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Keywords

Brazil, EME business cycles, Dutch disease, SVAR

JEL Classification

C51, E32, F43, F62

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Chinese Resource Demand and Commodity Price Shocks: Macroeconomic Effects on an Emerging Market Economy*

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Abstract

This paper empirically addresses the hypothesis that in the external commodity based sector, Chinese resource demand is the most important driver of emerging market economies' business cycles, using Brazil as a representative case. Using a structural VAR to examine the effects of Chinese resource demand, world commodity prices and foreign output on domestic macroeconomic variables, we show that shocks to Chinese demand induce an expansion in Brazilian resource exports, the non-tradeable primary commodity sector and other domestic activity. Commodity price shocks are less favorable than Chinese resource demand shocks. Our findings identify the important role of the interest rate in amplifying the real effects of the commodity sector boom, in contrast to the role of the interest rate in developed countries. When both Chinese resource demand and commodity prices are incorporated into the model, commodity prices play a smaller role in explaining the variance of domestic output than that found in the previous literature.

Keywords: Brazil; EME business cycles; Dutch disease; SVAR.

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1 Introduction

The emergence of China as an economic powerhouse has contributed to the rapid transformation of the structure of the global economy (Jenkins, 2014). In particular, the unprecedented demand for natural resources for purposes of industrialization and urbanization has led to potentially substantial spillover effects for commodity-exporting countries (Cesa-Bianchi et al., 2012; Dungey et al., 2014, 2017). The empirical evidence suggests that the impacts of Chinese economic shocks on a typical Latin American economy have tripled since mid-1990 (Cesa-Bianchi et al., 2012). On the one hand, the benefits of high Chinese demand for most Latin American economies include rapid growth in the exports of mineral and agricultural inputs, and the fast recovery of Latin American and other developing economies in the aftermath of the global financial crisis is related to trade linkages with China. On the other hand, a slowdown in the growth of China represents a key risk (Gruss, 2014). More specifically, the contraction in the value of China's imports since 2014 compounds concerns of negative spillovers from China to commodity-exporting economies as China reorients its growth domestically (Cashin et al., 2017). The effects of global economic cycles on commodity-exporting emerging market economies (EMEs) has emerged as an important topic in international macroeconomics as these economies face a reversal in primary commodity prices and capital inflows simultaneously, which is labeled a "sobering reversal of a double bonanza" by Reinhart et al. (2016).

This paper empirically evaluates the effects of Chinese resource demand on EMEs using Brazil as a representative case using a structural VAR (SVAR) framework closely following Dungey et al. (2014). The model contains an external sector consisting of Chinese resource demand, world commodity prices, foreign output and real resource exports and a domestic sector consisting of the non-tradeable primary commodity sector, domestic output, inflation, the interest rate and the real exchange rate. The set up of the model enables the examination of the impacts of three external shocks on Brazil. These shocks include the following: (*i*) a shock to Chinese resource demand; (*ii*) a general shock to world commodity prices; and (*iii*) a general shock to foreign output. The configuration of the domestic sector of the model enables the assessment of the transmission of these shocks through domestic activity that is directly linked to resource demand (real resource exports and the non-tradeable primary commodity sector) and to other domestic activity such as domestic output.

A widespread feature of business cycles in EMEs is the countercyclical nature of the cost of borrowing faced in international financial markets. While in developed economies interest rates are mildly pro-cyclical, in EMEs, periods of low (high) interest rates are associated with economic expansion (contraction) due to the relatively large country-specific risk spread included in these rates (Fernández and Gulan, 2015; Shousha, 2016). According to Neumeyer and Perri (2005) and Uribe and Yue (2006), the interest rate reacts to EME fundamentals and vice versa, consequently exacerbating business-cycle fluctuations caused by real shocks. The recent literature includes world commodity prices among the fundamentals able to influence interest rates in EMEs, arguing that the negative relationships between these variables cause a further expansion that would not otherwise occur (Shousha, 2016; Drechsel and Tenreyro, 2018; Fernández et al., 2018; Zeev et al., 2017). Shousha (2016) argues that world commodity price shocks drive the business cycle fluctuations of small open commodity exporters, with stronger effects on the real activity of emerging economies rather than that of developed economies, which is largely due to the response of the interest rate.[1] However, the literature has been silent about the influence of resource demand shocks, rather than commodity price shocks, on the interest rate of EMEs, which eventually may have flow-on effects on the domestic economy.

A first look at the data in Section 2 strongly supports the use of the Brazilian economy as a representative case. Similar to other EMEs, Brazil's primary commodity exports are approximately 50% of total Brazilian exports. China overtook the U.S. as the largest trading partner of Brazil in 2009; the U.S. had been Brazil's most important economic partner for the previous eighty years (Cardoso, 2013). The primary sector in Brazil contributes approximately 7 percent to GDP, making it susceptible to commodity market swings. As expected, in an EME (Fernández et al., 2018), both world commodity prices and Chinese resource demand relate positively to output and investment and negatively to the real exchange rate and the interest rate.

Our findings highlight the mechanisms through which the external commodity sector acts as an important driver of business cycles in the Brazilian economy. Shocks to Chinese resource demand induce an expansion in the real value of resource exports, the non-tradeable primary commodity sector and domestic output for approximately six years, as well as an appreciation of the real exchange rate and a decline in the interest rate. Shocks to world commodity prices not resulting from resource demand also produce an expansionary effect on the Brazilian economy. However, the effects are less persistent than the shocks from Chinese resource demand. Shocks to world output are the least important. We contribute to the literature highlighting the role of commodity prices as a source of business cycles in EME's (Fernández et al., 2018; Shousha, 2016; Drechsel and Tenreyro, 2018). These works found that commodity price shocks explain approximately one-third of business cycle fluctuations. In contrast, an historical decomposition of the variance of domestic output over the sample period attributes a remarkable 35% to Chinese resource demand shocks and 9% to shocks to world commodity prices over the longer time horizon. Our contribution shows the bulk of the influence of the commodity sector on economic fluctuations in EMEs comes from Chinese demand rather than commodity price shocks or general world output shocks.

Another important result confirms the findings of Shousha (2016), who showed that the inclusion of commodity price shocks in the model dampens the contribution of interest rate shocks on domestic output, which is often found to be crucial in accounting for EME business cycles (Uribe and Yue, 2006). We add to this literature by showing the contribution of resource demand on variances in Brazil's interest rate. By including Chinese resource demand in the model, the contribution of world commodity prices in explaining the variance in the interest rate is lower than that found in the previous literature. For example, using data

[1] Specifically, using a DSGE framework, Shousha (2016) finds that an increase in commodity prices reduces foreign country indebtedness due to an increase in exports, which consequently lowers the interest rate. Since EMEs face financial frictions, the interest rate falls further due to lower country risk, which, in turn, directly relates to capital flows. Similarly, Drechsel and Tenreyro (2018), suggest that the negative relationship between the interest rate spread and commodity prices may come from creditors decreasing the required interest rate premium during the commodity price boom phase, as the collateral value of the economy depends directly on commodity prices through export earnings. For examples of the negative relationship between world commodity prices and country risk, see Bastourre et al. (2012); Aslam et al. (2016); Hilscher and Nosbusch (2010); Bouri et al. (2016) and Barone and Descalzi (2012). For an example of the pro-cyclical nature of capital inflows in developing economies, see Kaminsky et al. (2004); and for an example of the link between large capital inflows and an increase in consumption, investment and private credit, see Benigno et al. (2015). See Ornelas (2017) for an investigation of the influence of gross debt on the country spread.

from 1995Q1 to 2014Q3, Zeev et al. (2017) found that approximately 26% of the variance in the interest rate spread in Brazil is explained by world commodity price fluctuations. Our results show the equal importance of shocks to Chinese resource demand and shocks to world commodity prices (approximately 15% each) in explaining the variance in the interest rate. In turn, the interest rate plays a smaller role in explaining the variance in domestic output than that found in previous literature.

This article further contributes to the literature on the spillover effects of Chinese activity on small open economy commodity exporters. Dungey et al. (2014) found that shocks to Chinese resource demand and commodity prices led to lower Australian output after the first year due to falls in non-resource sector output, which was not offset by an increase in the resource output sector, which is consistent with the symptoms of Dutch disease. Subsequently, Dungey et al. (2017) found reduced evidence of Dutch disease in the Australia economy in the aftermath of the end of the commodity price boom. The authors showed that Chinese resource demand explains less than 4% of the variance in Australian output, and commodity prices explain less than 6% in the longer time horizon. As we show in this article, resource demand and world commodity prices exhibit relatively much stronger effects on the domestic output of Brazil, supporting the high relevance of global commodity cycles for EMEs.

The remainder of this paper proceeds as follows. Section 2 presents some stylized facts on the features of the Brazilian economy that show it is an appropriate example of a commodity exporting EME. Section 3 describes the SVAR framework, the data and the sample. Section 4 presents the results from the benchmark model, while Section 5 reports the results from alternative specifications and the robustness exercises. Section 6 concludes.

2 Stylized facts

The empirical features of the Brazilian economy summarized in Table 1 indicate that Brazil is an appropriate country to use for the model of commodity resource demand for an EME. The table summarizes data on the sectoral composition of the Brazilian economy and the correlation of key Brazilian variables with Brazilian output, Chinese resource demand and real commodity prices over the period of the analysis (1999Q1 to 2017Q1). The first column of the table shows the mostly domestic composition of the economy, with 78.2% of GDP coming from the non-tradeable sector. The contributions of the commodity and non-commodity tradeable sectors reveal a reasonable degree of diversification of the Brazilian economy at 7.5% and 14.3% of GDP, respectively and the likely susceptibility to world commodity price fluctuations.

The characteristics of the Brazilian economy shown in Table 1 align with those expected for a commodity exporting EME (Fernández et al., 2018; Fernández and Gulan, 2015), including a positive association of world commodity prices with domestic consumption, investment and output and a negative association with the real exchange rate and the interest rate. The positive association of Chinese resource demand with Brazilian output, all of the domestic sectors and investment, as well as the negative association with the real exchange rate and the interest rate variable, unsurprisingly reflects the prominent role of China in commodity markets. Most notable is the strong negative association between Chinese resource demand (-68.9%) and world commodity prices (-74.9%) and the interest rate, which, in turn, has a non-trivial role for Brazilian output compared to other EMEs through the considerably large

Table 1: Sectoral composition of the Brazilian economy and the correlation of key variables with Chinese resource demand, real commodity prices and Brazilian output, 1999Q1 to 2017Q1.

Sector/variable	Value added (% of GDP)	Correlation with		
		Chinese resource demand	Real commodity prices	Domestic output
	(1)	(2)	(3)	(4)
Sector				
Primary commodity	0.075	0.536	0.407	0.349
Non-commodity tradables	0.143	0.849	0.903	0.863
Non-tradables	0.782	0.513	0.802	0.982
Variables				
Real commodity prices		0.781	1.000	0.869
Resource exports		0.687	0.858	0.823
Investment		0.359	0.730	0.932
Consumption		0.255	0.612	0.860
Domestic output		0.631	0.869	1.000
Interest rate		-0.689	-0.749	-0.654
Real exchange rate		-0.385	-0.653	-0.640

Notes: All variables are linearly detrended and expressed in log form. Column (1) summarizes the sectoral composition of the Brazilian economy for the following: primary commodities (crops, livestock and mining); non-commodity tradables (manufacturing); and non-tradables (services, building industry, public utilities). Chinese resource demand is proxied by Chinese steel production; the real commodity price variable is a trade-weighted index containing prices of Brazil's three primary commodity exports (soybeans, iron ore and oil); Brazilian resource exports are the sum of soybeans, iron ore and oil; the real exchange rate is a trade-weighted index defined in terms of a basket of foreign goods such that a decrease is a real appreciation of the Brazilian real; and the interest rate is the sum of the JP Morgan EMBI+ sovereign spread and the U.S. real interest rate. For complete details on data construction and sources see Section 3.2 and Appendix A.

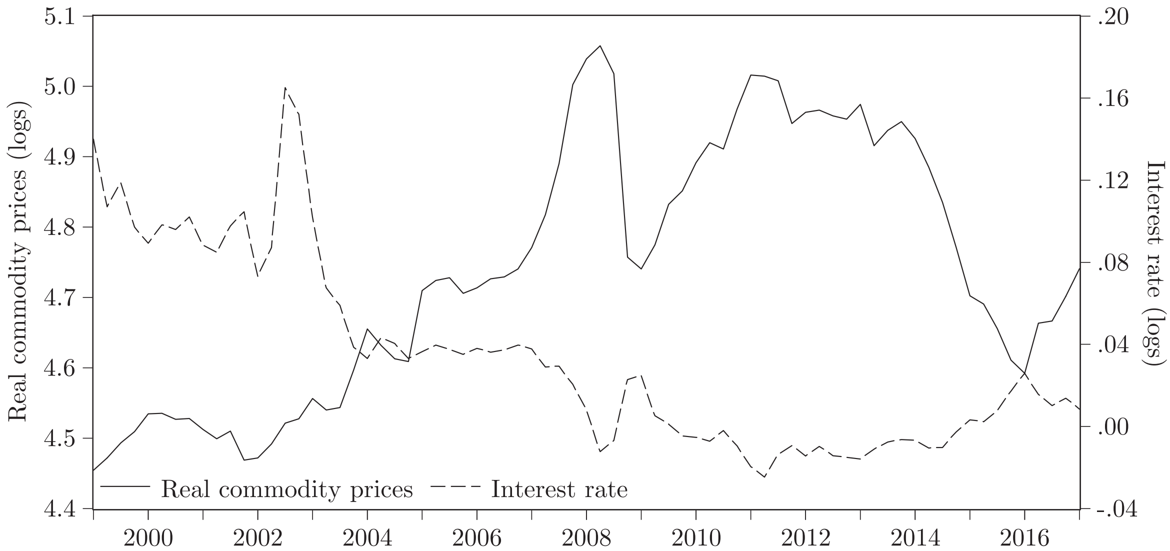

Figure 1: The Brazilian interest rate (left axis) and real commodity prices (right axis), 1999Q1 to 2017Q1.

Notes: The real commodity price variable is a trade-weighted index containing prices of Brazil's three primary commodity exports (soybeans, iron ore and oil). The interest rate is the sum of the JP Morgan EMBI+ sovereign spread and the U.S. real interest rate. For details on data construction and sources, see Section 3.2 and Appendix A.

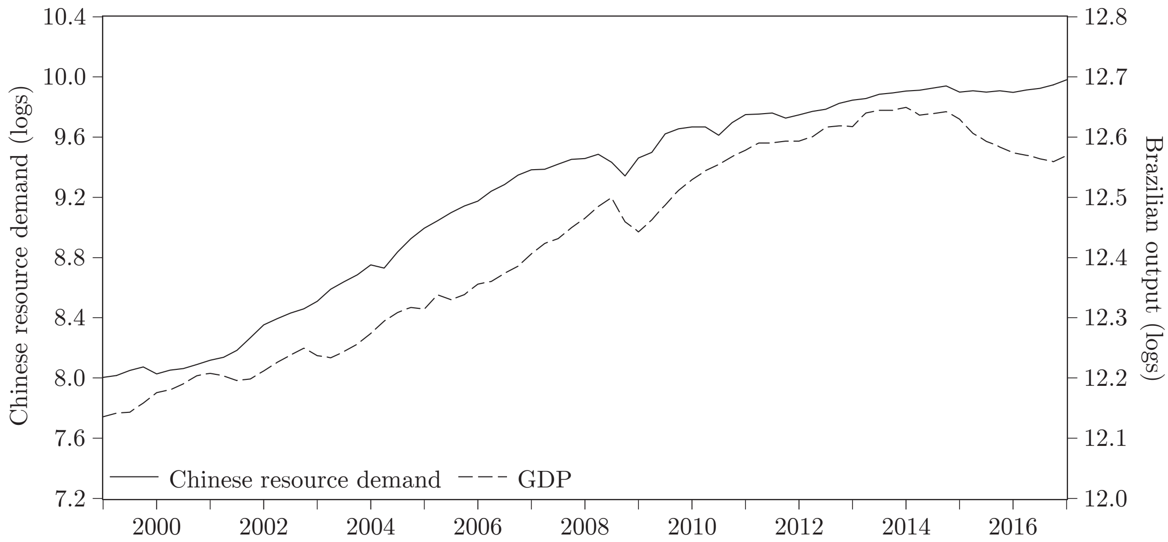

Figure 2: Chinese resource demand (left axis) and Brazilian GDP (right axis), 1999Q1 to 2017Q1.

Notes: Chinese resource demand is proxied by Chinese steel production. For complete details on data construction and sources, see Section 3.2 and Appendix A.

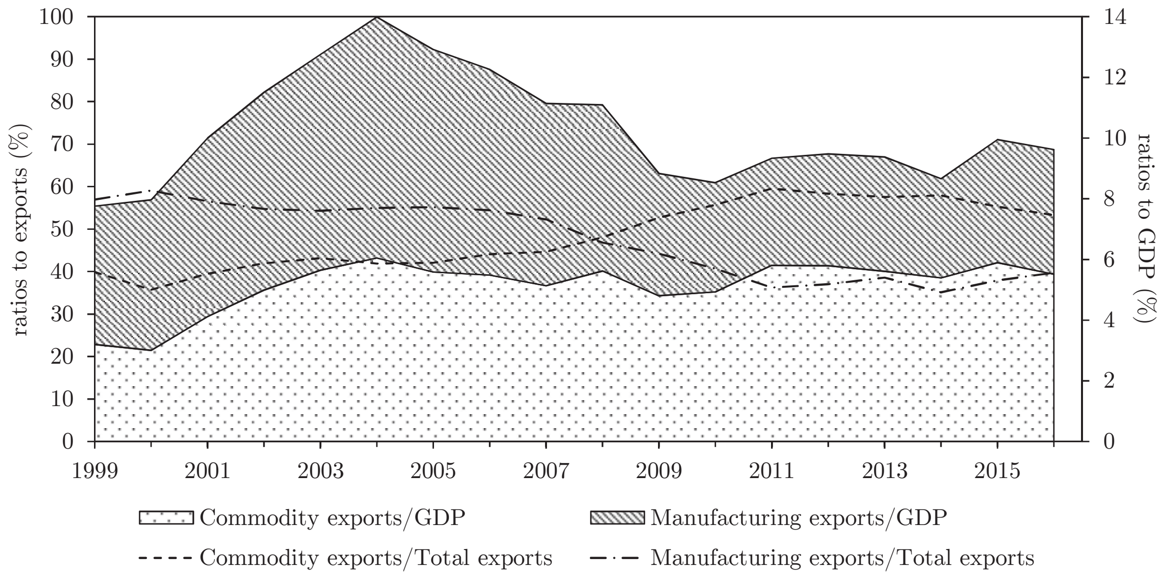

Figure 3: Commodity and manufacturing exports relative to total exports (left axis) and commodity and manufacturing exports relative to GDP (right axis), 1999Q1 to 2017Q1.

Notes: All data are in U.S. dollars, and the definition of commodities follows MDIC (2016). Sources: Central Bank of Brazil and AliceWeb.

stock of external debt (Fernández et al., 2018).[2]

To further explore the relationship between commodity prices and the cost of issuing debt faced by the Brazilian economy in international financial markets, Figure 1 plots real commodity prices against the interest rate. An inspection of Figure 1 shows a reduction in the cost of issuing debt when commodity prices rise, which is particularly evident at the peak of the commodity price cycle in 2007-2008 and again from 2010. From mid-2012, the interest rate variable increases as world commodity prices decline. In turn, Figure 2 shows a positive relationship between Chinese resource demand and Brazilian output. By 2016, after the slowdown in the rate of growth of both Brazilian output and Chinese resource demand, the Brazilian economy appears to recover, seemingly coinciding with the recovery in Chinese resource demand.

Since 1999, the share of commodity exports in terms of total Brazilian exports and GDP increased by approximately 15 and 3%, respectively, as shown in Figure 3. According to the AliceWeb dataset, the exports of soybeans, iron ore and oil accounted for 50.6% of primary commodity exports and 26.2% of total exports in Brazil during the sample period from 1999Q1 to 2017Q1.[3] This export demand mostly comes from China, which has been the leading importer of Brazilian soybeans since 2002 and iron ore since 2001.[4] The three largest

[2]For analyses of the external vulnerability indicators of the Brazilian economy during the period of 2001 to 2010, see Noije and de Conti (2016), and during the period of 2007 to 2013, see Prates (2014). For an analysis of Brazilian financial integration and new forms of external vulnerability, see Kaltenbrunner (2011).

[3]The System of Analysis of Foreign Trade Information (AliceWeb) is the main dataset used for Brazilian foreign trade. The platform obtains data from the Integrated Foreign Trade System of the Ministry of Industry, Foreign Trade and Services (MDIC). The data are available at `http://aliceweb.mdic.gov.br/`.

[4]Unless otherwise specified, soybeans refers to soybean complex: soybeans, soybean oil and soybean meal.

importers of Brazilian oil since 2005 include China in all years apart from in 2007.[5]

The decline in the share of manufactured goods in total Brazilian exports and in GDP coincides with an increase in the relative size of the commodity export market in Brazil, which is also shown in Figure 3. These numbers depict the challenges of the rapid growth in China faced by Brazil and several Latin American economies, particularly as the growth in global demand for imports from China means a loss of export markets for local producers (Jenkins and Barbosa, 2012; Hiratuka and Sarti, 2017). The debate abounds in Brazil about relative de-industrialization, which is mainly attributed to the maintenance of the overvalued Brazilian currency during the boom phase of the commodity price cycle (Oreiro et al., 2014; Bresser-Pereira, 2013; Sonaglio et al., 2016; Jenkins, 2015). Despite this debate, evidence of sectoral reallocation in the Brazilian economy from the commodity sector to the non-commodity sector is difficult to find.[6]

3 Empirical framework

Gauging the effects of Chinese resource demand on Brazil involves specifying a SVAR model of the Brazilian economy interacted with a sector specifically modeling Chinese demand, global commodity and general international shocks. This section outlines the SVAR model and identification assumptions and then describes the data and the sample period.

3.1 The SVAR model and identification

The SVAR model for the set of variables X_t in (1) follows

$$B(L)X_t = \epsilon_t, \quad (1)$$

with $B(L) = B_0 - B_1L - B_2L^2 - ... - B_pL^p$, lag operator L, the order of the matrix polynomial p, and with deterministic terms suppressed for convenience. In the application, X_t contains a 9×1 vector of endogenous macroeconomic variables. Formally, $X_t = [x_t^*, x_t]'$, with external variables denoted by x_t^* and domestic variables by x_t. The foreign variables in x_t^* consist of Chinese resource demand (csp_t), world commodity prices (pc_t), foreign output (yw_t) and Brazilian resource exports ($resx_t$). The domestic macroeconomic variables in x_t consist of

[5]For perspective, China accounted for 57.5% of soybean exports, 55% of iron ore exports and 38.8% of oil exports by Brazil in 2016. China imported USD14.4bn of Brazilian soybeans (in grain) in 2016, while the second largest importer imported around USD600mn. China imported USD7.3bn of iron ore in 2016, which is seven times more than the second largest importer. China imported USD5.8bn of Brazilian oil between January and September 2017, which is twice that of the second largest importer.

[6]Nassif et al. (2014) showed that there was a shift in the workforce from agriculture to the service sector, while there was a small increase in the share of manufacturing employment relative to total employment during the period from 2000 to 2009. However, the slowdown in labor productivity gains increased the technological gap in the Brazilian economy in the late 1990s. The authors concluded that Brazil has entered into a trajectory of falling behind due to an increase in the technological gap and a drop in manufactured exports, despite a relatively large and diversified Brazilian manufacturing industry. Benigno et al. (2015) provided empirical evidence of a reallocation of productive resources out of manufacturing, presumably into the non-tradable sector when there are large capital inflows into Latin America. There was one exception in the Brazilian economy. While Brazil did experience a consumption boom during the large capital inflows in the late 1990s, the share of employment dedicated to manufacturing sector was steady or rising.

the non-tradeable primary commodities sector in Brazil ($comm_t$), Brazilian output (yd_t), the inflation rate (pd_t), the interest rate (rd_t) and the real exchange rate (q_t). B_0 represents the contemporaneous relationships between the variables and is nonsingular and normalized to have unit values on the diagonal; ϵ_t denotes the 9×1 vector of normally distributed structural shocks with $E(\epsilon_t \epsilon_t') = D$ and $E(\epsilon_t \epsilon_{t+s}') = 0$, for all $s \neq 0$.The diagonal matrix D contains the variances in the structural innovations.

Model estimation begins with the reduced form representation

$$A(L)X_t = u_t, \tag{2}$$

where $A(L) = B_0^{-1}B(L) = I - A_1L - A_2L^2 - ...A_pL^p - ...A_pL^p$, and u_t represents a 9×1 vector of serially uncorrelated reduced form innovations with the characteristics $E(u_t) = 0$, $E(u_t u_t') = \sum$ and $E(u_t u_{t+s}') = 0$ for all $s \neq 0$. The reduced form residuals relate to the structural residuals through $u_t = B_0 \epsilon_t$. The estimation follows the AB form of the SVAR of Amisano and Giannini (1997). In this specification, $Au_t = B\epsilon_t$, where matrix A contains the contemporaneous parameters and matrix B controls the variance-covariance matrix of the structural innovations.

The identification of the structural shocks in the SVAR mainly takes place through lower triangular restrictions on the contemporaneous impact matrix B_0. Using the rationale of Dungey et al. (2014), the recursive ordering is as follows: csp_t, pc_t, yw_t, $resx_t$, $comm_t$, yd_t, pd_t, rd_t and q_t. We assume that the external variables in x_t affect all domestic variables contemporaneously. The Chinese resource demand variable comes first given its flow-on effect to world commodity prices and foreign output (Dungey et al., 2014). World commodity prices come before foreign output, following Berkelmans (2005). The domestic variables do not affect the external variables contemporaneously as Brazil is a small open economy. However, the domestic variables are able to affect the external sector with a lag. There is evidence of some market power of commodity-exporting economies in commodity markets, so this assumption allows for this channel if, in fact, this occurs in the data for the case of Brazil (Clements and Fry, 2008; Dungey et al., 2017).

As in Uribe and Yue (2006), the identification presupposes that changes in the interest rate influence domestic variables with one lag, but domestic shocks affect financial markets contemporaneously.[7] According to Shousha (2016), interest rate determination follows the domestic variables and precedes the real exchange rate for emerging market economies. Berkelmans (2005) argue that domestic monetary policy and inflation do not react contemporaneously to shocks to foreign output, and Dungey et al. (2014) extend that argument to the Chinese resource demand variable and real resource exports. We follow these same restrictions. Relaxing the restriction that external variables affect Brazil's interest rate with a lag and assuming that they affect the interest rate contemporaneously does not change the results very much, as shown in Section 5.

[7]According to Uribe and Yue (2006) financial markets react quickly to news about the business cycles in emerging economies. Moreover, decisions about real activity such as employment and spending on investment goods take time to implement.

3.2 Data and sample

External variables Chinese economic growth and urbanization has directly led to the demand for resources, particularly energy and mining products (Zhang and Zheng, 2008), and for food products such as meat and feed grains such as soybeans as Chinese diets shift towards higher meat consumption (Coates and Luu, 2012).[8] As in Dungey et al. (2014), the difficulty in sourcing a time series of overall Chinese resource demand necessitates using Chinese steel production (csp_t) as a proxy, which is a reasonable choice. The sensitivity analysis in Section 5 explores the use of alternative measures to Chinese steel production such as Chinese manufacturing exports (Roberts and Rush, 2010), Chinese industrial production and Chinese GDP.

The calculation of the real commodity price index for Brazil (pc_t) follows the method proposed by Deaton and Miller (1996) and Cashin et al. (2004). First, to calculate the weights of the index, the average value of each principal commodity export of Brazil (soybeans, iron ore and oil) is divided by the average total value of Brazil's commodity exports over the period 1996Q1 to 2017Q1. Second, the weights from step one are input into the calculation of the geometrically weighted index of monthly nominal commodity export prices expressed in U.S. dollars. Finally, dividing the nominal commodity price index (CPI) by the nominal price index of the U.S. CPI for all urban consumers results in the real commodity price index used in the empirical application. Dungey et al. (2014) also use the U.S. CPI to deflate the nominal price index, while Shousha (2016) and Zeev et al. (2017) use the U.S. import price of manufactured goods from industrialized countries to calculate the commodity terms of trade. To assess the propagation of commodity price shocks to the general macroeconomy, we retain the CPI-based deflator. The weights of the commodities in step one are soybeans (40.60%), iron ore (37.29%) and oil (22.11%).

The foreign output variable (yw_t) consists of a weighted measure of the real GDP of Brazil's eighteen most important trading partners in terms of the value of exports, with the weight calculated as the arithmetic average of export values from 1996Q1 to 2017Q1.[9] The measure of the real value of Brazilian resource exports ($resx_t$) contains the same products included in the real commodity price index.

Domestic variables The primary non-tradable commodity sector ($comm_t$) variable contains the sum of the value added of the crop and livestock sector and the mining sector and accounts for the direct effects of the variables in the commodity sector on the non-tradable commodity sector. The crop and livestock sector has a strong relationship with exported agricultural goods (soybeans), and the mining sector has a strong relationship with exported mineral goods (iron ore and oil). Domestic output (yd_t) consists of Brazilian real GDP, and the inflation rate (pd_t) is the Broad National Consumer Price Index (IPCA) and the main indicator of the inflation target of the Central Bank of Brazil.

The interest rate (rd_t) construction follows Uribe and Yue (2006) and Shousha (2016), and is the sum of JP Morgan's EMBI+ sovereign spread and the U.S. real interest rate. The three-

[8]China accounted for nearly 63% of global imports of soybeans in 2016, according to the dataset of the Food and Agriculture Organization of the United Nations (FAOSTAT). The data are available at `http://www.fao.org/faostat/en`.

[9]Foreign output calculated using export and import shares is similar to that calculated using only export shares. The results are available upon request.

month U.S. Treasury bill minus a measure of U.S. expected inflation measures the latter. The weighted index is composed of foreign debt instruments from the governments of emerging countries, which are actively traded and denominated in U.S. dollars.

The real exchange rate variable (q_t) utilizes the Central Bank of Brazil's trade weighted index expressed in real terms using the Broad National Consumer Price Index (IPCA). The inclusion of the real exchange rate links with the literature on the influence of external shocks on EMEs (Shousha, 2016; Fernández et al., 2018; Zeev et al., 2017; Drechsel and Tenreyro, 2018) and also to the literature on the impact of commodity booms on commodity-exporting economies (Dungey et al., 2014, 2017; Corden, 1984; Corden and Neary, 1982; Frankel, 2012; van Wijnbergen, 1984). Appendix A contains full details of the data and data sources.

Sample and treatment of the data The data frequency is quarterly, and the sample period extends from 1999 Quarter 1 to 2017 Quarter 1.[10] The start date of 1999 coincides with the floating of the Brazilian real exchange rate following the pressure of the Russian default in late 1998. Although it is common for SVAR papers on the Brazilian economy to begin their sample period in 1996 or before (for example, see Zeev et al. (2017)), a floating currency is likely to be a major shock absorber in of terms of trade shocks on the domestic economy (Aslam et al., 2016) and hence represents an important break in the exchange rate data for the questions under consideration. The sample period encompasses the entirety of the last commodity price boom and the aftermath period.

The data are transformed with all non-stationary variables linearly detrended and expressed in log form. The exception is the inflation rate, which is a percentage. The VAR lag order selection tests indicate either one (Schwartz Bayesian Information Criterion and Hannan-Quin Information Criteria) or two (Akaike Information Criteria and Likelihood Ratio) lags (using a maximum lag length of $pmax = 4$). The lag length of $p = 2$ ensures no serial correlation, and the SVAR satisfies the stability condition.

4 Chinese resource demand effects an EME

To disentangle the effects of the external shocks to Chinese resource demand (csp_t), real commodity prices (pc_t) and foreign output (yw_t) on the dynamic relationships between the external variables and the economy of Brazil, Sections 4.1 to 4.4 present the impulse response functions to shocks for each of these variables, followed by the forecast error variance decompositions for all variables in the model.

4.1 Shock to Chinese resource demand

A one standard deviation shock to Chinese steel production (or 3.76%), as shown in Figure 4, results in rising real commodity prices received by Brazilian exporters, indicating that the shock coming from China is a commodity demand shock. Real commodity prices peak at 3.43% above the baseline in the third quarter. Steel production in China and real commodity

[10] The Brazilian System of National Accounts (reference series 2010) is integrated with the National Classification of Economic Activities (CNAE). Taking into account the current classification of products and activities released in 2007, the Brazilian Institute of Geography and Statistics (IBGE) provides quarterly and chain-weighted data from the first quarter of 1996 expressed in 1995 prices.

prices converge to their initial values approximately six years after the shock. The characteristics of the shock are akin to those of a demand shock, and the duration of the shock is the same as in Dungey et al. (2017).

Brazilian resource exports and the primary commodity sector expand in response to the commodity demand shock, peaking at 6.81% and 1.09% above the baseline level in the fourth and third quarters, respectively. Consistent with Veríssimo and Xavier (2013), the rise in the real value of Brazilian resource exports occurs despite an appreciation of the real exchange rate, reflecting the high profitability of resource exports from EMEs. Higher Chinese resource demand and the resultant commodity price boom translate into an expansion of output in Brazil. Domestic output peaks at 1.05% in the third quarter and remains above the baseline for approximately eight years. The expansion occurs in both the resource sector and the non-resource sector of the Brazilian economy, suggesting that there is no evidence of Dutch disease.

Chinese resource demand and the resulting commodity price boom puts downward pressure on the interest rate available to Brazil in foreign capital markets as investors react to the improvement in Brazil's terms of trade. The interest rate remains below the baseline level for six years in response to a Chinese resource demand shock. This channel contributes to the explanation of the overall expansionary effect of the shock to Chinese resource demand on the domestic economy. Both increased commodity exports and the decline in the interest rate lead to an appreciation of the real exchange rate. Remarkably, all variables regarding domestic activity remain above the baseline level for nearly six years, which is similar to the duration of the shock to Chinese resource demand. The exception is inflation, which is neutralized by the appreciation of the real exchange rate.

The results for a shock to Chinese resource demand are more positive for the macroeconomy in Brazil than for the macroeconomy Australia. Unlike our results for Brazil, Dungey et al. (2014) find some evidence of Dutch disease as Australian output drops below the baseline after the first six quarters in response to the Chinese resource demand shock. The main reasons for this identified by the authors include the following: i) tighter monetary policy invoked as the economy expands; ii) the fall in the real value of Australian resource exports in response to the combined effect of the rise in real commodity prices and the appreciation of the real exchange rate; and iii) the movement of factors of production out of the non-resource sector into the expanding resource sector. These mechanisms are in direct contrast to the case of Brazil, where the (externally set) cost of borrowing in foreign markets is more favorable, commodity exports rise despite exchange rate appreciation, and both the resources sector and the non-resources sector expand in response to the shock.

4.2 Shock to commodity prices

A one standard deviation shock to real commodity prices received by Brazilian exporters, as shown in Figure 5, corresponds to a rise of 3.65%. Real commodity prices peak at 3.97% by the second quarter and remain above their initial level for six quarters. In response to the shock, steel production in China falls and remains below the baseline for approximately ten years. Foreign output reacts positively but eventually falls below the baseline after the first year. These results are consistent with a commodity supply shock, where commodity prices rise and commodity (steel) production falls. The price of goods that use commodities as inputs rise in response to the rupture in the supply of commodities, and subsequently,

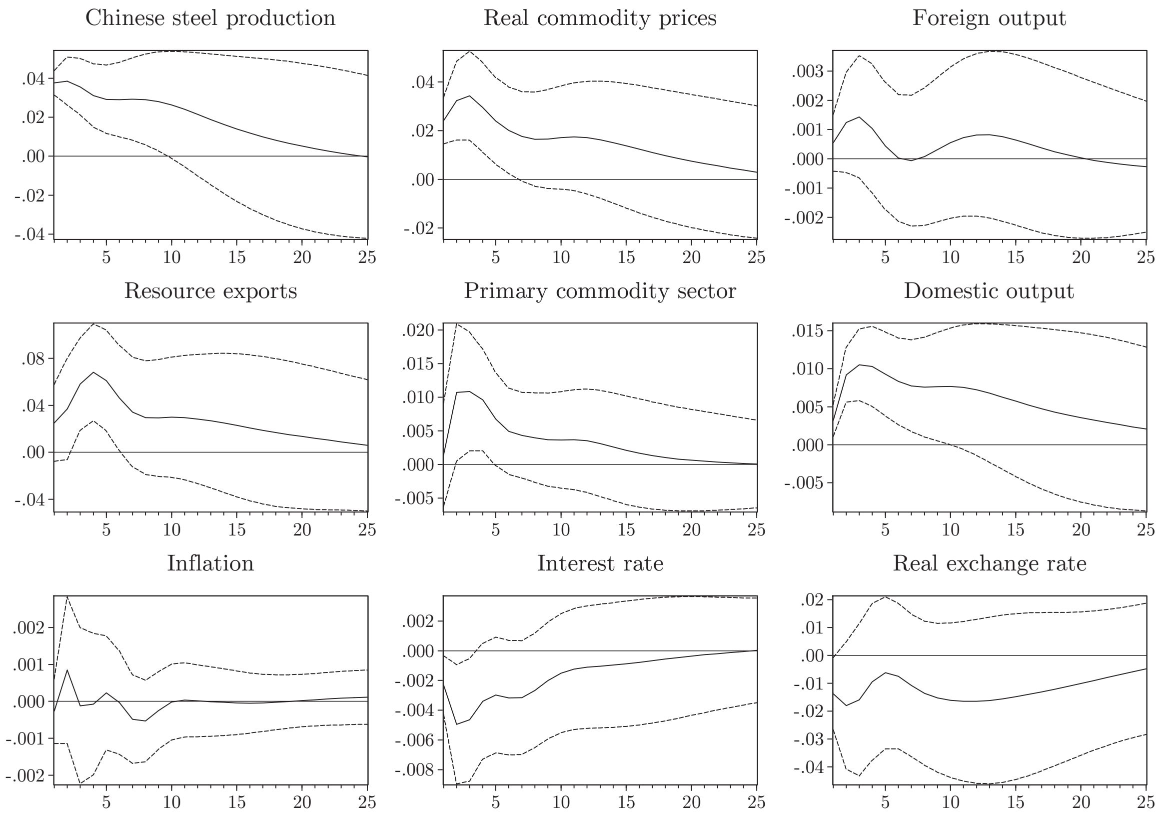

Figure 4: Impulse response functions to a shock to Chinese steel production, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

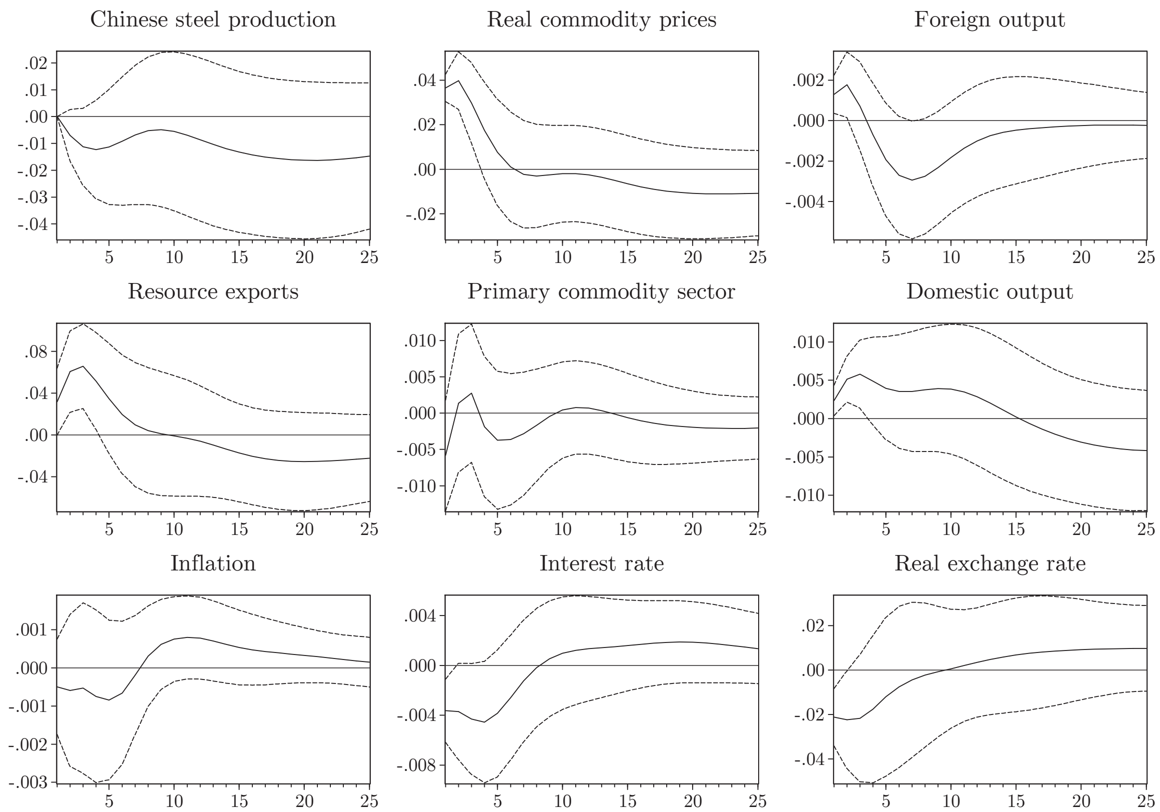

Figure 5: Impulse response functions to a shock to commodity prices, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

foreign output falls (Jääskelä and Smith, 2013).

The real value of Brazilian resource exports peaks at 6.56% in the third quarter and remains above the baseline for nine quarters, following the higher world commodity prices closely. Similar to the shock to Chinese resource demand, Brazilian resource exports rise in response to higher world commodity prices despite a real exchange rate appreciation. The primary commodity sector in Brazil fluctuates around the baseline level in response to a commodity supply shock, reflecting the combined effect of lower steel production in China, lower foreign output, and higher world commodity prices. Resource demand shocks rather than commodity price shocks drive the primary commodity sector in Brazil.

Domestic output peaks at 0.58% above the initial level in the third quarter in response to the commodity supply shock and remains above the baseline for fifteen quarters. Similar to the effect of the Chinese resource demand shock, Brazil's interest rate falls in response to the world commodity price shock and remains below the initial level for two years. The reaction of domestic output and the interest rate confirm the findings reported by Zeev et al. (2017); Shousha (2016); Drechsel and Tenreyro (2018); Fernández et al. (2018), who suggest that world commodity prices are important sources of business cycles in Latin America because they reduce the country's interest rate, causing a further expansion that would not otherwise occur. The spillover effect from commodity prices to the interest rate helps explain the expansionary impact of the shocks to commodity prices on domestic output.

The real exchange rate appreciates in response to higher world commodity prices, remaining below the baseline level for nine quarters, following higher resource exports and lower interest rate closely. As the interest rate measures the cost of borrowing that emerging countries face in international financial markets, a decrease in that rate leads to capital inflows, which puts further pressure on the real exchange rate. Indeed, Shousha (2016) argues that the interest rates of EMEs rise when there are capital outflows, while in advanced economies, interest rate rises are mainly due to monetary policy tightening. As in the previous shock, inflation is neutralized by the appreciation of the real exchange rate.

4.3 Shock to foreign output

Figure 6 shows the responses to a shock to foreign output of 0.38%, which has a long duration but quite insignificant effects compared to the Chinese resource demand and commodity price shocks. By the thirteenth quarter, the effect of the shock on itself is only 0.07%. Chinese steel production falls below the baseline for nineteen quarters, while world commodity prices, Brazilian resource exports and the primary commodity sector (shortly afterwards) fall in response to lower Chinese resource demand. The decrease in resource exports occurs despite the depreciation of the exchange rate. Brazilian resource exports more strongly relate to Chinese resource demand than higher world demand as the latter does not sustain Brazilian resource exports or output.

Brazil's interest rate initially falls in response to the positive external conditions, but after three quarters, it reverses to be above the baseline. The overshooting of the interest rate may be partly responsible for the negative response of the primary commodity sector. Lower commodity prices and Brazilian exports contribute to the real exchange rate depreciation, with the higher interest rate providing additional pressure for depreciation.

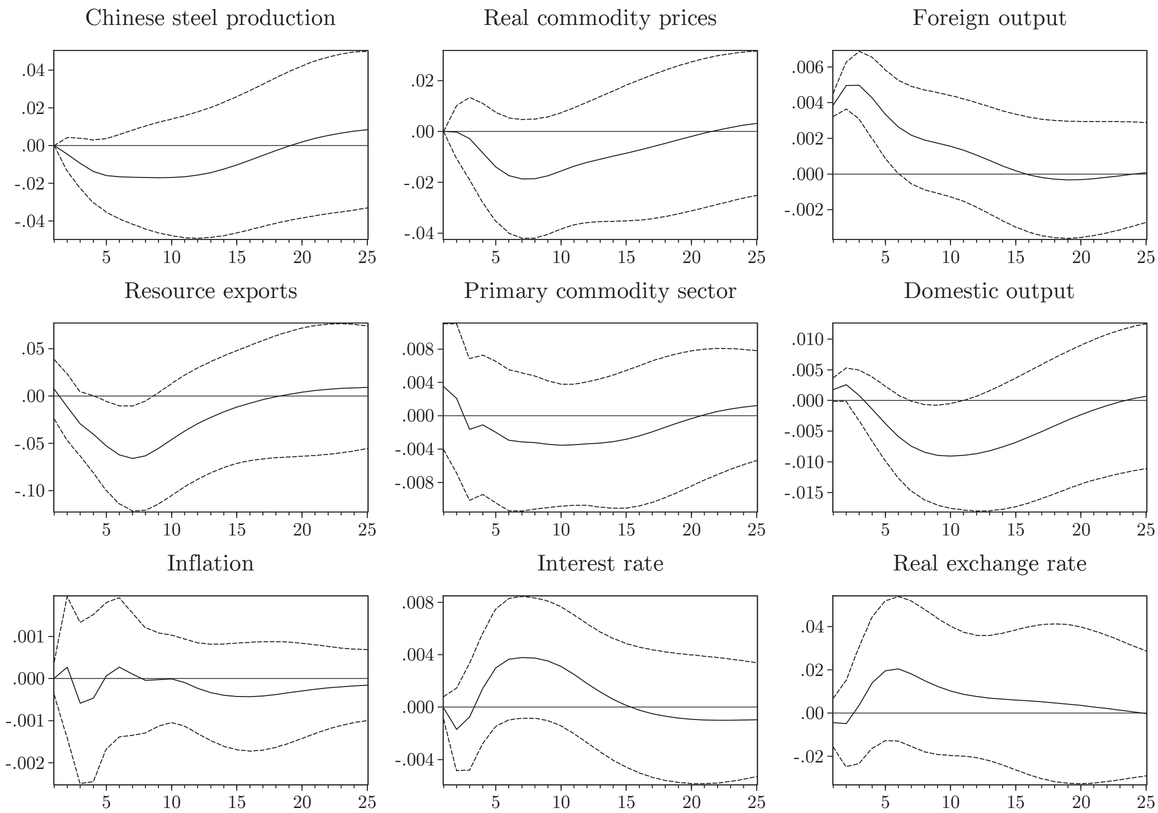

Figure 6: Impulse response functions to a shock to foreign output, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

4.4 Forecast error variance decomposition

Table 2 presents the forecast error variance decomposition of each variable. The decomposition shows the proportionate contribution of each of the shocks in the model to each variable over short (one and four quarters), medium (twelve quarters) and long (24 quarters) horizons.

The variance decompositions for the external sector of Chinese steel production, commodity prices and world output are shown in the first three rows of column one of Table 2. Over the long horizon (24 quarters), almost half of the variance of Chinese steel production comes from a combination of its own shocks (32.84%) and those of world commodity prices (9.18%) and foreign output (8.60%). The contribution to Chinese steel production of Brazilian output (11.97%), the primary commodity sector (14.23%) and the real exchange rate (14.92%) provides evidence of a strong interaction between commodity demand (from China) and supply (represented here by Brazil). Like Australia (Dungey et al., 2017), Brazil exhibits some market power in the commodity prices of their exports represented by the contribution of Brazilian output to commodity prices at the 24th quarter (9.88%). The decomposition of world demand falls mainly to the shock itself (46.79%) and commodity prices (18.31%).

The large contribution of the external sector of approximately 70% to the variance of Brazilian exports stands out. This result is expected because of the direct link between resource demand and commodity price fluctuations and Brazilian commodity exports. Brazilian resource exports react to resource demand and commodity prices regardless of the real exchange rate since the latter variable accounts for less than 5% of resource exports. These findings concur with the impulse responses shown in Sections 4.1 to 4.3.

The top panel in the second column of Table 2 provides evidence of direct links between the external resource sector and the non-tradable primary commodity sector as the second and third largest contributors to the primary commodity sector are Chinese resource demand (17.96%) and the exchange rate (14.21%), respectively. Overall, its own shocks dominate (42.58%), with the remaining quarter of contributions evenly spread between the domestic macroeconomy and the external sector. The commodity sector in Brazil is driven by demand shocks instead of price shocks.

The second panel of column 2 of Table 2 contains the most important variance decomposition of Brazilian output. The decomposition shows the susceptibility of the Brazilian economy to external shocks. Over the longer horizon, Chinese steel production (34.94%), world commodity prices (9.29%) and world demand (25.60%) combine to contribute around 70% of explaining the variance in domestic output. In comparison, the findings in Dungey et al. (2017) show that Chinese steel production and world commodity prices are responsible, respectively, for a mere 3.36% and 5.11% of Australian output in the long run. The contrasting results of the two papers align with Shousha (2016), who finds that real commodity prices are responsible for 23% of the movement in the domestic output of EMEs compared with 7% of that in advanced economies. Our findings confirm the idea that Chinese resource demand has a strong role in the business cycles of EMEs and that world commodity prices also have a non-trivial role, even when these prices are orthogonal to resource demand. The interest rate is generally considered essential in accounting for business cycles in EMEs (for example, see Uribe and Yue (2006)) and explains 1.49% of Brazilian output, again confirming Shousha (2016), who argues that, at least for commodity exporters, the interest rate shocks capture commodity price effects when the latter are omitted from the models, leading to an overestimation of the importance of the interest rate for the business cycle.

Table 2: Forecast error variance decomposition (in per cent), 1999Q1 to 2017Q1

Variable	Shock	Horizon (qtr) 1	4	12	24	Variable	Shock	Horizon (qtr) 1	4	12	24
	csp_t	100.00	81.18	47.31	32.84		csp_t	0.21	15.58	18.54	17.96
	pc_t	0.00	5.19	3.39	9.18		pc_t	3.22	2.23	3.30	4.09
	yw_t	0.00	4.73	10.71	8.60		yw_t	1.16	0.97	3.87	5.05
	$resx_t$	0.00	4.63	7.30	6.22		$resx_t$	6.62	5.47	5.64	5.34
csp_t	$comm_t$	0.00	0.31	8.05	14.23	$comm_t$	$comm_t$	88.80	53.52	45.24	42.58
	yd_t	0.00	0.75	10.01	11.97		yd_t	0.00	2.91	3.96	5.73
	pd_t	0.00	0.90	0.27	0.30		pd_t	0.00	0.45	0.72	0.68
	rd_t	0.00	0.42	0.78	1.73		rd_t	0.00	4.99	4.39	4.37
	q_t	0.00	1.89	12.18	14.92		q_t	0.00	13.90	14.35	14.21
	csp_t	30.37	43.97	41.69	34.10		csp_t	12.28	49.66	41.30	34.94
	pc_t	69.63	49.02	27.32	23.18		pc_t	6.68	14.30	9.92	9.29
	yw_t	0.00	0.95	14.03	11.44		yw_t	3.77	1.98	25.75	25.60
	$resx_t$	0.00	0.14	1.52	2.79		$resx_t$	0.15	0.21	1.48	1.82
pc_t	$comm_t$	0.00	2.06	4.02	8.67	yd_t	$comm_t$	1.01	2.83	3.67	4.30
	yd_t	0.00	0.14	6.71	9.88		yd_t	76.10	28.22	15.14	18.51
	pd_t	0.00	3.06	2.17	1.53		pd_t	0.00	1.82	1.32	0.92
	rd_t	0.00	0.35	0.46	1.28		rd_t	0.00	0.69	0.69	1.49
	q_t	0.00	0.31	2.07	7.13		q_t	0.00	0.29	0.71	3.12
	csp_t	1.78	4.86	3.13	3.57		csp_t	0.18	0.74	1.17	1.12
	pc_t	9.92	5.67	20.57	18.31		pc_t	0.63	1.33	4.00	5.43
	yw_t	88.30	80.46	54.16	46.79		yw_t	0.00	0.58	0.64	1.62
	$resx_t$	0.00	0.22	4.11	4.70		$resx_t$	0.14	2.88	3.43	3.52
yw_t	$comm_t$	0.00	1.09	7.45	12.78	pd_t	$comm_t$	1.46	13.26	13.18	14.39
	yd_t	0.00	1.55	1.81	2.06		yd_t	0.36	4.59	6.15	5.77
	pd_t	0.00	0.62	0.53	0.50		pd_t	97.22	40.76	37.02	34.73
	rd_t	0.00	0.26	0.39	0.41		rd_t	0.00	29.86	28.79	27.01
	q_t	0.00	5.29	7.86	10.87		q_t	0.00	5.99	5.63	6.40
	csp_t	3.26	20.59	21.76	20.05		csp_t	3.20	14.44	15.65	13.96
	pc_t	5.24	23.94	13.66	15.33		pc_t	7.89	15.18	13.60	15.86
	yw_t	0.25	5.50	25.59	21.05		yw_t	0.00	1.25	12.70	11.86
	$resx_t$	91.25	37.55	18.79	15.92		$resx_t$	0.23	8.56	6.20	5.94
$resx_t$	$comm_t$	0.00	5.61	4.65	7.84	rd_t	$comm_t$	2.16	1.83	2.32	5.53
	yd_t	0.00	3.56	12.50	12.94		yd_t	1.04	3.47	11.77	11.51
	pd_t	0.00	0.52	0.51	0.45		pd_t	0.14	0.61	0.64	0.62
	rd_t	0.00	2.37	1.90	2.23		rd_t	85.34	54.08	35.32	30.69
	q_t	0.00	0.35	0.64	4.19		q_t	0.00	0.58	1.79	4.04
							csp_t	5.31	4.94	9.06	12.38
							pc_t	12.52	9.87	7.75	8.65
							yw_t	0.54	1.45	7.87	6.97
							$resx_t$	1.46	0.57	0.67	2.13
						q_t	$comm_t$	10.79	28.30	28.65	26.34
							yd_t	1.86	2.71	5.33	7.08
							pd_t	0.47	0.46	0.64	0.53
							rd_t	21.00	11.70	8.20	6.92
							q_t	46.04	40.00	31.84	29.00

In turn, shocks in the external sector contribute the bulk of the variance of the interest rate in the long horizon with Chinese steel production (13.96%) and world commodity prices (15.86), following, in magnitude, the effect of the shock itself (30.69%). This result points to strong spillover effects from both Chinese resource demand and world commodity prices to the interest rates of EMEs, again, even when world commodity prices are orthogonal to resource demand. Our findings show that the inclusion of Chinese resource demand in the model dampens the contribution of commodity prices to the interest rate. Considering a two year horizon, Zeev et al. (2017) found that the commodity terms of trade explain 26% of interest rate spread fluctuations in Brazil. The interest rate channel helps to explain the expansionary effect of Chinese resource demand on the non-resource domestic sector.

Apart from its own shocks (29%) and the non-tradeable primary commodity sector in Brazil (26.34%), Chinese steel production (12.38%) and world commodity prices (8.65%) explain the majority of the variance of the real exchange rate. Combined, Chinese steel production and world commodity prices contribute approximately 20 percent to the variance of the real exchange rate in the longer term, confirming the findings of Chen and Rogoff (2003) and Cashin et al. (2004) that the real exchange rate in Brazil is associated with commodity market fluctuations in such way that it belongs to the group of commodity currencies.

As expected, the interest rate influences the variance in the exchange rate in the long horizon as the interest rate plays a non-trivial role in the determination of the exchange rate. These results align with the findings in Prates (2009), who argues that the effect of improved terms of trade and the resulting trade surplus on the Brazilian exchange rate was as much direct on the spot exchange rate, as indirect through its impact on the market expectations of the trajectory of Brazilian country and currency risk and hence the Brazilian interest rate available on international markets.[11]

5 Alternative specifications

This section sets out some alternative specifications to the benchmark model of Section 4 to investigate the model robustness to measures of Chinese resource demand, real commodity price indexes, the sample period, and a detrending of the data. Figures 7 to 15 present the impulse response functions for the shocks to Chinese resource demand, commodity prices and world output for the robustness experiments, while Table 3 contains the forecast error variance decomposition for the most important variable of output in Brazil for each case. The complete set of results are available upon request. Like the model in Section 4, the models for the robustness exercises have a lag length of $p = 2$, and all SVARs satisfy the stability condition.

Overall, the model is remarkably robust to the alternative specifications of the model. Table 3 shows that over the longer term horizon of 24 quarters, the contribution of Chinese resource demand shocks to Brazilian output range from 18.17 to 43.89 percent compared to the benchmark model, which was 34.94 percent. The contribution of the commodity price shocks to output ranges from 1.56 to 9.56 percent, compared to the benchmark model, which

[11] Although not directly modeled, our findings support the view that world commodity price fluctuations influence capital flows to Brazil in terms of both foreign direct investment (Frizoa and Lima, 2014) and portfolio investment (Bredow et al., 2016). These results also concur with the argument of Forbes et al. (2016), who show that when Brazil implemented its capital controls, investors increased the share of their portfolios allocated to 'dragon play'

was 9.29 percent, while the contribution of foreign output shocks to output in Brazil ranges from 10.88 to 42.34 percent compared to the benchmark of 25.60 percent.

5.1 Alternative measures of Chinese resource demand

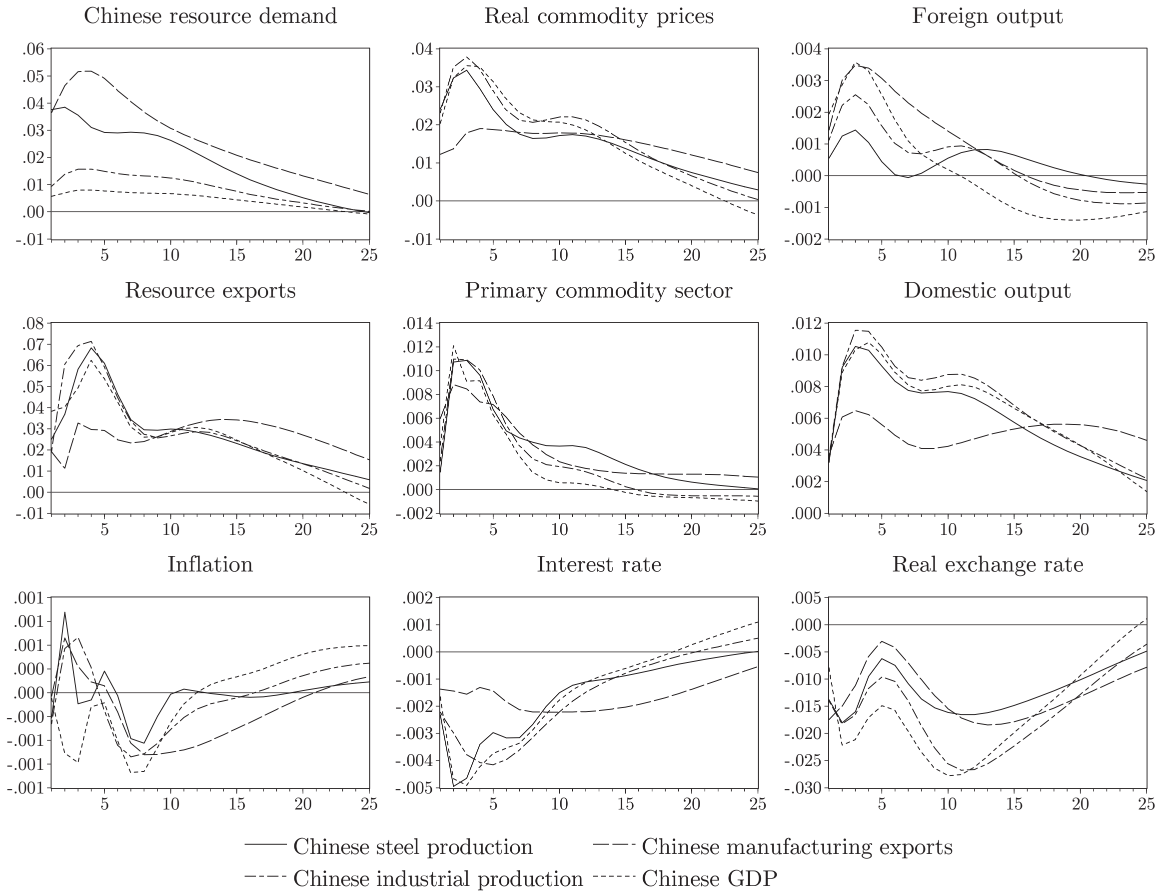

Figure 7: Robustness of impulse response functions for shocks to Chinese resource demand for models with alternative measures of Chinese resource demand, 1999Q1 to 2017Q1.

Three alternative proxies of Chinese resource demand of Chinese manufacturing exports, industrial production and GDP are sequentially substituted into the VAR in place of the Chinese steel production (csp_t) variable to examine the sensitivity of the model to the alternative measures. Figures 7 to 9 compare the impulse response functions to each of the shocks to Chinese resource demand, real commodity prices and foreign output shocks for the benchmark model of Chinese steel production (illustrated with the solid line) with the alternatives. In the majority of cases, the impulse response functions follow similar patterns to our benchmark.

Roberts and Rush (2010) show that China's manufacturing exports significantly drive its resource demand, potentially making a good alternative proxy for Chinese resource demand in place of the Chinese steel production variable. Replacing Chinese steel production with

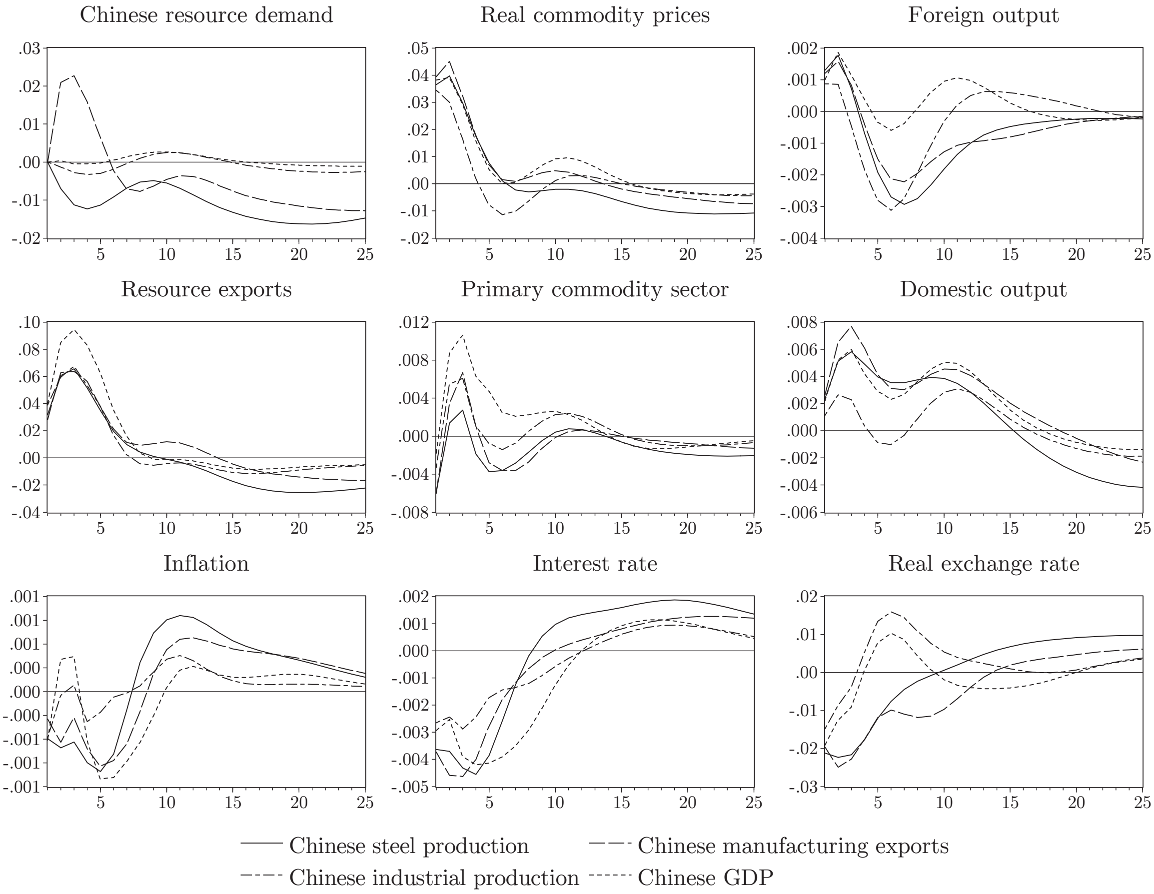

Figure 8: Robustness of impulse response functions for shocks to real commodity prices for models with alternative measures of Chinese resource demand, 1999Q1 to 2017Q1.

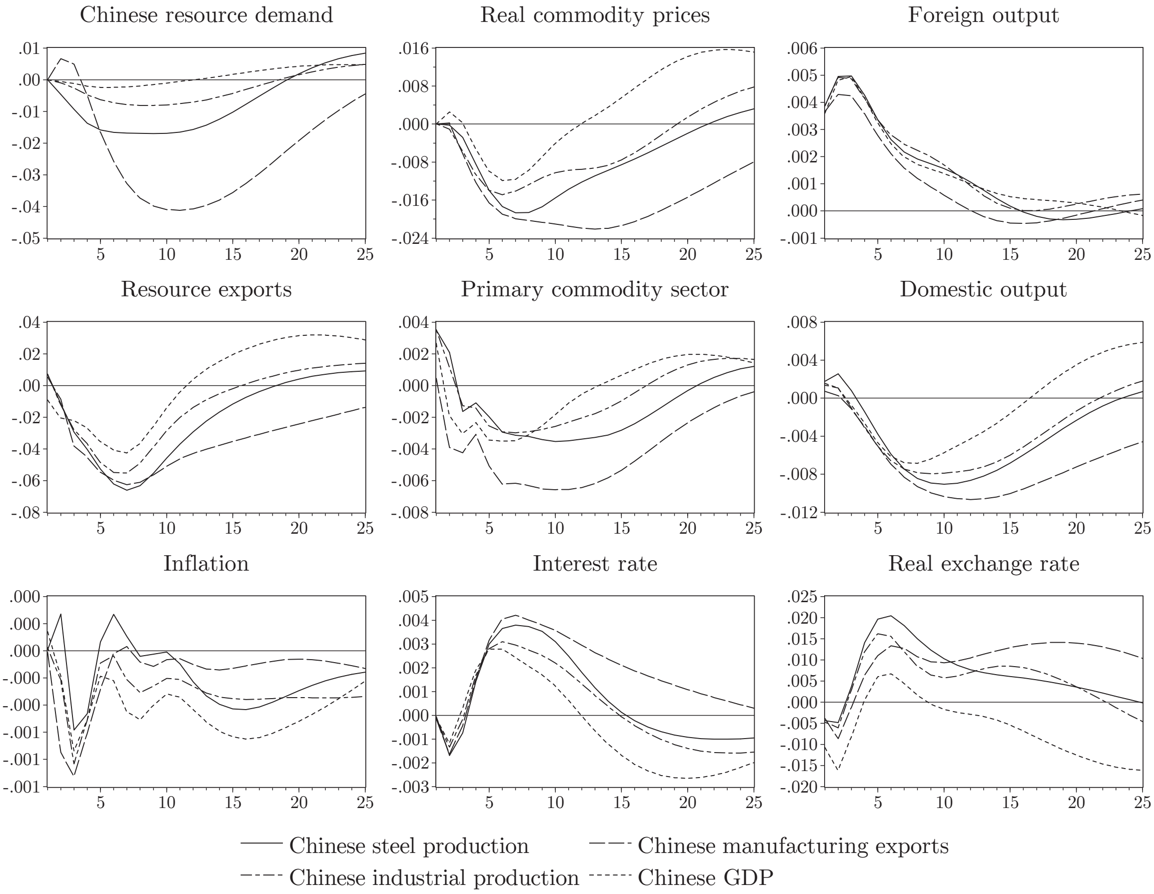

Figure 9: Robustness of impulse response functions for shocks to foreign output for models with alternative measures of Chinese resource demand, 1999Q1 to 2017Q1.

Table 3: Robustness analysis: Forecast error variance decomposition of output for models with alternative specifications (in per cent).

	Horizon (qtr)					Horizon (qtr)			
	1	4	12	24		1	4	12	24
Robustness to Chinese resource demand					Robustness to commodity price index				
Chinese manufacturing exports					*Broad basket*				
cme_t	14.65	23.70	17.35	18.17	csp_t	10.54	46.67	40.70	36.09
pc_t	7.82	26.41	15.65	8.67	$pc7_t$	8.37	12.56	10.25	8.38
yw_t	0.58	1.94	39.23	42.34	yw_t	2.36	1.40	24.98	26.13
$resx_t$	0.53	1.90	1.58	2.19	$resx7_t$	0.46	0.35	1.87	1.86
$comm_t$	0.54	5.66	5.70	4.70	$comm_t$	2.18	2.08	2.67	2.76
yd_t	75.87	36.70	17.01	17.91	yd_t	76.09	34.04	14.94	16.84
pd_t	0.00	2.45	1.06	0.64	pd_t	0.00	1.72	1.69	1.19
rd_t	0.00	0.61	1.04	4.44	rd_t	0.00	0.87	1.00	1.14
q_t	0.00	0.63	1.38	0.94	q_t	0.00	0.32	1.91	5.62
Chinese industrial production					*Non-oil basket*				
cip_t	15.47	61.13	44.21	30.16	csp_t	12.07	47.84	46.47	42.52
pc_t	1.63	2.30	2.03	1.56	$pc6_t$	4.34	9.14	7.99	6.52
yw_t	2.37	2.28	19.63	14.37	yw_t	4.03	2.22	21.63	23.05
$resx_t$	0.72	0.69	3.10	3.18	$resx6_t$	0.01	0.55	1.89	1.12
$comm_t$	1.81	0.81	6.05	15.60	$comm_t$	1.24	1.80	1.76	2.90
yd_t	78.00	23.92	16.18	26.24	yd_t	78.30	35.34	14.43	13.48
pd_t	0.00	7.94	6.93	4.59	pd_t	0.00	1.68	1.35	0.85
rd_t	0.00	0.19	1.31	3.99	rd_t	0.00	1.17	1.26	1.28
q_t	0.00	0.73	0.58	0.30	q_t	0.00	0.25	3.20	8.27
Chinese GDP					*Commodity terms of trade*				
$cgdp_t$	12.77	49.87	41.26	30.40	csp_t	11.48	48.60	39.84	34.11
pc_t	5.91	13.71	9.92	6.04	$ctot_t$	6.78	14.90	11.02	9.56
yw_t	2.91	1.72	13.36	10.88	yw_t	3.94	2.08	25.93	26.23
$resx_t$	0.22	0.50	4.71	5.00	$resx_t$	0.14	0.23	1.60	1.47
$comm_t$	1.24	0.42	5.65	11.58	$comm_t$	0.90	2.77	3.71	4.06
yd_t	76.94	26.35	18.33	28.19	yd_t	76.76	28.50	15.13	18.67
pd_t	0.00	5.50	5.13	3.24	pd_t	0.00	1.76	1.28	0.91
rd_t	0.00	0.56	0.54	1.17	rd_t	0.00	0.81	0.91	1.99
q_t	0.00	1.38	1.09	3.50	q_t	0.00	0.36	0.58	3.01
Robustness to sample period					Robustness to detrending				
Boom period									
csp_t	9.50	42.85	40.78	38.19	csp_t	7.00	29.22	43.60	43.89
pc_t	8.23	16.37	13.92	9.16	pc_t	8.18	15.19	6.60	3.21
yw_t	5.15	3.21	21.57	27.64	yw_t	3.16	2.31	6.54	14.06
$resx_t$	0.25	0.58	0.96	0.70	$resx_t$	0.99	1.47	12.12	9.11
$comm_t$	0.89	6.11	7.51	4.58	$comm_t$	2.47	4.45	4.70	3.86
yd_t	75.99	29.72	12.56	12.16	yd_t	78.20	41.75	18.63	12.55
pd_t	0.00	0.11	1.12	5.21	pd_t	0.00	3.48	3.48	2.15
rd_t	0.00	0.56	0.68	0.62	rd_t	0.00	0.92	2.04	1.29
q_t	0.00	0.49	0.90	1.74	q_t	0.00	1.19	2.30	9.88
Long period									
csp_t	8.04	33.59	37.42	32.98					
pc_t	6.63	18.38	10.08	7.73					
yw_t	3.60	2.47	14.22	14.32					
$resx_t$	0.02	0.48	2.07	3.89					
$comm_t$	0.00	7.07	4.87	4.46					
yd_t	81.70	33.92	14.01	8.46					
pd_t	0.00	3.23	5.71	4.76					
rd_t	0.00	0.01	2.13	6.61					
q_t	0.00	0.84	9.49	16.79					

manufacturing exports and shocking the exports variable as a proxy for Chinese resource demand results in impulse response functions of a larger magnitude over its duration. However, the quantitative effect on real commodity prices is smaller than that of the original model, with the consequences for the Brazilian variables of resource exports and domestic output being substantially smaller (see Figure 7). The response of manufacturing exports to the real commodity price shock (Figure 8) and foreign output (Figure 9) is the most different of all of the alternatives, with Chinese resource demand changing signs, as shown in Figure 8, for the commodity price shock and increasing in magnitude, as shown in Figure 9, for the foreign output shock.

Replacing the Chinese steel production variable with Chinese industrial production and Chinese GDP, as shown in Figures 7 to 9, results in its own shocks and responses being muted, compared to the benchmark, reflecting the sectors not related to resource demand that these variables capture. Overall the impulse responses of Chinese industrial production and Chinese GDP in the models track each other quite closely but follow dynamics that are similar to those of the impulse response functions of the benchmark model.

The first three panels in the first column of the table show the historical decomposition of output when Chinese manufacturing, industrial production and GDP are substituted into the model for Chinese steel production. The decompositions of Chinese industrial production and the GDP are similar to the results when Chinese steel production is used in the benchmark model with Chinese steel production contribution 34.94 percent to output after six years, compared to 30.16 percent for industrial production, and 30.40 percent for the GDP. The contribution for manufacturing is lower at 18.17 percent.

In contrast to the Chinese resource demand shocks, the commodity price shocks in the alternative models explain a small percentage of output after six years, ranging from a contribution of 1.56 percent to 8.67 percent, compared to 9.29 percent in the benchmark model. The robustness exercises strongly support the overturning of the premise that world commodity price shocks have an important effect on the Brazilian economy. Instead, Chinese resource demand for primary commodities exported by Brazil is a more important driver of output.

5.2 Alternative measures of real commodity price indexes

The index for the benchmark model contains the three main primary commodities exported by Brazil to China: soybeans, iron ore and oil. The second robustness exercise explores alternative definitions of the basket of commodities used in the calculation of the commodity price series and the resource exports variable. Figures 10 to 12 and the first three rows of the second column of the forecast error variance decomposition of output in Table 3 present the results.

First a broader basket of commodities containing the seven most important primary commodities exported by Brazil substitutes into the model. In addition to soybeans, iron ore and oil, the expanded versions of real commodity prices ($pc7_t$) and resource exports ($resx7_t$) contain chicken meat, beef and coffee. Second, the commodities basket is recalculated to exclude oil since energy prices have a particular growth dynamic that may be different from the other main commodities in the basket. Cashin et al. (2014) and Mohaddes and Pesaran (2016) present evidence on the effects of oil prices on growth. Finally, following Zeev et al. (2017) and Shousha (2016), the commodity terms of trade are substituted into the model in

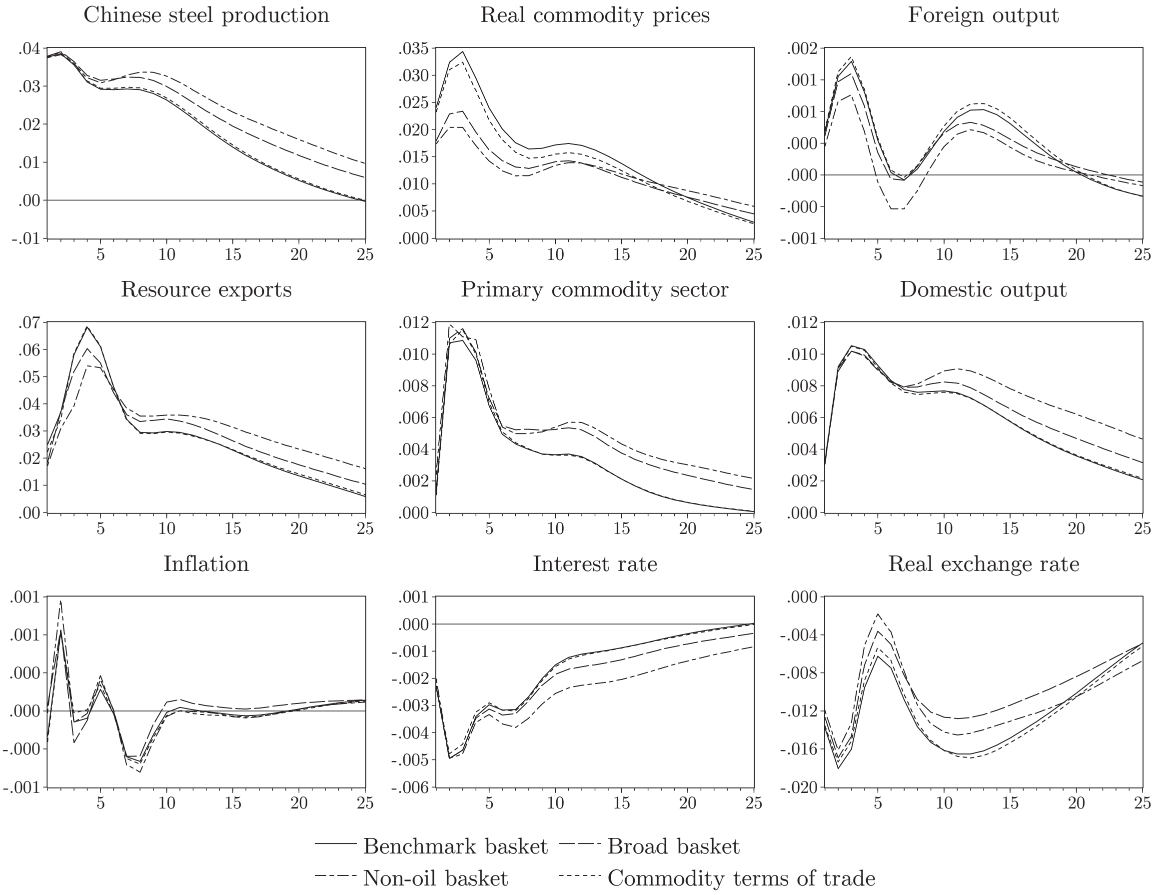

Figure 10: Robustness of impulse response functions for shocks to Chinese resource demand for models with alternative measures of real commodity prices, 1999Q1 to 2017Q1.

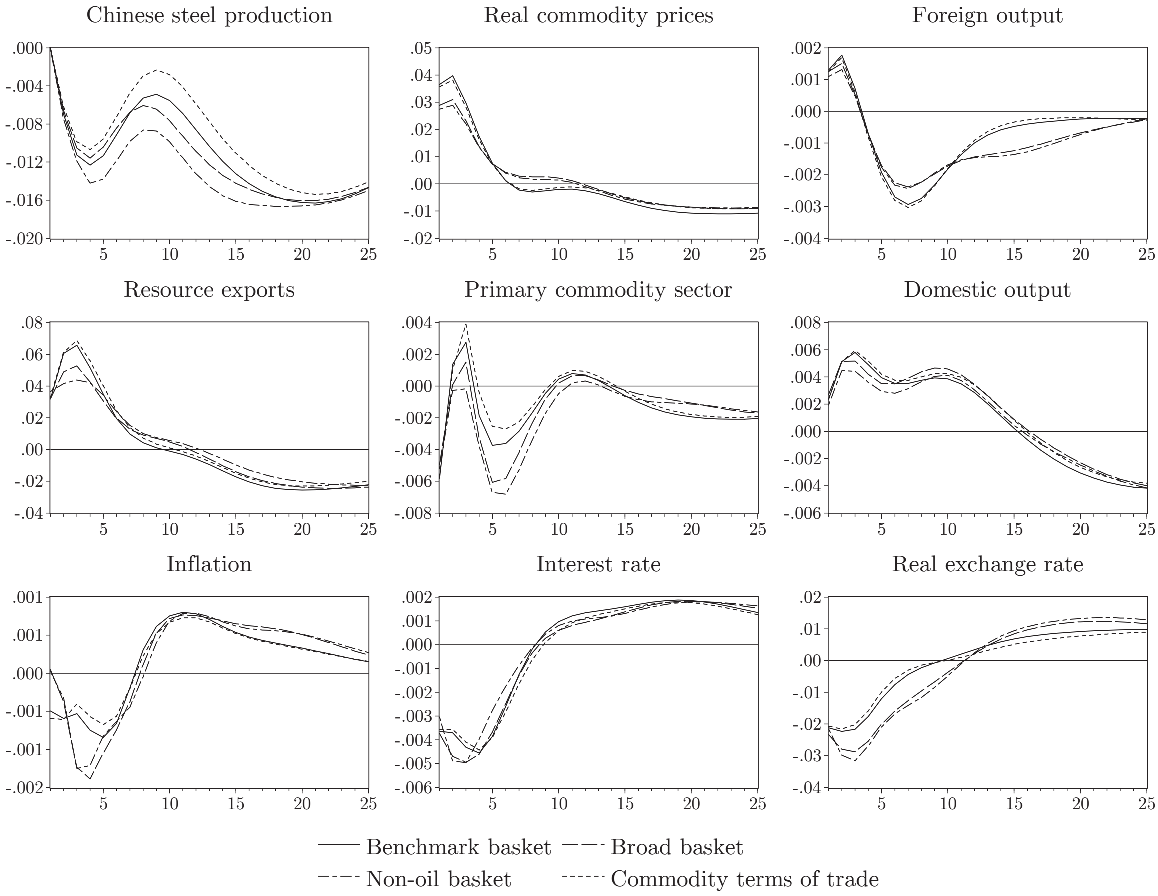

Figure 11: Robustness of impulse response functions for shocks to real commodity prices for models with alternative measures of real commodity prices, 1999Q1 to 2017Q1.

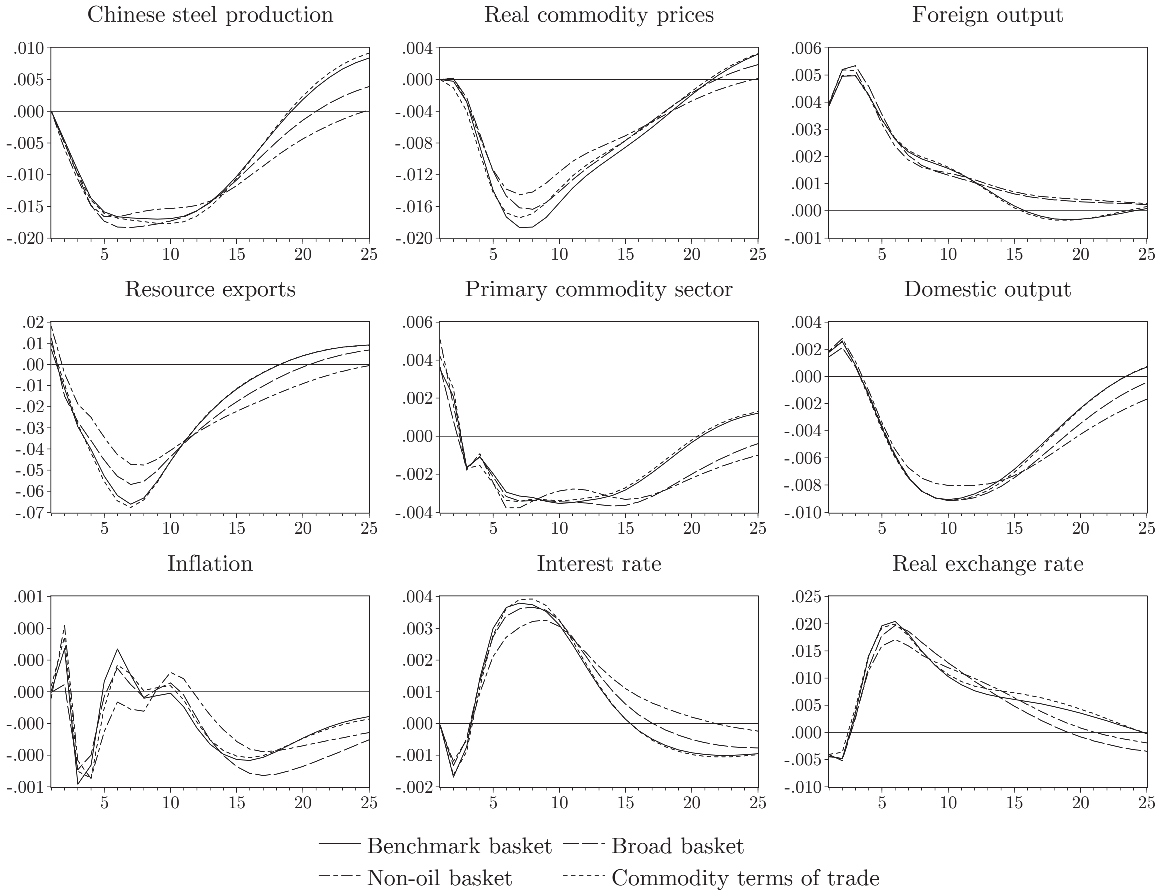

Figure 12: Robustness of impulse response functions to shocks to foreign output for models with alternative measures of real commodity prices, 1999Q1 to 2017Q1.

place of the real commodity price index. The series is computed by dividing the commodity price index by the U.S. import price of manufactured goods from industrialized countries.

The benchmark model shows little sensitivity to changes in the definitions of the real commodity price index, as illustrated in Figures 10 to 12 and Table 3. Figure 10 shows that in response to the Chinese resource demand shock, world commodity prices composed of the seven commodities peak at 2.33% in the third quarter, and resource exports peak at 6.03% in the fourth quarter, which is only slightly lower than for the benchmark model. Excluding oil reinforces the results of the Chinese steel production shock. Real commodity prices and Brazilian resource exports peak at a value slightly lower than the benchmark model. Comparing the variance decomposition tables for the output of the benchmark model with the model where the commodities' terms of trade are substituted for the commodity price variable shows only minute differences. In the latter model, the contribution of commodity prices, commodity terms of trade and world output are 34.11, 9.56 and 26.23 percent, respectively, after six years. For the benchmark model the contributions are 34.94, 9.29 and 25.60 percent, respectively. The results are clearly similar enough to the benchmark model to conclude that Brazilian resource exports to China are sufficiently represented by the three main commodities of soybeans, iron ore and oil.

5.3 Long sample period

Previous papers in the literature such as Zeev et al. (2017) and Shousha (2016) using a VAR framework for Brazil sometimes use a sample starting point before our chosen starting point of 1999Q1. Zeev et al. (2017) and Shousha (2016) use a starting point of 1995Q1 and 1994Q2, respectively. The earlier starting point inevitably includes a period prior to the adoption of a floating exchange rate regime for Brazil. To assess the sensitivity to the sample period definition we estimated the model encompassing a long sample period beginning in 1996Q1. Figures 13 to 15 present the results, with Figure 13 showing that in response to a shock to Chinese resource demand, the real exchange rate returns to the initial level faster than the benchmark model. As a consequence, the response of domestic output to shocks to Chinese resource demand is still positive in the fiftieth quarter. The historical decompositions show that in the model with the long sample period, Chinese resource demand explains just over four percent of the exchange rate in comparison to just over twelve percent for the sample period beginning that coincides with the floating of the currency.[12] This alternative specification suggests that the use of data prior to 1999Q1 can overestimate the impact of Chinese resource demand shocks on domestic variables since the real exchange rate is not allowed to dampen those shocks.

5.4 Commodity prices boom period

Dungey et al. (2014) estimate a VAR model for the Australian economy taking into account the impact of Chinese resource demand on the domestic economy with a sample spanning 1988Q1 to 2012Q2. The end of 2012Q2 coincides with the end of the commodity price boom for Australia (for example, see Kulish and Rees (2017)). Figure 1 shows that this timing roughly coincides with the end of the boom period for Brazil. Dungey et al. (2017), which is an extension of Dungey et al. (2014), find reduced evidence of decreased domestic production

[12]The results of the historical decomposition for the long sample period are available on request.

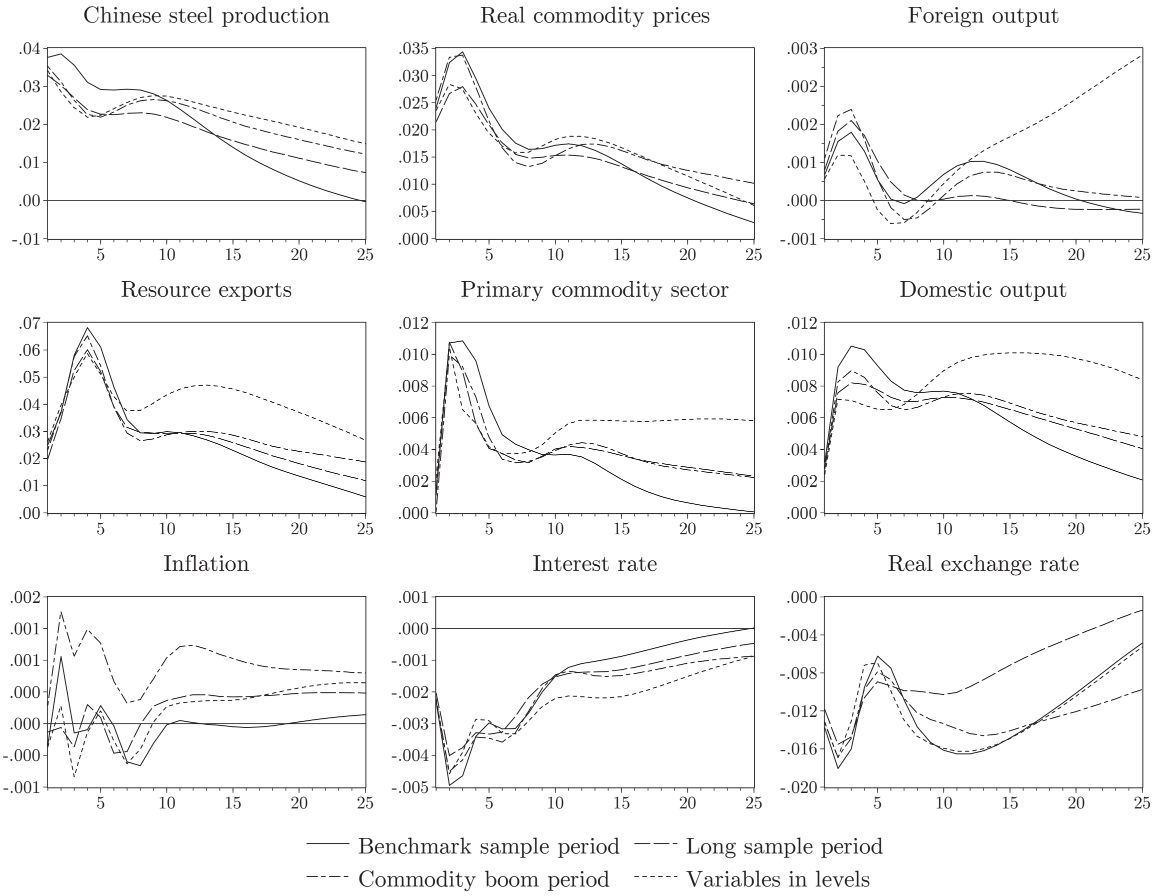

Figure 13: Robustness of impulse response functions to shocks to Chinese resource demand for models with alternative sample period definitions and variables in levels.

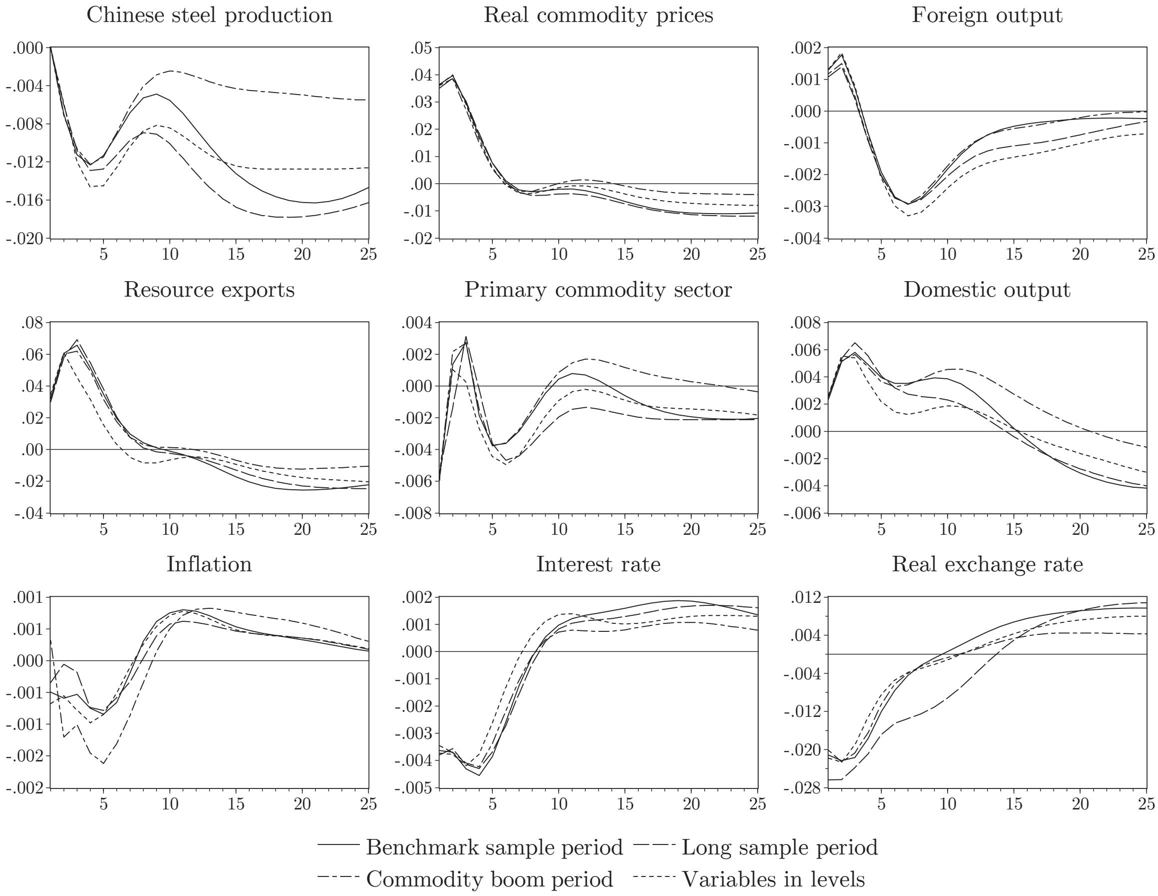

Figure 14: Robustness of impulse response functions to shocks to real commodity prices for models with alternative sample period definitions and variables in levels.

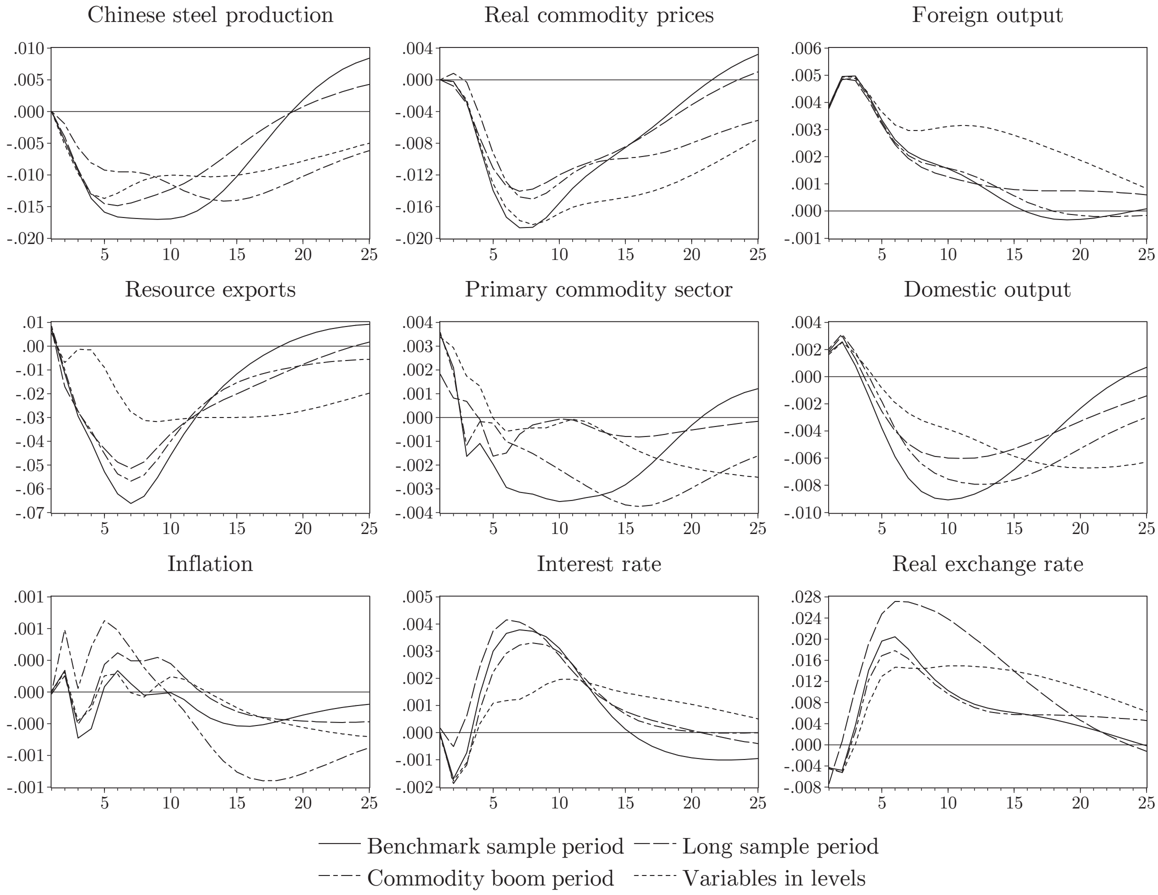

Figure 15: Robustness of impulse response functions to shocks to foreign output for models with alternative sample period definitions and variables in levels.

associated with commodity price shocks (or less evidence of Dutch disease symptoms) for Australia over the longer sample period. The authors argue that despite the longevity of the shock, the Australian economy responded to the commodity boom as though it was temporary rather than permanent. Specifically, commodity prices return to their initial level much faster than in the model with the sample ending in 2012Q1 in response to both Chinese resource demand shocks and commodity price shocks.

To verify the post-boom effects in the benchmark model for Brazil, the model is re-estimated by inserting a dummy variable into all equations of the VAR from 2012Q2 to 2017Q1. Figures 13 to 15 show the impulse response functions taking into account the specification with the dummy variable (the commodity boom period), while the fourth row in column one of Table 3 presents the variance decomposition. Figure 13 shows that in response to a shock to Chinese steel production, commodity prices return to their initial level faster in the benchmark model than in the model where the commodity prices boom period is contained. However, the differential effects are much smaller than that shown for the Australian economy by Dungey et al. (2017).

5.5 Detrending

Figures 13 to 15 also present the results of the model's robustness to the detrending of the data. The impulse response functions for the variables in log levels form and the last panel of the variance decomposition where the data is not detrended shows that the model is remarkably resilient to the treatment of the trends in the data.

5.6 Additional robustness tests

A range of additional robustness checks were undertaken but did not substantially affect the results. These results are not reported but are available on request including: (*i*) allowing external variables to affect the interest rate contemporaneously in line with Uribe and Yue (2006); (*ii*) removing the primary commodity sector from the domestic output variable; and (*iii*) replacing the domestic sector variables with the series measured in U.S. dollars instead of in local currency terms.

6 Conclusion

Unprecedented demand for commodity resources coinciding with the industrialization and urbanization of China may have significant consequences for those with large commodity resources. The effects of global swings in the commodity sector are relevant for emerging markets that have historically been highly vulnerable to the sector. This paper sheds light on the effects of external shocks on EMEs with a case study of Brazil. The demand of China for Brazilian commodity exports of iron ore, soybeans and oil dwarfs the demand of any other country. We carefully identify shocks to Chinese resource demand, general world commodity prices and world output, and our findings support the idea that external forces are substantial sources of aggregate fluctuations in EMEs, with the prominent source being Chinese resource demand. Shocks to the prices of the commodities that Brazil exports also have a non-trivial role in the aggregate fluctuations in EMEs, even with orthogonality between commodity prices and resource demand. More specifically, a shock to Chinese resource demand triggers expansionary effects on domestic output, even when we abstract from the sectors directly linked to resource demand such as real resource exports and the primary non-traded commodity sector in Brazil. Commodity price shocks prove less favorable than the price swings driven by resource demand shocks in terms of persistence.

The results of a battery of robustness checks indicate that over the longer term horizon of 24 quarters, the contribution of Chinese resource demand shocks to Brazilian output ranges from 18.17 to 43.89 percent compared to the benchmark model of 34.94 percent. The contribution of the commodity price shocks to output ranges from 1.56 to 9.56 percent compared to the benchmark model of 9.29 percent, while the contribution of foreign output shocks to output in Brazil ranges from 10.88 to 42.34 percent compared to the benchmark of 25.60 percent.

A salient mechanism of adjustment in Brazil is the movement of the interest rate in the opposite direction to both resource demand and commodity prices, amplifying the real effects of the commodity sector boom. The interest rate response to similar shocks in developed economies tends to be opposite that of EMEs, as in emerging countries, the interest rate is influenced by international investors assigning favorable movements in country risk as the commodity sector booms, hence reducing the applicable interest rate, whereas in developed countries interest rates tend to rise as the monetary authority seeks to dampen the inflationary effect of a commodity boom (Dungey et al., 2014, 2017).

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A Data appendix

The following describes the dataset used in this article. Items *(i)* to *(vii)* contain the data used in the benchmark model. Items *(viii)* to *(xii)* contain the data used in the robustness exercises in Section 5:

***(i)* Chinese steel production (csp_t)** : In thousand tonnes, monthly. The monthly data are converted to quarterly data by summing the values of the quarter; these data are seasonally adjusted using ARIMA X13. The data source is Datastream (code CHVALSTLH). Missing data for 2014M1, 2014M2, 2016M1 and 2016M2 are replaced with estimates from the World Steel Association.

***(ii)* Real commodity prices (pc_t) and resource exports ($resx_t$)** : Nominal commodity prices in U.S. dollars, monthly. The data are deflated by the U.S. CPI for All Urban Consumers. The sources are The World Bank - Global Economic Monitor Commodities and the Bureau of Labor statistics.

Brazilian exports in U.S. dollars are used to derive the weights to construct the real commodity price index and to calculate the value of Brazilian resource exports. The export data come from the System of Analysis of Foreign Trade Information (AliceWeb). We follow the definitions of commodities proposed by MDIC (2016). Specifically, we use the products related to the following NCM (Common Nomenclature of MERCOSUL - South American trade bloc) codes: soybeans (12010010, 12010090, 12011000, 12019000, 15071000, 23040010, and 23040090), iron ore (26011100, 26011200, 26012000, 26011210, and 260112900), and crude oil (27090010). Soybeans encompass all the soybean complexes: soybeans, soybean oil and soybean meal. The export series is deflated by the U.S. CPI and seasonally adjusted using ARIMA X13.

***(iii)* Foreign output (yw_t)** : Constant U.S. dollars and seasonally adjusted. The source is the World Bank - Global Economic Monitor.

***(iv)* Non-tradable primary commodity sector ($comm_t$) and the Brazilian GDP (domestic output) (yd_t)** : The source is the Brazilian System of National Accounts of the Brazilian Institute of Geography and Statistics (IBGE). The data are chain-weighted in 1995 prices and seasonally adjusted.

***(v)* Inflation (pd_t)** : The source is the Brazilian Institute of Geography and Statistics (IBGE) (code: 433).

***(vi)* Interest rate (rd_t)** : The sum of JP Morgan's Emerging Markets Bond Index (EMBI+ Brazil) and the U.S. real interest rate. The source of the JP Morgan EMBI+ is the Brazilian Institute of Applied Economic Research (IPEA). The source of data on the three-month U.S. Treasury bill and the measure of U.S. expected inflation is the Federal Reserve Bank of St. Louis.

(*vii*) Real exchange rate (q_t) : The source is the Central Bank of Brazil (code 11752).

(*viii*) Chinese manufacturing exports (cme_t) : In hundred million U.S. dollars, deflated by the U.S. CPI and seasonally adjusted using ARIMA X13. The source for the data on manufacturing exports is Datastream (code CHEXMANUA). The source for the U.S. CPI for All Urban Consumers: all items is the Bureau of Labor statistics.

(*ix*) Chinese industrial production (cip_t) : Constant U.S. dollars and seasonally adjusted. The source is the World Bank - Global Economic Monitor (code: IPTOTSAKD).

(*x*) Chinese GDP ($cgdp_t$) : Constant U.S. dollars and seasonally adjusted. The source is the World Bank - Global Economic Monitor.

(*xi*) Commodity terms of trade ($ctot_t$) : U.S. import prices of manufactured goods from industrialized countries are used to calculate the commodity terms of trade. The source is the Federal Reserve Bank of St. Louis (code: INDUSMANU);

(*xii*) Domestic output denominated in U.S. dollars ($yd(\$)_t$): Constant U.S. dollars and is seasonally adjusted. The source is the World Bank - Global Economic Monitor.

B Online appendix of alternative model specifications

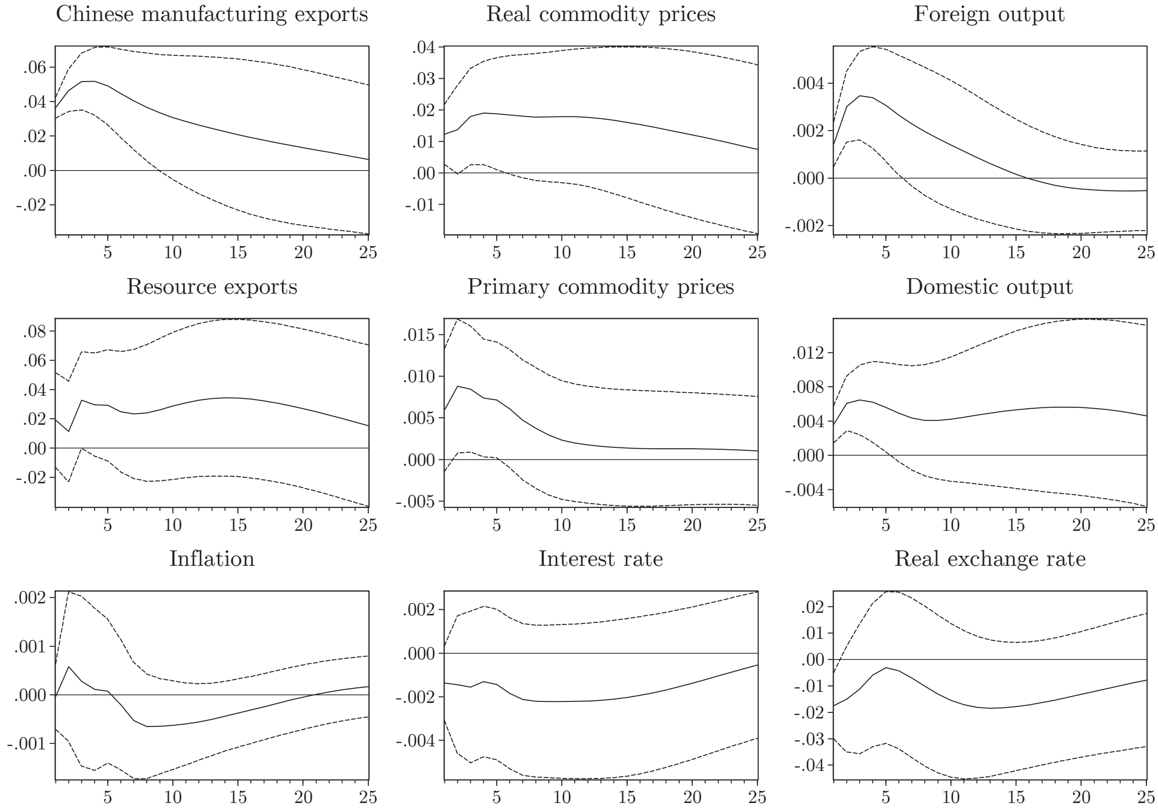

Figure 16: Impulse response functions to a shock to Chinese manufacturing exports for the model with Chinese manufacturing exports, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

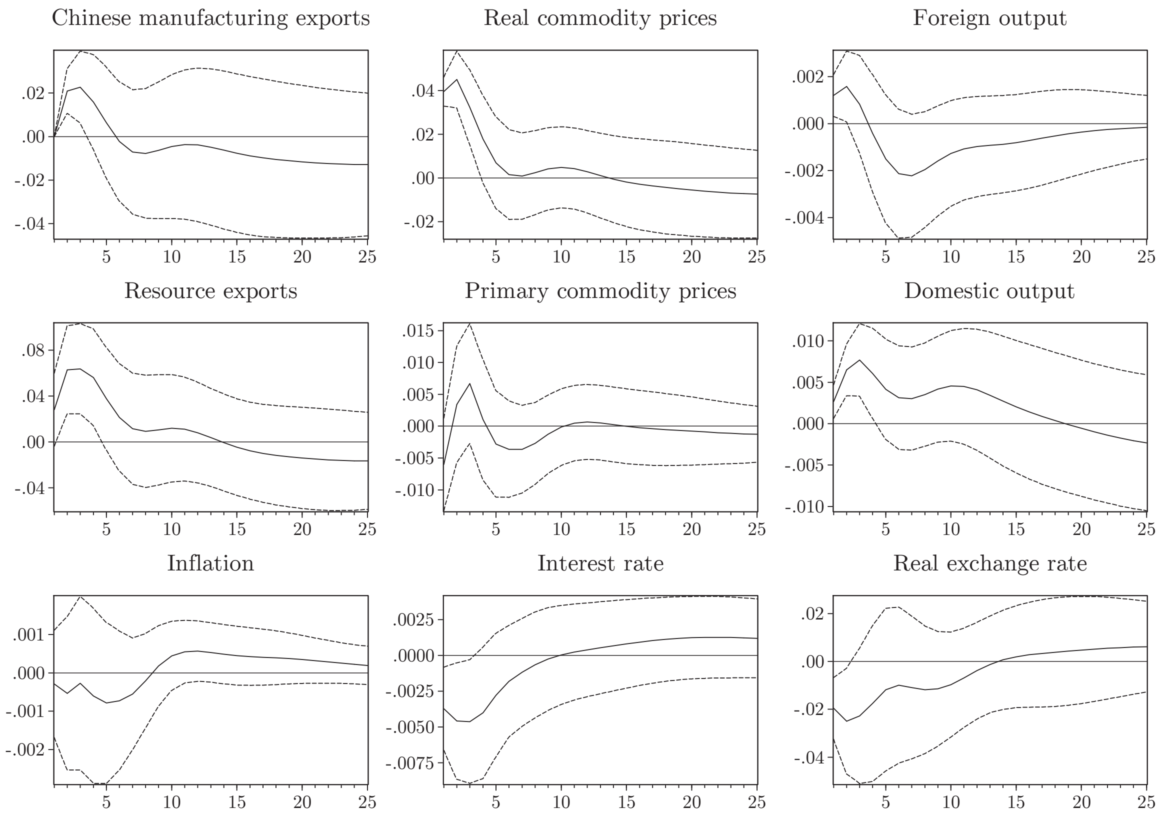

Figure 17: Impulse response functions to a shock to commodity prices for the model with Chinese manufacturing exports, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

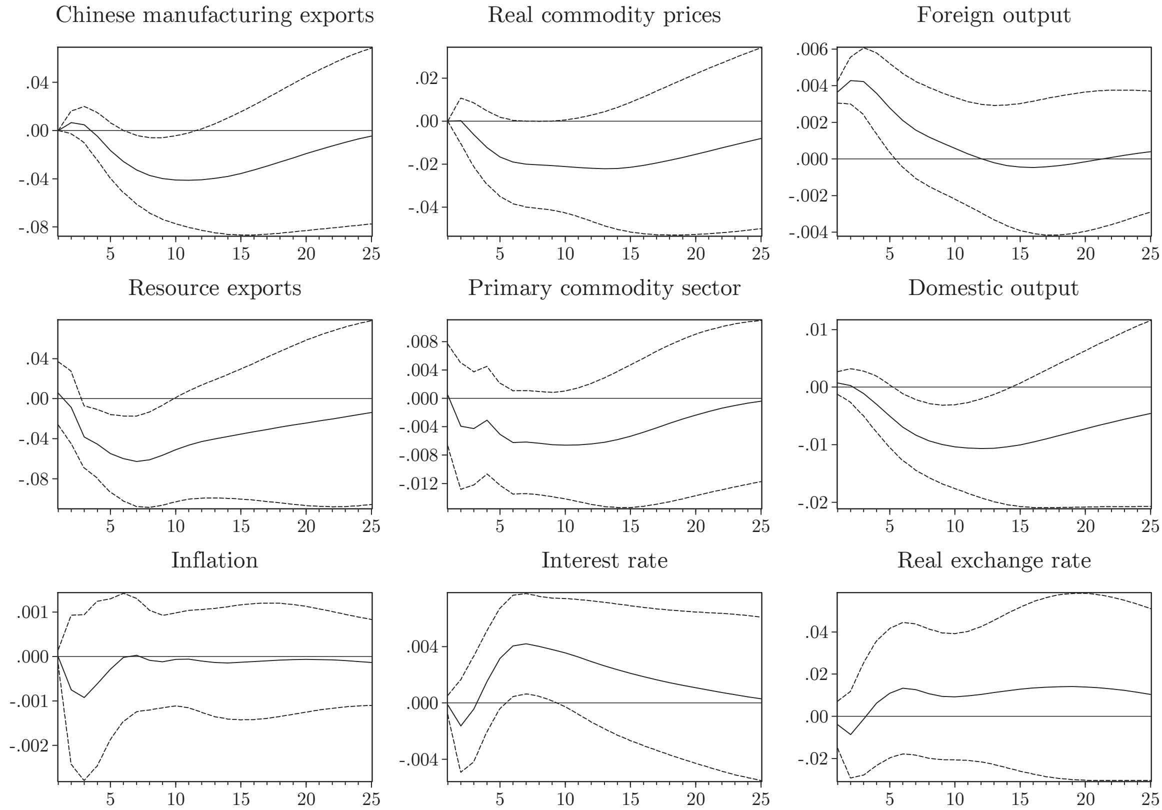

Figure 18: Impulse response functions to a shock to foreign output for the model with Chinese manufacturing exports, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

Table 4: Forecast error variance decomposition for the model with Chinese manufacturing exports (in per cent).

Variable	Shock	1	4	12	24	Variable	Shock	1	4	12	24
	cme_t	100.00	83.46	50.59	35.45		cme_t	3.60	12.19	14.44	13.37
	pc_t	0.00	11.37	3.70	4.20		pc_t	3.65	4.77	5.15	4.74
	yw_t	0.00	0.87	25.93	28.48		yw_t	0.02	2.20	13.41	17.55
	$resx_t$	0.00	0.16	0.15	0.42		$resx_t$	5.03	6.32	4.88	4.60
cme_t	$comm_t$	0.00	0.64	6.59	11.47	$comm_t$	$comm_t$	87.71	51.59	41.09	37.20
	yd_t	0.00	1.91	7.00	10.85		yd_t	0.00	6.33	6.03	7.92
	pd_t	0.00	1.03	0.68	0.69		pd_t	0.00	0.33	0.67	0.68
	rd_t	0.00	0.53	3.49	5.29		rd_t	0.00	4.20	3.91	4.41
	q_t	0.00	0.03	1.87	3.15		q_t	0.00	12.06	10.41	9.53
	cme_t	8.81	14.19	23.36	22.34		cme_t	14.65	23.70	17.35	18.17
	pc_t	91.19	68.83	32.79	20.66		pc_t	7.82	26.41	15.65	8.67
	yw_t	0.00	2.66	22.32	27.37		yw_t	0.58	1.94	39.23	42.34
	$resx_t$	0.00	2.64	2.48	1.92		$resx_t$	0.53	1.90	1.58	2.19
pc_t	$comm_t$	0.00	5.93	6.19	8.85	yd_t	$comm_t$	0.54	5.66	5.70	4.70
	yd_t	0.00	0.24	5.38	9.78		yd_t	75.87	36.70	17.01	17.91
	pd_t	0.00	2.89	1.53	1.08		pd_t	0.00	2.45	1.06	0.64
	rd_t	0.00	1.43	2.89	5.00		rd_t	0.00	0.61	1.04	4.44
	q_t	0.00	1.20	3.06	2.98		q_t	0.00	0.63	1.38	0.94
	cme_t	12.23	30.34	30.73	28.34		cme_t	0.00	0.40	2.20	2.74
	pc_t	8.49	4.17	12.20	12.54		pc_t	0.22	0.75	2.59	3.85
	yw_t	79.28	54.69	36.60	33.17		yw_t	0.00	1.67	1.57	1.59
	$resx_t$	0.00	0.22	1.78	1.88		$resx_t$	0.04	2.25	3.21	3.17
yw_t	$comm_t$	0.00	0.86	8.15	12.16	pd_t	$comm_t$	0.50	11.47	11.68	13.07
	yd_t	0.00	0.84	0.89	0.87		yd_t	0.10	6.50	7.88	7.52
	pd_t	0.00	1.78	1.28	1.23		pd_t	99.13	41.92	37.41	35.60
	rd_t	0.00	0.24	0.56	0.54		rd_t	0.00	28.38	27.51	26.26
	q_t	0.00	6.84	7.81	9.28		q_t	0.00	6.64	5.96	6.20
	cme_t	1.93	5.90	9.25	14.21		cme_t	1.12	2.12	6.80	9.46
	pc_t	4.19	28.95	15.68	12.41		pc_t	8.20	18.93	13.64	12.72
	yw_t	0.15	8.78	29.93	28.79		yw_t	0.01	1.36	17.82	18.13
	$resx_t$	93.72	44.67	22.22	16.15		$resx_t$	0.21	5.70	4.60	3.88
$resx_t$	$comm_t$	0.00	4.60	4.48	7.17	rd_t	$comm_t$	1.57	2.02	2.29	6.00
	yd_t	0.00	3.63	12.04	13.21		yd_t	2.48	4.05	11.01	11.87
	pd_t	0.00	0.52	0.35	0.34		pd_t	0.00	0.65	0.55	0.55
	rd_t	0.00	2.15	4.12	5.62		rd_t	86.40	64.59	42.60	36.03
	q_t	0.00	0.79	1.92	2.09		q_t	0.00	0.60	0.68	1.36
							cme_t	8.71	3.86	7.06	13.06
							pc_t	10.98	10.27	9.74	8.17
							yw_t	0.43	0.73	4.02	9.03
							$resx_t$	2.24	1.70	2.38	1.97
						q_t	$comm_t$	10.36	26.86	26.33	23.46
							yd_t	0.95	4.30	7.40	8.38
							pd_t	0.77	0.39	0.32	0.30
							rd_t	19.50	10.20	7.89	7.76
							q_t	46.06	41.70	34.87	27.86

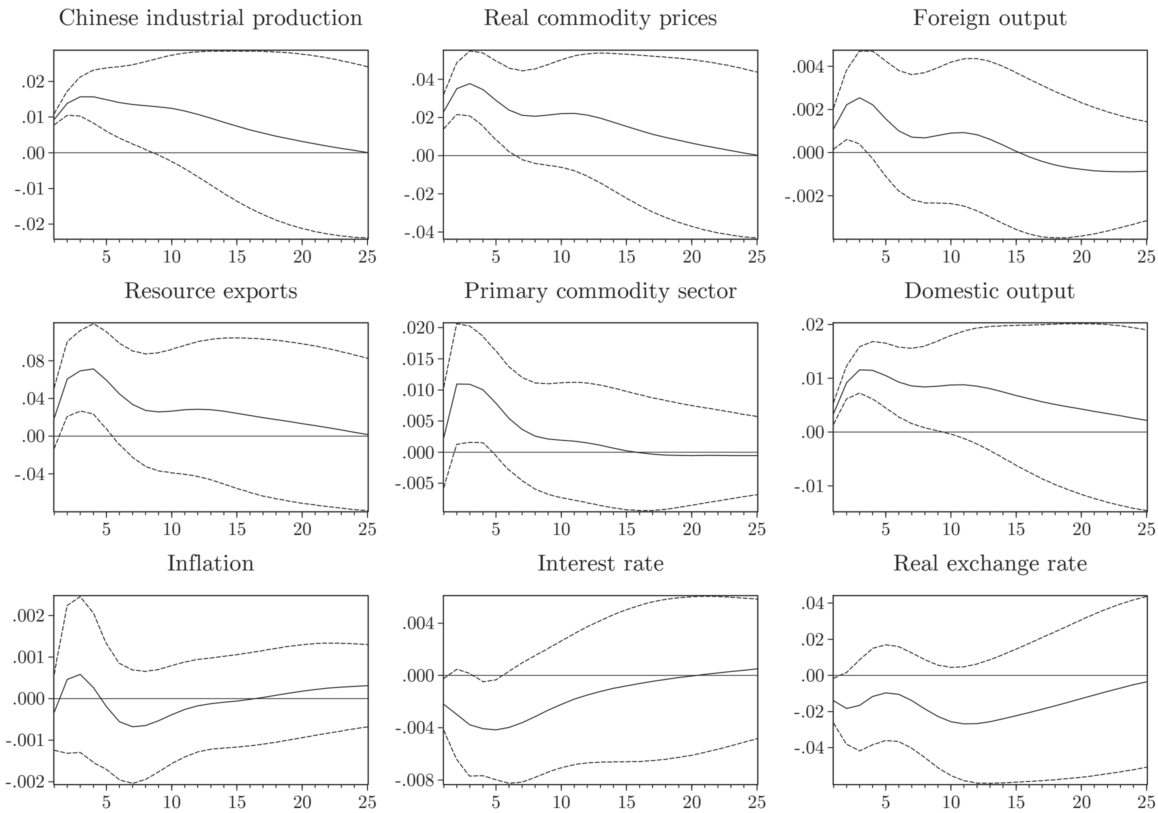

Figure 19: Impulse response functions to a shock to Chinese industrial production for the model with Chinese industrial production, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

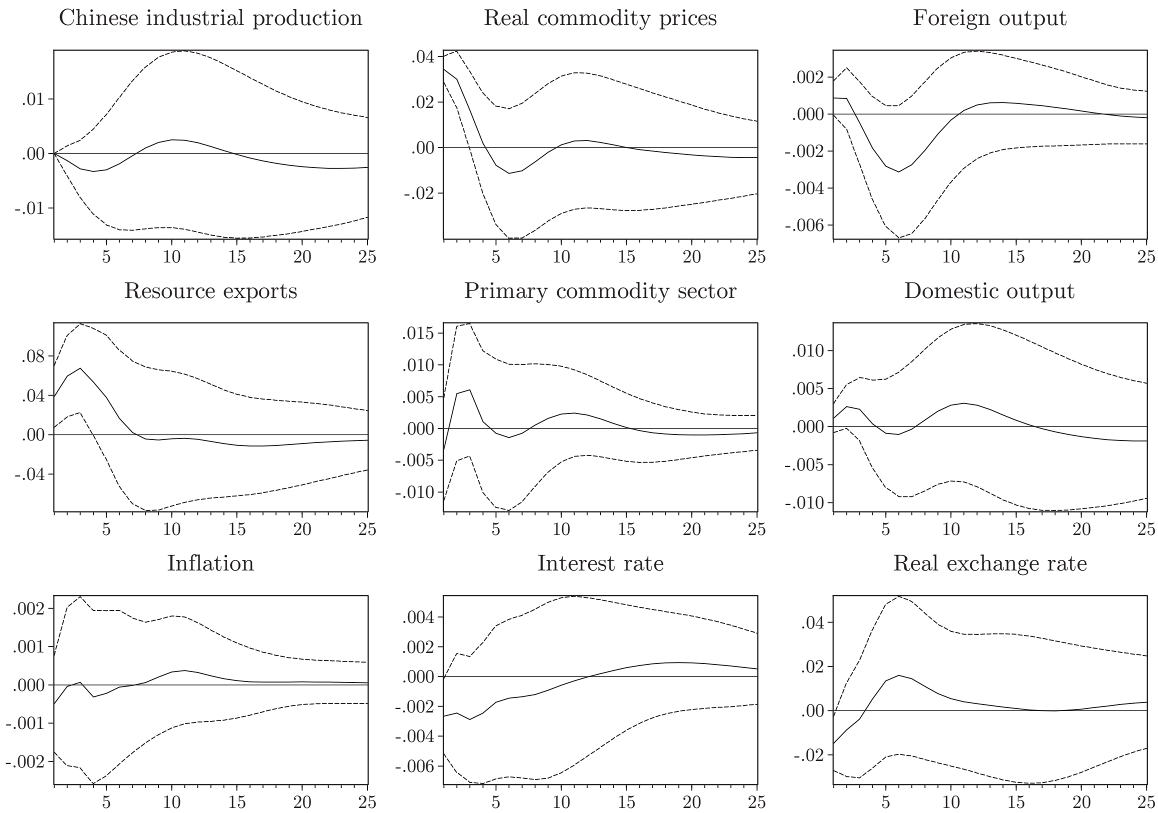

Figure 20: Impulse response functions to a shock to commodity prices for the model with Chinese industrial production, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

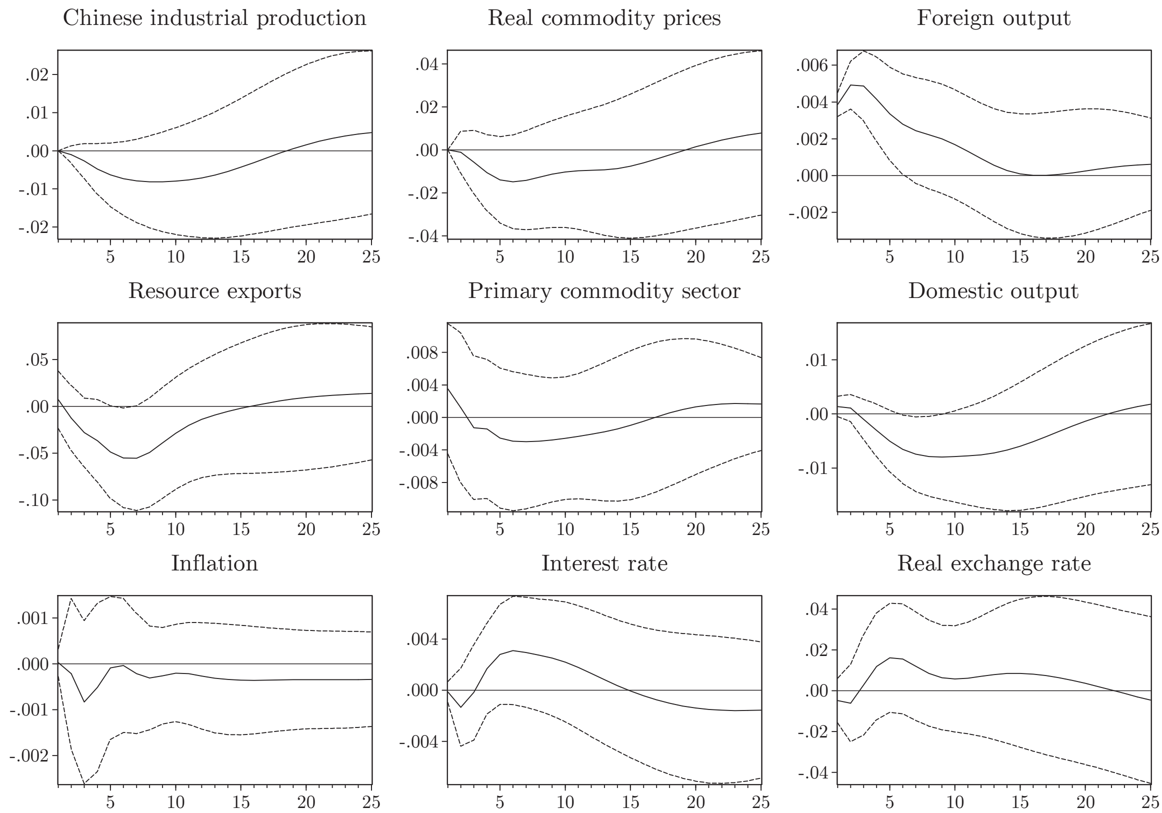

Figure 21: Impulse response functions to a shock to foreign output for the model with Chinese industrial production, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

Table 5: Forecast error variance decomposition for the model with Chinese industrial production (in per cent).

Variable	Shock	1	4	12	24	Variable	Shock	1	4	12	24
	cip_t	100.00	70.47	39.23	27.73		cip_t	0.49	15.14	16.95	16.43
	pc_t	0.00	1.89	1.01	1.14		pc_t	0.93	3.44	3.60	3.80
	yw_t	0.00	2.85	9.15	7.30		yw_t	1.07	0.77	2.68	3.27
	$resx_t$	0.00	2.77	5.53	4.95		$resx_t$	4.45	3.75	4.07	3.93
cip_t	$comm_t$	0.00	6.65	18.22	24.89	$comm_t$	$comm_t$	93.07	61.97	55.66	54.25
	yd_t	0.00	1.72	17.84	25.34		yd_t	0.00	1.50	3.36	4.80
	pd_t	0.00	9.53	5.48	3.85		pd_t	0.00	1.31	2.69	2.61
	rd_t	0.00	2.65	3.05	4.48		rd_t	0.00	3.75	3.53	3.72
	q_t	0.00	1.48	0.51	0.33		q_t	0.00	8.38	7.47	7.20
	cip_t	31.27	54.84	40.29	30.16		cip_t	15.47	61.13	44.21	30.16
	pc_t	68.73	29.36	12.76	8.44		pc_t	1.63	2.30	2.03	1.56
	yw_t	0.00	1.83	6.32	5.22		yw_t	2.37	2.28	19.63	14.37
	$resx_t$	0.00	0.35	3.71	4.08		$resx_t$	0.72	0.69	3.10	3.18
pc_t	$comm_t$	0.00	0.38	12.74	21.19	yd_t	$comm_t$	1.81	0.81	6.05	15.60
	yd_t	0.00	0.49	12.18	20.39		yd_t	78.00	23.92	16.18	26.24
	pd_t	0.00	8.39	6.90	5.01		pd_t	0.00	7.94	6.93	4.59
	rd_t	0.00	3.94	4.50	5.09		rd_t	0.00	0.19	1.31	3.99
	q_t	0.00	0.43	0.60	0.41		q_t	0.00	0.73	0.58	0.30
	cip_t	7.32	15.38	10.24	11.44		cip_t	0.27	0.71	1.99	2.19
	pc_t	4.47	4.46	14.60	14.23		pc_t	0.61	0.34	0.65	0.73
	yw_t	88.21	70.01	48.86	45.80		yw_t	0.00	0.98	1.11	2.17
	$resx_t$	0.00	0.18	5.20	5.41		$resx_t$	0.05	2.19	2.91	3.01
yw_t	$comm_t$	0.00	0.07	11.91	13.15	pd_t	$comm_t$	0.68	11.39	16.58	17.61
	yd_t	0.00	0.28	0.23	0.58		yd_t	0.10	5.65	7.72	7.86
	pd_t	0.00	2.65	2.50	2.59		pd_t	98.29	45.55	38.34	36.84
	rd_t	0.00	1.05	1.77	1.67		rd_t	0.00	27.47	25.87	24.88
	q_t	0.00	5.92	4.70	5.12		q_t	0.00	5.72	4.83	4.70
	cip_t	2.01	25.16	21.28	18.71		cip_t	3.01	11.98	15.22	13.27
	pc_t	8.13	22.55	12.54	10.16		pc_t	4.30	7.30	4.74	4.73
	yw_t	0.28	4.20	14.15	11.31		yw_t	0.01	1.25	7.01	7.64
	$resx_t$	89.57	31.41	15.83	13.31		$resx_t$	0.23	7.03	5.38	5.03
$resx_t$	$comm_t$	0.00	7.94	8.57	16.10	rd_t	$comm_t$	1.63	2.81	14.86	18.38
	yd_t	0.00	4.76	19.58	22.40		yd_t	2.48	4.87	16.71	19.43
	pd_t	0.00	1.87	2.70	2.39		pd_t	0.01	1.39	2.24	1.94
	rd_t	0.00	1.72	4.94	5.25		rd_t	88.34	62.23	32.70	28.60
	q_t	0.00	0.39	0.41	0.37		q_t	0.00	1.14	1.14	0.97
							cip_t	6.25	6.74	16.45	17.30
							pc_t	6.99	2.42	4.65	2.79
							yw_t	0.74	1.50	4.17	3.37
							$resx_t$	1.00	0.67	2.22	3.86
						q_t	$comm_t$	8.66	23.37	20.12	26.33
							yd_t	1.39	7.01	12.81	20.06
							pd_t	0.76	0.97	2.49	2.50
							rd_t	20.45	10.62	8.97	7.32
							q_t	53.77	46.70	28.12	16.47

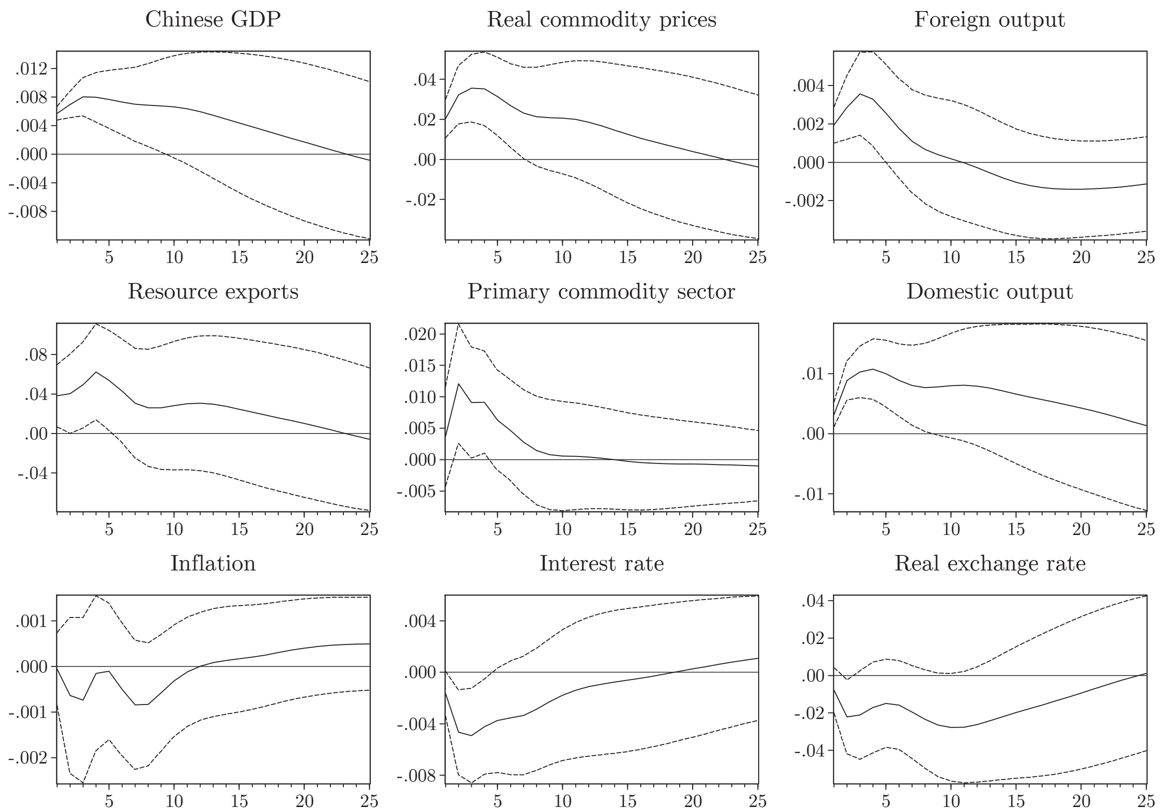

Figure 22: Impulse response functions to a shock to Chinese GDP for the model with Chinese GDP, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

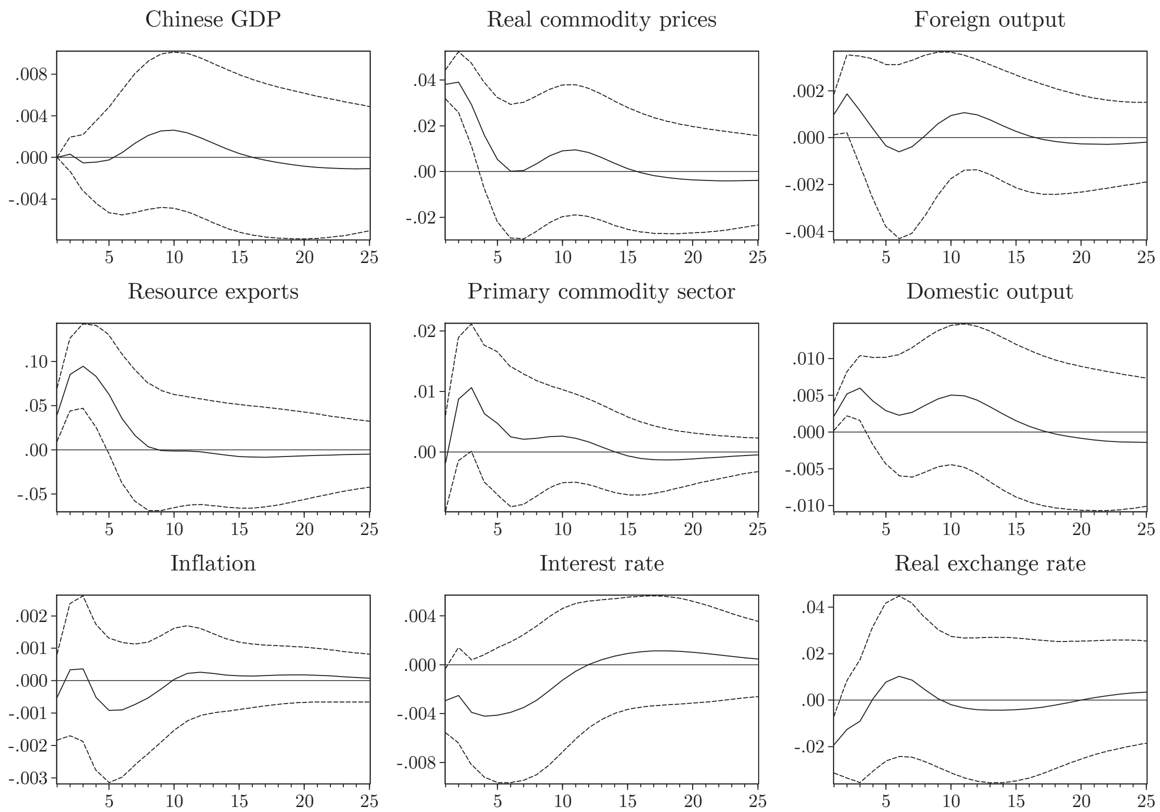

Figure 23: Impulse response functions to a shock to commodity prices for the model with Chinese GDP, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

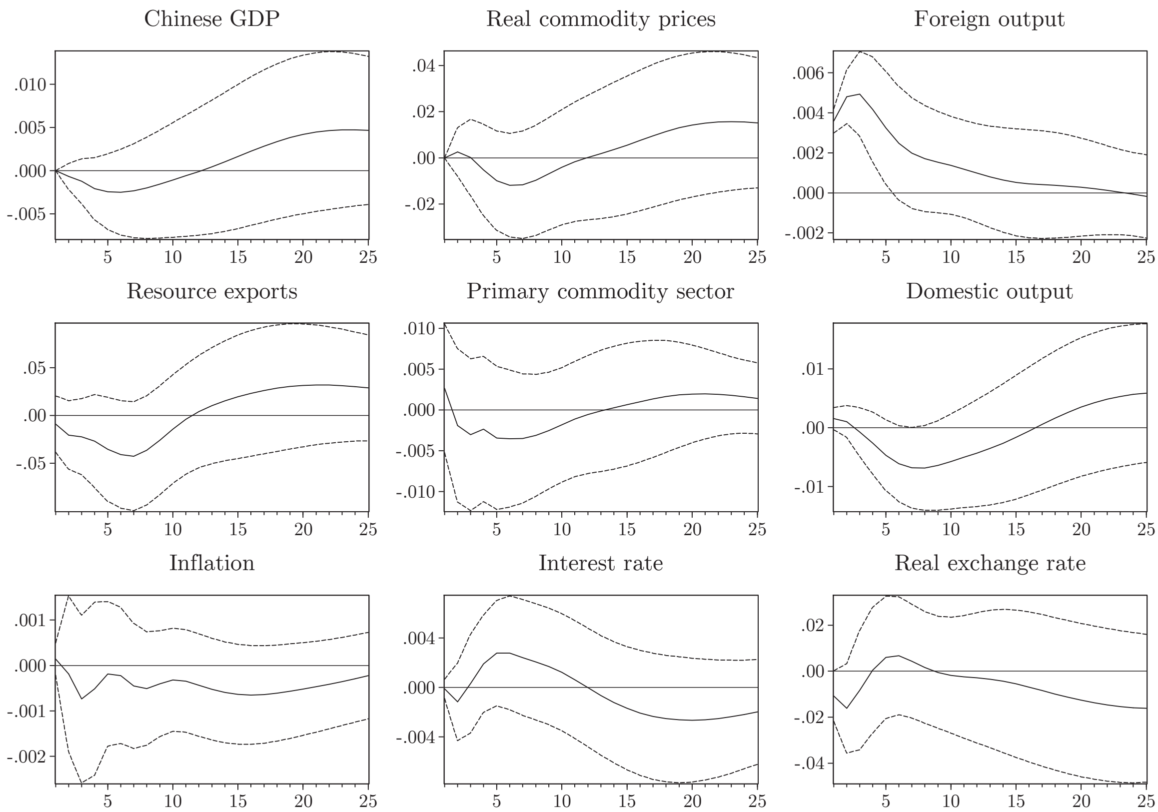

Figure 24: Impulse response functions to a shock to foreign output for the model with Chinese GDP, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

Table 6: Forecast error variance decomposition for the model with Chinese GDP (in per cent).

Variable	Shock	1	4	12	24	Variable	Shock	1	4	12	24
	$cgdp_t$	100.00	73.29	45.09	32.22		$cgdp_t$	1.24	14.06	14.85	14.60
	pc_t	0.00	0.20	2.31	1.78		pc_t	0.29	9.99	10.81	10.92
	yw_t	0.00	2.21	2.45	8.26		yw_t	0.63	1.09	3.09	3.96
	$resx_t$	0.00	3.60	7.70	6.74		$resx_t$	3.89	4.24	4.12	4.01
$cgdp_t$	$comm_t$	0.00	5.07	11.39	14.67	$comm_t$	$comm_t$	93.95	60.77	54.82	53.48
	yd_t	0.00	1.49	21.01	26.48		yd_t	0.00	1.61	3.36	4.03
	pd_t	0.00	5.49	3.23	2.19		pd_t	0.00	1.40	2.55	2.52
	rd_t	0.00	0.09	0.32	0.97		rd_t	0.00	1.83	1.71	1.84
	q_t	0.00	8.55	6.51	6.67		q_t	0.00	5.01	4.69	4.64
	$cgdp_t$	22.20	44.81	40.13	31.59		$cgdp_t$	12.77	49.87	41.26	30.40
	pc_t	77.80	46.24	21.46	15.66		pc_t	5.91	13.71	9.92	6.04
	yw_t	0.00	0.39	2.78	7.62		yw_t	2.91	1.72	13.36	10.88
	$resx_t$	0.00	0.43	4.92	4.85		$resx_t$	0.22	0.50	4.71	5.00
pc_t	$comm_t$	0.00	0.44	9.86	12.42	yd_t	$comm_t$	1.24	0.42	5.65	11.58
	yd_t	0.00	0.22	13.56	19.92		yd_t	76.94	26.35	18.33	28.19
	pd_t	0.00	6.55	5.28	3.92		pd_t	0.00	5.50	5.13	3.24
	rd_t	0.00	0.65	0.43	0.98		rd_t	0.00	0.56	0.54	1.17
	q_t	0.00	0.28	1.59	3.04		q_t	0.00	1.38	1.09	3.50
	$cgdp_t$	21.37	26.48	23.44	26.30		$cgdp_t$	0.01	0.95	2.43	3.34
	pc_t	5.59	4.41	4.91	4.53		pc_t	0.66	0.76	2.73	2.81
	yw_t	73.04	57.99	53.72	44.46		yw_t	0.05	0.84	1.56	4.02
	$resx_t$	0.00	0.74	3.74	4.44		$resx_t$	0.04	3.96	4.32	4.21
yw_t	$comm_t$	0.00	0.32	3.09	4.45	pd_t	$comm_t$	1.57	10.94	14.05	13.68
	yd_t	0.00	0.29	0.22	4.78		yd_t	0.43	4.48	7.40	7.86
	pd_t	0.00	1.66	2.13	2.13		pd_t	97.24	43.85	36.48	34.61
	rd_t	0.00	0.13	0.29	0.30		rd_t	0.00	27.01	24.62	23.31
	q_t	0.00	7.97	8.46	8.61		q_t	0.00	7.20	6.41	6.16
	$cgdp_t$	7.91	15.30	16.78	15.36		$cgdp_t$	1.70	15.95	15.37	13.46
	pc_t	8.59	40.13	26.52	20.76		pc_t	5.38	11.47	13.28	12.26
	yw_t	0.45	2.81	7.70	11.69		yw_t	0.01	1.23	4.37	9.87
	$resx_t$	83.05	26.13	15.64	13.11		$resx_t$	0.14	7.87	6.06	5.35
$resx_t$	$comm_t$	0.00	8.13	9.48	10.90	rd_t	$comm_t$	2.04	3.08	12.54	12.51
	yd_t	0.00	4.21	18.52	21.04		yd_t	1.27	2.92	16.15	17.62
	pd_t	0.00	1.15	2.03	1.61		pd_t	0.02	1.36	1.93	1.72
	rd_t	0.00	1.65	2.36	2.18		rd_t	89.43	55.59	29.63	25.54
	q_t	0.00	0.48	0.98	3.34		q_t	0.00	0.53	0.67	1.69
							$cgdp_t$	2.09	9.17	21.93	20.98
							pc_t	12.14	4.30	3.51	2.58
							yw_t	3.85	3.16	2.21	5.22
							$resx_t$	0.12	0.89	4.21	5.23
						q_t	$comm_t$	9.94	20.16	17.25	18.00
							yd_t	0.40	6.25	13.35	20.00
							pd_t	0.02	0.84	1.53	1.36
							rd_t	19.40	9.63	5.89	4.32
							q_t	52.05	45.59	30.12	22.31

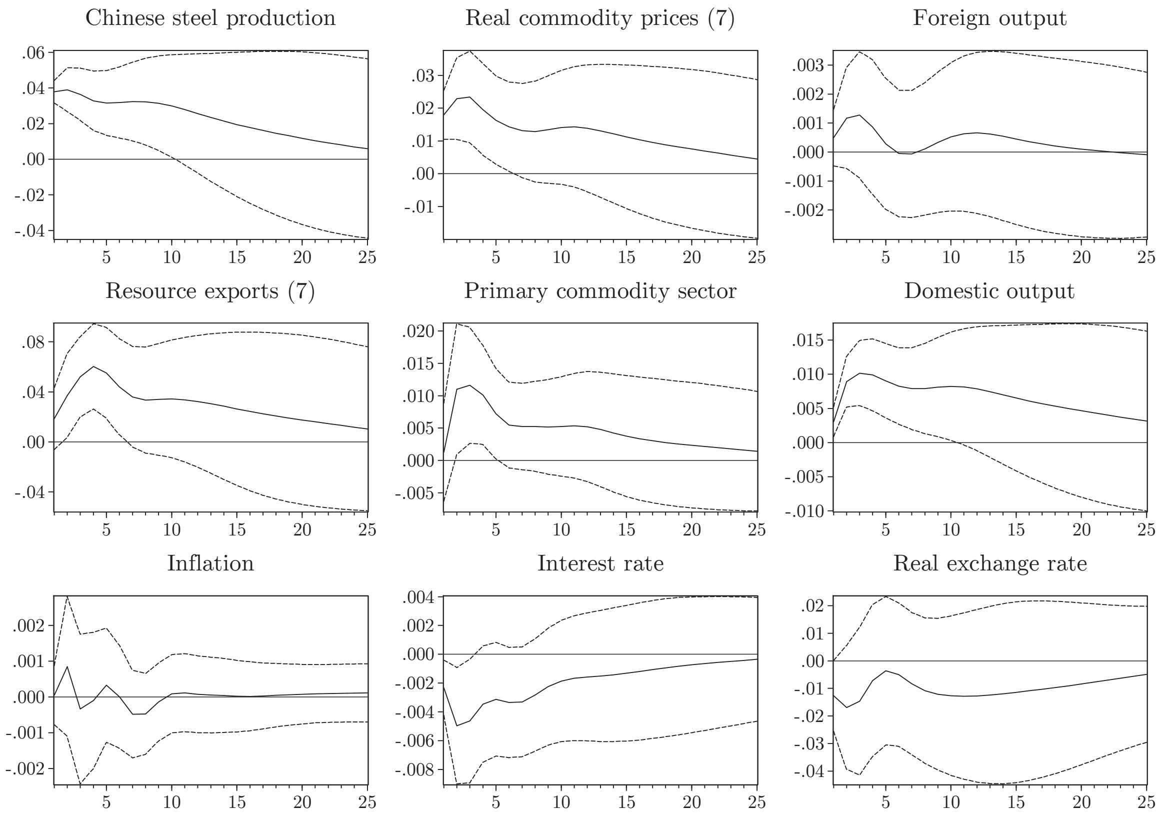

Figure 25: Impulse response functions to a shock to Chinese steel production for the model with broad basket, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

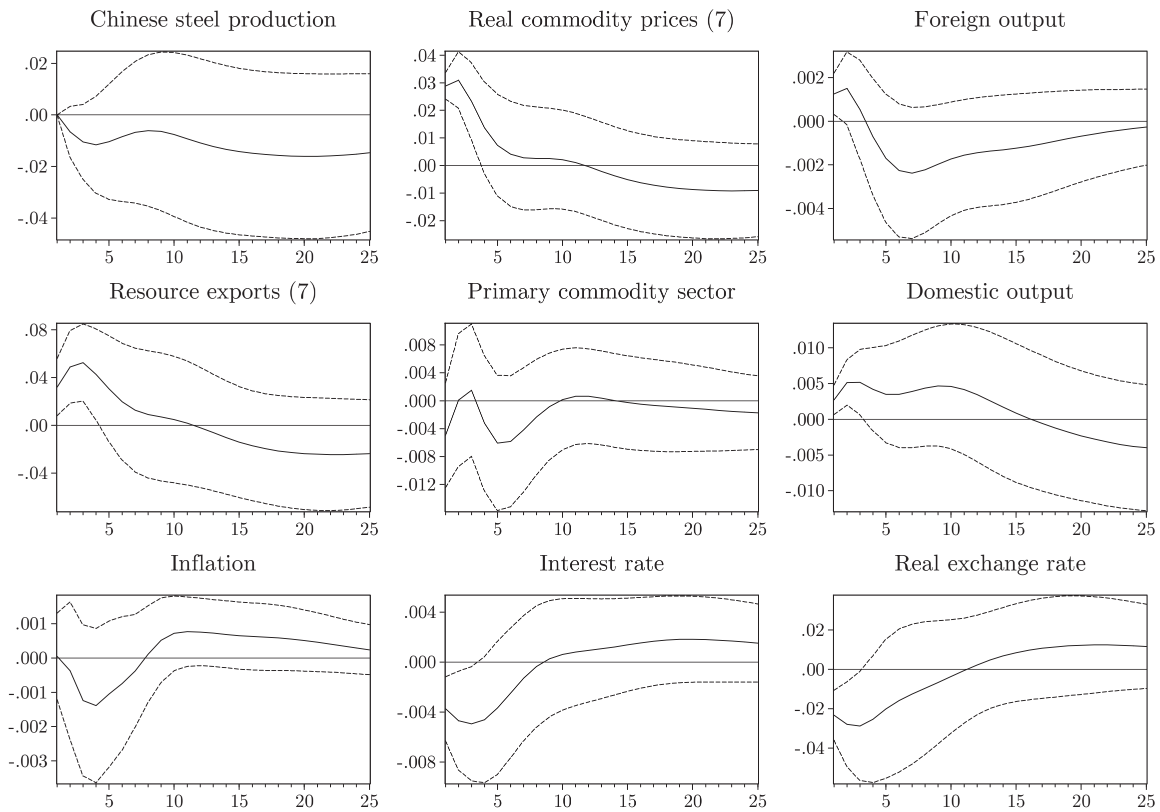

Figure 26: Impulse response functions to a shock to commodity prices for the model with broad basket, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

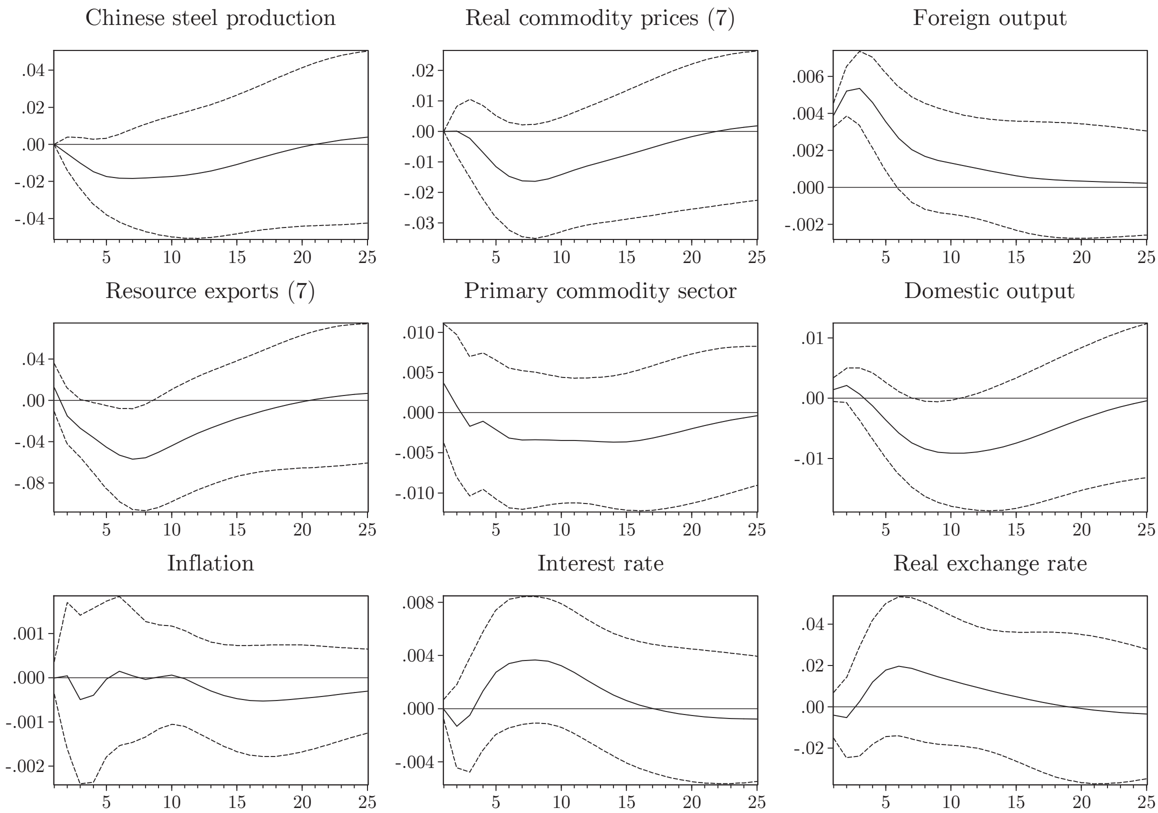

Figure 27: Impulse response functions to a shock to foreign output for the model with broad basket, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

Table 7: Forecast error variance decomposition for the model with broad basket (in per cent).

Variable	Shock	1	4	12	24	Variable	Shock	1	4	12	24
	csp_t	100.00	81.73	51.63	39.55		csp_t	0.16	17.21	21.87	22.94
	$pc7_t$	0.00	4.40	3.46	9.13		$pc7_t$	2.41	1.78	4.78	4.64
	yw_t	0.00	5.28	11.29	8.79		yw_t	1.29	0.85	3.73	6.05
	$resx7_t$	0.00	3.40	4.50	3.72		$resx7_t$	5.93	5.87	5.07	4.71
csp_t	$comm_t$	0.00	0.23	5.31	10.12	$comm_t$	$comm_t$	90.22	51.12	40.53	36.69
	yd_t	0.00	0.71	6.06	6.66		yd_t	0.00	4.42	4.24	5.11
	pd_t	0.00	0.76	0.27	0.26		pd_t	0.00	0.21	0.38	0.36
	rd_t	0.00	0.27	0.29	0.72		rd_t	0.00	4.17	3.60	3.30
	q_t	0.00	3.23	17.19	21.05		q_t	0.00	14.37	15.79	16.21
	csp_t	27.91	37.53	34.80	31.27		csp_t	10.54	46.67	40.70	36.09
	$pc7_t$	72.09	53.36	27.18	23.70		$pc7_t$	8.37	12.56	10.25	8.38
	yw_t	0.00	1.11	17.27	14.44		yw_t	2.36	1.40	24.98	26.13
	$resx7_t$	0.00	0.20	1.59	1.94		$resx7_t$	0.46	0.35	1.87	1.86
$pc7_t$	$comm_t$	0.00	3.99	5.28	7.35	yd_t	$comm_t$	2.18	2.08	2.67	2.76
	yd_t	0.00	0.16	8.65	10.21		yd_t	76.09	34.04	14.94	16.84
	pd_t	0.00	2.86	2.02	1.46		pd_t	0.00	1.72	1.69	1.19
	rd_t	0.00	0.18	0.21	0.74		rd_t	0.00	0.87	1.00	1.14
	q_t	0.00	0.61	3.01	8.89		q_t	0.00	0.32	1.91	5.62
	csp_t	1.43	3.63	2.61	2.67		csp_t	0.01	0.80	1.18	1.14
	$pc7_t$	9.22	4.19	17.01	18.49		$pc7_t$	0.01	3.37	5.95	8.22
	yw_t	89.35	83.40	61.23	52.45		yw_t	0.00	0.38	0.37	2.13
	$resx7_t$	0.00	0.43	2.77	2.56		$resx7_t$	0.19	3.57	4.05	3.78
yw_t	$comm_t$	0.00	0.87	6.50	11.08	pd_t	$comm_t$	1.51	12.04	11.36	12.22
	yd_t	0.00	0.84	0.54	0.69		yd_t	0.98	6.06	8.69	8.27
	pd_t	0.00	0.18	0.37	0.46		pd_t	97.31	39.42	35.21	32.66
	rd_t	0.00	0.31	0.65	0.58		rd_t	0.00	28.56	27.35	25.36
	q_t	0.00	6.15	8.32	11.03		q_t	0.00	5.81	5.83	6.22
	csp_t	3.11	25.30	26.46	24.90		csp_t	3.21	13.92	16.62	15.82
	$pc7_t$	9.24	25.10	12.79	14.31		$pc7_t$	8.28	17.88	14.87	16.66
	yw_t	1.38	7.58	27.16	22.01		yw_t	0.00	0.83	11.92	11.07
	$resx7_t$	86.27	30.93	13.85	10.90		$resx7_t$	0.20	7.62	5.77	5.22
$resx7_t$	$comm_t$	0.00	3.17	3.03	5.54	rd_t	$comm_t$	1.40	1.13	1.20	3.47
	yd_t	0.00	2.82	11.89	12.55		yd_t	1.44	2.71	9.36	9.54
	pd_t	0.00	0.93	0.91	0.74		pd_t	0.50	0.97	0.98	0.92
	rd_t	0.00	2.28	1.34	1.58		rd_t	84.98	51.84	34.06	29.79
	q_t	0.00	1.89	2.56	7.47		q_t	0.00	3.12	5.23	7.52
							csp_t	4.69	4.30	6.03	8.28
							$pc7_t$	15.86	16.85	14.48	16.05
							yw_t	0.49	1.17	8.07	7.11
							$resx7_t$	3.20	1.00	1.12	1.52
						q_t	$comm_t$	8.52	24.82	24.28	22.64
							yd_t	2.21	3.93	11.48	11.67
							pd_t	0.84	0.66	0.93	0.82
							rd_t	16.90	8.85	5.99	5.29
							q_t	47.28	38.41	27.63	26.62

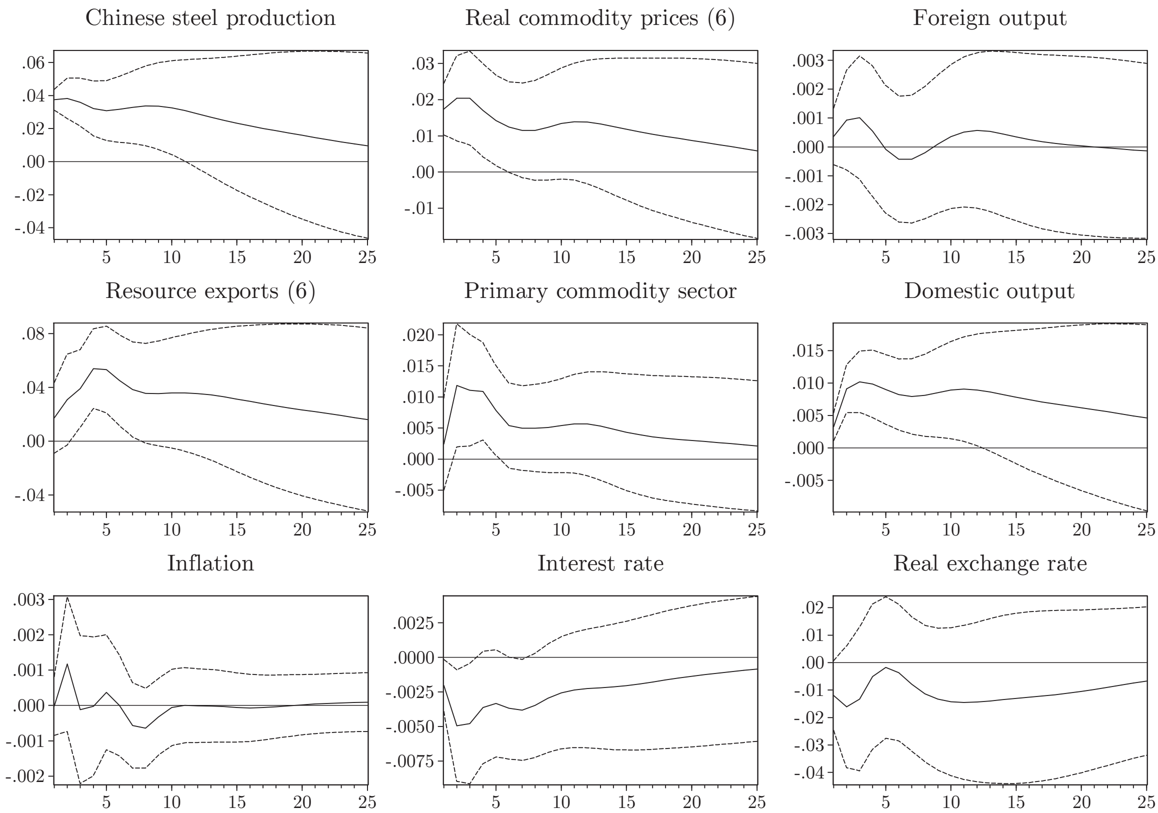

Figure 28: Impulse response functions to a shock to Chinese steel production for the model with non-oil basket, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

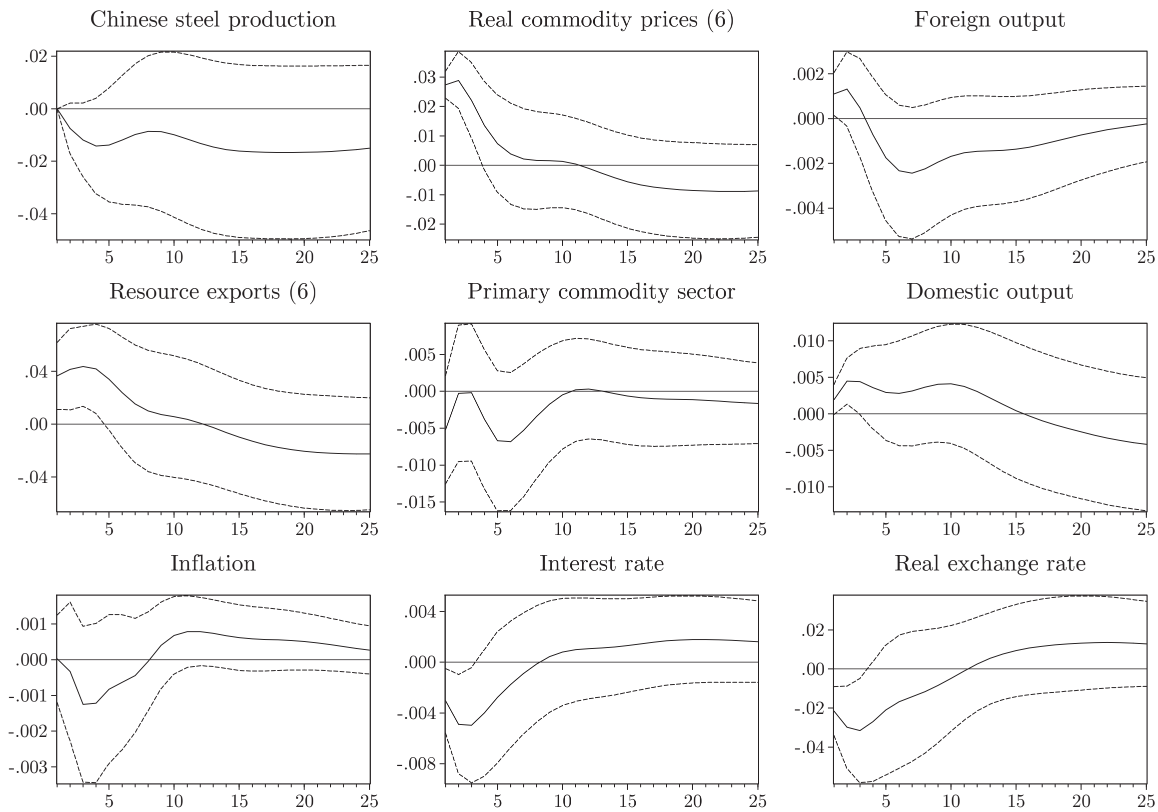

Figure 29: Impulse response functions to a shock to commodity prices for the model with non-oil basket, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

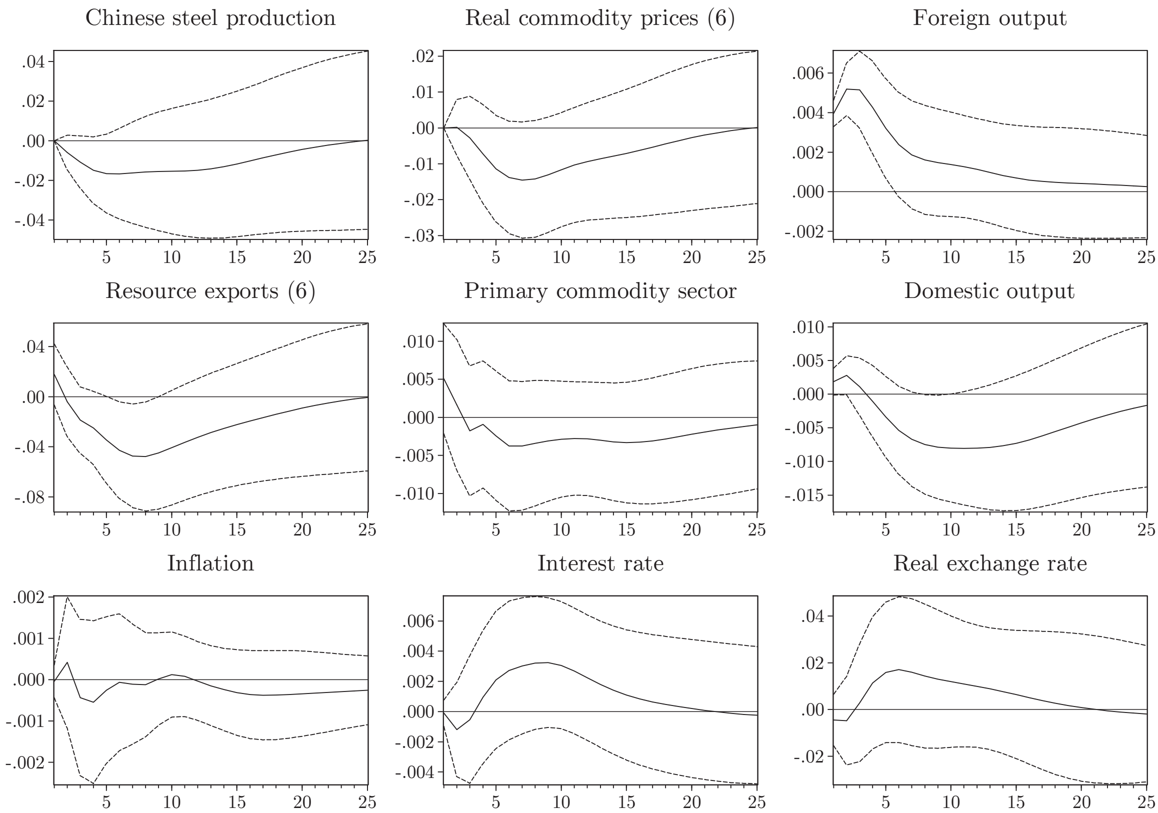

Figure 30: Impulse response functions to a shock to foreign output for the model with non-oil basket, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

Table 8: Forecast error variance decomposition for the model with non-oil basket (in per cent).

Variable	Shock	1	4	12	24	Variable	Shock	1	4	12	24
	csp_t	100.00	80.06	52.79	41.90		csp_t	0.60	18.46	22.96	25.05
	$pc6_t$	0.00	6.16	5.48	10.72		$pc6_t$	2.79	1.98	6.25	5.92
	yw_t	0.00	5.74	9.38	7.55		yw_t	2.64	1.54	3.98	5.99
	$resx6_t$	0.00	3.26	2.54	1.67		$resx6_t$	6.97	9.00	7.09	6.24
csp_t	$comm_t$	0.00	0.16	7.23	11.58	$comm_t$	$comm_t$	87.01	45.86	36.29	32.84
	yd_t	0.00	0.97	4.30	4.28		yd_t	0.00	5.89	5.18	5.18
	pd_t	0.00	0.29	0.09	0.21		pd_t	0.00	0.21	0.33	0.30
	rd_t	0.00	0.36	0.29	0.58		rd_t	0.00	3.88	3.38	3.06
	q_t	0.00	3.00	17.90	21.50		q_t	0.00	13.18	14.55	15.40
	csp_t	28.68	34.93	34.87	32.67		csp_t	12.07	47.84	46.47	42.52
	$pc6_t$	71.32	55.40	29.54	24.98		$pc6_t$	4.34	9.14	7.99	6.52
	yw_t	0.00	1.48	16.39	13.24		yw_t	4.03	2.22	21.63	23.05
	$resx6_t$	0.00	0.13	0.62	0.58		$resx6_t$	0.01	0.55	1.89	1.12
$pc6_t$	$comm_t$	0.00	4.28	4.72	7.81	yd_t	$comm_t$	1.24	1.80	1.76	2.90
	yd_t	0.00	0.11	8.26	8.61		yd_t	78.30	35.34	14.43	13.48
	pd_t	0.00	2.95	1.85	1.33		pd_t	0.00	1.68	1.35	0.85
	rd_t	0.00	0.17	0.30	0.77		rd_t	0.00	1.17	1.26	1.28
	q_t	0.00	0.55	3.45	10.01		q_t	0.00	0.25	3.20	8.27
	csp_t	0.76	2.18	1.71	1.77		csp_t	0.00	1.27	1.90	1.80
	$pc6_t$	7.05	3.49	17.07	19.58		$pc6_t$	0.00	2.90	5.06	7.40
	yw_t	92.19	82.85	57.96	50.74		yw_t	0.00	0.61	0.63	1.50
	$resx6_t$	0.00	2.75	6.63	5.77		$resx6_t$	0.06	6.00	6.05	5.70
yw_t	$comm_t$	0.00	0.57	6.06	9.62	pd_t	$comm_t$	0.59	7.62	8.03	9.06
	yd_t	0.00	0.48	1.24	1.51		yd_t	0.95	7.62	9.48	9.04
	pd_t	0.00	0.18	0.74	0.84		pd_t	98.40	37.66	33.84	31.81
	rd_t	0.00	0.28	0.33	0.29		rd_t	0.00	29.96	28.52	26.76
	q_t	0.00	7.21	8.25	9.88		q_t	0.00	6.36	6.49	6.92
	csp_t	2.43	20.67	29.47	29.72		csp_t	2.52	14.03	20.60	20.88
	$pc6_t$	10.81	24.36	14.23	13.89		$pc6_t$	5.68	15.99	12.80	14.24
	yw_t	2.56	4.75	23.91	20.07		yw_t	0.01	0.57	9.61	8.91
	$resx6_t$	84.20	40.18	17.80	12.47		$resx6_t$	0.10	8.19	5.79	4.84
$resx6_t$	$comm_t$	0.00	1.16	1.22	4.20	rd_t	$comm_t$	0.98	0.90	1.58	4.22
	yd_t	0.00	2.00	7.10	8.38		yd_t	1.54	2.67	5.82	6.11
	pd_t	0.00	0.63	0.78	0.62		pd_t	0.97	0.93	0.80	0.75
	rd_t	0.00	3.30	1.89	1.87		rd_t	88.20	51.76	35.18	29.39
	q_t	0.00	2.95	3.60	8.78		q_t	0.00	4.95	7.83	10.66
							csp_t	4.26	3.86	6.65	10.03
							$pc6_t$	13.89	19.63	17.52	18.78
							yw_t	0.61	1.15	7.03	6.19
							$resx6_t$	1.51	0.90	1.17	1.12
						q_t	$comm_t$	8.10	21.18	19.26	18.58
							yd_t	2.79	4.72	13.35	12.79
							pd_t	1.54	0.90	0.94	0.86
							rd_t	18.27	9.62	6.66	5.60
							q_t	49.02	38.05	27.42	26.05

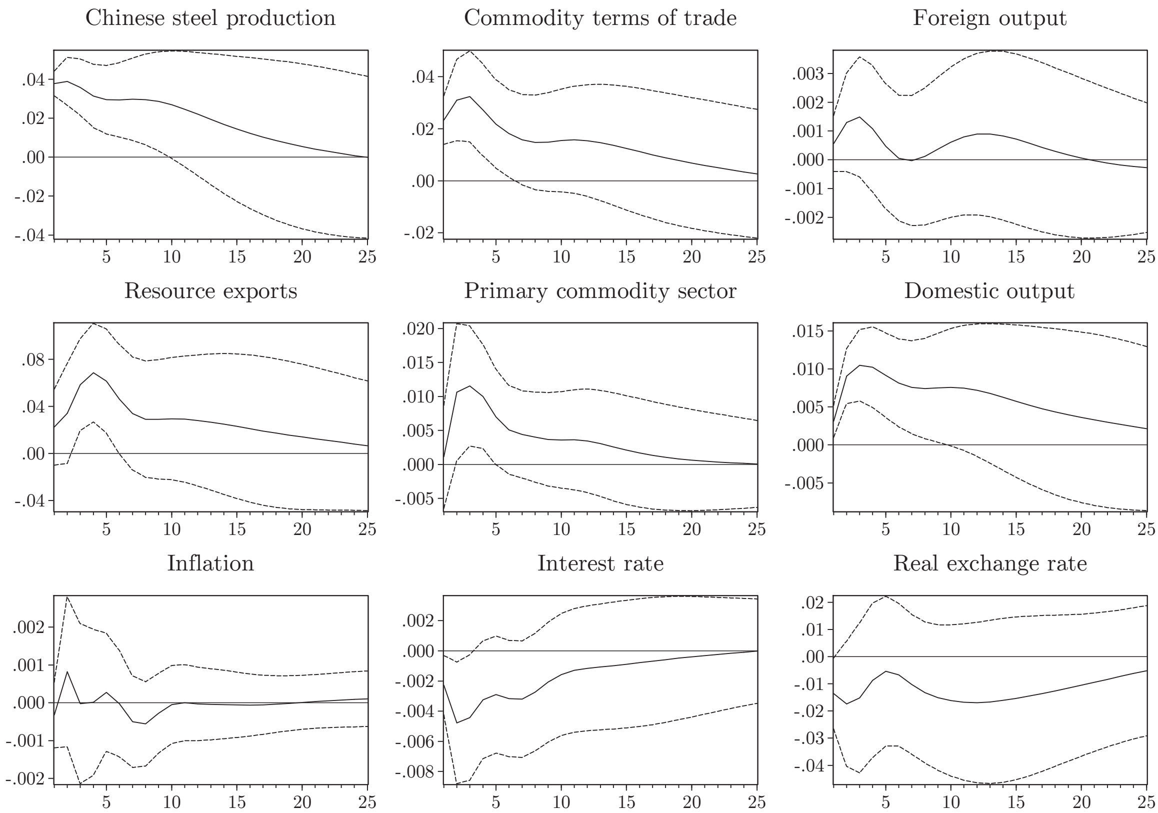

Figure 31: Impulse response functions to a shock to Chinese steel production for the model with commodity terms of trade, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

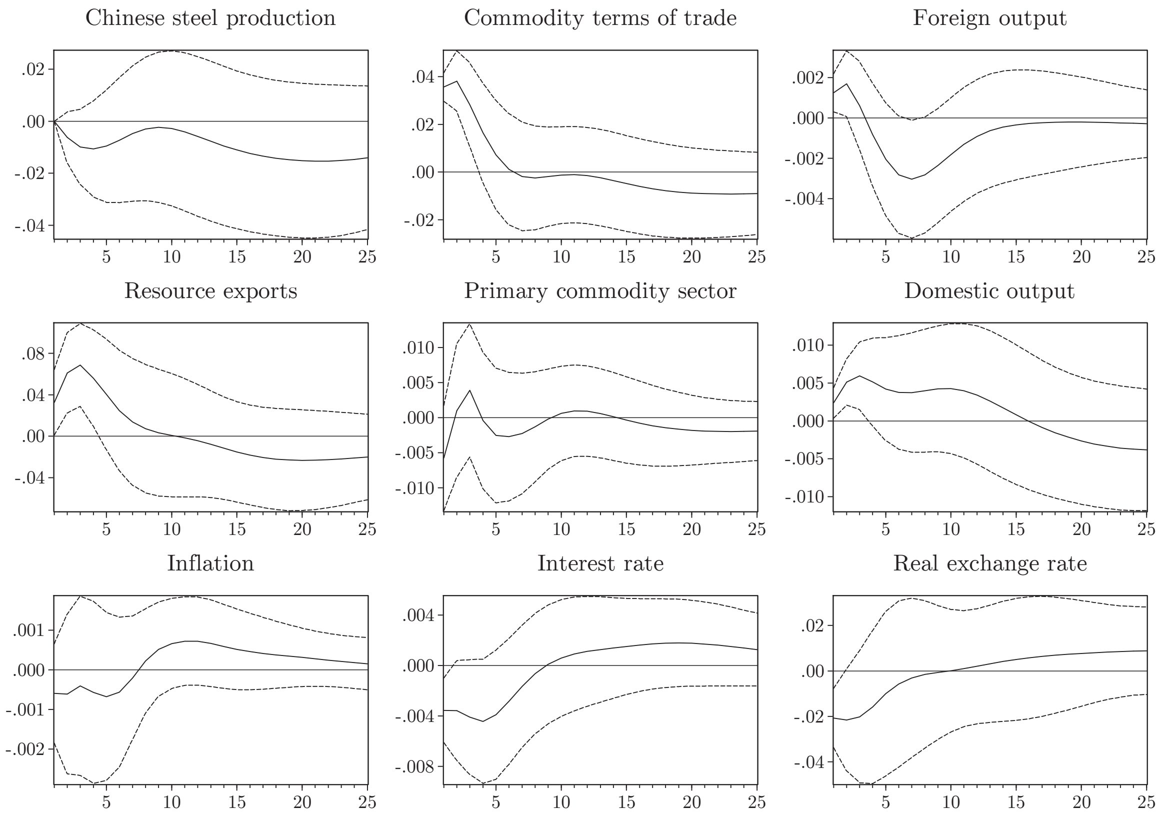

Figure 32: Impulse response functions to a shock to commodity prices for the model with commodity terms of trade, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

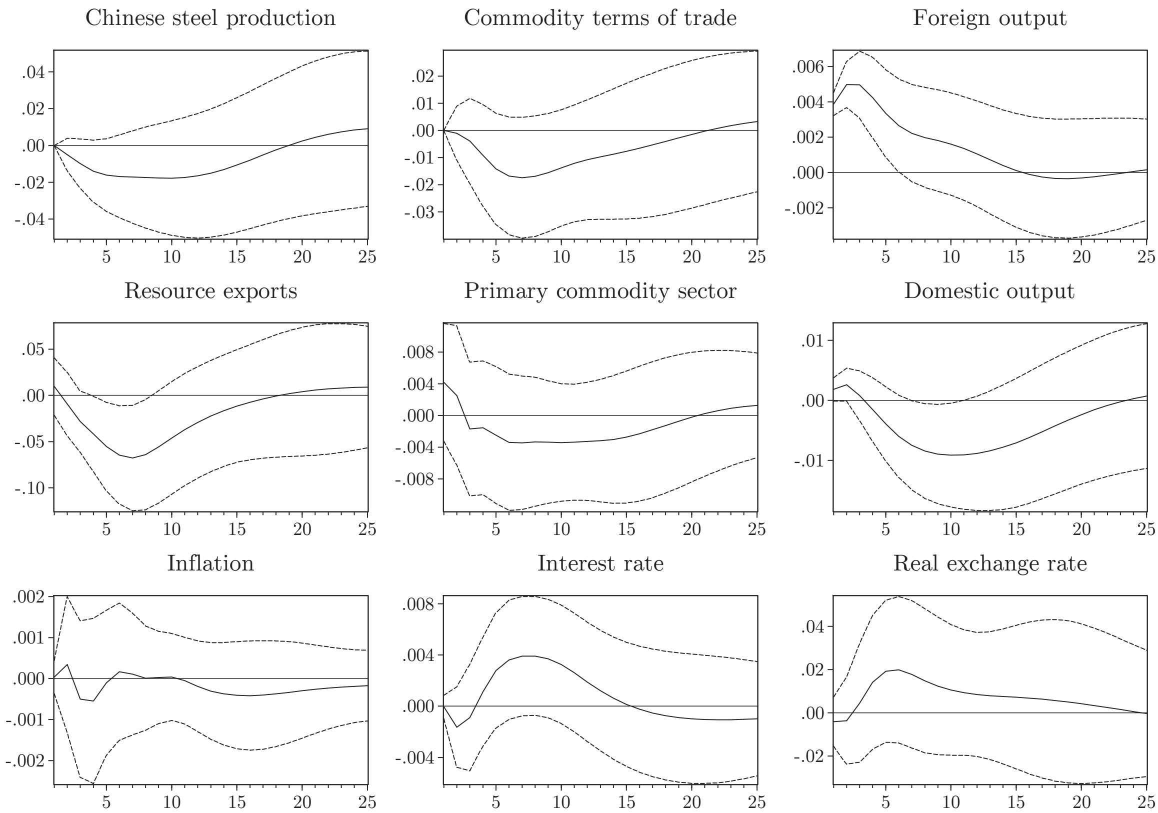

Figure 33: Impulse response functions to a shock to foreign output for the model with commodity terms of trade, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

Table 9: Forecast error variance decomposition for the model with commodity terms of trade (in per cent).

Variable	Shock	1	4	12	24	Variable	Shock	1	4	12	24
	csp_t	100.00	82.01	48.46	33.97		csp_t	0.12	16.52	19.61	19.01
	$ctot_t$	0.00	3.95	2.11	7.19		$ctot_t$	3.26	2.36	2.79	3.48
	yw_t	0.00	5.03	11.44	9.33		yw_t	1.71	1.39	4.40	5.45
	$resx_t$	0.00	4.02	5.33	4.04		$resx_t$	5.57	5.53	5.17	4.81
csp_t	$comm_t$	0.00	0.27	7.17	12.92	$comm_t$	$comm_t$	89.33	51.38	43.45	40.97
	yd_t	0.00	0.93	11.23	13.11		yd_t	0.00	2.66	3.69	5.38
	pd_t	0.00	1.05	0.35	0.28		pd_t	0.00	0.51	0.86	0.80
	rd_t	0.00	0.56	1.35	3.07		rd_t	0.00	5.76	5.25	5.35
	q_t	0.00	2.18	12.56	16.10		q_t	0.00	13.88	14.78	14.74
	csp_t	29.86	43.23	41.09	34.26		csp_t	11.48	48.60	39.84	34.11
	$ctot_t$	70.14	49.88	28.89	23.73		$ctot_t$	6.78	14.90	11.02	9.56
	yw_t	0.00	1.34	14.03	11.60		yw_t	3.94	2.08	25.93	26.23
	$resx_t$	0.00	0.12	1.23	1.72		$resx_t$	0.14	0.23	1.60	1.47
$ctot_t$	$comm_t$	0.00	1.56	3.32	7.67	yd_t	$comm_t$	0.90	2.77	3.71	4.06
	yd_t	0.00	0.09	6.70	10.04		yd_t	76.76	28.50	15.13	18.67
	pd_t	0.00	3.07	2.26	1.61		pd_t	0.00	1.76	1.28	0.91
	rd_t	0.00	0.48	0.60	1.98		rd_t	0.00	0.81	0.91	1.99
	q_t	0.00	0.23	1.87	7.39		q_t	0.00	0.36	0.58	3.01
	csp_t	1.88	5.29	3.44	4.02		csp_t	0.27	0.72	1.23	1.18
	$ctot_t$	9.20	5.35	20.99	18.45		$ctot_t$	0.90	1.11	3.14	4.50
	yw_t	88.93	81.15	53.91	46.63		yw_t	0.00	0.62	0.62	1.56
	$resx_t$	0.00	0.23	3.40	3.59		$resx_t$	0.11	3.62	4.14	4.04
yw_t	$comm_t$	0.00	0.82	7.45	12.38	pd_t	$comm_t$	1.36	12.68	12.82	13.97
	yd_t	0.00	1.53	1.52	1.95		yd_t	0.24	3.74	5.62	5.29
	pd_t	0.00	0.64	0.53	0.48		pd_t	97.12	40.64	37.02	34.76
	rd_t	0.00	0.28	0.48	0.69		rd_t	0.00	30.82	29.71	28.00
	q_t	0.00	4.71	8.27	11.83		q_t	0.00	6.05	5.71	6.71
	csp_t	2.67	20.12	21.04	19.78		csp_t	3.06	13.30	14.93	13.43
	$ctot_t$	5.66	26.07	15.19	15.78		$ctot_t$	7.45	14.16	13.02	14.90
	yw_t	0.50	5.59	26.14	21.72		yw_t	0.00	1.09	13.04	12.30
	$resx_t$	91.18	36.42	17.83	14.77		$resx_t$	0.19	9.23	6.45	5.82
$resx_t$	$comm_t$	0.00	4.91	4.55	7.44	rd_t	$comm_t$	2.06	1.79	2.09	5.05
	yd_t	0.00	3.75	12.19	12.86		yd_t	1.31	3.30	12.12	11.88
	pd_t	0.00	0.50	0.56	0.47		pd_t	0.08	0.55	0.58	0.53
	rd_t	0.00	2.35	1.86	2.62		rd_t	85.83	56.19	36.44	32.09
	q_t	0.00	0.30	0.64	4.56		q_t	0.00	0.39	1.33	3.98
							csp_t	5.05	4.46	8.62	12.41
							$ctot_t$	11.76	8.75	6.67	7.01
							yw_t	0.45	1.41	7.73	7.20
							$resx_t$	1.11	0.37	0.60	1.41
						q_t	$comm_t$	10.92	27.64	27.73	25.16
							yd_t	2.27	2.10	4.75	7.19
							pd_t	0.36	0.44	0.57	0.47
							rd_t	22.29	13.35	9.37	8.22
							q_t	45.78	41.49	33.96	30.94

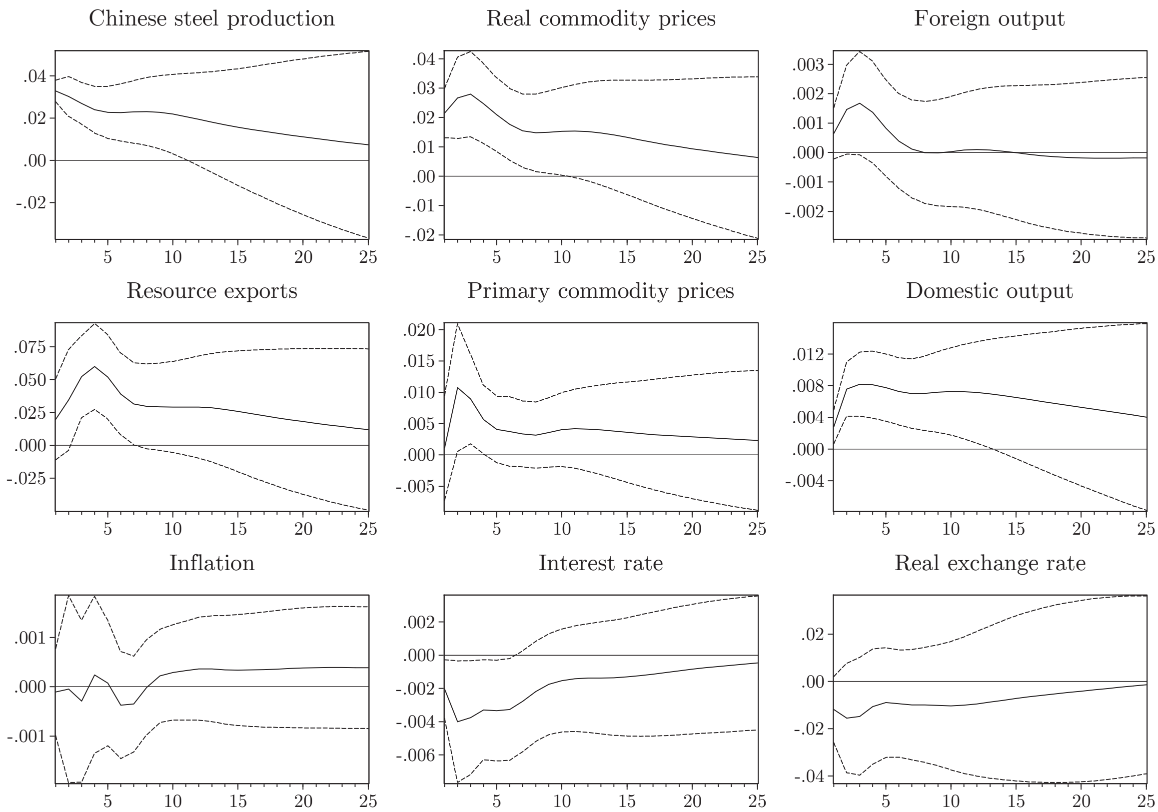

Figure 34: Impulse response functions to a shock to Chinese steel production for the model with long sample period, 1996Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

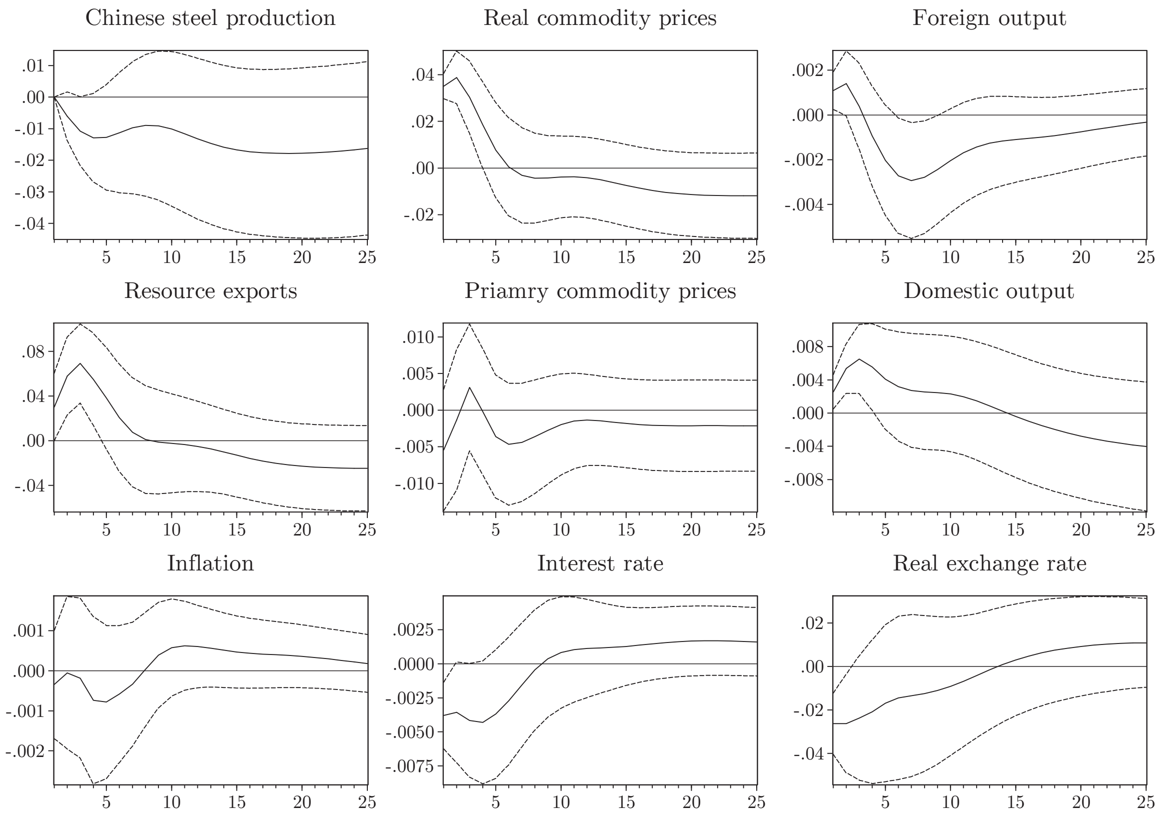

Figure 35: Impulse response functions to a shock to commodity prices for the model with long sample period, 1996Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

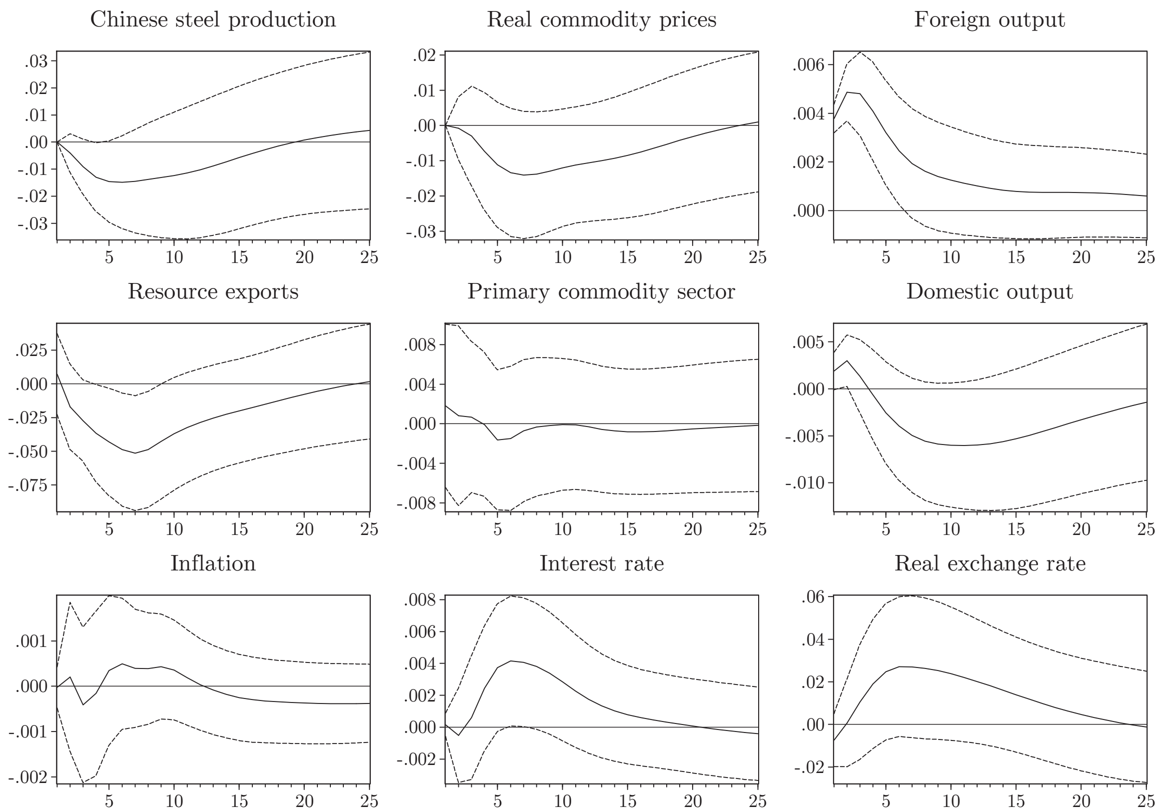

Figure 36: Impulse response functions to a shock to foreign output for the model with long sample period, 1996Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

Table 10: Forecast error variance decomposition for the model with long sample period (in per cent).

Variable	Shock	1	4	12	24	Variable	Shock	1	4	12	24
	csp_t	100.00	74.11	38.74	25.68		csp_t	0.09	9.86	10.65	11.79
	pc_t	0.00	7.20	6.91	13.35		pc_t	2.06	1.78	3.84	4.37
	yw_t	0.00	6.05	8.97	5.26		yw_t	0.23	0.19	0.31	0.37
	$resx_t$	0.00	3.50	7.10	6.83		$resx_t$	7.00	5.53	5.06	5.11
csp_t	$comm_t$	0.00	0.45	4.85	7.61	$comm_t$	$comm_t$	90.62	57.68	41.99	35.28
	yd_t	0.00	0.97	2.41	1.48		yd_t	0.00	3.02	5.09	4.71
	pd_t	0.00	2.92	2.12	1.64		pd_t	0.00	1.77	3.62	3.58
	rd_t	0.00	1.67	7.75	11.69		rd_t	0.00	6.72	9.82	11.20
	q_t	0.00	3.13	21.15	26.46		q_t	0.00	13.44	19.61	23.60
	csp_t	27.23	35.77	37.09	29.80		csp_t	8.04	33.59	37.42	32.98
	pc_t	72.77	55.81	32.83	26.11		pc_t	6.63	18.38	10.08	7.73
	yw_t	0.00	0.88	10.33	8.41		yw_t	3.60	2.47	14.22	14.32
	$resx_t$	0.00	0.08	2.46	4.25		$resx_t$	0.02	0.48	2.07	3.89
pc_t	$comm_t$	0.00	3.00	3.64	5.89	yd_t	$comm_t$	0.00	7.07	4.87	4.46
	yd_t	0.00	0.18	2.46	2.77		yd_t	81.70	33.92	14.01	8.46
	pd_t	0.00	3.43	4.86	3.53		pd_t	0.00	3.23	5.71	4.76
	rd_t	0.00	0.60	2.25	6.52		rd_t	0.00	0.01	2.13	6.61
	q_t	0.00	0.25	4.08	12.71		q_t	0.00	0.84	9.49	16.79
	csp_t	2.67	7.62	4.41	3.75		csp_t	0.02	0.14	0.60	1.70
	pc_t	7.39	4.39	25.54	25.36		pc_t	0.24	0.63	2.25	3.43
	yw_t	89.94	81.67	57.59	50.68		yw_t	0.00	0.21	0.94	1.77
	$resx_t$	0.00	0.15	1.97	2.00		$resx_t$	0.26	1.63	1.88	1.78
yw_t	$comm_t$	0.00	0.58	3.72	5.06	pd_t	$comm_t$	3.54	8.83	9.58	9.40
	yd_t	0.00	1.64	1.01	2.41		yd_t	0.38	9.73	15.39	15.49
	pd_t	0.00	0.22	0.66	0.56		pd_t	95.55	52.30	44.63	42.38
	rd_t	0.00	0.35	0.54	2.24		rd_t	0.00	22.34	19.35	18.32
	q_t	0.00	3.37	4.56	7.94		q_t	0.00	4.20	5.39	5.72
	csp_t	1.97	17.52	21.68	20.81		csp_t	2.37	10.28	12.95	12.77
	pc_t	4.52	26.60	17.44	17.07		pc_t	8.21	14.31	13.09	14.79
	yw_t	0.26	5.38	20.85	17.56		yw_t	0.01	1.50	14.09	12.72
	$resx_t$	93.25	43.13	25.31	20.46		$resx_t$	0.18	3.31	2.92	3.48
$resx_t$	$comm_t$	0.00	2.86	2.60	4.50	rd_t	$comm_t$	2.23	2.30	2.28	3.78
	yd_t	0.00	0.36	4.82	5.77		yd_t	0.05	5.12	7.15	7.39
	pd_t	0.00	1.17	2.55	2.15		pd_t	0.00	2.71	3.07	2.69
	rd_t	0.00	1.46	2.32	4.61		rd_t	86.96	59.20	40.61	36.52
	q_t	0.00	1.51	2.42	7.06		q_t	0.00	1.27	3.86	5.86
							csp_t	2.86	3.37	3.95	4.28
							pc_t	14.11	11.34	9.38	9.80
							yw_t	1.11	2.50	14.45	15.25
							$resx_t$	1.36	1.02	0.63	0.93
						q_t	$comm_t$	8.05	8.98	6.02	6.15
							yd_t	0.19	6.96	17.90	21.77
							pd_t	2.64	1.23	0.73	0.66
							rd_t	21.06	21.27	15.57	13.67
							q_t	48.61	43.34	31.37	27.50

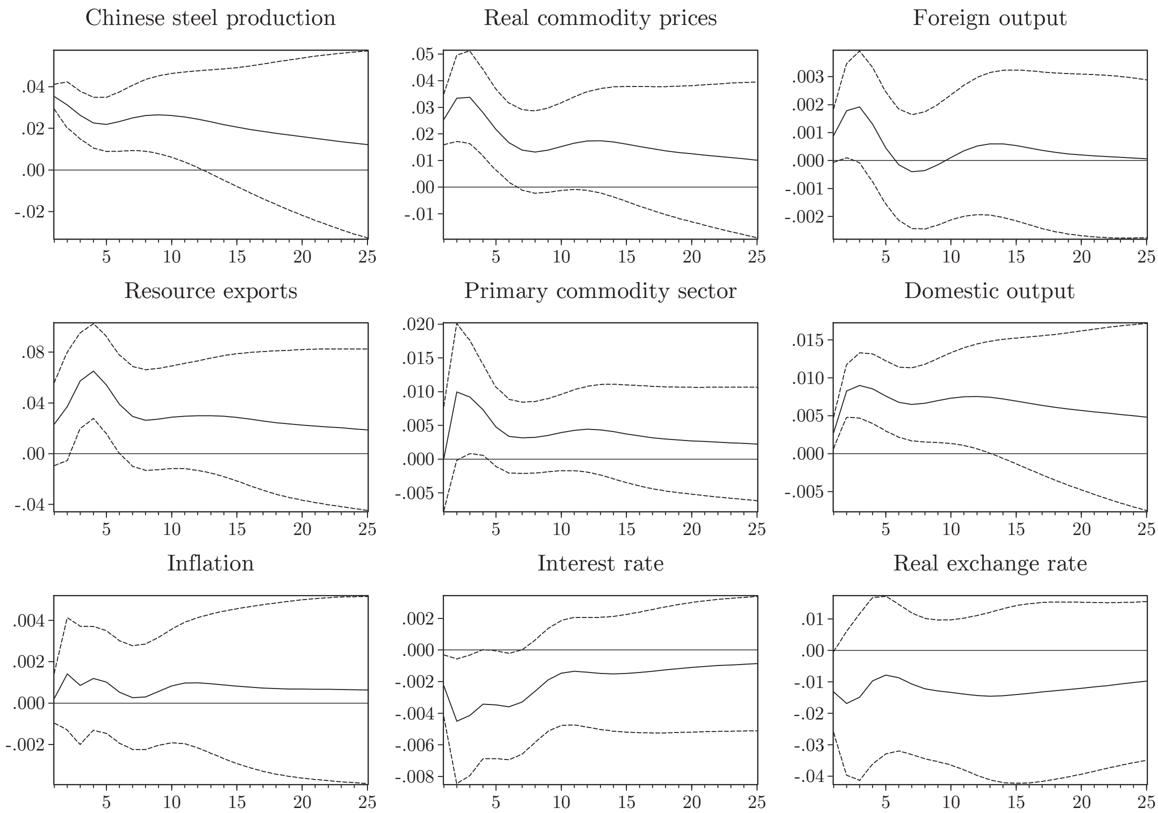

Figure 37: Impulse response functions to a shock to Chinese steel production for the model with commodity boom period, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

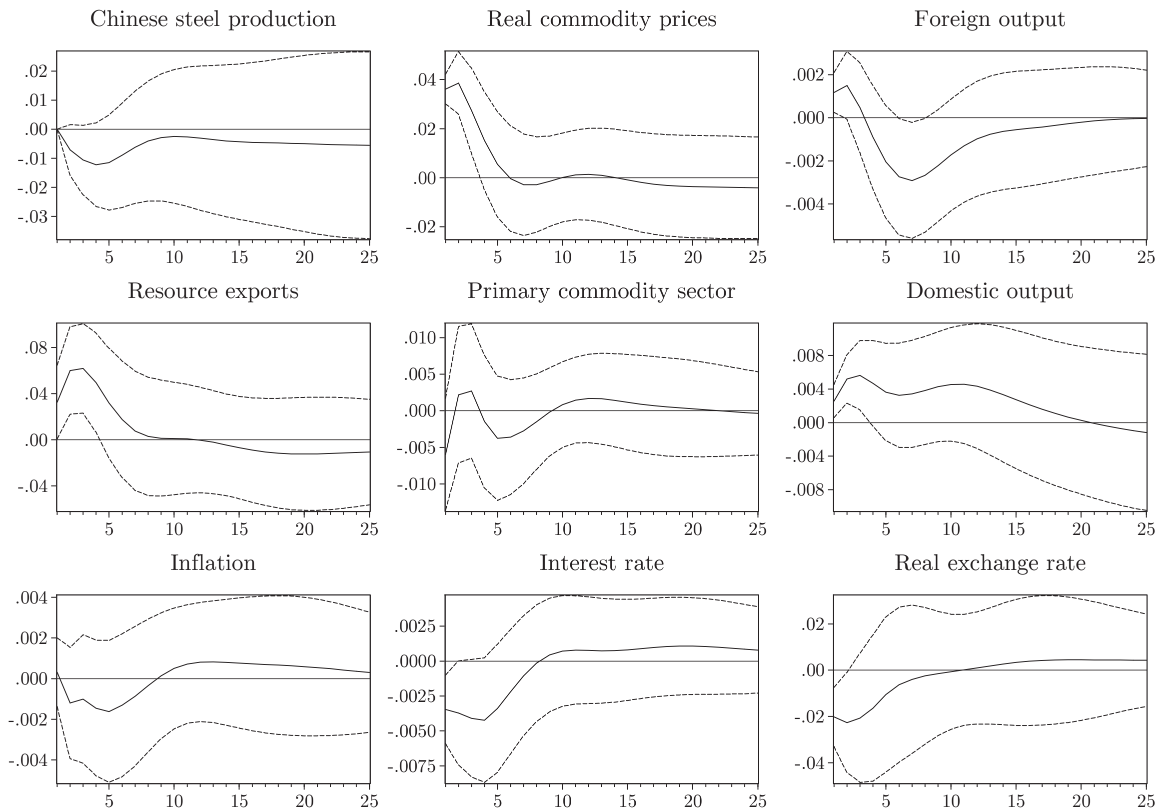

Figure 38: Impulse response functions to a shock to commodity prices for the model with commodity boom period, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

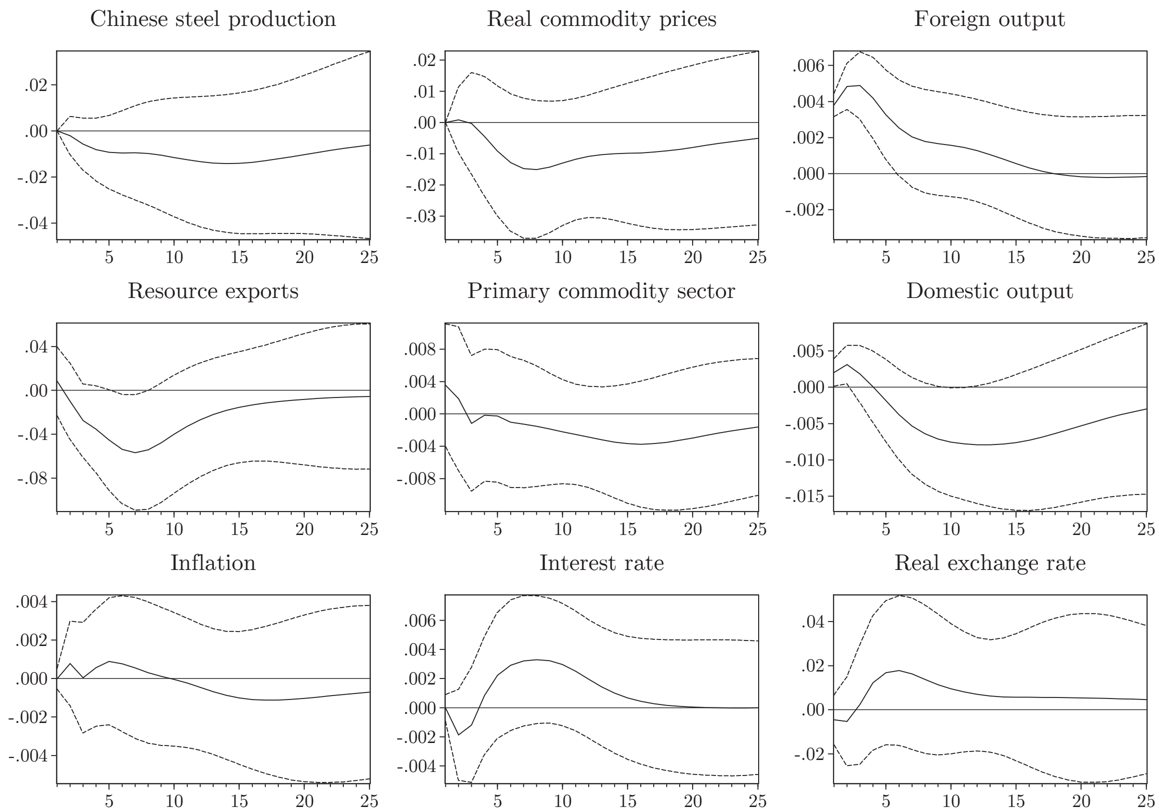

Figure 39: Impulse response functions to a shock to foreign output for the model with commodity boom period, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

Table 11: Forecast error variance decomposition for the model with commodity boom period (in per cent).

Variable	Shock	1	4	12	24	Variable	Shock	1	4	12	24
	csp_t	100.00	78.93	49.15	37.67		csp_t	0.00	11.87	14.88	16.70
	pc_t	0.00	7.24	3.59	2.74		pc_t	3.33	2.48	3.84	3.51
	yw_t	0.00	2.38	6.11	8.13		yw_t	1.20	0.88	1.90	5.67
	$resx_t$	0.00	4.44	6.56	3.98		$resx_t$	6.48	5.44	5.24	4.43
csp_t	$comm_t$	0.00	2.34	6.50	5.57	$comm_t$	$comm_t$	89.00	56.49	48.17	40.61
	yd_t	0.00	0.57	3.07	5.32		yd_t	0.00	2.90	3.02	3.95
	pd_t	0.00	0.76	8.80	22.33		pd_t	0.00	0.40	2.99	7.85
	rd_t	0.00	1.30	0.66	0.58		rd_t	0.00	5.37	4.94	4.18
	q_t	0.00	2.05	15.57	13.68		q_t	0.00	14.16	15.01	13.11
	csp_t	33.21	46.48	45.33	41.72		csp_t	9.50	42.85	40.78	38.19
	pc_t	66.79	47.62	29.92	20.20		pc_t	8.23	16.37	13.92	9.16
	yw_t	0.00	0.26	10.57	11.48		yw_t	5.15	3.21	21.57	27.64
	$resx_t$	0.00	0.35	1.34	1.69		$resx_t$	0.25	0.58	0.96	0.70
pc_t	$comm_t$	0.00	3.88	5.82	5.18	yd_t	$comm_t$	0.89	6.11	7.51	4.58
	yd_t	0.00	0.05	2.78	4.92		yd_t	75.99	29.72	12.56	12.16
	pd_t	0.00	0.58	1.24	8.09		pd_t	0.00	0.11	1.12	5.21
	rd_t	0.00	0.36	0.37	0.55		rd_t	0.00	0.56	0.68	0.62
	q_t	0.00	0.43	2.62	6.18		q_t	0.00	0.49	0.90	1.74
	csp_t	4.79	9.18	4.82	4.68		csp_t	0.07	1.83	2.29	3.26
	pc_t	8.30	4.59	19.98	17.58		pc_t	0.14	2.04	3.01	3.47
	yw_t	86.91	78.12	52.95	45.47		yw_t	0.00	0.41	0.80	3.05
	$resx_t$	0.00	0.17	4.40	4.62		$resx_t$	0.00	3.66	3.48	3.59
yw_t	$comm_t$	0.00	0.88	7.16	11.71	pd_t	$comm_t$	0.03	1.93	2.48	4.35
	yd_t	0.00	1.25	1.38	1.29		yd_t	0.02	2.41	2.30	2.19
	pd_t	0.00	0.39	0.74	3.19		pd_t	99.74	69.94	73.34	69.27
	rd_t	0.00	0.32	0.41	0.36		rd_t	0.00	14.21	9.87	8.13
	q_t	0.00	5.10	8.16	11.09		q_t	0.00	3.56	2.43	2.70
	csp_t	2.82	20.30	22.17	24.21		csp_t	3.14	13.30	17.10	17.33
	pc_t	5.53	23.51	14.56	12.58		pc_t	7.27	14.77	12.80	12.50
	yw_t	0.36	4.69	22.35	19.21		yw_t	0.00	1.37	11.18	10.19
	$resx_t$	91.29	38.90	21.41	17.36		$resx_t$	0.23	7.47	5.51	4.96
$resx_t$	$comm_t$	0.00	5.01	5.80	5.70	rd_t	$comm_t$	2.29	2.49	3.07	3.71
	yd_t	0.00	3.94	9.29	9.25		yd_t	0.59	3.13	8.23	8.21
	pd_t	0.00	0.70	1.70	6.42		pd_t	0.63	1.52	3.01	7.35
	rd_t	0.00	2.58	1.97	1.82		rd_t	85.85	55.33	37.19	32.28
	q_t	0.00	0.37	0.75	3.45		q_t	0.00	0.62	1.91	3.48
							csp_t	4.96	4.39	7.85	12.93
							pc_t	11.50	9.15	7.32	6.66
							yw_t	0.59	1.15	6.51	6.58
							$resx_t$	1.51	0.68	0.78	1.74
						q_t	$comm_t$	10.43	30.61	31.47	27.44
							yd_t	1.21	2.74	4.29	4.76
							pd_t	2.51	0.54	0.51	2.31
							rd_t	20.52	10.68	7.85	6.68
							q_t	46.76	40.06	33.41	30.90

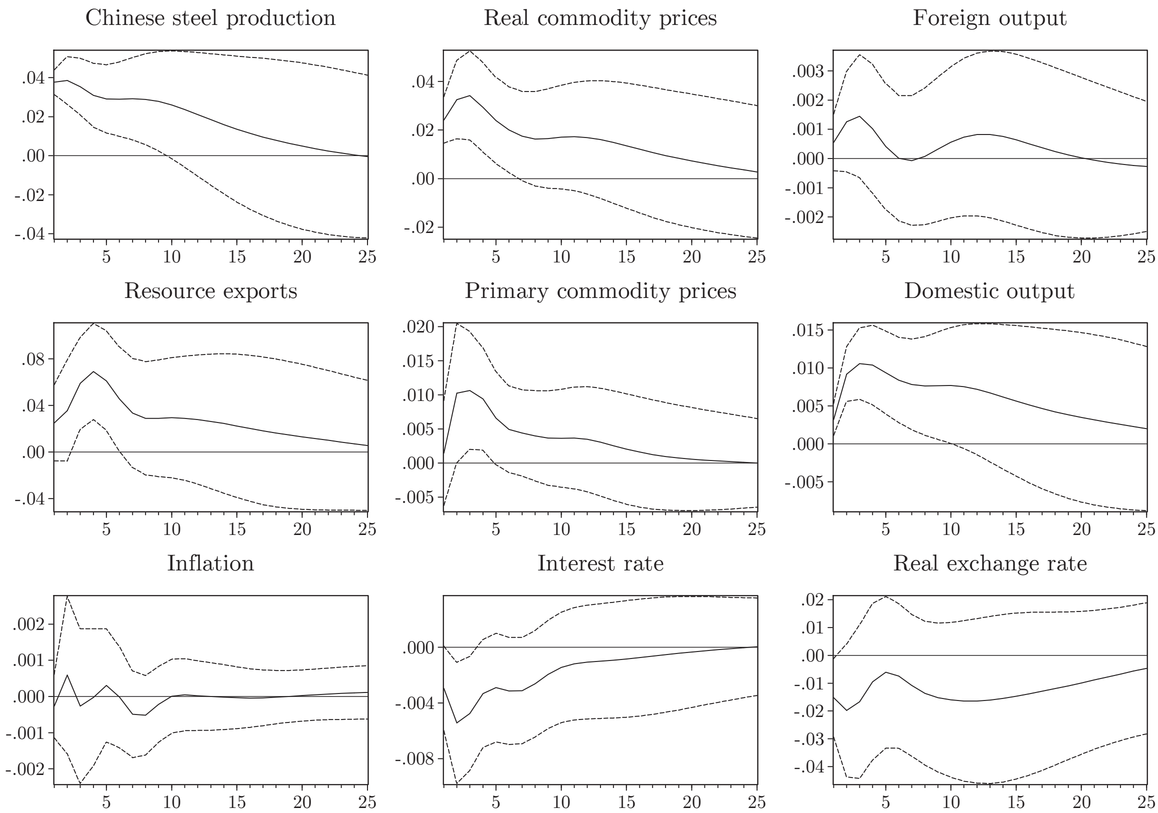

Figure 40: Impulse response functions to a shock to Chinese steel production for the model without restriction in the interest rate, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

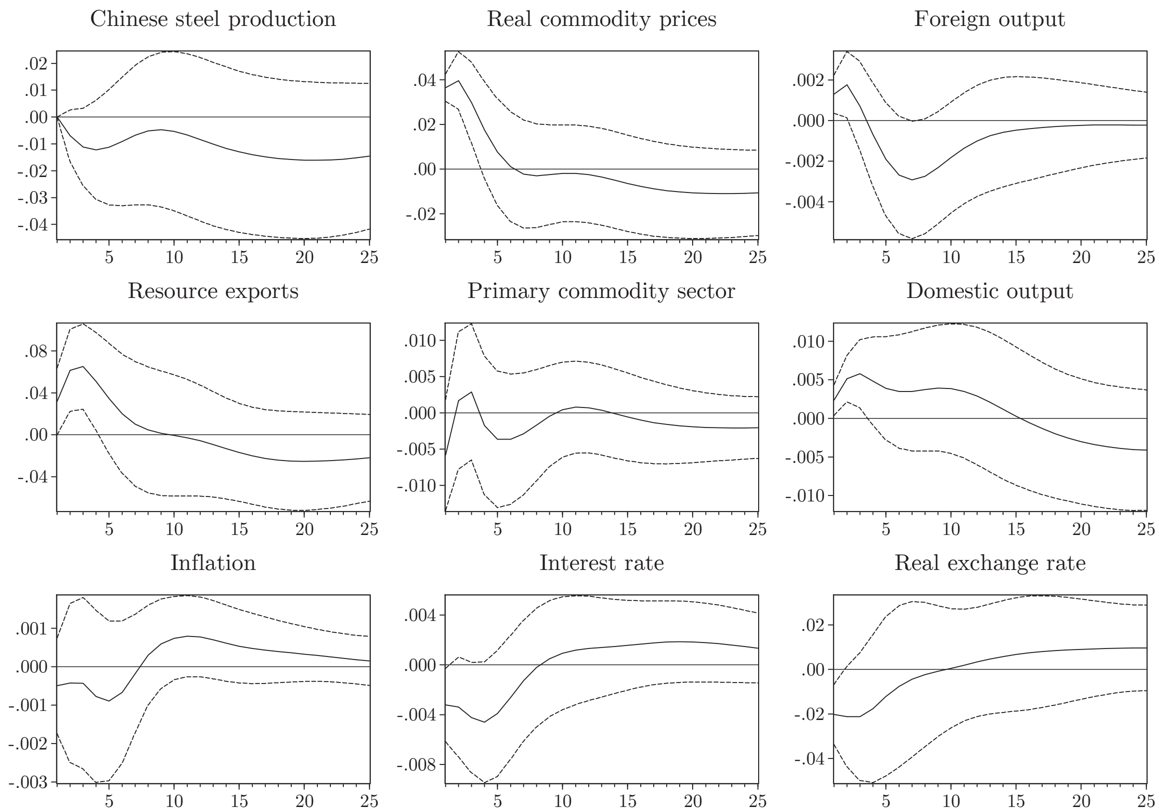

Figure 41: Impulse response functions to a shock to commodity prices for the model without restriction in the interest rate, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

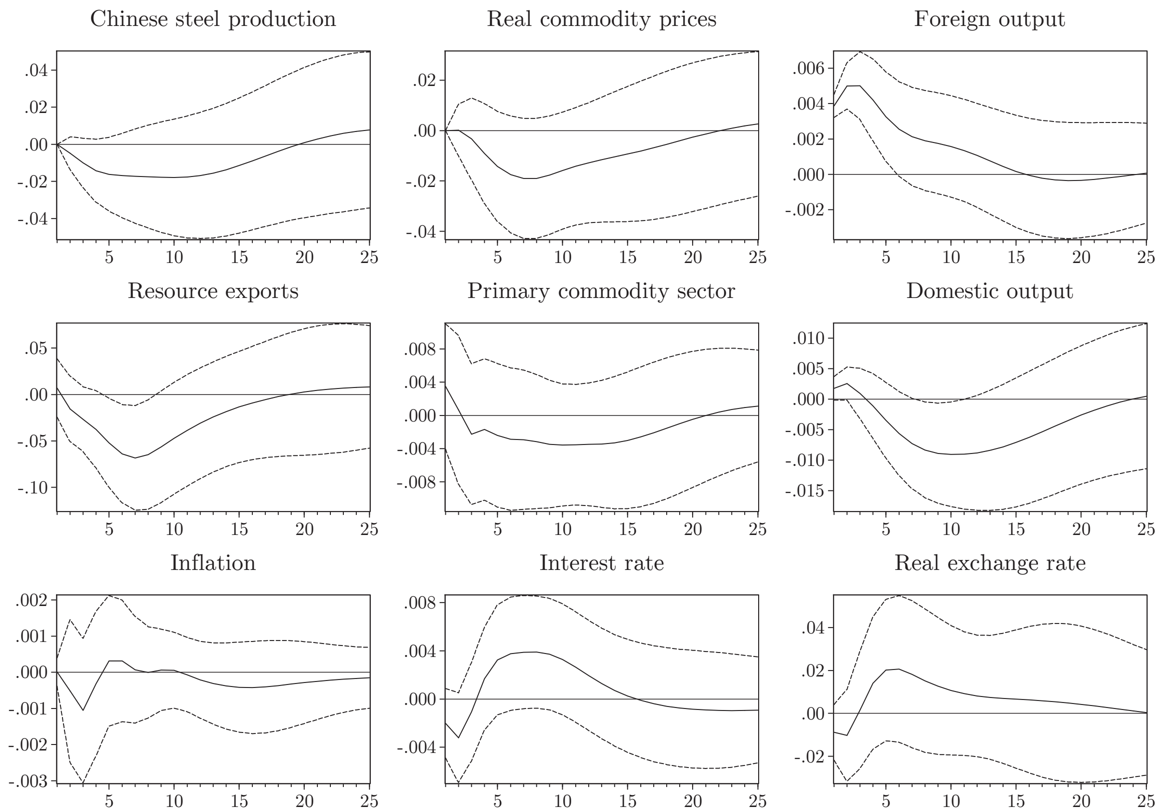

Figure 42: Impulse response functions to a shock to foreign output for the model without restriction in the interest rate, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

Table 12: Forecast error variance decomposition for the model without restriction in the interest rate (in per cent).

Variable	Shock	1	4	12	24	Variable	Shock	1	4	12	24
	csp_t	100.00	80.35	46.49	32.22		csp_t	0.21	15.12	18.18	17.56
	pc_t	0.00	5.07	3.28	8.90		pc_t	3.22	2.35	3.41	4.16
	yw_t	0.00	5.16	11.50	9.37		yw_t	1.16	1.01	4.00	5.37
	$resx_t$	0.00	5.23	8.19	7.48		$resx_t$	6.62	4.63	5.01	4.88
csp_t	$comm_t$	0.00	0.32	7.85	13.87	$comm_t$	$comm_t$	88.80	54.45	45.80	42.98
	yd_t	0.00	0.69	9.63	11.42		yd_t	0.00	3.06	4.13	5.81
	pd_t	0.00	0.90	0.27	0.29		pd_t	0.00	0.45	0.73	0.68
	rd_t	0.00	0.39	0.71	1.58		rd_t	0.00	4.68	4.10	4.07
	q_t	0.00	1.89	12.09	14.86		q_t	0.00	14.26	14.64	14.47
	csp_t	30.37	43.75	41.17	33.52		csp_t	12.28	50.24	41.92	34.89
	pc_t	69.63	48.98	27.18	22.93		pc_t	6.68	14.18	9.88	9.14
	yw_t	0.00	1.11	14.62	12.18		yw_t	3.77	1.88	25.52	26.16
	$resx_t$	0.00	0.23	1.84	3.62		$resx_t$	0.15	0.19	1.28	2.15
pc_t	$comm_t$	0.00	2.08	4.02	8.49	yd_t	$comm_t$	1.01	2.75	3.60	4.17
	yd_t	0.00	0.14	6.52	9.47		yd_t	76.10	28.03	15.12	18.09
	pd_t	0.00	3.07	2.17	1.53		pd_t	0.00	1.81	1.32	0.92
	rd_t	0.00	0.32	0.42	1.16		rd_t	0.00	0.63	0.64	1.36
	q_t	0.00	0.31	2.06	7.10		q_t	0.00	0.29	0.72	3.12
	csp_t	1.78	4.88	3.15	3.58		csp_t	0.18	0.47	0.96	0.92
	pc_t	9.92	5.58	20.48	18.23		pc_t	0.63	1.15	3.91	5.35
	yw_t	88.30	80.52	53.96	46.65		yw_t	0.00	1.40	1.44	2.32
	$resx_t$	0.00	0.30	4.31	4.94		$resx_t$	0.14	3.67	4.83	4.90
yw_t	$comm_t$	0.00	1.09	7.49	12.79	pd_t	$comm_t$	1.46	12.36	12.24	13.52
	yd_t	0.00	1.52	1.85	2.06		yd_t	0.36	5.32	6.59	6.18
	pd_t	0.00	0.61	0.53	0.50		pd_t	97.22	41.65	37.61	35.27
	rd_t	0.00	0.24	0.35	0.37		rd_t	0.00	27.88	26.71	25.05
	q_t	0.00	5.26	7.87	10.88		q_t	0.00	6.12	5.71	6.49
	csp_t	3.26	20.89	21.52	19.73		csp_t	5.17	16.53	16.59	14.75
	pc_t	5.24	23.91	13.54	15.12		pc_t	6.20	14.04	12.82	15.11
	yw_t	0.25	4.97	26.26	21.74		yw_t	2.42	4.22	15.64	14.34
	$resx_t$	91.25	38.07	19.06	16.59		$resx_t$	6.43	9.63	7.19	7.04
$resx_t$	$comm_t$	0.00	5.55	4.63	7.71	rd_t	$comm_t$	1.36	1.26	1.89	5.08
	yd_t	0.00	3.58	12.12	12.47		yd_t	0.21	3.41	11.28	11.02
	pd_t	0.00	0.51	0.51	0.44		pd_t	0.09	0.63	0.66	0.63
	rd_t	0.00	2.17	1.72	2.03		rd_t	78.12	49.69	32.15	28.00
	q_t	0.00	0.35	0.64	4.17		q_t	0.00	0.59	1.78	4.03
							csp_t	6.37	5.63	9.41	12.47
							pc_t	11.22	9.16	7.27	8.18
							yw_t	2.17	2.18	8.57	7.71
							$resx_t$	4.88	2.21	1.87	3.47
						q_t	$comm_t$	9.65	27.25	27.90	25.66
							yd_t	1.16	2.85	5.33	6.92
							pd_t	0.42	0.47	0.64	0.53
							rd_t	18.89	10.61	7.44	6.28
							q_t	45.25	39.64	31.57	28.78

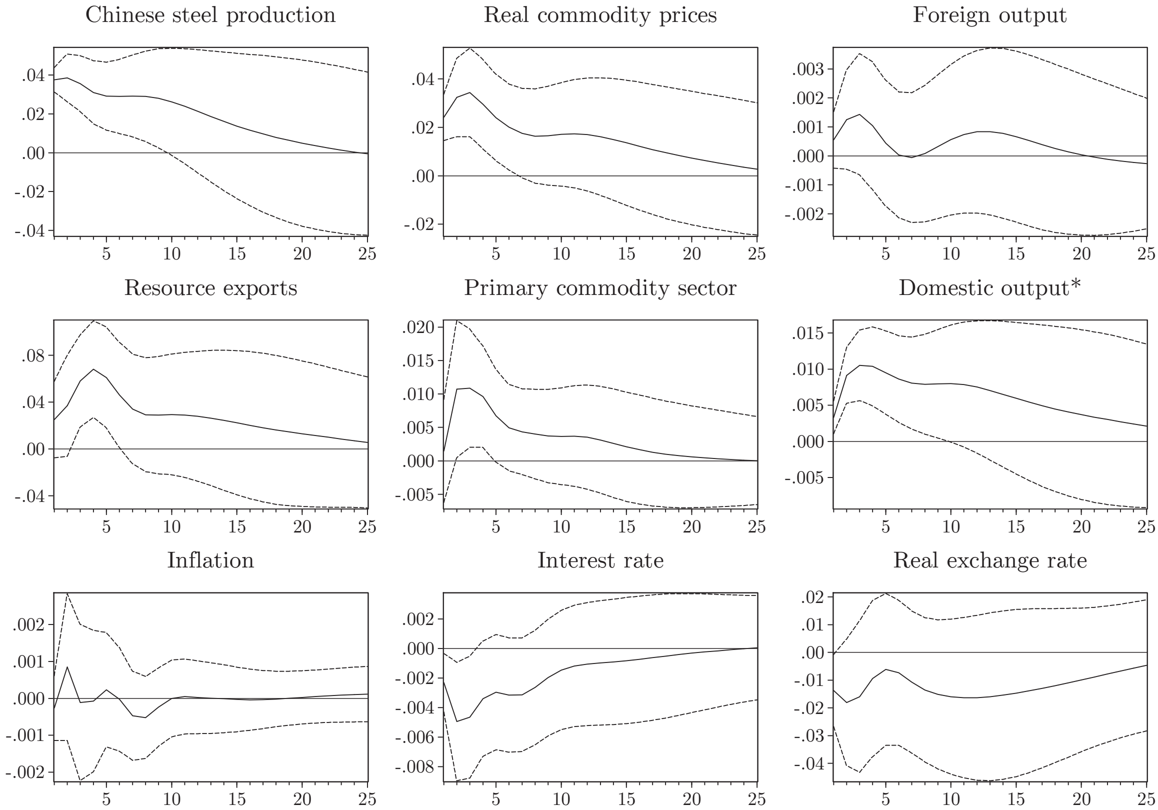

Figure 43: Impulse response functions to a shock to Chinese steel production for the model with domestic output minus primary commodity sector, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

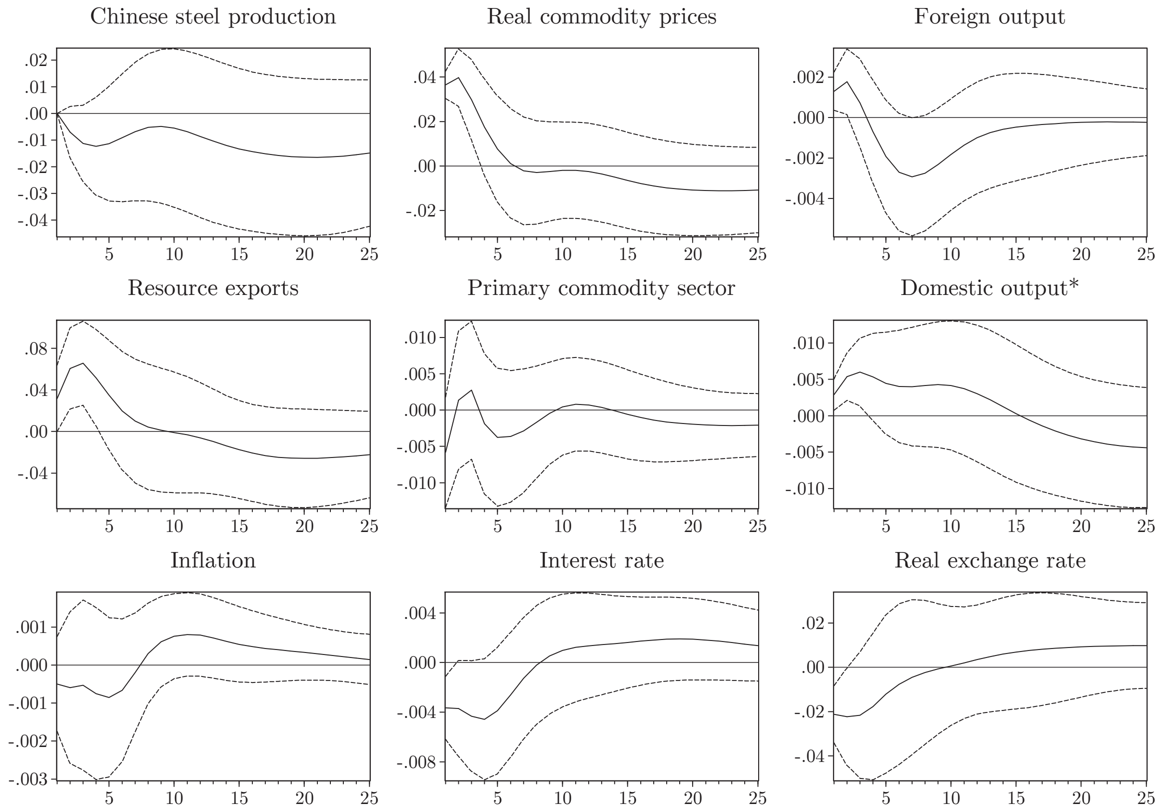

Figure 44: Impulse response functions to a shock to commodity prices for the model with domestic output minus primary commodity sector, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

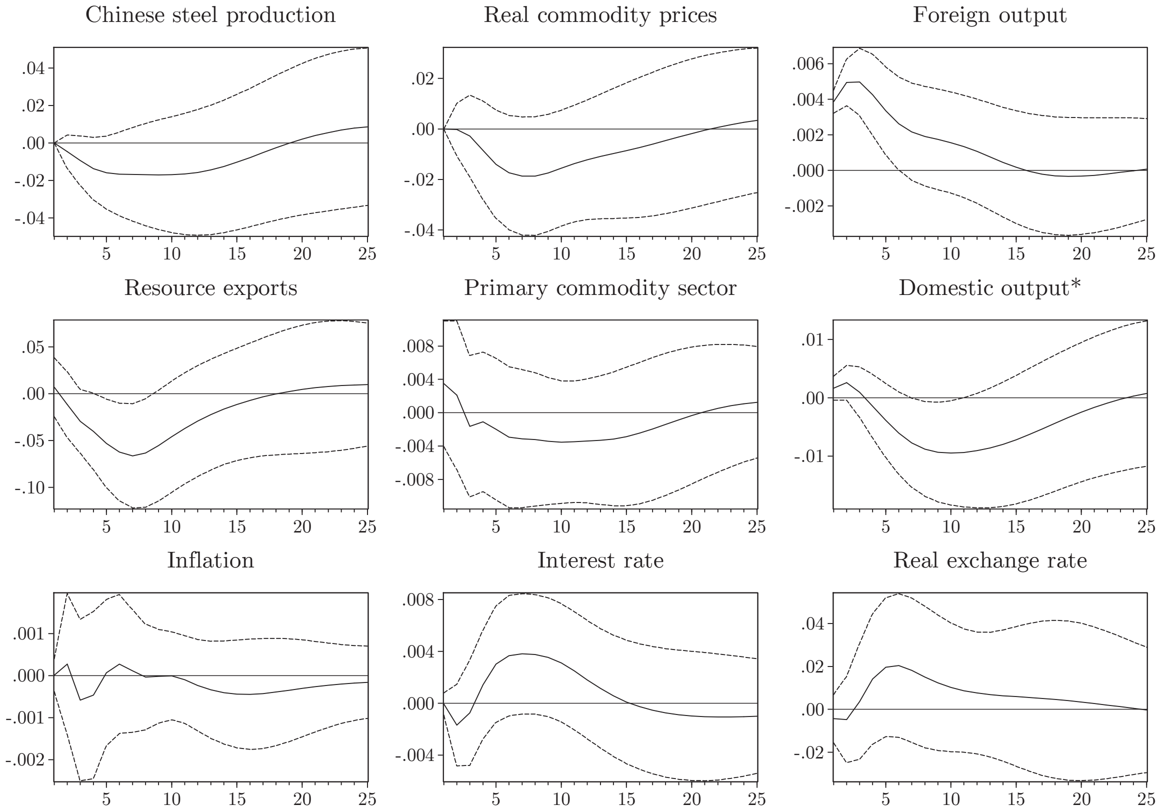

Figure 45: Impulse response functions to a shock to foreign output for the model with domestic output minus primary commodity sector, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

Table 13: Forecast error variance decomposition for the model with domestic output minus primary commodity sector (in per cent).

Variable	Shock	1	4	12	24	Variable	Shock	1	4	12	24
	csp_t	100.00	81.18	47.18	32.64		csp_t	0.21	15.60	18.58	17.97
	pc_t	0.00	5.19	3.38	9.29		pc_t	3.22	2.23	3.31	4.11
	yw_t	0.00	4.74	10.73	8.65		yw_t	1.16	0.97	3.87	5.08
	$resx_t$	0.00	4.62	7.25	6.13		$resx_t$	6.62	5.47	5.63	5.32
csp_t	$comm_t$	0.00	0.31	8.11	14.27	$comm_t$	$comm_t$	88.80	53.48	45.20	42.50
	yd_t^*	0.00	0.76	10.18	12.19		yd_t^*	0.00	2.92	3.97	5.81
	pd_t	0.00	0.90	0.27	0.30		pd_t	0.00	0.45	0.71	0.67
	rd_t	0.00	0.42	0.81	1.80		rd_t	0.00	5.01	4.40	4.39
	q_t	0.00	1.88	12.09	14.73		q_t	0.00	13.87	14.32	14.15
	csp_t	30.37	43.98	41.57	33.89		csp_t	11.35	46.23	39.61	33.73
	pc_t	69.63	49.01	27.30	23.26		pc_t	8.67	15.03	10.70	9.79
	yw_t	0.00	0.96	14.07	11.47		yw_t	2.80	1.83	25.63	25.66
	$resx_t$	0.00	0.14	1.51	2.73		$resx_t$	0.96	0.25	1.39	1.73
pc_t	$comm_t$	0.00	2.06	4.01	8.68	yd_t^*	$comm_t$	1.26	3.64	4.31	4.66
	yd_t^*	0.00	0.14	6.86	10.10		yd_t^*	74.96	29.58	15.39	18.86
	pd_t	0.00	3.05	2.17	1.54		pd_t	0.00	1.83	1.33	0.93
	rd_t	0.00	0.35	0.47	1.32		rd_t	0.00	1.02	0.85	1.61
	q_t	0.00	0.32	2.05	7.01		q_t	0.00	0.59	0.80	3.04
	csp_t	1.79	4.87	3.15	3.61		csp_t	0.18	0.74	1.15	1.10
	pc_t	9.91	5.67	20.58	18.29		pc_t	0.64	1.34	4.04	5.51
	yw_t	88.30	80.47	54.12	46.73		yw_t	0.00	0.58	0.64	1.69
	$resx_t$	0.00	0.22	4.10	4.70		$resx_t$	0.14	2.88	3.42	3.51
yw_t	$comm_t$	0.00	1.09	7.45	12.79	pd_t	$comm_t$	1.46	13.21	13.12	14.32
	yd_t^*	0.00	1.52	1.82	2.09		yd_t^*	0.33	4.61	6.25	5.87
	pd_t	0.00	0.61	0.53	0.50		pd_t	97.25	40.75	36.97	34.66
	rd_t	0.00	0.26	0.38	0.41		rd_t	0.00	29.89	28.79	26.99
	q_t	0.00	5.29	7.87	10.88		q_t	0.00	5.98	5.60	6.35
	csp_t	3.25	20.56	21.51	19.70		csp_t	3.20	14.44	15.47	13.73
	pc_t	5.25	23.96	13.66	15.46		pc_t	7.89	15.20	13.62	15.97
	yw_t	0.25	5.51	25.62	21.13		yw_t	0.00	1.25	12.75	11.97
	$resx_t$	91.25	37.50	18.71	15.85		$resx_t$	0.23	8.55	6.16	5.88
$resx_t$	$comm_t$	0.00	5.63	4.63	7.83	rd_t	$comm_t$	2.16	1.83	2.32	5.52
	yd_t^*	0.00	3.59	12.80	13.22		yd_t^*	1.03	3.51	12.06	11.76
	pd_t	0.00	0.53	0.52	0.46		pd_t	0.15	0.61	0.65	0.62
	rd_t	0.00	2.36	1.92	2.27		rd_t	85.34	54.04	35.23	30.61
	q_t	0.00	0.35	0.63	4.09		q_t	0.00	0.58	1.74	3.93
							csp_t	5.29	4.91	8.92	12.14
							pc_t	12.56	9.91	7.79	8.74
							yw_t	0.53	1.45	7.88	6.96
							$resx_t$	1.45	0.56	0.65	2.09
						q_t	$comm_t$	10.78	28.23	28.59	26.35
							yd_t^*	1.79	2.78	5.50	7.24
							pd_t	0.48	0.47	0.65	0.54
							rd_t	21.08	11.74	8.23	6.97
							q_t	46.05	39.95	31.79	28.96

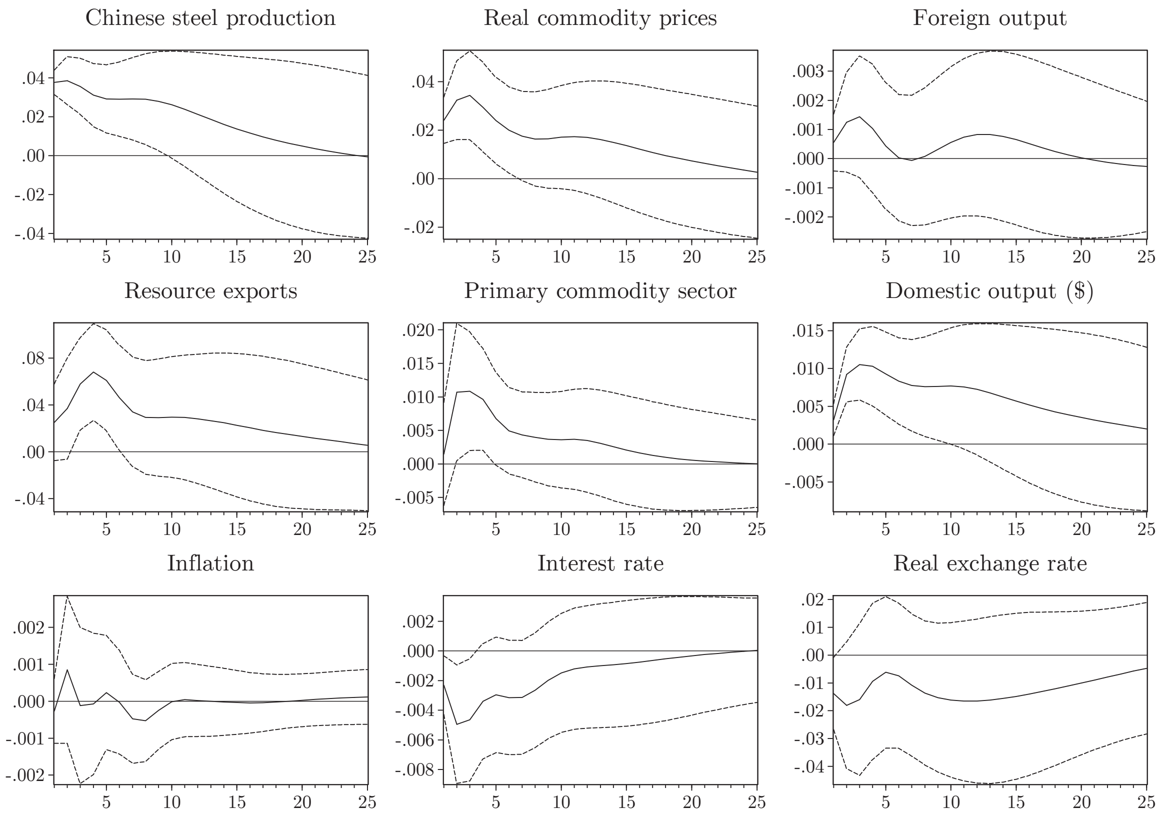

Figure 46: Impulse response functions to a shock to Chinese steel production for the model with domestic output in dollar, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

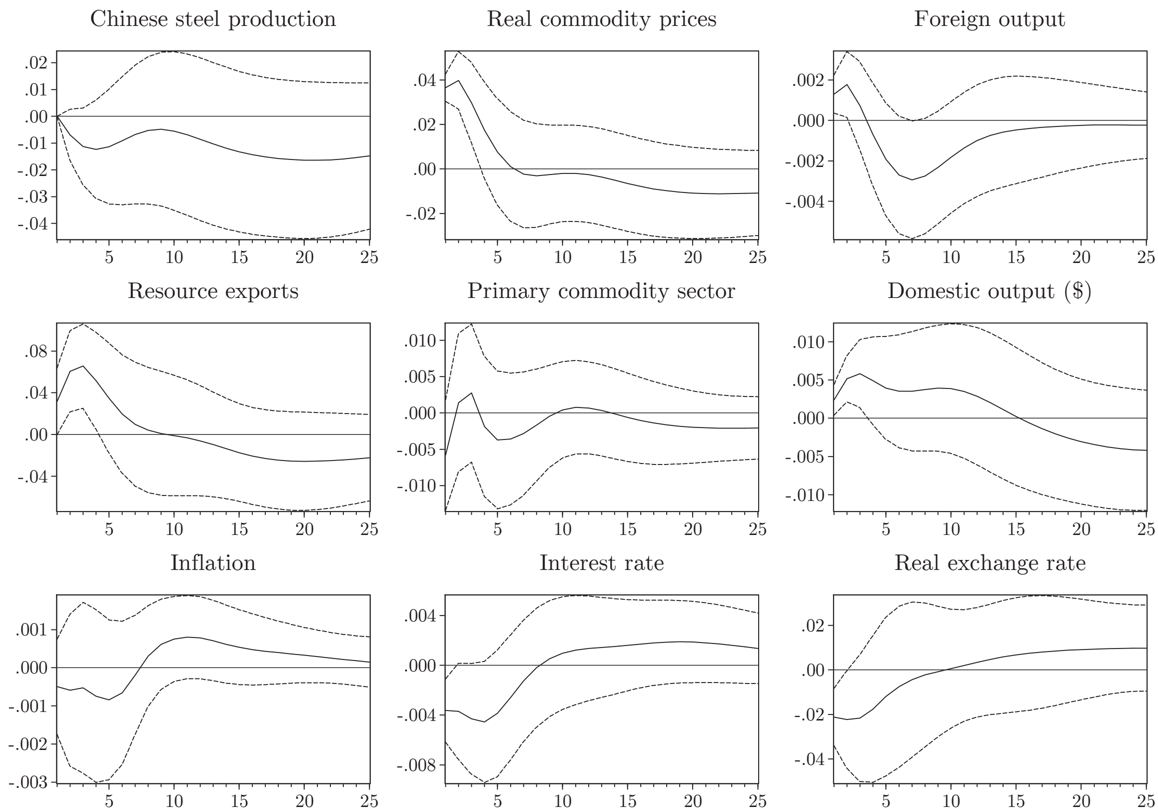

Figure 47: Impulse response functions to a shock to commodity prices for the model with domestic output in dollar, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

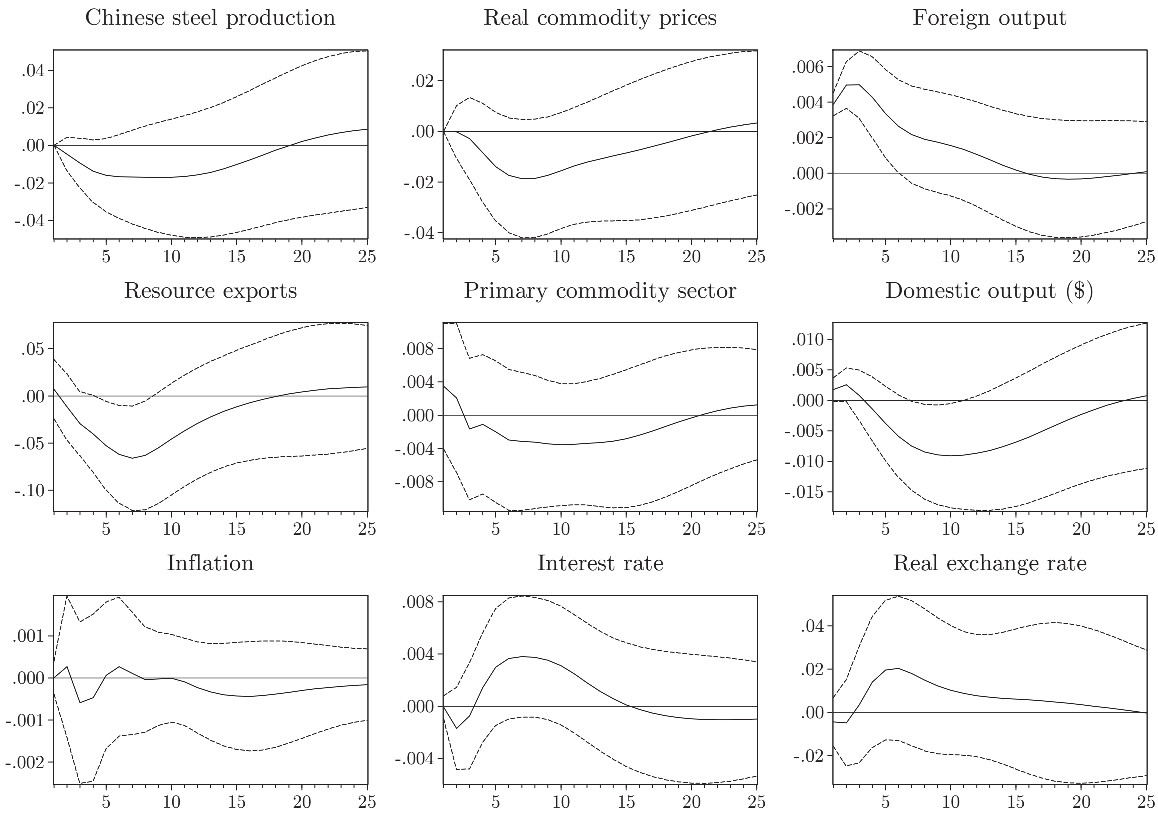

Figure 48: Impulse response functions to a shock to foreign output for the model with domestic output in dollar, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

Table 14: Forecast error variance decomposition for the model with domestic output in dollar (in per cent).

Variable	Shock	1	4	12	24	Variable	Shock	1	4	12	24
	csp_t	100.00	81.18	47.16	32.63		csp_t	0.21	15.57	18.52	17.91
	pc_t	0.00	5.20	3.38	9.26		pc_t	3.22	2.23	3.30	4.10
	yw_t	0.00	4.73	10.75	8.66		yw_t	1.16	0.98	3.89	5.06
	$resx_t$	0.00	4.61	7.21	6.10		$resx_t$	6.61	5.43	5.59	5.29
csp_t	$comm_t$	0.00	0.31	8.07	14.25	$comm_t$	$comm_t$	88.81	53.56	45.29	42.63
	$yd(\$)_t$	0.00	0.76	10.24	12.25		$yd(\$)_t$	0.00	2.97	4.04	5.84
	pd_t	0.00	0.90	0.27	0.30		pd_t	0.00	0.44	0.71	0.67
	rd_t	0.00	0.42	0.79	1.75		rd_t	0.00	4.97	4.37	4.36
	q_t	0.00	1.89	12.13	14.81		q_t	0.00	13.84	14.29	14.14
	csp_t	30.37	43.95	41.57	33.92		csp_t	12.33	49.62	41.27	34.76
	pc_t	69.63	49.05	27.34	23.25		pc_t	6.84	14.32	9.90	9.30
	yw_t	0.00	0.96	14.05	11.45		yw_t	3.76	1.97	25.74	25.62
	$resx_t$	0.00	0.14	1.48	2.71		$resx_t$	0.10	0.19	1.45	1.76
pc_t	$comm_t$	0.00	2.05	4.02	8.68	$yd(\$)_t$	$comm_t$	1.02	2.82	3.66	4.28
	$yd(\$)_t$	0.00	0.13	6.83	10.09		$yd(\$)_t$	75.96	28.35	15.26	18.79
	pd_t	0.00	3.05	2.18	1.54		pd_t	0.00	1.76	1.30	0.92
	rd_t	0.00	0.35	0.46	1.29		rd_t	0.00	0.68	0.70	1.50
	q_t	0.00	0.31	2.07	7.07		q_t	0.00	0.29	0.72	3.08
	csp_t	1.79	4.87	3.14	3.59		csp_t	0.18	0.74	1.17	1.12
	pc_t	9.93	5.68	20.57	18.30		pc_t	0.63	1.31	3.99	5.43
	yw_t	88.28	80.48	54.13	46.77		yw_t	0.00	0.59	0.64	1.64
	$resx_t$	0.00	0.21	4.13	4.72		$resx_t$	0.14	2.84	3.38	3.48
yw_t	$comm_t$	0.00	1.09	7.46	12.79	pd_t	$comm_t$	1.48	13.30	13.22	14.42
	$yd(\$)_t$	0.00	1.53	1.81	2.08		$yd(\$)_t$	0.37	4.64	6.26	5.87
	pd_t	0.00	0.60	0.52	0.49		pd_t	97.20	40.76	37.00	34.71
	rd_t	0.00	0.26	0.39	0.41		rd_t	0.00	29.85	28.75	26.97
	q_t	0.00	5.28	7.84	10.85		q_t	0.00	5.97	5.60	6.36
	csp_t	3.27	20.49	21.57	19.80		csp_t	3.20	14.42	15.50	13.79
	pc_t	5.24	23.95	13.65	15.38		pc_t	7.87	15.17	13.58	15.89
	yw_t	0.26	5.51	25.59	21.08		yw_t	0.00	1.26	12.73	11.93
	$resx_t$	91.23	37.46	18.70	15.83		$resx_t$	0.22	8.50	6.12	5.86
$resx_t$	$comm_t$	0.00	5.64	4.65	7.86	rd_t	$comm_t$	2.18	1.84	2.33	5.54
	$yd(\$)_t$	0.00	3.71	12.77	13.21		$yd(\$)_t$	1.08	3.56	12.06	11.77
	pd_t	0.00	0.53	0.53	0.46		pd_t	0.14	0.61	0.66	0.63
	rd_t	0.00	2.36	1.90	2.24		rd_t	85.30	54.06	35.24	30.62
	q_t	0.00	0.35	0.64	4.14		q_t	0.00	0.58	1.77	3.98
							csp_t	5.33	4.93	9.06	12.34
							pc_t	12.52	9.85	7.72	8.63
							yw_t	0.55	1.45	7.84	6.97
							$resx_t$	1.50	0.59	0.68	2.11
						q_t	$comm_t$	10.85	28.38	28.69	26.36
							$yd(\$)_t$	1.89	2.77	5.42	7.24
							pd_t	0.46	0.47	0.65	0.54
							rd_t	20.93	11.67	8.18	6.91
							q_t	45.98	39.90	31.75	28.90

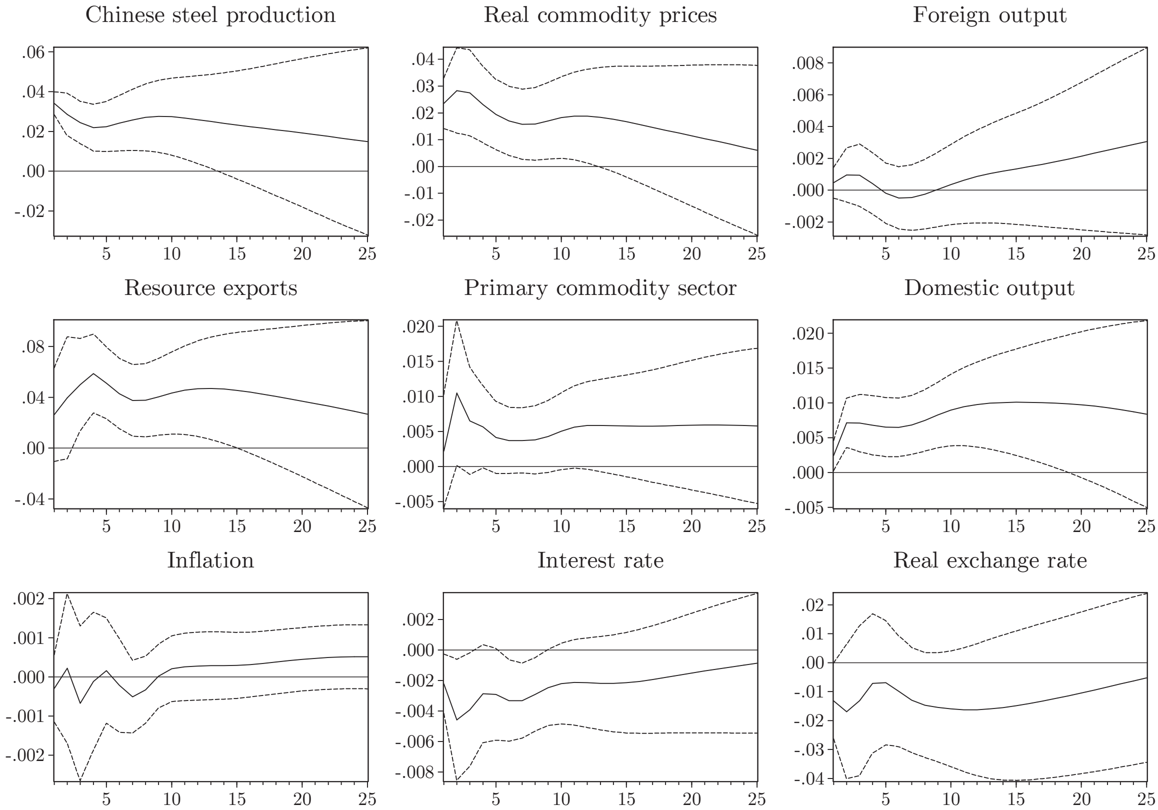

Figure 49: Impulse response functions to a shock to Chinese steel production for the model with variables non-detrended, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

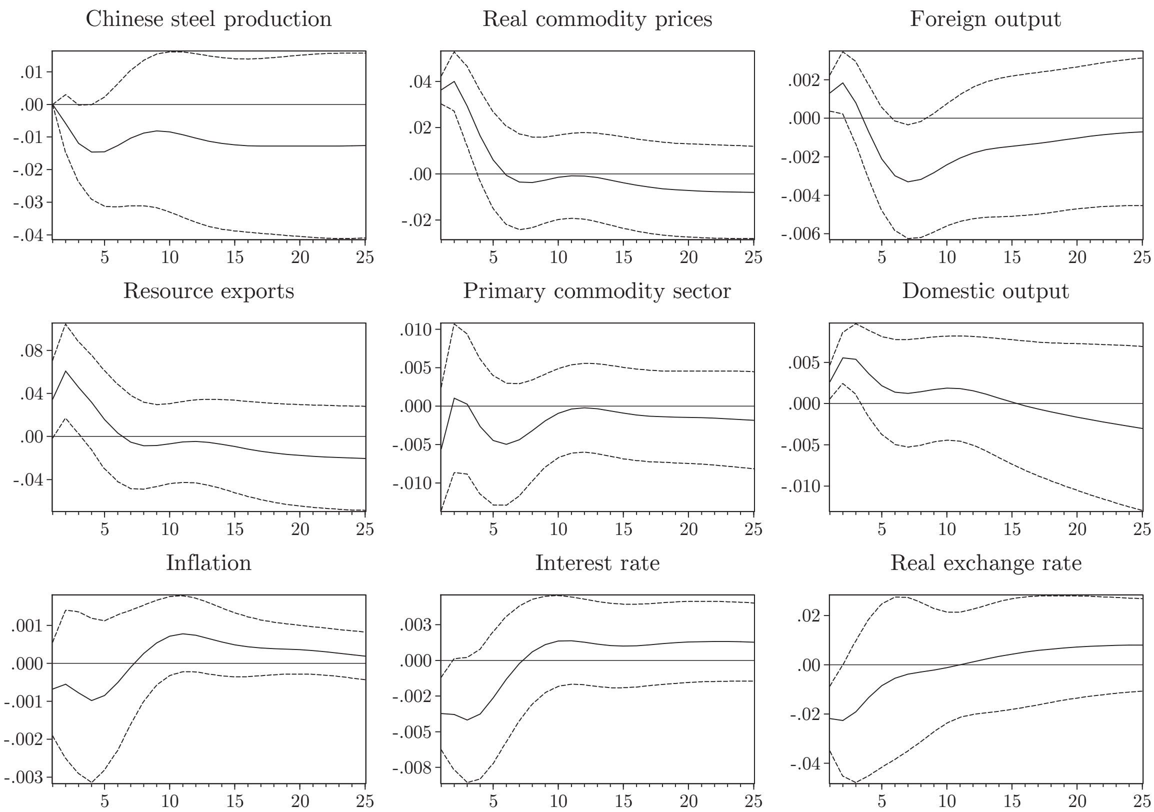

Figure 50: Impulse response functions to a shock to commodity prices for the model with variables non-detrended, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

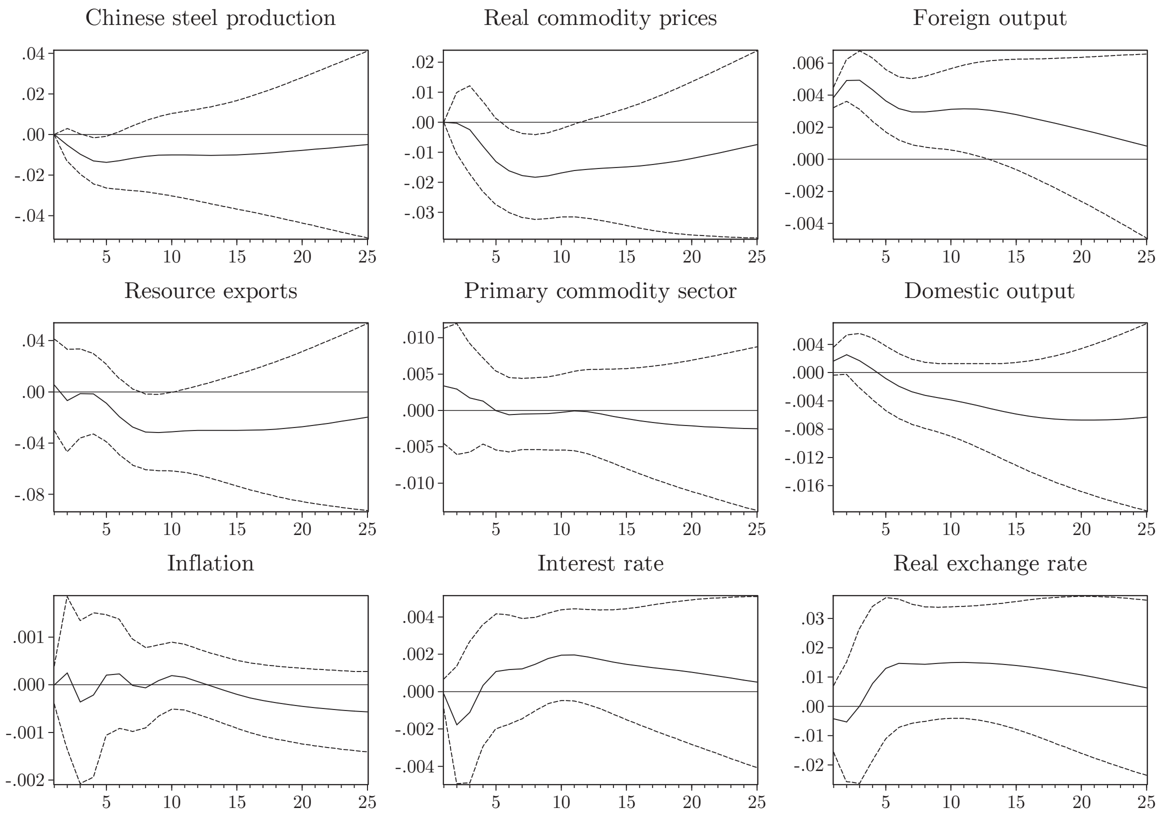

Figure 51: Impulse response functions to a shock to foreign output for the model with variables non-detrended, 1999Q1 to 2017Q1. Dashed lines are the 90 percent confidence intervals.

Table 15: Forecast error variance decomposition for the model with variables non-detrended (in per cent).

Variable	Shock	1	4	12	24	Variable	Shock	1	4	12	24
	csp_t	100.00	70.41	43.23	33.45		csp_t	0.42	9.47	13.44	21.35
	pc_t	0.00	9.03	6.55	7.83		pc_t	2.65	1.95	4.40	3.83
	yw_t	0.00	6.77	6.76	5.43		yw_t	0.98	1.23	0.96	1.86
	$resx_t$	0.00	3.92	10.30	9.69		$resx_t$	13.31	8.92	12.53	14.78
csp_t	$comm_t$	0.00	2.41	8.75	13.28	$comm_t$	$comm_t$	82.64	57.56	46.05	36.55
	yd_t	0.00	0.80	3.51	5.48		yd_t	0.00	2.67	3.70	3.12
	pd_t	0.00	3.33	1.41	0.86		pd_t	0.00	0.73	1.32	1.34
	rd_t	0.00	1.07	0.73	1.15		rd_t	0.00	5.25	4.33	3.24
	q_t	0.00	2.27	18.76	22.83		q_t	0.00	12.21	13.26	13.94
	csp_t	29.65	35.56	36.00	29.34		csp_t	7.00	29.22	43.60	43.89
	pc_t	70.35	54.27	28.80	18.35		pc_t	8.18	15.19	6.60	3.21
	yw_t	0.00	0.95	15.82	17.01		yw_t	3.16	2.31	6.54	14.06
	$resx_t$	0.00	0.29	0.69	0.64		$resx_t$	0.99	1.47	12.12	9.11
pc_t	$comm_t$	0.00	3.73	5.94	6.63	yd_t	$comm_t$	2.47	4.45	4.70	3.86
	yd_t	0.00	0.10	4.98	12.48		yd_t	78.20	41.75	18.63	12.55
	pd_t	0.00	4.30	3.23	1.99		pd_t	0.00	3.48	3.48	2.15
	rd_t	0.00	0.49	0.63	2.04		rd_t	0.00	0.92	2.04	1.29
	q_t	0.00	0.32	3.91	11.51		q_t	0.00	1.19	2.30	9.88
	csp_t	1.28	2.12	1.18	7.10		csp_t	0.23	0.56	0.98	2.39
	pc_t	10.18	6.11	18.43	10.85		pc_t	1.22	2.18	4.29	5.51
	yw_t	88.53	80.17	47.98	30.13		yw_t	0.00	0.22	0.33	1.67
	$resx_t$	0.00	0.66	12.39	24.50		$resx_t$	0.34	3.00	3.97	3.77
yw_t	$comm_t$	0.00	1.16	6.43	9.35	pd_t	$comm_t$	2.41	11.40	10.85	11.30
	yd_t	0.00	2.29	7.91	11.68		yd_t	0.90	6.66	9.90	9.68
	pd_t	0.00	0.72	0.32	0.45		pd_t	94.89	39.54	35.27	32.80
	rd_t	0.00	0.26	0.49	1.37		rd_t	0.00	31.12	29.61	27.70
	q_t	0.00	6.51	4.87	4.57		q_t	0.00	5.32	4.80	5.17
	csp_t	2.82	17.24	29.88	29.65		csp_t	2.92	11.58	18.55	18.51
	pc_t	4.89	16.81	10.95	7.97		pc_t	8.27	14.02	12.91	11.87
	yw_t	0.12	0.17	7.86	10.77		yw_t	0.01	1.05	4.26	5.41
	$resx_t$	92.17	56.13	37.15	22.05		$resx_t$	0.20	12.67	12.04	9.66
$resx_t$	$comm_t$	0.00	6.46	6.19	7.24	rd_t	$comm_t$	1.53	1.42	2.67	5.60
	yd_t	0.00	0.40	2.41	7.92		yd_t	1.68	2.34	5.00	7.84
	pd_t	0.00	0.33	0.97	0.80		pd_t	0.04	0.83	1.05	0.83
	rd_t	0.00	2.17	1.58	1.92		rd_t	85.36	55.79	41.28	31.76
	q_t	0.00	0.29	3.00	11.68		q_t	0.00	0.30	2.25	8.50
							csp_t	4.69	3.88	8.77	11.49
							pc_t	12.87	8.68	6.52	6.16
							yw_t	0.49	0.61	7.00	9.92
							$resx_t$	0.28	0.09	0.16	0.19
						q_t	$comm_t$	8.15	26.92	27.89	22.48
							yd_t	3.96	1.41	3.94	9.10
							pd_t	0.12	0.42	0.67	0.58
							rd_t	22.76	13.73	9.71	8.30
							q_t	46.68	44.26	35.32	31.78