMC) are expected in the first instance to influence asset prices and yields, which in turn affect the evolution of the economy. Some economists like McGough et al. (2005) and Kulish (2007) propose to consider using long-term interest rates as monetary policy instruments. It is of great importance for monetary authorities if alternative policy tools are available to boost the nation's economic growth and employment, particularly against the backdrop of the recent downturn where central banks in the United States, the United Kingdom, Canada and the euro area pushed their policy rates close to their lower bound of zero. For emerging economies, unfortunately, their bond markets remain relatively immature and more importantly, data series of long-term interest rates are rarely available or very short if at all. As such, we do not include long-term interest rates measuring the monetary policy transmission. In some BRICS countries, such as China, direct credit controls have long been a major conduct of monetary policy. In this case, the effect of the monetary policy would be a composite one by the money supply and the short-term nominal interest rate. This treatment shares the opinion of McCallum and Nelson (2010) who suggest including both interest rates and money stock in macroeconomic empirical analyses.

A striking advantage of using structural fiscal balance, instead of the more conventional headline balance, as the fiscal policy indicator is that it is cyclically-adjusted, allowing policymakers, analysts and observers to more accurately assess the fiscal position net of cyclical effects. Public revenues and expenditures are often affected substantially by the boom and bust cycle of the economy that is not related to the underlying fiscal position. Decreases in tax revenues and increases in unemployment benefits spending during economic recessions, for instance, will generally lead to a huge surge in government deficits, which indeed is not the result of a deliberately expansive policy. A price boom of commodities helps increase commodity-related revenues and in turn improves a nation's budget balance, especially for countries like Russia and Brazil whose recent economic booms are largely commodity-driven. Some one-off, or temporary, revenues or expenditures may also materially change fiscal balances (e.g., the temporary reconstruction expenses after disasters), without the repercussion of fiscal policy. As such, structural fiscal balance has been widely used by national governments and international organizations including the IMF in policy assessment and budgetary surveillance. It is noteworthy nevertheless that although the structural fiscal balance is generally believed to be capable of measuring both discretionary changes in fiscal policy and the effect of fiscal policy on aggregate demand (e.g., Blanchard, 1990), some degree of caution is warranted when the instrument is relied on to derive concrete policy conclusions.[12] Assumptions are made, for example, and thus uncertainty may be induced in calculating the cyclical component of the budget balance. In addition, the effects of automatic stabilizers can be hard to factor out completely. Thus, an appropriate interpretation of the structural fiscal balance requires a close scrutiny of data and more theoretical underpinnings.

3.2 Preliminary Analysis: A General Picture

[12] Alternative fiscal policy measures are suggested by Guajardo, Leigh and Pescatori (2011) who identify deficit-driven fiscal adjustments based on historical documents which provide evidence of fiscal policy changes motivated by the desire to reduce the budget deficit.

Figs. 1-5 describe the economic performance, macro policies and external balances over the sample period for the BRICS countries. Generally, these large emerging economies enjoyed robust economic growth with mild inflation over the years, particularly during the first decade of the new century. The average real GDP growth rate was 3.2% in Brazil, 3.4% in Russia, 7.0% in India, 9.9% in China, and 3.6% in South Africa. While the performances in Brazil and South Africa were relatively less flattering, Russia's boom in 2000-2008 is apparently overshadowed by the average figure, as its high growth rate averaged 7.0% during this period. The recent global financial crisis originating in advanced countries has presented a substantial hit to these new global economic powerhouses. Brazil, South Africa, and especially Russia all experienced significant economic downturns in 2009, with Russia declining by 7.9% that year. China and India, arguably the leaders of the BRICS, were affected by the global economic slowdown as well, albeit much less severe.

(**Figs. 1-5 here**)

Among the BRICS countries, Brazil and Russia suffered hyperinflation in the early of 1990s with a slightly mild resurgence in 1998 in the latter. In the peak year of 1993, the annual inflation rate mounted notoriously to 2,477.15% in Brazil and 840.02% in Russia.[13] Our sample nevertheless covers only the most recent hyperinflation periods of 1998-99 in Russia resulting from the "Ruble crisis". China's inflation was generally maintained at a benign level, ranging from -2.2% to 7.8%, over the sample period. Concerns, however, have been raised on soaring prices driven by rising raw material and energy costs along with the increasingly faster wage growth. Given its recent credit expansion in order to cushion the impact of the global financial crisis, with a money supply growth of 30% in 2009, this concern is further coupled with fears of asset bubbles particularly in housing markets. India confronted similar price pressure in recent years although the trend seems to be interrupted by the global financial meltdown.

[13] The TradingEconomics (www.tradingeconomics.com) reports that the inflation rate in Russia reached an all-time high of 2333.3% in December of 1992. We do not obtain data prior to 1992 for Russia from the IFS and thus report the rate in 1993.

China and Russia have consistently run a huge current account surplus while the rest of the BRICS countries generally maintained current account deficits. Although China's current account surpluses have been often seen as the most serious source of global imbalances on the surplus side, its external imbalances were relatively small with the trade surplus averaging only 3 percent of GDP from 1994−2003. Starting in 2004, the country's current account surplus took an unprecedented turn upwards and quickly mounted to double digits as a share of GDP in 2007. The burst of the global financial crisis, however, soon brought an abrupt turnaround in China's current account surplus which fell to 5% in 2010, and the trend of rebalancing looks to continue in the near future. The acceleration of external imbalances in Russia was even more dramatic after the Ruble crisis. Russia's current account surpluses reached 18.4% of its GDP in 2000 and remained a double-digit share of GDP for several years. The current account deficits for the rest of the BRICS countries generally represented a relatively small share of their GDP. Brazil and India managed to maintain a surplus for some time in the mid-2000s but returned to deficits again in recent years. In contrast, South Africa used to run a roughly balanced current account before 2003 but its external balance deteriorated substantially in subsequent years with a deficit accounting for over 7% of its GDP in 2008. Interestingly, South Africa's current account was improving in the most recent years while the other BRICS countries' current accounts were all adversely affected by the global economic slowdown.

Brazil adopted the real in 1994, with an initial one-to-one parity to the dollar, as part of the Plano Real which aimed to stabilize the country's economy from rampant inflation. A strong value was maintained in the first several years for the new currency but the real lost almost 75% of its value by October 2002 after two currency crises in 1999 and in 2002. It then appreciated gradually and is now worth about $0.50. Like Brazil, Russia suffered a severe currency crisis in the late 1990s. The ruble devalued over 70% from the rate of 6:1 to 21:1 with the U.S. dollar during the second half of 1998. In 2008, the global financial crisis presented a further hit to the value of Russia's currency which was once

placed at a rate of over 36 rubles to the dollar. In India and South Africa, their currencies kept depreciating until the early 2000s. Subsequently, the Indian rupee roughly leveled off while the rand partly recovered during the mid-2000s but had a considerable devaluation during 2008-09. China devalued the renminbi in 1994 from 5.8 yuan to 8.7 yuan per dollar. The exchange rate then had settled down to about 8.28 yuan per dollar and was held there until July 2005 when a steady upward crawl started. The renminbi appreciated about 21% in three years and then returned to pegging at the outset of the 2008 financial crisis.

3.3 Unit Roots and Cointegration

Testing nonstationarity and cointegration is often an integral part of time-series modeling, particularly in VAR analysis. Failing to account for these properties of the data may lead to spurious or misleading characterization of the dynamic relationships among variables. To date, several methods have been developed to test for unit roots in panels. Levin, Lin, and Chu (2002, LLC) and Im, Pesaran and Shin (2003, IPS) are among the first to develop so-called first-generation tests assuming cross-sectional independence in the context of panel data allowing for fixed effects, individual deterministic trends and heterogeneous serially correlated errors. The LLC and IPS tests both maintain the null hypotheses that each series in the panel contains a unit root, but the alternative of the LLC test requires each series to be stationary with an identical autoregressive coefficient for all panel units while the alternative of the IPS test allows for some (but not all) of the individual series to have unit roots; that is, the autoregressive coefficients are heterogeneous. From a different approach, Hadri (2000) derives a residual-based test where the null hypothesis is that the series are stationary against the alternative of a unit root in the panel. The assumption of cross-sectional independence has been criticized as macro time series often exhibit significant cross-sectional correlation among the countries in the panel. As such, we also employ the Pesaran (2007) test to account for cross-sectional dependence.

Table 1 reports the results of the panel unit root tests based on different testing procedures. Levels of time series are found unanimously nonstationary except the short-term interest rate. Unlike other macro time series such as real GDP, price index, and money supply that are commonly believed to be nonstationary, earlier evidence of whether or not nominal interest rates are stationary has been mixed.[14] In our case, the null hypothesis that interest rate series contains a unit root is strongly rejected based on the LLC, IPS and Pesaran tests. Controversially, the Hadri test suggests that the interest rate is nonstationary. Nevertheless, it has been shown by Hlouskova and Wagner (2006) that the Hadri test may suffer significant size distortion in the presence of autocorrelation when the series does not contain a unit root. Indeed, Hlouskova and Wagner find that the Hadri test tends to over-reject the null hypothesis of stationarity for all processes that are not close to a white noise. When it comes to first differences, series generally appear to be stationary. Discord arises in the real GDP growth and money supply growth for which the LLC test suggests that they contain unit roots but IPS and Pesaran tests show the opposite. Overall, the results of the Pesaran test do not differ much from those of the LLC and IPS tests, which implies that cross-sectional dependence may not be materially present among the BRICS countries.[15]

(**Table 1 here**)

Two panel cointegration tests developed by Pedroni (1999) and Westerlund (2007) respectively are employed to check if long-run relationships exist among integrated variables for the BRICS countries.[16] Pedroni (1999) develops two classes of statistics to test for the null hypothesis of no cointegration in heterogeneous panels, namely panel cointegration statistics (within-dimension) and group-mean cointegration statistics (between-dimension, which allow for heterogeneity in cointegrating relationships across members of the panel. The Pedroni tests are essentially residual-based extensions

[14] See Caporalea and Gil-Alanab (2009) for details.

[15] We confirm this using the Pesaran (2004) CD test for cross-section dependence in panel data, particularly in the first-differenced series (not reported).

[16] We exclude the short-term interest rate in cointegration tests.

from the principles of the Phillips-Perron and Dickey-Fuller statistics. In contrast, the Westerlund tests for the null of no cointegration are based on structural rather than residual dynamics by inferring whether the error correction term in a conditional error correction model is equal to zero. Similar to the Pedroni tests, the Westerlund tests design both panel and group-mean statistics with the former testing the alternative hypothesis that the panel is cointegrated as whole while the latter testing the alternative that at least one unit is cointegrated. Table 2 presents results of the cointegration tests. Both Pedroni and Westerlund tests overwhelmingly indicate that there are no long-run relationships among macro variables of interest (excluding the short-term interest rate) in the panel of the BRICS countries.

(**Table 2 here**)

4. Results

4.1 Estimating the Panel VAR

The panel VAR model given in (1) is estimated using the generalized method of moment (GMM) after the fixed effects have been removed. The Akaike information criterion (AIC) suggests two lags be used in the estimation. Table 3 presents the coefficient estimates. Although it is often difficult to interpret the coefficients in VAR models given the atheoretical nature, some plausible relationships are worthwhile to be explored here.

(**Table 3 here**)

It appears that there exist some monetary channels in which the effect of monetary policy is transmitted to real economic activity and inflation as both the first lag of money growth and two lags of short-term interest rate help explain the subsequent movements in GDP growth and inflation. This result is consistent with the finding by Hafer and Kutan (2002) whose study covers a sample of diverse economies including both developed and developing countries. Cumulatively, real output growth is negatively related to increases in interest rates, and is positively related to money growth and its own

lagged values. Inflation on the other hand is positively related to interest rates and money growth as well as its own lags. The positive sign on lagged interest rates in inflation equation is somewhat unexpected as monetary authorities, particularly advocates of Taylor rules, often use interest rate tools to curb inflation hikes. Nevertheless, it is in line with Fisher's hypothesis that nominal interest rate is the equilibrium real interest rate plus the expected future inflation.

Money growth is generally unexplainable by other macro variables except its own lagged values although it tends to be depressed by higher interest rates and real GDP growth but rises with inflation. This is somewhat consistent with the equation of exchange given the dominance of inflation over real growth in magnitude and is also predicted by the effect of a tight monetary policy. Interest rates tend to respond negatively to previous inflation which seems counter-intuitive. However, countries like Brazil and Russia once plagued recurrently by hyperinflation might proactively increase interest rates even when inflation is low if they forecast inflationary pressures would increase in the future while other countries like China often maintain a high interest rate to encourage saving as opposed to inflation. First differences of fiscal balances (share of GDP) along with interest rates exhibit considerable persistence, with the coefficients on their first lags taking on values of 0.725 and 0.765 respectively. Fiscal balances seem to be significantly associated with real GDP, inflation, and money growth but the effects of two respective lags of real growth and inflation are almost exactly offsetting and the effect of money growth is rather trivial in magnitude.

According with one's priors, the movements in exchange rates are hardly explained using macro variables like real output, money supply, and prices. Prominent studies by Meese and Rogoff (1983) and Cheung, Chinn, and Pascual (2005) have well established the disconnection between exchange rates and macroeconomic fundamentals suggested by canonical exchange rate determination models. Our results nevertheless show that short-term interest rates deliver some predictive power in accounting for exchange rate movements. More specifically, higher interest rates are likely associated with depreciation in home

currencies for BRICS countries, which is not in line with the finding for G7 countries by Eichenbaum and Evans (1995) who document currency appreciation due to interest rate innovations. This discrepancy is plausibly attributed to a number of important differences between advanced economies and emerging market economies emphasized by Eichengreen (2005), such as credibility problems and higher degrees of exchange rate pass-through.

Current account balances seem to bear no statistically significant relationships to real growth, money growth and interest rates, a result largely consistent with the finding by Ferrero et al. (2010) who find the behavior of the international variables (such as current account and real exchange rate) is less sensitive to monetary policy. However, the external balances tend to improve when inflation moves higher but are likely to deteriorate when a nation's currency gets stronger. While the effect of the real effective exchange rate on the external balances is intuitively convincing, the linkage between current account and inflation may not be that straightforward. Bayouni and Gagnon (1992) show that a movement to a higher inflation rate would lead to an increase in capital inflows and decrease in saving rate which therefore decrease the current account balance. In contrast, Sobrino (2010) finds that current account balances worsen after a country adopts an inflation targeting policy which typically brings stable and lower inflation.[17] In addition, the fiscal position presents no significant impact on the external balances. Thus, we see no evidence in favor of the so-called "twin deficits" hypothesis among the BRICS countries.

4.2 Impulse Response Functions

The impulse responses to monetary shocks, fiscal shocks and international variable shocks are displayed with 95% confidence bands in Figs. 6-9.[18] A positive shock in money supply increases the real GDP

[17] Among BRICS countries, Brazil and South Africa may be identified as inflation targeting (see e.g., Eichengreen, 2005), while the Central Bank of Russia seems to have been gradually moving towards inflation targeting recently.

[18] We pay more attention to the responses of real activities and inflation as well as international variables (exchange rate and external balances) to policy shocks, thus the responses of policy variables are not reported to conserve space. A shock is defined by default as a positive change by one standard deviation of a variable.

growth by 0.3% and the effect remains significantly positive within one year. In contrast, the real economic activity is depressed about 0.2% by an increase in interest rates but the real GDP recovers quickly and the adverse effect fades away thereafter. The reactions of real growth are largely in line with the prediction of New Keynesian models that monetary expansion can temporarily boost economic growth while a rise in nominal interest rate is contractionary for the real economy in the short run when some prices of the economy do not fully adjust. An innovation in inflation also leads to a rise in real growth which peaks at 0.2% after three quarters. The positive reaction of real GDP to inflation can plausibly be explained by the transitional Tobin-type effect documented by Walsh (1998) who shows that inflation can induce more consumption, and in turn requires more capital accumulation to produce that consumption. The fiscal policy innovations and shocks from international variables generally present no statistically significant impacts on real economic activity although fiscal shocks and real exchange rate shocks tend to increase output for the first few quarters while external balance innovations tend to depress real growth initially and then have a positive effect. The weak impact of fiscal policy on real economic activities in these economies may be attributed to a number of factors that characterize their economic, political, and institutional situations. Notably, the efficacy of public spending, apart from the problem of crowding out private investment, requires a well-functioning public sector which is generally not seen in many developing countries. Massive fiscal expansion also raises concern on large fiscal deficits and the accumulation of a high debt levels. Countries like Brazil and India constrained by debt would have less policy flexibility, making it more difficult to run countercyclical policy. Other factors, such as low democratic accountability, low level of financial openness, and lack of price flexibility may also undermine the effectiveness of fiscal policy in these countries.

(**Figs. 6-9 here**)

In the case of inflation we observe a significant effect of an interest rate hike which brings a rise of 1.1% in inflation. This result is in line with the price puzzle first noted by Sims (1992) and also

consistent with the finding of many other VAR studies on the monetary policy transmission process. The fact that a sudden rise in interest rates is followed immediately by a sustained increase in inflation rate is actually contrary to the expectation of policymakers who attempt to achieve price stability using interest rate tools and thus cast doubts on the effectiveness of interest rate policies to control inflation. As we know, capital controls and exchange rate regimes can substantially affect the independence of monetary policies and thus their impact of on real activity and price stability. While other emerging market economies often take measures to limit capital flows especially during financial stress period, China has notably maintained tight controls over its capital account and currency fluctuations although efforts have been made progressively toward more financial liberalization and exchange rate flexibility in recent years. A nominal exchange rate peg and restrictions on capital movements leave little room for the role of policy interest rates. This explains what we have seen that monetary policies tend to have a significant impact on real growth but fail to maintain inflation stability, a breakdown of the "divine coincidence" suggested by Blanchard and Gali (2007).

Inflation also reacts in the same direction to the innovations of external balances with an initial increase of about 0.4%. The positive comovements may be attributed to the inflation targeting policies adopted by some BRICS countries as aforementioned. Given the dominant role of China in terms of the size of the economy and the amount of current account surplus, the positive linkage is also possibly a manifestation of China's situation where large "twin surpluses" in the current account and capital account interplayed with high inflationary pressures in recent years. Interestingly, the innovation in money aggregates does not exert a substantial direct effect on inflation dynamics although it tends to induce an upward movement in inflation. Similarly, shocks in real output, fiscal policy, and real effective exchange rate show no strong impacts on inflation.

The responses of the real exchange rate to innovations in macroeconomic variables are generally insignificant except to the shock in the interest rates. Standard theory such as Dornbusch's overshooting

model predicts that in response to an unexpected tightening in monetary policy (an increase of the domestic interest rate), the real (and nominal) exchange rate will exhibit an immediate appreciation that is followed by a gradual depreciation in line with uncovered interest parity (UIP). Empirical studies particularly those based on VAR models, however, find that a contractionary monetary shock often leads to an instant depreciation in the home currency, or an appreciation over a sustained period of time then followed by depreciation, two anomalies usually termed the "forward discount bias puzzle" and the "delayed exchange rate overshooting puzzle" in literature. Our result for the BRICS countries regarding the interaction between the short-term interest rates and the exchange rates confirms the forward discount bias. More specifically, the interest rate hike innovation induces an instant 2% depreciation in the real exchange rate. It is also of interest to know how exchange rates interact with fiscal policy as there are increasingly heated debates on fiscal consolidation in the wake of the Great Recession. Theoretically, if government spending is viewed as public consumption, the real exchange rate is predicted to appreciate in response to an increase in government spending. Our result, however, shows that the contractionary fiscal shock (an increase in fiscal balance) tend to appreciate the real exchange rate, although not significantly. In this respect, our finding regarding the effects of fiscal policy for the BRICS countries is somewhat in line with that of studies on the U.S. by Kim and Roubini (2008) and Monacelli and Perotti (2010).

The responses of current account to inflation shocks again confirm the positive linkage between inflation and external balances for these five largest emerging economies. Particularly, an inflation shock induces an increase of 0.15% in the current account and the effect remains significant in the subsequent two quarters. As expected, appreciation in real exchange rate has an adverse effect on these countries' external balances but we do not see a J-curve effect associated with this interaction. The finding is consistent with the empirical evidence in the literature that the J-curve effect is generally more prominent for industrial countries than emerging or developing economies. The current account reacts in inertia initially to a monetary contraction (a rise in interest rates) and then improves shortly with a peak of 0.2%

in the third quarter. It is interesting to note that the lagged significant response of the current account balances to the interest rate innovations is not revealed by the estimated equation described above where the coefficients on two lags of the interest rates are insignificant. The fiscal balances are extremely sluggish in affecting the external balances, which again shows no evidence supporting the twin deficits hypothesis. Thus, the dynamics of the interaction between fiscal policy and current account in BRICS countries present a rather different story from those for advanced countries documented by Kim and Roubini (2008) and Monacelli and Perotti (2010).[19] Furthermore, neither of the innovations in output and money growth is sufficiently strong to affect the external balances.

4.3 Robustness: Comparing BIS to RC Countries

In this sub-section, we apply the panel VAR model to subsamples based on the data from Brazil, India and South Africa (BIS countries) and the one from Russia and China (RC countries). The BIS countries are generally recognized as democratic market economies. In contrast, Russia and China have been shifting from a centrally planned to a market based economy and their market-oriented transition remains incomplete, with many key areas of the economy still controlled by the government, such as Russia's energy and defense-related sectors and China' financial industry, for example. In addition, the growth of Russia and China relies heavily on exports and accordingly they have run consistent trade surpluses over the years while the BIS countries are generally less trade dependent. Therefore, we are interested to know whether these differences would play out in analyzing the impacts of monetary and fiscal policies for these economies.

(**Figs. 10-11 here**)

[19] Kim and Roubini (2008) find that expansionary fiscal shocks improve current account balances for the U.S., supporting the twin convergence hypothesis, while Monacelli and Perotti (2010) show that a rise in government spending tends to increase the trade deficit, supporting the twin deficit hypothesis.

The responses of real GDP growth, inflation, and external balances to policy shocks for the BIS and RC countries are shown in Figs. 10-11. In general, these impulse responses are consistent with what we have found for the whole sample data: fiscal shocks do not display significant impacts on real growth and external balances for both the BIS and RC countries while monetary policy shocks appear to be more effective in affecting economic activities. There are a few aspects worth noting though. First, inflation tends to be depressed for a couple of quarters due to fiscal policy shocks for the BIS countries, which is not seen for the RC countries. Instead, inflation in Russia and China is more likely to respond positively to the innovation of interest rate hikes. Second, a contractionary monetary shock (a rise in interest rates) tends to improve external balances for the both subsets of countries but it comes into play materially only after the third quarter for the BIS countries.

5. The Nexus of BRICS-U.S.

Being the largest economy in the world, the United States plays a dominant role in virtually every aspect of the global economy. Shocks in the U.S. real economic activities, financial markets, and monetary and fiscal policies are often spilled quickly over to the rest of world through various transmission channels, including not only trading relationships but also financial linkages such as interest rates, commodity prices, and exchange rates. For instance, China, one of the main exporters to the U.S. and Europe, has seen its export growth decline dramatically since the burst of the global credit crunch. The Fed's two rounds of "quantitative easing" in the wake of the crisis pushed its policy interest rates down to a near-zero level and spurred a large expansion of global liquidity. This expansion in global liquidity has coincided with surges in gross capital inflows to many emerging markets, especially those in Asia and Latin America. The massive capital inflows have further brought about expansions in domestic credit, real exchange rate appreciations, and rises in inflationary pressures in these countries.

Today, the U.S. represents the 2nd, 4th, 3rd, 1st, and 3rd largest single country trading partner of Brazil, Russia, India, China, and South Africa, respectively, in terms of total exports and imports.[20] As such, adjustments on the U.S. trade balances may present important repercussions on these countries' economic performance. Particularly, concerns aroused about whether the U.S. external balances were sustainable when its current account deficit reached an unprecedented high of around 6% of GDP in 2005-06 and thus a reversal or at least a narrowing of the U.S. current account deficit would be quite foreseeable.[21] However, using overall current account balances instead of bilateral trade balances between BRICS countries and the United States may not be able to describe accurately the impacts of the U.S. external adjustments on these emerging economies. For instance, India and South Africa generally run a current account deficit but maintained a bilateral trade surplus with the United States. The Sino-U.S. trade balance started to fall in 2005 while China's current account surplus continued to surge steadily until the third quarter of 2008. To better understand the economic and policy nexus of BRICS-U.S., we thus reconduct the exercise by replacing the international variables with bilateral trade balances and bilateral nominal exchange rates (vis-à-vis the US dollar).

(**Table 4 here**)

Table 4 reports the coefficient estimates for the panel VAR with the new set of variables. Although including bilateral international variables does not fundamentally alter the results compared to those in Table 3 where overall current account balances and real effective exchange rates are used, some important changes are noteworthy. Real GDP growth remains significantly related to lags of money growth and interest rates but the effect of monetary policy seems slightly weaker. In contrast, the fiscal policy variable shows stronger effect on future real growth. More strikingly, real output growth is likely

[20] As a single economy, the European Union (27 countries) is the largest trading partner of all BRICS countries except India for which the UAE (United Arab Emirates) is the primary trading partner.

[21] In fact, the U.S. current account deficit fell gradually in 2007-08 to roughly 5% and then more abruptly in 2009 to 2.7%.

associated with the preceding movements of the bilateral exchange rates but contrary to the prediction of standard theory, depreciation in nominal exchange rate tends to be contractionary. As for inflation, increases in BRICS countries' trade balances against the United States are still likely to push price levels higher but the positive linkage is no longer significant as in the case of current account balances considered. Unlike real effective exchange rates, bilateral nominal rates exert significant impacts on policy variables in that currency depreciation tends to deteriorate fiscal balances and to depress interest rates in these emerging countries. The most interesting pattern emerges in the dynamics of the interplay between international variables. As we have seen, depreciation in the real effective exchange rate does help improve current account balances but the latter carries no significant predictive power to the former. In contrast, when bilateral variables considered, rising trade surpluses in BRICS countries tend to induce weaker currencies but pushing these countries' currencies to appreciate (or a weakening dollar) can hardly improve the U.S. trade deficits.

Figs. 12-13 display the impulse responses of real growth and inflation to innovations in bilateral international variables.[22] A currency depreciation shock induces a slowdown in real output growth by 0.2% and it takes one year or so to recover. This is consistent with the finding by Chou and Chao (2001) who find that weaker currency leads to a short-run contractionary effect for 5 Asian countries but different from that of Upadhyaya et al. (2004) whose results suggest that the exchange rate depreciation is expansionary in the short run. The reaction of real growth to trade balance shocks is rather puzzling. It shows that an innovation expanding BRICS countries' trade surplus tends to depress their economy at least two quarters, although the magnitude of the adverse effect is fairly small. One plausible explanation is that a widening trade deficit in the U.S. is a signal of a sluggish economy which soon generates significant spillovers through financial linkages to the rest of the world. Since financial effect dominates

[22] The impacts of monetary and fiscal policies on real economic activities and inflation are not qualitatively different from those presented in Figs. 6-9, except that fiscal shocks appear to be slightly more significant.

the international spillovers according to Bayoumi and Swiston (2007), the world economy would suffer a downturn including BRICS countries.

(**Figs. 12-13 here**)

Inflation is not quite responsive to depreciation shocks in nominal exchange rate, akin to its response to those of the real effective rates. A positive shock in trade balances nevertheless tends to induce a rise in inflation but the reaction turns out to be statistically significant only after two quarters and rather short-lived. Nominal exchange rates increase about 1% when they experience a positive shock in the bilateral trade balances. The portfolio balance approach to exchange rate determination infers that when the home country experiences a trade surplus, it accumulates foreign bonds, which creates an excess supply of foreign bonds and in turn leads to a depreciation of the foreign currency. The BRICS-U.S. case nevertheless shows the opposite. This, however, is not surprising as a large body of empirical literature has shown that monetary and portfolio balance models often fail to describe the short-run dynamics of exchange rate movements. Interestingly, the BRICS-U.S. bilateral trade balances do not react considerably to currency depreciation shocks. In other words, exchange rates may not play a critical role in the adjustment of the U.S. large trade deficits. Thus our finding, in line with Fratzscher et al. (2010), suggests that a weakening dollar policy may not be necessary or effective to return the U.S. external deficits to a more sustainable level.

6. Conclusion

In this paper, we use a panel VAR model to empirically investigate the dynamic interactions between monetary policy, fiscal policy, exchange rates, and external balances as well as their impacts on GDP growth and price stability in the five largest emerging market economies, i.e. the BRICS countries. We try to improve the existing literature in several directions. First, although cross-country empirical studies have emerged as a growing body of literature, they are mainly confined to the advanced economies such

as G7, OECD, and Eurozone countries. Our work is among the very few studies that focus on this set of major emerging market countries.[23] Understanding the dynamic interactions between policy impacts, real economic activities, and external imbalances for these counties may provide important insights into international policy coordination and global imbalance adjustment. Second, we consider both fiscal and monetary policy transmissions in the panel VAR specification, in recognition that fiscal policy and monetary policy are interdependent in nature. Thus, the paper contributes to the literature on monetary and fiscal analysis by integrating monetary VARs and fiscal VARs into one framework. Finally, from a methodological perspective, our panel VAR model enriches the VAR family by emphasizing the importance of the identifying the policy shocks based on cross-country observations because individual-country VAR models in macroeconomic research often suffer from the curse of dimensionality and thus fail to uncover accurately the dynamic relationships among variables, particularly for emerging countries that are generally unable to maintain sufficiently long macro time-series.

We find that a contractionary monetary policy shock (an interest rate hike) tends to have strong negative effects on real economic activity and a positive money growth shock has significant expansionary impacts on GDP growth. The transmissions of the fiscal policy, however, seem to be much weaker in these countries. Our results also indicate that monetary policy shocks have significant repercussions on price stability. Contrary to expectation, nevertheless, an unexpected tightening in monetary policy does not help stabilize inflation. Instead, an interest rate hike tends to bring a substantial rise in inflation. Thus, our work adds further evidence to literature about the "price puzzle" which is recorded in many empirical studies based on VAR analysis. More importantly, it suggests that the attempt to curb inflation based on interest rate tools alone may not be successful.

[23] A prominent example is provided recently by Mallick and Sousa (2013) who examine the impact of commodity prices and monetary policy on real economy for the BRICS countries.

The dynamics of external balances are of central focus particularly in the wake of recent global financial turmoil as it believed that they are intimately connected (e.g., Obstfeld and Rogoff, 2009). The twin deficits hypothesis posits that government budget balances move together with current account balances in the same direction. The notion is theoretically justified in standard theories such as the Mundell-Fleming model under flexible exchange rates and is empirically buttressed by the finding of Monacelli and Perotti (2010). However, Kim and Roubini's (2008) VAR analysis suggests the "twin divergence", in which an expansionary fiscal policy shock (a positive government deficit shock) actually improves the U.S. current account. Our results for the BRICS countries nonetheless show a different story. We find that the relationship between the fiscal balances and current account is rather weak, in favor of neither the twin deficit nor two divergence hypotheses. The weak impact of fiscal policy on external balances may plausibly be attributed to a low level of financial openness, nominal rigidity in exchange rate, and lack of price flexibility in many emerging market economies indicated by Ali Abbas et al. (2010). In contrast, monetary policy shocks appear to have some impact on the external balances. More specifically, a rise in interest rates tends to improve the current account in the BRICS countries. This finding is in accordance with some scholars' argument that an extended loose monetary policy (mainly in the U.S.) would have severely exacerbated the massive global imbalances. Our analysis also records a positive interaction between inflation and current account. Given the price puzzle and the impact of an interest rate rise on the current account, it is of particular interest to understand how shocks are transmitted among interest rates, inflation, and current account. In this vein, further careful causality analyses and theoretical models capable of accounting for these empirical may be warranted.

When bilateral exchange rates and trade balances are used in attempt to assess the BRICS-US nexus, the results show that the impacts of fiscal policy on real economic activity and price stability appear to be stronger while monetary policy shocks turn out to be less influential in these emerging market economies. This finding hinges on the fact that shocks in the U.S. monetary and fiscal policies as

well as other economic activities can spill over to the rest of world through various transmission channels including international trade and foreign exchange markets. Turning to the role of exchange rates, we find that innovations that strengthen the trade-weighted real effective rates do worsen the BRICS countries' overall external positions but shocks that lead to weaker bilateral exchange rates (vis-à-vis the U.S. dollar) do not help improve these countries' trade balance against the United States. In other words, the attempt to redress the U.S. massive trade deficits counting upon a weakening dollar policy would prove futile, at least from the perspective of the BRICS countries.

These findings may have some important policy implications for these emerging countries. The expansion of global liquidity spurred by the lax monetary policies such as quantitative easing in advanced countries has created substantial inflationary pressures in emerging market economies. The fact that interest rate tools tend to be less sufficient to fulfill the goal of price stability calls for more effective policy tools which can tighten domestic credit conditions without encouraging capital inflows. Prominent examples may include higher bank capital requirements, stricter and less cyclically sensitive loan loss reserves, and lower loan-to-value or debt-to-income ratios. Emerging economies also need to be cautious about implementing large-scale fiscal spending programs. The efficacy of a fiscal expansion, if any, might not be that significant as expected, and more critically fiscal stimulus could have adverse long-run effects if higher taxes were eventually required to service the debt. This is particularly relevant given the recent experience of sovereign debt crisis in the Eurozone. As far as global imbalances are concerned, broader international policy coordination among both emerging market economies and advanced countries is warranted as pure exchange rate policy tools would hardly play a material role.

A number of interesting insights have been offered here into the dynamic relationships between policy transmissions and external balances as well as other important macro variables though, several issues are noteworthy. First, one caveat that warrants some caution when interpreting the results is that the high-frequency (quarterly) data for fiscal variables are obtained through interpolation. While using

interpolated data in macroeconomic analysis is not uncommon (e.g., Dees et al., 2005), the uncertainty and bias may be introduced into the VAR results. Second, emerging market economies differ considerably from developed countries in various ways including market structure, economic path, financial development, and policy management, etc. Even within the BRICS countries, there is a lot of heterogeneity in exchange rate regime, capital control, policy targeting and others. Although our panel VAR model has accounted for country-specific heterogeneity, further research remains clearly needed for a better understanding of the factors that lie behind the dynamic interactions. Finally, while this analysis follows Kim and Roubini's (2008) data-oriented approach without imposing theoretical restrictions, we believe a study based on a VAR framework with structural innovations would present an important complement to relevant literature in our future research agenda.

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Table 1. Panel Unit Root Tests

		gdp	*cpi*	*m*	*fb*	*ir*	*ca*	*tb*	*e*	*s*
Panel A: variables in level (in logarithms)										
LLC Test	*stat*	-0.591	0.104	1.745	1.152	-3.479 ***	-0.498	0.155	0.664	-0.729
	p-value	0.277	0.541	0.960	0.875	0.000	0.309	0.562	0.747	0.233
IPS Test	*stat*	-0.341	1.510	1.604	-0.675	-3.538 ***	-0.722	-0.901	0.193	-0.541
	p-value	0.367	0.934	0.946	0.250	0.000	0.235	0.184	0.576	0.294
Pesaran Test	*stat*	1.753	1.500	0.918	0.460	3.176 ***	0.822	-1.235	-1.312 *	1.229
	p-value	0.960	0.933	0.821	0.677	0.001	0.794	0.108	0.095	0.890
Hadri Test	*stat*	4.841 ***	5.517 ***	4.440 ***	3.192 ***	5.857 ***	3.736 ***	1.566 *	3.691 ***	4.726 ***
	p-value	0.000	0.000	0.000	0.001	0.000	0.000	0.059	0.000	0.000
Panel B: variables in first differnces										
LLC Test	*stat*	-0.053	-7.701 ***	-0.516	-4.224 ***	-14.162 ***	-3.987 ***	-5.013 ***	-11.141 ***	-6.649 ***
	p-value	0.479	0.000	0.303	0.000	0.000	0.000	0.000	0.000	0.000
IPS Test	*stat*	-5.512 ***	-7.543 ***	-6.412 ***	-7.724 ***	-12.716 ***	-6.565 ***	-6.521 ***	-10.514 ***	-7.013 ***
	p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Pesaran Test	*stat*	-4.295 ***	-6.319 ***	-8.769 ***	-6.651 ***	-7.697 ***	-3.773 ***	-5.431 ***	-6.757 ***	-5.840 ***
	p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hadri Test	*stat*	2.171 **	1.407 *	0.779	-0.175	0.459	0.362	1.292 *	0.357	2.331 *
	p-value	0.015	0.080	0.218	0.570	0.323	0.359	0.098	0.361	0.010

Notes: LLC test is based on Levine, Lin and Chu (2002), IPS test is based on Im, Pesaran and Shan (2003), and Hadri test is based on Hadri (2000). H_0^{LLC}: panel series contain a common unit root; H_0^{IPS}: panel series contain heterogenous unit roots; H_0^{Hadri}: panel series contain no unit root. Whenever needed, the lag length is chosen by SIC, kernel is based on Bartlett, and bandwidth is based on New-West. The level variables of GDP, Money, and CPI are assumed to be with a trend in testing. * denotes significance at 10%, ** at 5%, and *** at 1%, repectively.

Table 2. Panel Cointegration Tests

Pedroni's residual-based test

with intercept, no linear trend			with intercept and linear trend			no intercept , no linear trend		
	Statistic	Prob.		Statistic	Prob.		Statistic	Prob.
Panel v-Statistic	3.668	0.000	Panel v-Statistic	2.548	0.005	Panel v-Statistic	-2.162	0.985
Panel rho-Statistic	-0.331	0.370	Panel rho-Statistic	0.877	0.810	Panel rho-Statistic	-0.792	0.214
Panel PP-Statistic	0.105	0.542	Panel PP-Statistic	1.468	0.929	Panel PP-Statistic	-1.464	0.072
Panel ADF-Statistic	0.294	0.616	Panel ADF-Statistic	1.274	0.899	Panel ADF-Statistic	-2.257	0.012
Group rho-Statistic	0.662	0.746	Group rho-Statistic	2.627	0.996	Group rho-Statistic	1.281	0.900
Group PP-Statistic	-0.590	0.278	Group PP-Statistic	1.483	0.931	Group PP-Statistic	0.317	0.624
Group ADF-Statistic	-3.233	0.001	Group ADF-Statistic	-2.788	0.003	Group ADF-Statistic	-1.743	0.041

Westerlund ECM panel cointegration tests

no cross-sectional dependencies				with cross-sectional dependencies				
Statistic	Value	Z-value	P-value	Statistic	Value	Z-value	P-value	Robust P-value
Gt	-2.799	-0.359	0.36	Gt	-3.731	-1.74	0.041	0.432
Ga	-15.562	-0.159	0.437	Ga	-14.576	1.136	0.872	0.482
Pt	-3.335	1.824	0.966	Pt	-5.363	0.869	0.808	0.642
Pa	-11.193	0.033	0.513	Pa	-11.473	1.043	0.852	0.528

Notes: Pedroni test is based on Pedroni (1999). The null hypothesis of all Pedroni's statistics is no cointegration. The panel cointegration statistics (within-dimension) require a common value in cointegration while group-mean cointegration statistics (between-dimension) do not. Under the alternative hypothesis, all the panel cointegration test statistics except Panel v-statistic diverge to negative infinity, and the null is therefore rejected for observed values far in the left tail of the distribution while the latter diverges to positive infinity and the null is accordingly rejected in the right tail of distribution. Westerlund test is based on Westerlund (2007). The null hypothesis of all Westerlund's statistics is no cointegration. Pt and Pa are panel statitics while Gt and Ga are group mean statitics. Z-values in Westerlund test, the normalized statistics, converges to a standard normal distribution asymptotically.

Table 3. Panel VAR Estimation

	Δgdp_{t-1}	Δcpi_{t-1}	Δm_{t-1}	Δfb_{t-1}	ir_{t-1}	Δe_{t-1}	Δca_{t-1}	Δgdp_{t-2}	Δcpi_{t-2}	Δm_{t-2}	Δfb_{t-2}	ir_{t-2}	Δe_{t-2}	Δca_{t-2}
Δgdp_t	0.267 ***	0.064	0.044 ***	0.875	-0.040 *	0.028 *	-0.146	0.279 *	0.027	0.020	-1.057	0.032 *	0.004	0.175
	(3.465)	(1.445)	(3.766)	(1.207)	(-1.694)	(1.657)	(-0.793)	(1.869)	(0.331)	(1.140)	(-1.241)	(1.874)	(0.168)	(0.668)
Δcpi_t	-0.040	0.626 ***	0.033 *	-0.392	0.314 ***	-0.021	0.719 ***	-0.043	-0.214 ***	0.002	0.595	-0.244 ***	-0.016	-0.130
	(-0.806)	(6.806)	(1.651)	(-0.590)	(3.358)	(-0.800)	(3.248)	(-0.381)	(-2.671)	(0.125)	(0.983)	(-3.130)	(-0.706)	(-0.658)
Δm_t	-0.018	0.270	-0.359 ***	2.329	-0.143	-0.073	0.174	-0.314	0.310	-0.090	-0.358	-0.019	0.160 *	-0.172
	(-0.097)	(0.879)	(-4.038)	(0.897)	(-0.744)	(-0.667)	(0.257)	(-1.081)	(1.404)	(-1.392)	(-0.153)	(-0.095)	(1.753)	(-0.259)
Δfb_t	-0.036 ***	-0.011 *	0.003 **	0.725 ***	0.000	0.002	0.011	0.039 ***	0.012 **	0.003 ***	-0.528 ***	0.004	0.002	0.002
	(-8.905)	(-1.984)	(2.469)	(9.812)	(-0.001)	(1.018)	(0.669)	(5.682)	(2.227)	(3.165)	(-6.817)	(1.546)	(1.404)	(0.166)
ir_t	0.005	-0.620 **	0.019	0.801	0.765 **	0.065	-0.464	0.137	0.333	0.002	0.012	-0.144	0.010	-0.082
	(0.047)	(-2.413)	(0.632)	(0.394)	(2.522)	(1.136)	(-0.801)	(0.958)	(1.498)	(0.048)	(0.007)	(-0.605)	(0.202)	(-0.122)
Δe_t	-0.044	0.114	0.029	1.360	-0.558 ***	0.178 *	-0.186	-0.065	0.105	0.060	-1.505	0.326 ***	-0.067	-0.202
	(-0.354)	(0.545)	(0.379)	(0.536)	(-3.385)	(1.656)	(-0.278)	(-0.331)	(0.575)	(1.083)	(-0.630)	(2.356)	(-0.620)	(-0.327)
Δca_t	-0.022	0.057 **	0.003	0.162	0.017	-0.026 ***	0.712 ***	0.017	-0.006	0.001	-0.207	-0.010	-0.007	-0.107
	(-1.343)	(2.405)	(0.446)	(0.624)	(1.203)	(-3.823)	(8.426)	(0.529)	(-0.203)	(0.111)	(-0.840)	(-0.845)	(-0.926)	(-1.163)

Note: Panel VAR model is estimated using the generalized method of moment (GMM) after the fixed effects have been removed. The endogenous variables included in estimation are the log difference of real GDP, Δgdp_t, the log difference of price level, Δcpi_t, the log difference of nominal broad money, Δm_t, the difference of fiscal balance, Δfb_t, the level of the short-term nominal interest rate, ir_t, the log difference of real effective exchange rate, Δe_t, and the difference of current account, Δca_t. Heteroskedasticity robust t-statistics are in parenthese. * denotes significance at 10%, ** at 5%, and *** at 1%, repectively.

Table 4. Panel VAR Estimation with Bilateral Variables

	Δgdp_{t-1}	Δcpi_{t-1}	Δm_{t-1}	Δfb_{t-1}	ir_{t-1}	Δs_{t-1}	Δtb_{t-1}	Δgdp_{t-2}	Δcpi_{t-2}	Δm_{t-2}	Δfb_{t-2}	ir_{t-2}	Δs_{t-2}	Δtb_{t-2}
Δgdp_t	0.264 ***	0.096 **	0.044 ***	1.085 *	-0.041	-0.031 ***	-0.987	0.331 ***	0.070	0.020	-1.233 *	0.046 **	-0.029 ***	-0.063
	(3.706)	(2.083)	(4.075)	(1.801)	(-1.392)	(-2.605)	(-1.329)	(2.734)	(1.153)	(1.160)	(-1.821)	(2.031)	(-2.818)	(-0.149)
Δcpi_t	-0.012	0.627 ***	0.034 *	0.018	0.297 ***	0.019	1.179	-0.082	-0.183 **	0.006	0.162	-0.238 ***	0.033	0.077
	(-0.229)	(6.565)	(1.683)	(0.028)	(3.029)	(0.640)	(1.370)	(-0.706)	(-2.483)	(0.450)	(0.283)	(-2.876)	(1.643)	(0.115)
Δm_t	-0.052	0.260	-0.347 ***	1.771	-0.189	0.079	-0.151	-0.335	0.368 *	-0.093	0.187	0.034	-0.187 **	1.367
	(-0.274)	(0.854)	(-3.901)	(0.698)	(-1.008)	(0.712)	(-0.058)	(-1.086)	(1.850)	(-1.429)	(0.083)	(0.163)	(-2.020)	(0.536)
Δfb_t	-0.037 ***	-0.007	0.003 ***	0.727 ***	0.000	-0.004 ***	0.056	0.039 ***	0.014 ***	0.003 ***	-0.531 ***	0.004	-0.002 *	0.033
	(-9.287)	(-1.177)	(2.759)	(10.815)	(0.126)	(-2.690)	(1.447)	(5.339)	(2.575)	(3.533)	(-7.550)	(1.544)	(-1.741)	(0.788)
ir_t	-0.019	-0.554 **	0.016	0.209	0.764 ***	-0.128 **	1.632	0.101	0.219	0.000	0.541	-0.201	0.047	0.203
	(-0.175)	(-2.329)	(0.567)	(0.132)	(3.600)	(-2.210)	(0.824)	(0.555)	(1.394)	(0.005)	(0.410)	(-0.815)	(1.003)	(0.124)
Δs_t	0.125	0.147	0.021	-0.150	0.791 ***	0.263 **	6.384 **	-0.118	0.080	-0.068	0.362	-0.486 ***	-0.093	-0.442
	(0.841)	(0.623)	(0.269)	(-0.053)	(4.214)	(2.140)	(1.976)	(-0.521)	(0.443)	(-1.152)	(0.140)	(-3.355)	(-0.859)	(-0.179)
Δtb_t	0.010 **	0.008	-0.001	0.036	0.006 **	0.000	0.586 ***	-0.002	-0.012	0.000	-0.039	-0.001	-0.002	0.020
	(2.453)	(1.502)	(-0.513)	(0.538)	(1.999)	(0.183)	(5.880)	(-0.275)	(-1.312)	(-0.344)	(-0.619)	(-0.341)	(-1.522)	(0.235)

Note: Panel VAR model is estimated using the generalized method of moment (GMM) after the fixed effects have been removed. The endogenous variables included in estimation are the log difference of real GDP, Δgdp_t, the log difference of price level, Δcpi_t, the log difference of nominal broad money, Δm_t, the difference of fiscal balance, Δfb_t, the level of the short-term nominal interest rate, ir_t, the log difference of the bilateral exchange rates (vis-à-vis the US dollar), Δs_t, and the difference of bilateral trade balances, Δtb_t. Heteroskedasticity robust t-statistics are in parenthese. * denotes significance at 10%, ** at 5%, and *** at 1%, repectively.

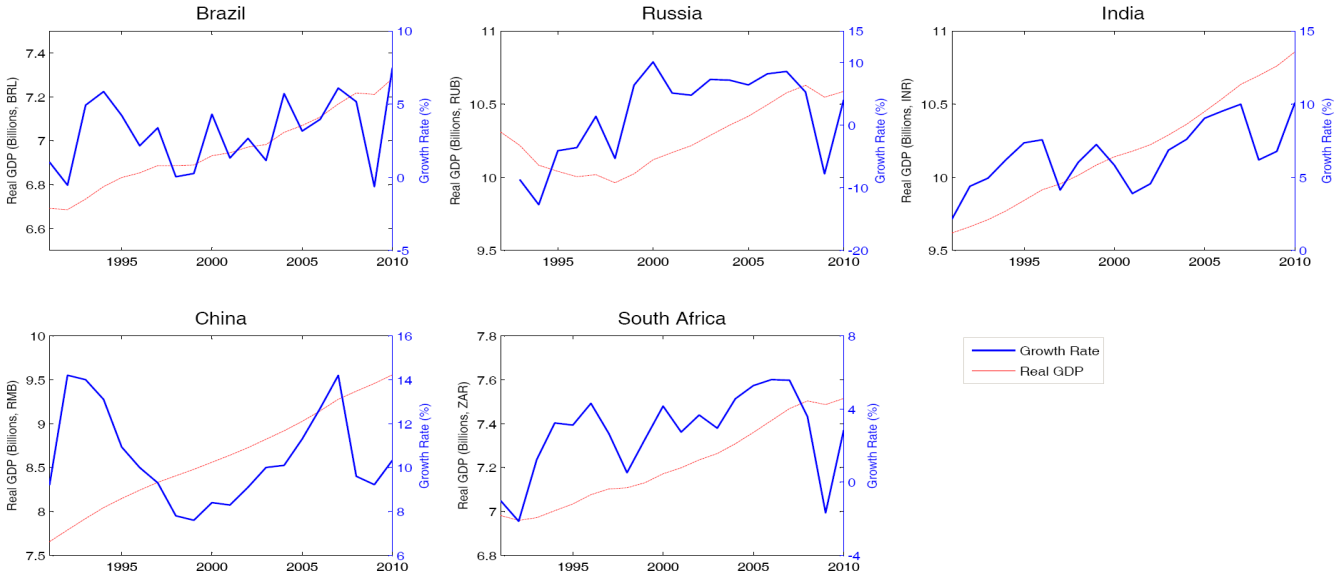

Fig. 1. Real GDP

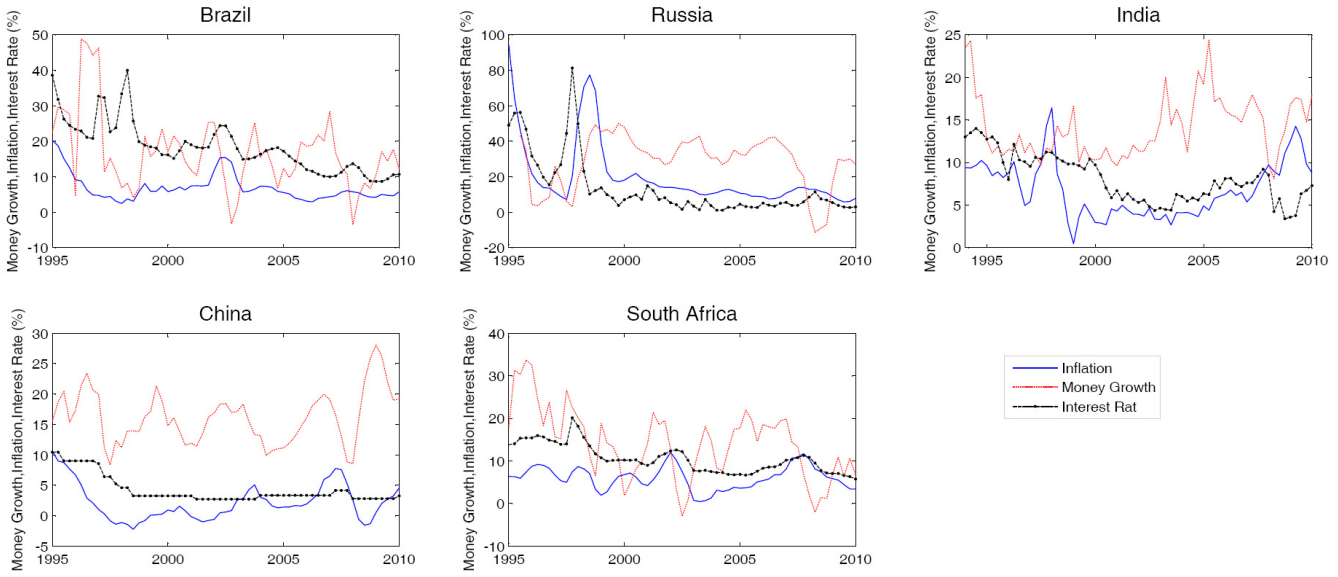

Fig. 2. Money, Interest Rates and Inflation

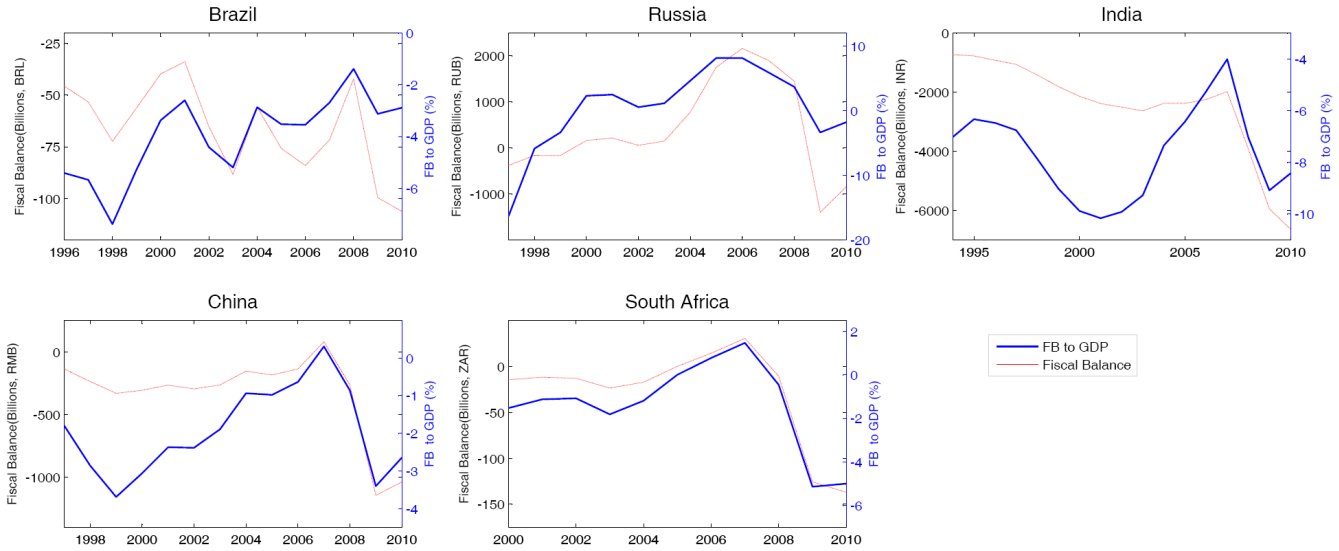

Fig. 3. Fiscal Balances

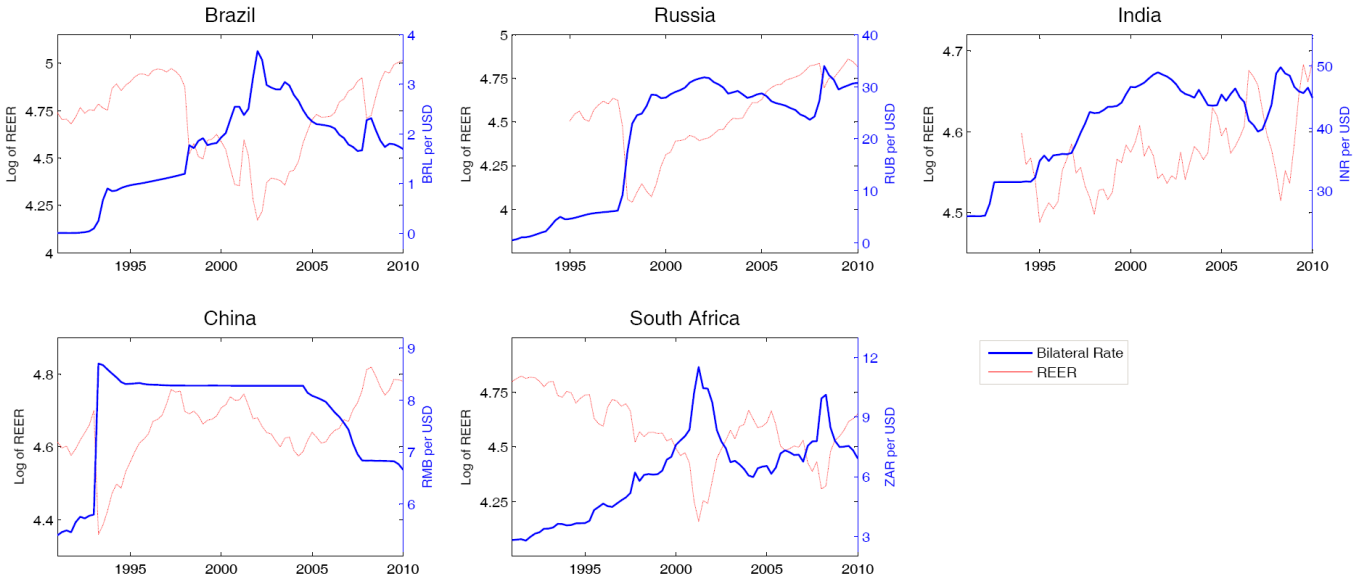

Fig. 4. Exchange Rates

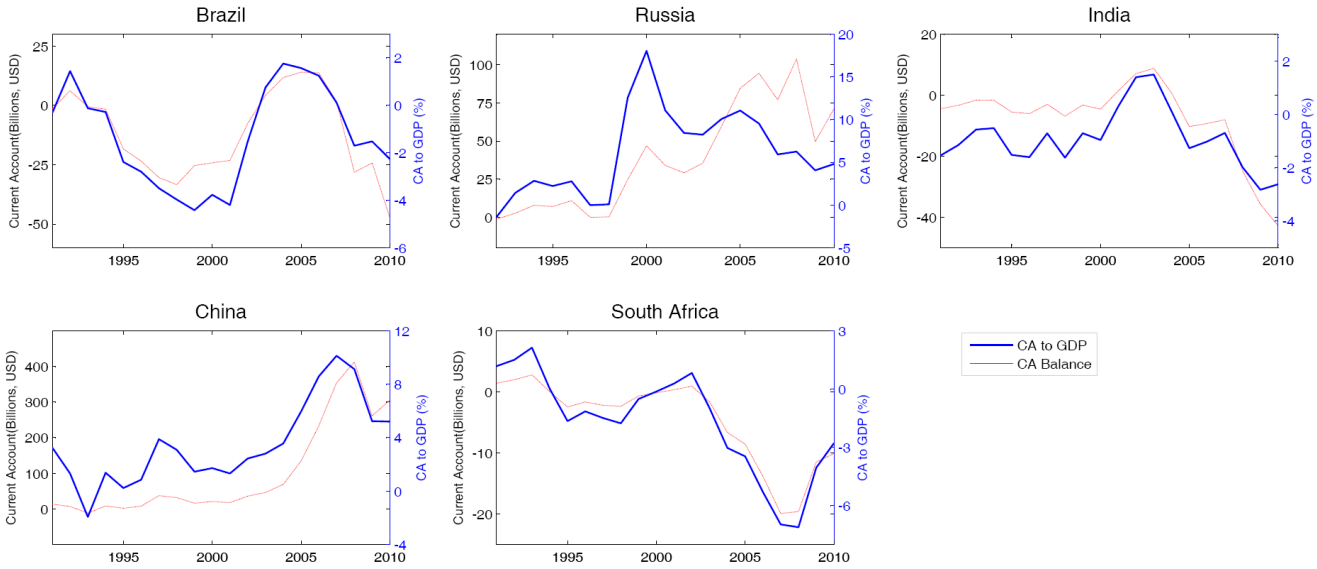

Fig. 5. Current Account

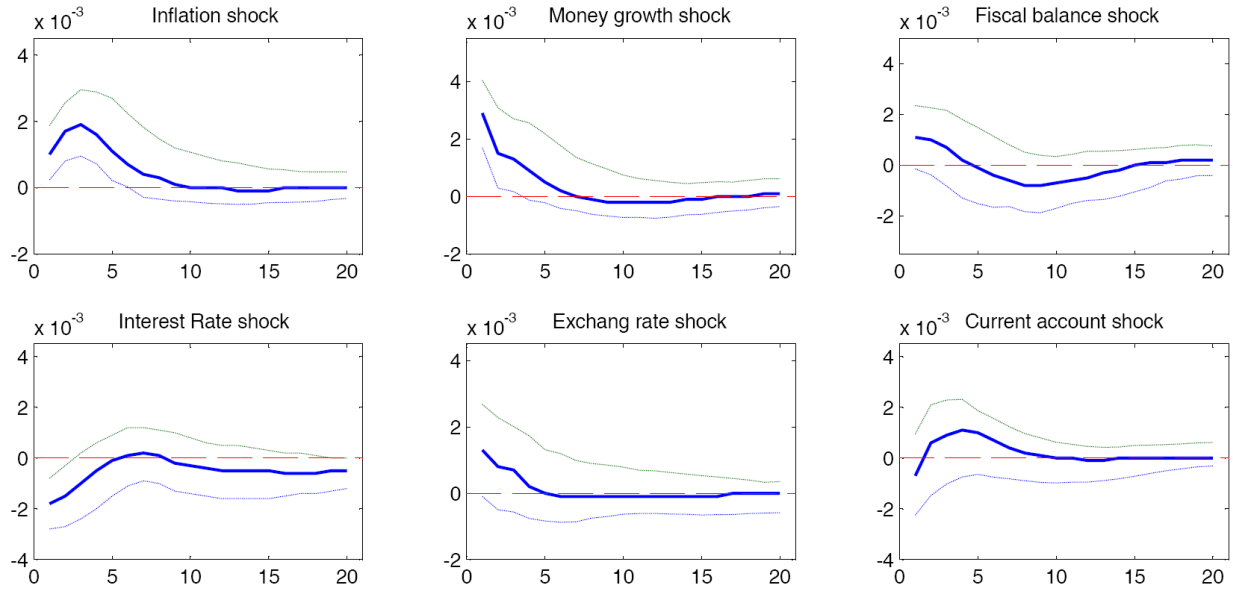

Fig. 6. Response of Real GDP Growth

Note: Panel VAR model is estimated based on endogenous variables $\left(\triangle gdp_{it},\ \triangle cpi_{it},\ \triangle m_{it},\ \triangle fb_{it},\ ir_{it},\ \triangle e_{it},\ \triangle ca_{it}\right)$, This figure displays the impulse responses of real GDP to shocks from other variables. 5% error band is generated by Monte-Carlo with 1000 reps (Similarly for Figs. 7-9).

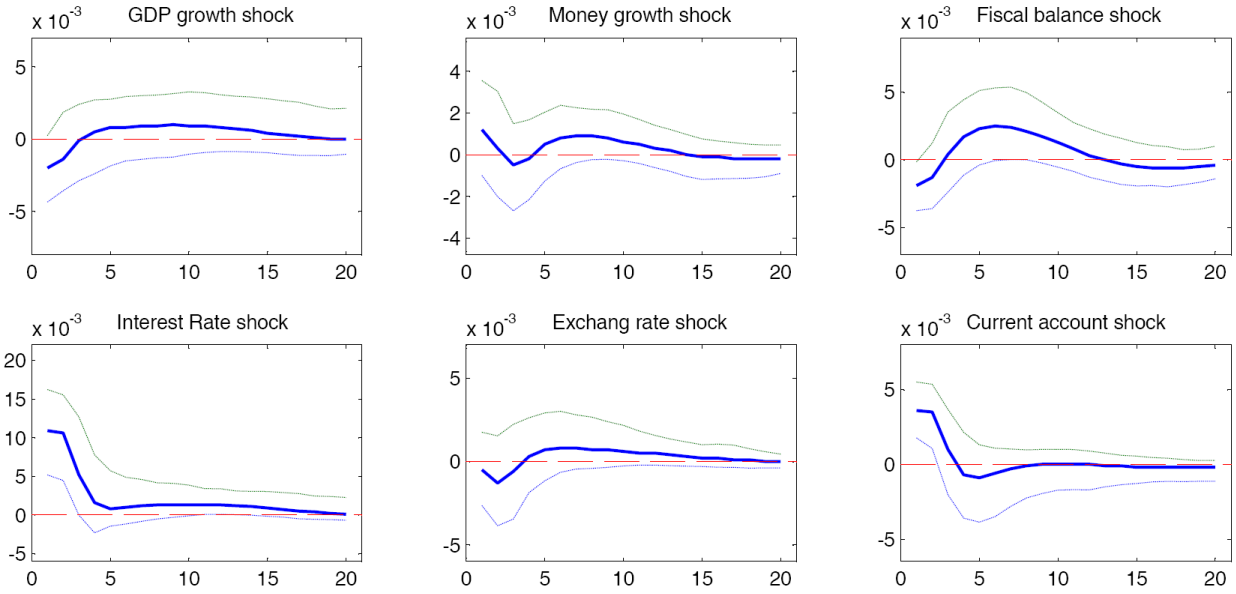

Fig. 7. Response of Inflation

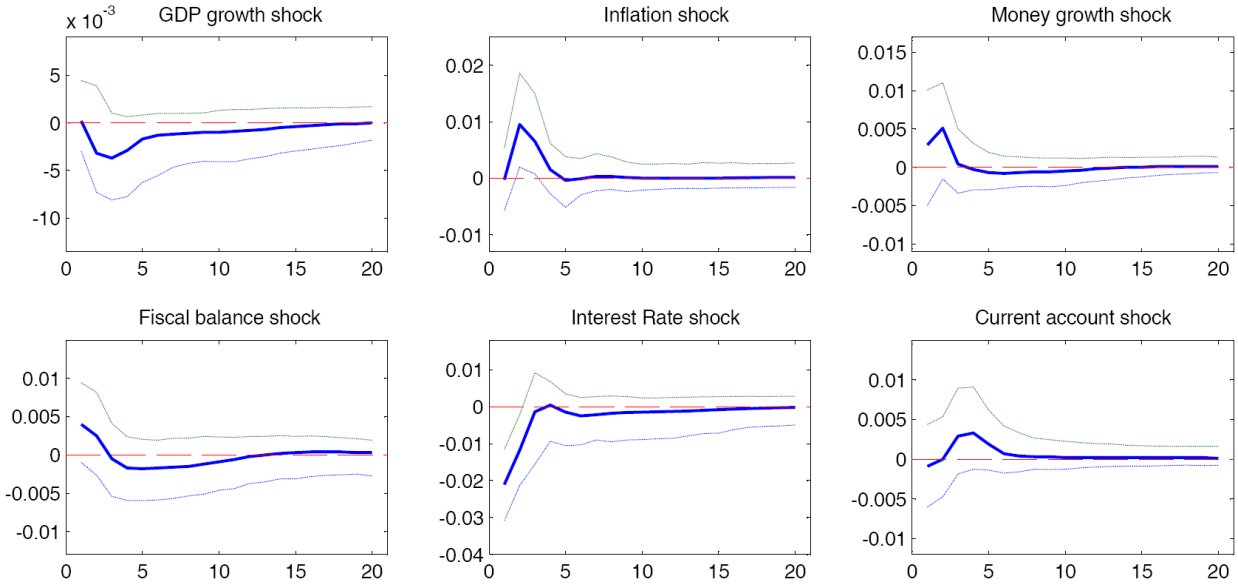

Fig. 8. Response of Exchange Rate

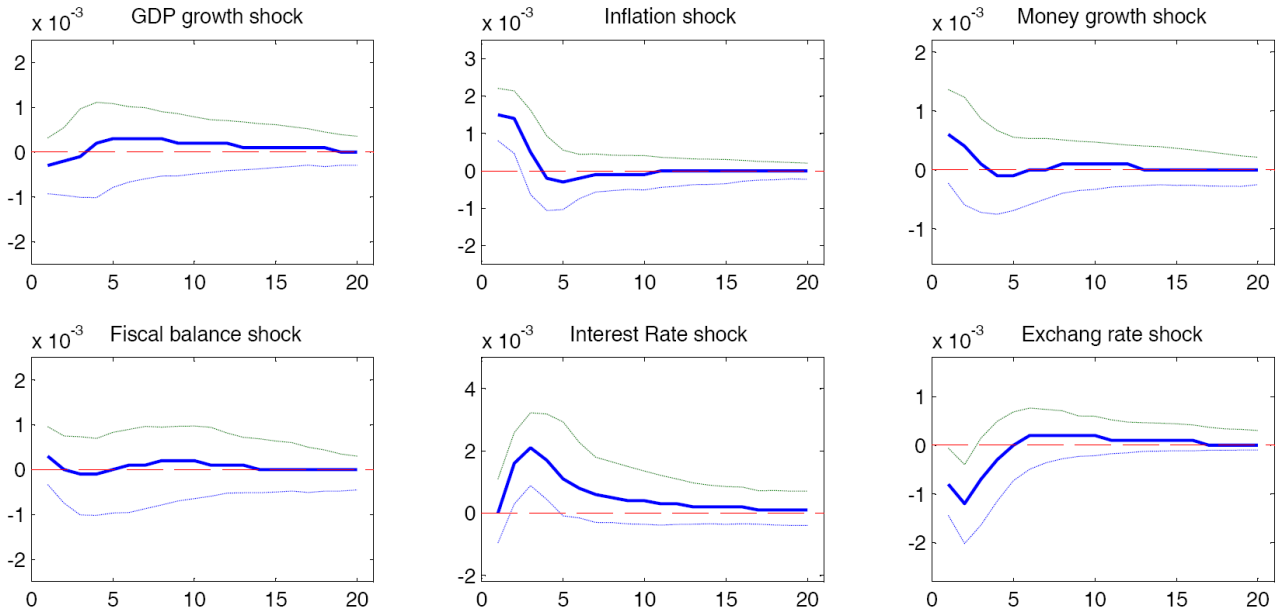

Fig. 9. Response of Current Account

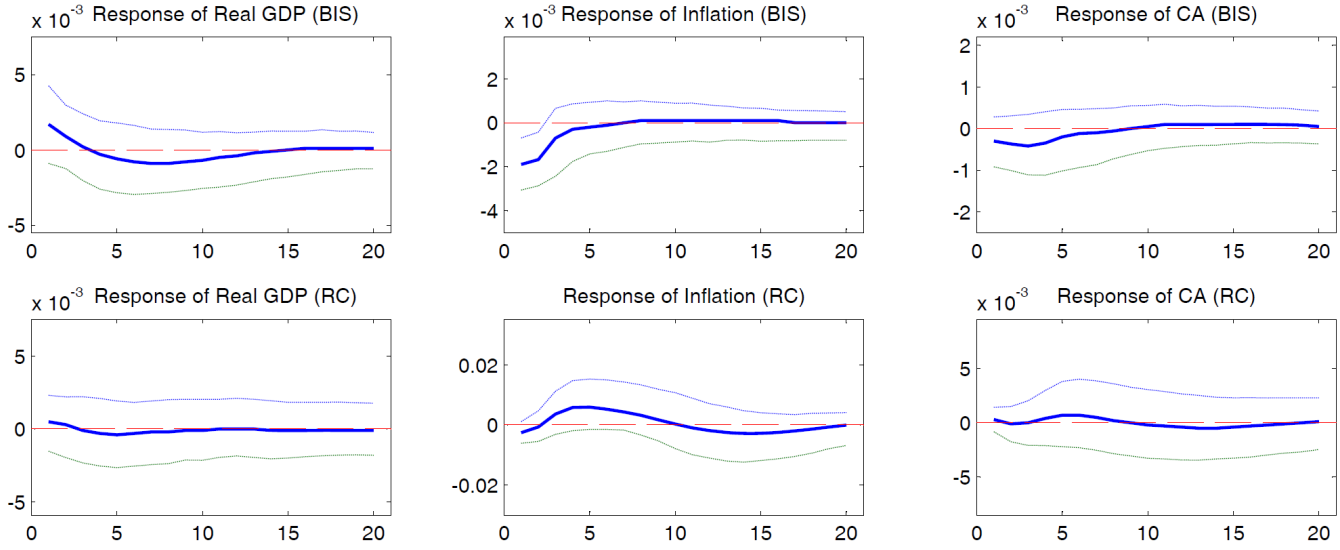

Fig. 10. Responses to Fiscal Policy Shocks (BIS vs RC countries)

Note: Panel VAR model is estimated using subsamples for the BIS (Brazil, India, and South Africa) and the RC (Russia and China) countries, respectively, based on endogenous variables $(\triangle gdp_{it}, \triangle cpi_{it}, \triangle m_{it}, \triangle fb_{it}, ir_{it}, \triangle e_{it}, \triangle ca_{it})$. We focus on the impact of policy shocks on real GDP, inflation, and external balances. This figure displays the impulse responses to fiscal policy shocks. 5% error band is generated by Monte-Carlo with 1000 reps (Similarly for Figs. 11).

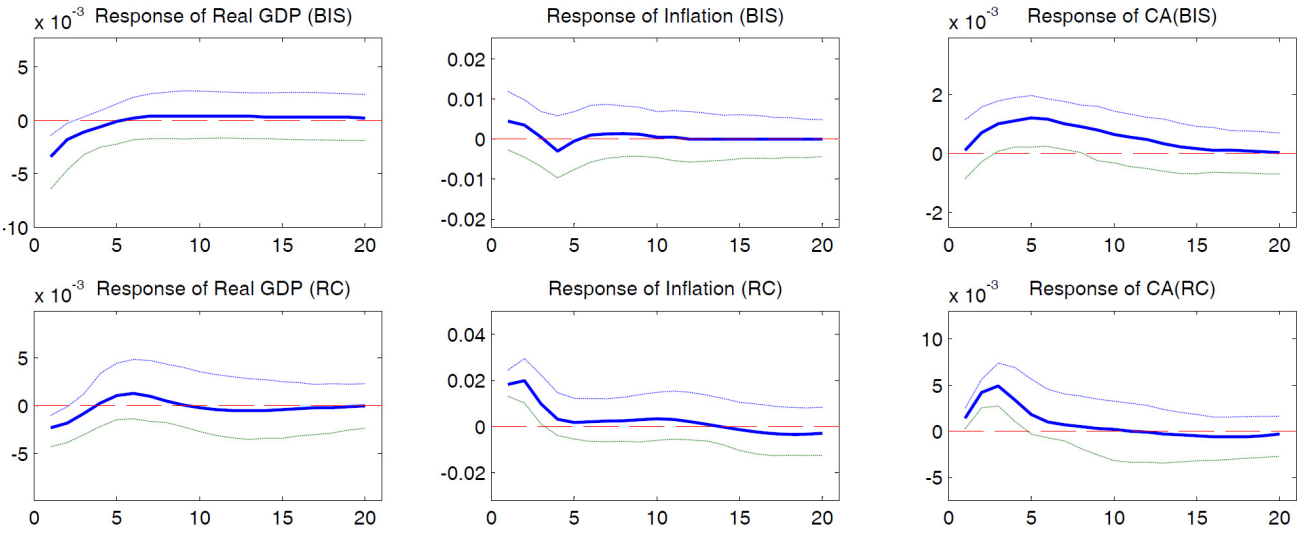

Fig. 11. Responses to Monetary Policy Shocks (BIS vs RC countries)

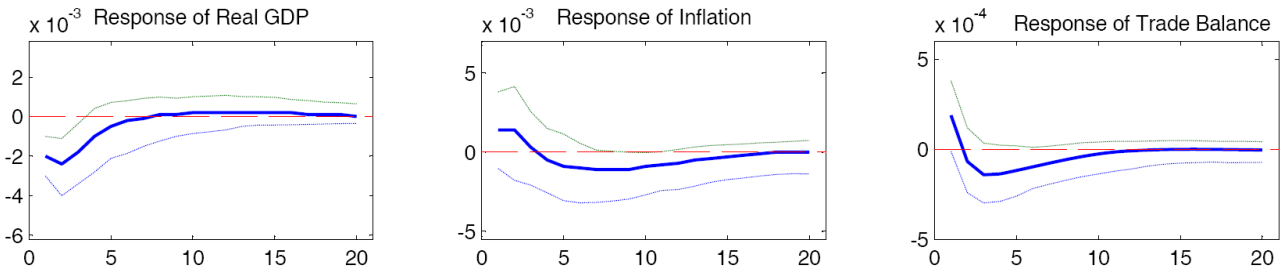

Fig. 12. Response to Bilateral Exchange Rate Shocks

Note: Panel VAR model is estimated based on endogenous variables $(\triangle gdp_{it},\ \triangle cpi_{it},\ \triangle m_{it},\ \triangle fb_{it},\ ir_{it},\ \triangle s_{it},\ \triangle tb_{it})$, where the last two variables are bilateral nominal exchange rates and trade balances with the U.S.. We focus on the impact of bilateral variables. This figure displays the impulse responses of real GDP, inflation, and trade balances to the shock from nominal exchange rates. 5% error band is generated by Monte-Carlo with 1000 reps (Similarly for Fig. 13).

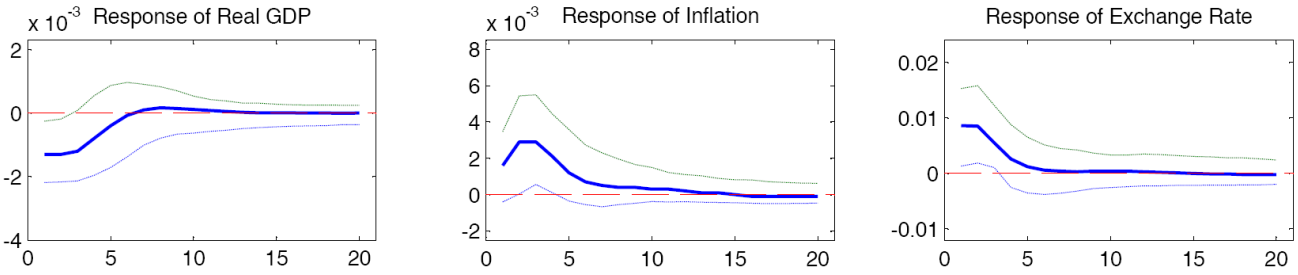

Fig. 13. Response to Bilateral Trade Balance Shocks