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External Commodity Shocks and the Insulating Role of Fiscal Policy on Real Output: Evidence from a Commodity-Exporting Economy

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external commodity shocks, fiscal policy, real output, Mongolia

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External Commodity Shocks and the Insulating Role of Fiscal Policy on Real Output: Evidence from a Commodity-Exporting Economy*

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Abstract

This study investigates the role of fiscal policy in stabilising resource-rich economies vulnerable to external commodity shocks, with a specific focus on Mongolia. We analyse the effects of various external commodity shocks on Mongolia's economy and find that fiscal policy's responses to these shocks have been counter-cyclical. Additionally, we construct policy counterfactuals to examine the insulating role of fiscal policy on real domestic output. The findings reveal that counter-cyclical fiscal measures, particularly government expenditure, and to a lesser extent, government revenue, played an important role in Mongolia's response to external commodity shocks.

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* *The views expressed herein are solely those of the authors and do not necessarily reflect the views of The SEACEN Centre, the Bank of Mongolia, the SEACEN member central banks/monetary authorities, and CAMA-ANU.*

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1 Introduction

Resource-rich countries are often vulnerable to external shocks emanating from commodity markets which have direct implications on their growth and welfare (Bjørnland & Thorsrud, 2019; Durand-Lasserve & Karanfil, 2023). For instance, the sharp downturn in commodity prices during the 2008 and early 2009 as a result of the Global Financial Crisis (GFC) and the European debt crisis, which followed several years of almost uninterrupted rise in commodity prices, including oil, metals, chemicals and fuels have hit these resource-rich, commodity exporting economies particularly hard. It is clear that there is a crucial need to stabilise these group of economies during episodes of commodity booms and busts. In this study, we are mainly interested in examining the role that fiscal policy plays in insulating these economies from external commodity shocks. We will focus on the extent of the fiscal policy's insulating role on domestic output from these shocks in the specific context of Mongolia.

Mongolia's economy has experienced the commodity boom and bust firsthand, and thus provides a useful and interesting case study on this issue. After discovering major coal deposits and gold-copper ore in the early 2000s, it became an economy heavily reliant on mining. During the commodity boom, Mongolia enjoyed a surge in demand for its mineral resources, which led to rapid and high economic growth. However, with the sharp decline in commodity prices during the GFC, Mongolia's economy faced a severe recession. It was able to recover quickly from late 2009, but in 2015-2016 due to a combination of factors, it again suffered a sharp economic slowdown. In May 2017, it entered an Extended Fund Facility (EFF) with the IMF (Doojav et al., 2023).

To achieve the above aim, it is important to first unpack and disentangle the effects of various manifestations of external commodity shocks and their interactions with some key domestic macroeconomic aggregates, including fiscal policy measures. To do this, we rely on structural vector autoregression (SVAR) modelling in which the identification of the external commodity shocks is made through a block exogeneity assumption similar to that employed by Doojav et al. (2023) also in the case of Mongolia, and Souza and Fry-McKibbin (2021) in the case of Brazil. Also similar to these two studies, the various manifestations of external commodity shocks that we consider in this study are one-time, unexpected shocks in Chinese steel production, foreign liquidity, commodity prices and foreign output. However, unlike Doojav et al. (2023) and Souza and Fry-McKibbin (2021), who included a domestic interest rate as one of their domestic variables, effectively focusing on a monetary policy SVAR modelling set-up, our study replaces the domestic interest rate with either government expenditure or government revenue (both as a proportion of GDP) as one of the domestic variables. In view of the focus of our study, we effectively use a fiscal policy SVAR modelling set-up. Just as what we found in this study through forecast error variance decomposition analysis (FEVD), Doojav et al. (2023) and Souza and Fry-McKibbin (2021) both found that these four external commodity shocks play a very important role in explaining the variance of certain key macroeconomic variables.

The SVAR modelling we carry out in this study adds to a growing number of studies that uses this approach to examine the interrelationship between shocks to commodity markets, fiscal policy and a host of other macroeconomic variables. For instance, Medina (2016) analyses the effects of commodity price shocks on fiscal revenues and expenditures in Latin American countries. The studies of Farzanegan and Markwardt (2009), and Farzanegan (2011) find that oil price shocks have important and unique effects on the economy of Iran. Pieschacón (2012) finds that in the cases of Mexico and Norway, fiscal policy seems capable of regulating the size of the pass-through from oil price shocks to key macroeconomic variables, and it appears to be welfare improving when it is able to insulate the economy from oil price shocks compared to when it is procyclical. Jabri et al. (2022) study the impact of oil price shocks on fiscal policy and real GDP in Oman using new unexplored data. Their results suggest that fiscal policy has a stabilising role in reducing the impact of oil price fluctuations. In light of these sets of previous studies, we believe that our study uses a richer set of manifestations of external commodity shocks, which serves as another key contribution of this study. Raddatz (2007) conducted a study that also uses a richer set of manifestations of external shocks and is conducted in a panel-SVAR modelling framework. This study considers the following set of external shocks: shocks to rich countries' GDP, shock to the Deaton-Miller commodity prices index, shock to international interest rates, geological disaster, climatic disaster, human disaster, shock to per capita aid flows and shock to real per capita GDP. However, Raddatz (2007) did not include any fiscal policy variable in their model.

According to our impulse response analysis, in response to respective positive shocks in Chinese steel production, foreign liquidity, commodity prices and foreign output, fiscal policy in Mongolia has been counter-cyclical characterised either by a reduction in government expenditure or an increase in government revenue. This result is in conformity with theoretical results coming from both the neo-classical (Barro, 1979) and standard Keynesian or neo-Keynesian models (Christiano et al., 2011) which prescribe that fiscal policy should be counter-cyclical to stabilise the economy and avoid welfare losses (Durand-Lasserve & Karanfil, 2023). However, our result is not universally supported by empirical evidence because the findings have been mixed as to whether fiscal policy has a procyclical or cyclical response to certain shocks. Furthermore, the evidence on this literature is mostly panel-based, unlike our present study which uses time-series data. For instance, Kaminsky, Reinhart, and Vegh (2004) claim that in all developing countries, fiscal policy has been procyclical. In contrast, Frankel, Vegh, and Vuletin (2013) presented evidence of a 'graduation' from fiscal policy in a large number of developing countries. Furthermore, Céspedes and Velasco (2014) argue that the focus of empirical studies that found evidence of fiscal procyclicality has been on the behaviour of fiscal policy across the output cycle or fluctuations. However, they presented evidence that when the focus is instead on the behaviour of fiscal policy across the commodity price cycle or fluctuations, which is the pertinent shock more relevant or related to our study, procyclicality is greatly reduced across a panel of countries. More interestingly, a careful examination of the sample of countries that are included in the panel estimations of these previous studies indicate that Mongolia is not included in the sample, possibly due to a dearth of available data. To the best of our knowledge, this study then makes a contribution to this empirical literature by providing the first evidence using time-series data and macro-econometric methods for a major commodity-exporting developing economy like Mongolia.

Given our evidence that fiscal policy in Mongolia has been counter-cyclical, we then turn to our ultimate focus in this study by investigating the extent of the fiscal policy's insulating role on domestic output in Mongolia from these shocks. To do this, from our SVAR model, we resort to the construction of policy counterfactuals by applying the method proposed by Kilian and Lewis (2011).[1] The working idea of Kilian and Lewis (2011) is that to ascertain the insulating role of fiscal policy on real domestic output, the fiscal authorities react to fluctuations in the other variables

[1] A related study by Pieschacón (2012) uses a reduced-form VAR to construct counterfactuals to examine the insulating role of fiscal policy against oil price shocks in the economies of Norway and Mexico.

included in the SVAR model, but with only the direct response of the fiscal authorities to the pertinent external commodity shock shut down. This allows us to compare the actual evolution of the impulse responses of domestic real output with that under the counterfactual policy shock sequence. We find that counter-cyclical fiscal policy through government expenditure generally mattered to Mongolian fiscal authorities in responding to external shocks. Government revenue has also made a difference in responding to external shocks in a few instances.[2,3]

This paper is organised as follows. The next section discusses the SVAR model we employ, the data, the identification of structural shocks, and the construction of the counterfactuals. Section 3 presents the main empirical results of our study. Section 4 discusses the sensitivity checks we conduct to assess the robustness of our results. Concluding remarks are offered in Section 5.

2 Estimation framework and data

This section discusses the SVAR model for Mongolia to examine the effects of the four external shocks (shocks to Chinese steel production, foreign liquidity, real commodity prices and foreign output), and from this SVAR model outline the implementation of policy counterfactuals to assess whether the responses of the fiscal authorities in Mongolia to these four individual external shocks mattered for real domestic output. 2.1 discusses the model, data and the identification assumptions. Section 2.2 presents how the policy counterfactual is implemented in this study.

2.1 SVAR model, data and identification of structural shocks

Consider the following structural VAR(p) representation of a vector of K dimensional vector of variables Y_t:

$$A_0 Y_t = A_1 Y_{t-1} + \ldots + A_p Y_{t-p} + \epsilon_t \tag{1}$$

[2] We use interchangeably the characterisation whether fiscal policy mattered or made a difference to real domestic output with that of its insulating role on real output.

[3] We note that we are not the first to utilise the idea of constructing and using counterfactuals to assess the insulating role of fiscal policy on domestic real output. The relevant study that precedes ours is the study of Pieschacón (2012). However, we are the first to apply the Kilian-Lewis technique to construct fiscal policy counterfactuals in the specific context of Mongolia.

where A_0 is a nonsingular matrix normalised to have unit values on the diagonal and summarises the contemporaneous relationships between the variables contained in Y_t. $A_1, \ldots,$ and A_p are the structural parameters on the lagged relationships between the variables contained in Y_t. The $K \times 1$ vector ϵ_t contains the serially uncorrelated structural shocks which has the properties $E_t(\epsilon_t \epsilon_t') = D$ and $E_t(\epsilon_t \epsilon_{t+s}') = 0$, for all $s \neq 0$. D is a diagonal matrix containing the variances of the structural disturbances. The intercept has been suppressed for notational convenience.

For a sample period that ranges from 2000Q1 to 2020Q4, the Y_t vector contains ten variables of which four are foreign or international variables and six are domestic variables. The foreign variables include a Chinese steel production variable ($chsp_t$), real foreign liquidity using real M2 of the BRIC (Brazil, Russia, India and China) and the US ($forliq_t$), real commodity prices (rcp_t) and real foreign output ($forout_t$). The domestic variables include real commodity exports ($commex_t$), real commodity sector output ($commout_t$), government expenditure to domestic output ratio ($gexp_t$) as one of our two measures of domestic fiscal policy, real domestic output ($domout_t$), inflation ($inflat_t$), and real effective exchange rate ($reer_t$). In another section of our analysis, we replace $gexp_t$ in the Y_t vector by the government revenue to domestic output ratio ($grev_t$) as our other measure of domestic fiscal policy. With the exception of the two domestic fiscal policy variables $gexp_t$ and $grev_t$, the selection of the variables follows Dungey et al. (2014), Dungey et al. (2020), Doojav et al. (2023), and Souza and Fry-McKibbin (2021), among others.[4] Based on these studies, Chinese steel production ($chsp_t$) serves as a proxy of the quantity of resource demand coming from China, as it is argued to be the most directly related variable for Chinese resource demand. The sum of the M2 of the BRIC and the US is the measure of foreign or international liquidity.[5] The M2 monetary aggregates are deflated by the corresponding domestic CPI and transformed into US dollars by the nominal exchange rate. A commodity price index in real terms (rcp_t) is constructed for the principal commodities that Mongolia exports, namely, copper concentrate, coal, crude gold, crude oil, and iron ore. Real foreign output ($forout_t$) is the real GDP of Mongolia's thirteen largest trading partners weighted in terms of the average value of Mongolia's exports to each country.

[4] Dungey et al. (2014), Dungey et al. (2020), Doojav et al. (2023), and Souza and Fry-McKibbin (2021) focused on a monetary policy SVAR modelling set-up by including a domestic interest rate as one of their domestic variables. However, given the focus of our study, we replace the domestic interest rate with either government expenditure or government revenue (both as a proportion of GDP). Therefore, we use a fiscal policy SVAR modelling set-up in our study.

[5] See also for instance Ratti and Vespignani (2015) on the significance of BRIC liquidity.

The real commodity exports ($commex_t$) consist of the same products included in the commodity price index. The measure of the output of the commodity sector ($commout_t$) is proxied by the value added in the mining and quarrying sector. The two domestic fiscal policy variables, namely, government expenditures ($gexp_t$) and government revenues ($grev_t$) both as a percentage of Mongolia's GDP are in line with previous studies that use either government expenditures and government revenues or both as their measure of fiscal policy (e.g., Farzanegan and Markwardt (2009), Farzanegan (2011), Pieschacón (2012), Medina (2016), Bjørnland and Thorsrud (2019) and Jabri et al. (2022)). On the other hand, Fátas and Mihov (2001) use the primary deficit as a broad indicator of fiscal policy (i.e.,without distinction between government spending and tax policies). Domestic output ($domout_t$) is the real GDP in Mongolia. The inflation rate ($inflat_t$) is the headline CPI-based annual inflation in Mongolia, which is the primary indicator of the inflation target of the Bank of Mongolia (BoM). The real effective exchange rate ($reer_t$) is a trade-weighted index expressed in real terms by deflating it by the CPI. A further description of the construction of these variables is also provided in Table 1. In summary, the dataset is:

$$Y_t = \Big[chsp_t\ forliq_t\ rcp_t\ forout_t\ commex_t\ commout_t\ gexp_t\ domout_t\ inflat_t\ reer_t\Big]' \tag{2}$$

$$Y_t = \Big[chsp_t\ forliq_t\ rcp_t\ forout_t\ commex_t\ commout_t\ grev_t\ domout_t\ inflat_t\ reer_t\Big]' \tag{3}$$

In Equation (2), as our first of two measures of domestic fiscal policy, we include the ratio of government expenditure to output ($gexp_t$) in the dataset, while in Equation (3), we include the ratio of government revenue to output ($grev_t$).

The structural shocks in the SVAR are identified similar to the restrictions employed by Doojav et al. (2023), and Souza and Fry-McKibbin (2021) two studies which built on Dungey et al. (2014), Dungey et al. (2020), with lower triangular restrictions placed on the contemporaneous impact matrix A_0, and also restrictions on the structural parameters of the lagged A_1 and A_p matrices. Furthermore, the general ordering follows the order of the variables in Equation (1) and Equation (2) in which Chinese steel production is ordered the very first due to Chinese demand being domestically generated and less dependent on the global economy than the other foreign variables. The variable real foreign liquidity comes before real commodity prices based on the finding by Ratti and Vespignani (2015) that foreign liquidity has a significant influence on real commodity prices. Real foreign output is the last among the four foreign or international variables in the dataset. Dungey et al. (2014), Dungey et al. (2020), Doojav et al. (2023), and Souza and Fry-McKibbin (2021) also order real commodity prices before foreign output. Foreign variables influence each other through the lags.

Because Mongolia is a small open economy with negligible influence on the global economy, these four foreign variables contained in Y_t affect all domestic variables contemporaneously, as well as through the lags. However, the six domestic variables do not affect the foreign variables contemporaneously or through the lags. In addition to Doojav et al. (2023), and Souza and Fry-McKibbin (2021), this block exogeneity assumption was employed by relevant studies such as Bergholt et al. (2019), Jabri et al. (2022), Raddatz (2007), and Medina (2016). Furthermore, Doojav et al. (2023), and Souza and Fry-McKibbin (2021) made the assumption that the following domestic variables, namely, commodity sector output, either of our two fiscal policy variables, domestic output, and inflation do not affect domestic resource exports contemporaneously and through the lags. The general ordering of the domestic variables $\begin{bmatrix} gexp_t & domout_t & inflat_t & reer_t \end{bmatrix}'$ when the ratio of government expenditure to domestic output is included in the vector autoregression (VAR), or when the ratio of government revenue to domestic output is included in the VAR $\begin{bmatrix} grev_t & domout_t & inflat_t & reer_t \end{bmatrix}'$, both align with SVAR studies and open economy New Keynesian (NK) DSGE models. For instance, the two domestic fiscal policy variables, government expenditures and government revenues both as a percentage of Mongolia's GDP are in line with closed or open-economy fiscal SVAR studies such as by Blanchard and Perotti (2002), Galí, López-Salido, and Vallés (2007), Perotti (2008) and Ferrara et al. (2021) that order such similar measures of government expenditure and government revenue to come before domestic output, inflation and the exchange rate. The NK Phillips equation or the NK aggregate supply (AS) equation offers the explanation as to why domestic output comes before inflation. Finally, the uncovered interest rate parity (UIP) can be used to describe why the exchange rate is placed last. As emphasised by Doojav et al. (2023), in view that the real exchange rate is ordered last, the VAR model can capture the effect of developments in the commodity and financial markets to a commodtiy-exporting economy like Mongolia.

In summary, the restrictions placed on the contemporaneous impact matrix when government expenditure (as a percentage of GDP) ($gexp_t$) is included in the dataset is presented as follows:

$$A_0 Y_t = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{2,1} & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{3,1} & a_{3,2} & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{4,1} & a_{4,2} & a_{4,3} & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{5,1} & a_{5,2} & a_{5,3} & a_{5,4} & 1 & 0 & 0 & 0 & 0 & 0 \\ a_{6,1} & a_{6,2} & a_{6,3} & a_{6,4} & a_{6,5} & 1 & 0 & 0 & 0 & 0 \\ a_{7,1} & a_{7,2} & a_{7,3} & a_{7,4} & a_{7,5} & a_{7,6} & 1 & 0 & 0 & 0 \\ a_{8,1} & a_{8,2} & a_{8,3} & a_{8,4} & a_{8,5} & a_{8,6} & a_{8,7} & 1 & 0 & 0 \\ a_{9,1} & a_{9,2} & a_{9,3} & a_{9,4} & a_{9,5} & a_{9,6} & a_{9,7} & a_{9,8} & 1 & 0 \\ a_{10,1} & a_{10,2} & a_{10,3} & a_{10,4} & a_{10,5} & a_{10,6} & a_{10,7} & a_{10,8} & a_{10,9} & 1 \end{bmatrix} \begin{bmatrix} chsp_t \\ forliq_t \\ rcp_t \\ forout_t \\ commex_t \\ commout_t \\ gexp_t \\ domout_t \\ inflat_t \\ reer_t \end{bmatrix} \tag{4}$$

A similar presentation of the restrictions placed on the contemporaneous impact matrix can be made when government revenue (as a percentage of GDP) ($grev_t$) is instead included in the dataset. And, the identification restrictions through lags 1 to p pertaining to A_1 and A_p matrices when $gexp_t$ is included in the dataset is as follows:

$$A_p Y_{t-p} = \begin{bmatrix} a^p_{1,1} & a^p_{1,2} & a^p_{1,3} & a^p_{1,4} & 0 & 0 & 0 & 0 & 0 & 0 \\ a^p_{2,1} & a^p_{2,2} & a^p_{2,3} & a^p_{2,4} & 0 & 0 & 0 & 0 & 0 & 0 \\ a^p_{3,1} & a^p_{3,2} & a^p_{3,3} & a^p_{3,4} & 0 & 0 & 0 & 0 & 0 & 0 \\ a^p_{4,1} & a^p_{4,2} & a^p_{4,3} & a^p_{4,4} & 0 & 0 & 0 & 0 & 0 & 0 \\ a^p_{5,1} & a^p_{5,2} & a^p_{5,3} & a^p_{5,4} & a^p_{5,5} & 0 & 0 & 0 & 0 & a^p_{5,10} \\ a^p_{6,1} & a^p_{6,2} & a^p_{6,3} & a^p_{6,4} & a^p_{6,5} & a^p_{6,6} & a^p_{6,7} & a^p_{6,8} & a^p_{6,9} & a^p_{6,10} \\ a^p_{7,1} & a^p_{7,2} & a^p_{7,3} & a^p_{7,4} & a^p_{7,5} & a^p_{7,6} & a^p_{7,7} & a^p_{7,8} & a^p_{7,9} & a^p_{7,10} \\ a^p_{8,1} & a^p_{8,2} & a^p_{8,3} & a^p_{8,4} & a^p_{8,5} & a^p_{8,6} & a^p_{8,7} & a^p_{8,8} & a^p_{8,9} & a^p_{8,10} \\ a^p_{9,1} & a^p_{9,2} & a^p_{9,3} & a^p_{9,4} & a^p_{9,5} & a^p_{9,6} & a^p_{9,7} & a^p_{9,8} & a^p_{9,9} & a^p_{9,10} \\ a^p_{10,1} & a^p_{10,2} & a^p_{10,3} & a^p_{10,4} & a^p_{10,5} & a^p_{10,6} & a^p_{10,7} & a^p_{10,8} & a^p_{10,9} & a^p_{10,10} \end{bmatrix} \begin{bmatrix} chsp_{t-p} \\ forliq_{t-p} \\ rcp_{t-p} \\ forout_{t-p} \\ commex_{t-p} \\ commout_{t-p} \\ gexp_{t-p} \\ domout_{t-p} \\ inflat_{t-p} \\ reer_{t-p} \end{bmatrix} \tag{5}$$

Likewise, a similar presentation of the restrictions through lags 1 to p pertaining to A_1 and A_p matrices can be made when government revenue (as a percentage of GDP) ($grev_t$) is instead included in the dataset.

2.2 Counterfactual analysis

The construction of policy counterfactuals using SVAR models has a long tradition in economics that dates back to the work of Bernanke, Gertler, and Watson (1997) and Sims and Zha (2006), among others. For the same class of models, a different policy counterfactual that we use in this study was proposed by Kilian and Lewis (2011). We employ their idea that the relevant counterfactual to answer the question whether the direct responses of the fiscal authorities in Mongolia to four individual external shocks (i.e., one-time unexpected changes in Chinese steel production, foreign liquidity, commodity prices and foreign output) made a difference to real domestic output is one in which the fiscal authorities react to fluctuations in the other variables included in the SVAR model, but with only the direct response to the pertinent external shock shut down. To do this, a sequence of hypothetical shocks to either government expenditure or government revenue needs to be constructed that offsets the contemporaneous and lagged effects of including the relevant external shock in the fiscal policy reaction function. Such a shock sequence may be recovered from the estimated SVAR, allowing us to compare the actual evolution of the impulse responses of domestic output during a given episode with that under the counterfactual policy shock sequence (Kilian & Lütkepohl, 2017).

To formally begin, rewrite the SVAR model in Equation (1) as:[6]

$$Y_t = (I - A_0)A_1 Y_{t-1} + \ldots + A_p Y_{t-p} + \epsilon_t \tag{6}$$

and define a $K \times K(p+1)$ matrix:

$$B \equiv \begin{bmatrix} C & A_1 & \ldots & A_p \end{bmatrix} \tag{7}$$

where $C = I - A_0$.

We consider, for instance, a one-time unexpected increase in Chinese steel production as the pertinent external shock. The relevant counterfactual is where government expenditure or govern-

[6] The discussion follows Kilian and Lewis (2011) and Chen (in press).

ment revenue reacts to fluctuations in all the variables in the SVAR model except for the shock in Chinese steel production. To shut down the direct responses of either government expenditure or government revenue to the shock in Chinese steel production, the sequence of hypothetical shocks to either government expenditure or government revenue that offset the contemporaneous and lagged effects of including Chinese steel production in the fiscal policy reaction function is:

$$e_{gexp/grev} = -B_{7,1}x_{1,h} - \sum_{m=1}^{min(p,h)} B_{7,mK+1}z_{1,h-m}, \qquad h = 0, 1, 2, \ldots \tag{8}$$

At $h = 0$, $e_{gexp/grev,0} = -B_{7,1}x_{1,h}$,[7] where $x_{i,0}$, for $i = 1, 2, \ldots, K$, denotes the contemporaneous response of variable i to the shock in Chinese steel production in the absence of a counterfactual policy intervention, while $B_{i,j}$ refers to the (i, j) element of the matrix B. The counterfactual impulse response of variable i to a shock in Chinese steel production at $h = 0$ is:

$$z_{i,0} = x_{i,0} + \frac{\theta_{i,7,0}e_{gexp/grev,0}}{\sigma_7} \tag{9}$$

where $\sigma_{gexp/grev}$ is the standard deviation of the exogenous government expenditure/revenue shock, while $\theta_{i,j,h}$ refers to the (i, j) element of the $K \times K$ impulse response coefficient matrix at horizon h.

For $h > 0$, the corresponding values of $x_{i,h}$ and $z_{i,h}$ can be generated recursively as:

$$x_{i,h} = \sum_{m=1}^{min(p,h)} \sum_{j=1}^{K} B_{i,mK+j}z_{j,h-m} + \sum_{j<1} B_{i,j}x_{j,h} \tag{10}$$

and

$$z_{i,h} = x_{i,h} + \frac{\theta_{i,7,0}e_{gexp/grev,h}}{\sigma_7} \tag{11}$$

where $j = 1, 2, \ldots, K$.

From the above, one can observe that in the construction of the policy counterfactual, Kilian and

[7] The subscripts 7 and 1 refer to the positions of government expenditure/revenue and Chinese steel production, respectively, in the ordering of the SVAR model.

Lewis (2011) only shut down the responses of government expenditure/government revenue to the shock in Chinese steel production and allow the responses of government expenditure/government revenue to respond to the other variables in the SVAR model. Thus, the counterfactual impulse responses of government expenditure/revenue need not be zero.

3 Empirical results

This section presents the empirical results of our study. Sections 3.1 and 3.2 present the impulse responses of the effects of the four external shocks, while Section 3.3 looks at the importance of the four foreign variables in our model using variance decomposition analysis. Section 3.4 presents the results of our implementation of the counterfactual analysis, which is the main highlight of our study.[8]

Before proceeding with the main empirical results, we verify the stationarity of the variables using unit root tests. Popular unit root test such as Dickey and Fuller and augmented Dickey-Fuller have low power in the presence of structural breaks (Perron, 1989). To deal with the problem, Perron and Vogelsang (1992) and Perron (1997) developed unit root tests, including one endogeneously determined structural structural break to deal with this problem. The results of the individual unit root test based on the innovational outlier model developed by Perron (1997) for our variables in the VAR are shown in Table 2. The unit root test results indicate that all foreign variables, i.e., $chsp_t$, $forliq_t$, rcp_t and $forout_t$, and domestic output ($domout_t$), real exchange rate ($reer_t$) are $I(1)$, while domestic resource exports ($commex_t$), commodity sector output ($commout_t$), government expenditure ($gexp_t$), government revenue ($grev_t$) and inflation ($inflat_t$) are $I(0)$ process.

Since not all variables are $I(1)$, we cannot directly use a first-differenced VAR for all variables or a vector error correction model (VECM) as this will be misspecified (Canova, 2007). Moreover, Sims et al. (1990) have argued in favor of using a VAR in levels as there is no real advantage to differencing the variables to make them stationary unless attention is not directed towards the unit root behavior of the series. Hamilton (1994) has also highlighted that in a VAR comprised of variables which are $I(1)$ and cointegrated, the cointegrating relationships will be implicitly determined, and the

[8] We empirically implement this part of our analysis using an EViews add-in named Kilianlewis, which was created by both authors for this study.

variables can be estimated in levels using standard ordinary least squares. Finally, Canova (2007) suggests that a VAR in levels is appropriate if it is stable. In Figure 1, we present the inverse roots of an autoregressive (AR) characteristic polynomial for a VAR(1) specification of all our ten variables. The results show that the estimated VAR in levels is stable (stationary) since all roots have modulus less than one and lie inside the unit circle.[9] We estimate the VAR using two lags.[10]

3.1 Impulse responses (*with government expenditure included in the SVAR model*)

3.1.1 Effects of shock to Chinese steel production

The one-time one standard deviation shock to Chinese steel production as illustrated in Figure 2 is characterised as a positive shock. In response to this shock, foreign liquidity, real commodity prices and foreign output all increase. Foreign liquidity peaks at 2.6% above the baseline three quarters after the shock. The response of real commodity prices is large, peaking at 8% above the baseline also after three quarters. Although the confidence intervals are relatively wider, real foreign output rises steadily remaining above the baseline for quite some time, and at the end of the fifth year after the shock is still 0.7% higher than the baseline.

In general, the positive commodity demand shock expands Mongolia's domestic economy. This assertion is buttressed by the pronounced response in real commodity exports, which peaks at 6% above the baseline two quarters after the shock. Real domestic output likewise experiences an expansion, recording a 1% growth. The expansion in real commodity exports is complemented, on a trade-weighted basis, by the real depreciation of the Mongolian currency during the initial five quarters following the shock. However, there is a subsequent real appreciation in the Mongolian currency, aligning with a minor decline in commodity exports—although still remaining above the baseline. This expansion in the domestic economy places inflationary pressure on consumer prices. Yet, this pressure manifests as an oscillating pattern in the inflation response: an initial slight increase is followed by a dip below the baseline between the first and third quarters after the shock,

[9] The inverse roots are calculated with the government expenditure included in the VAR. The results of the inverse roots are similar when the government revenue is included instead in the VAR. The results are available upon request from the authors.

[10] The Schwarz information criteria (SC) suggests an optimal lag length of one. As part of our robustness tests, we estimate the model with only one lag. The results are robust with the use of one or two lags.

and then a subsequent rise, peaking after six quarters. In response to this positive shock, the fiscal policy has been counter-cyclical, characterised by a dip in government expenditure—up to 0.8% below the baseline—two quarters after the shock.

3.1.2 Effects of shock to foreign liquidity

Figure 3 displays the effects of a one-time standard deviation shock to foreign liquidity. Following this shock, foreign liquidity increases for approximately two years before settling back to its baseline. Aligning with the insights from Ratti and Vespignani (2015), this liquidity shock propels an increase in real commodity prices, culminating in a 6% peak two quarters after the shock. Concurrently, we observe a gradual fall in Chinese steel production, which plateaus at 1.5% below the baseline roughly two years following the shock. This result, as interpreted by Souza and Fry-McKibbin (2021), hints at the domestic-centric nature of Chinese industrialisation. In contrast, real foreign output witnesses a transient, statistically significant increase before returning close to the baseline.

Real commodity exports exhibit a pronounced hump-shaped pattern in response to the foreign liquidity shock, with significant increases between the second and fourth quarters after the shock. Yet, commodity sector output declines. Echoing the perspective of Doojav et al. (2023), such a financial shock does not affect commodity sector output but only influences real commodity prices and, consequently, the export value. This stands in constrast to the finding of Souza and Fry-McKibbin (2021) regarding Brazil, where resource export volumes remain largely unaffected by liquidity shocks. Such nuances suggest a more potent ripple effect of global liquidity shocks on real commodity prices and exports for a predominant commodity exporter like Mongolia. Domestic real output increases, which peaks two quarters after the shock. However, this outcome is tenously measured due to the relatively wide confidence intervals. For the initial seven quarters following the shock, inflation shows a significant, positive, and hump-shaped response. The real exchange rate response follows a similar pattern, marked by an initial three-quarter real depreciation of the Mongolian currency, succeeded by a prolonged real appreciation. Finally, fiscal policy responds in a counter-cyclical manner, with government expenditure showing a statistically significant decrease in the two quarters following the shock.

3.1.3 Effects of shock to commodity prices

Figure 4 illustrates the consequences of a one-time standard deviation shock to real commodity prices. Following this shock, real commodity prices rise for approximately five quarters before returning to the baseline. In reaction to this shock, Chinese steel production and foreign liquidity decrease. While foreign output initially increases, it declines by the end of the first year following the shock. Both Dungey et al. (2014) and Souza and Fry-McKibbin (2021) observed similar outcomes. They interpret the aforementioned effects of the increase in real commodity prices as a negative shock for commodity importers. This is attributed to the heightened input production costs, which subsequently escalate the prices of final goods. This surge then precipitates a decline in these foreign variables, including foreign demand. A similar interpretation is offered by Jääskelä and Smith (2013).

For a commodity exporter like Mongolia, the rise in real commodity prices acts as a beneficial external shock. This assertion is buttressed by the expansion observed in Mongolia's domestic economy. For instance, real commodity exports exceed the baseline by the fifth quarter following the shock. Commodity sector output also witnesses an increase above the baseline in the subsequent nine quarters after the shock, with a notable peak at 1.5% in the second quarter. Real domestic output displays a hump-shaped response, registering a marked positive peak of approximately 0.8% above the baseline at the end of the first year after the shock. Both inflation and the real exchange rate mirror this hump-shaped pattern. Inflation achieves a significant positive peak in the fifth quarter after the shock. Meanwhile, the real exchange rate initially falls (indicating a real depreciation of the Mongolian currency) for one quarter, but increases (signifying a real appreciation of the Mongolian currency) from the second to the sixth quarters following the shock. Consistently, in response to this positive external shock, fiscal policy acts counter-cyclically, causing government expenditure to dip below the baseline for nearly a year following the shock.

3.1.4 Effects of shock to foreign output

In Figure 5, the impact of a one-time standard deviation shock to foreign output is depicted. As a result of this shock, real commodity prices experience an uptick for the first two quarters, with a noteworthy peak at 1.2% above the baseline. However, by the third quarter, these prices fall and consistently remain below the baseline. A parallel pattern can be observed for Chinese steel production and foreign liquidity. Both demonstrate an initial increase in the first two quarters after the shock, but subsequently decrease and remain below the baseline from the third quarter onward.

The positive shock to foreign output has a beneficial effect on the Mongolian economy. Specifically, real commodity exports increases above the baseline for the first five quarters subsequent to the shock. Similarly, commodity sector output also expands, attaining its peak of 3.5% concurrently with the shock. Despite a subsequent fall from this peak, real commodity output remain above the baseline for quite some time, approximately 0.8% higher even at the conclusion of the fifth year after the shock. In a similar vein, real domestic output also expands reaching its peak of 1.5% at the shock's onset. Even though a subsequent decline ensues, by the end of the fifth year after the shock, it remains 0.6% above the baseline. The real exchange rate presents a dynamic response: a dip in the initial two quarters, a rise between the third and eleventh quarters, and ultimately, a decline below the baseline, culminating in a 0.4% decrease by the fifth year—indicates a tangible real depreciation of the Mongolian currency. In response to this positive shock to foreign output, government expenditure contracts and falls below the baseline reaching its lowest point at 1.2% two quarters after the shock. This response of fiscal policy again underscores the counter-cyclical reaction in the wake of this positive external shock.

3.2 Impulse responses (*with government revenue included in the SVAR model*)

3.2.1 Effects of shocks to: Chinese steel production, foreign liquidity, commodity prices and foreign output

Figures 6, 7, 8, and 9 delineate the effects of one-time standard deviation shocks to Chinese steel production, foreign liquidity, real commodity prices, and real foreign output, respectively, when the SVAR model includes government revenue. To avoid repeating the same details, we will just mention at this point that the impulse responses presented in these figures correspond closely to those presented in Figures 2, 3, 4, and 5 where we also considered these four external shocks, and when government expenditure is included instead in the SVAR model.

Given the focus of this study, we again note the counter-cyclical nature of the fiscal policy's response to these positive external shocks to Mongolia, this time through a rise in government revenue. Delving into specifics, Figure 6 demonstrates that the increase in government revenue, consequent to the shock in Chinese steel production, remains statistically significant even two years after the shock, peaking at 1.1% above baseline in the subsequent second quarter following the shock. Meanwhile, Figure 7 shows a pronounced, positive, hump-shaped response in government revenue for the first seven quarters after the foreign liquidity shock. In Figures 8 and 9, the government revenue's response show a consistent pattern following shocks to real commodity prices and foreign output, respectively. More explicitly, after the real commodity price shock, government revenue retains a significant positive response for the ensuing two years, as illustrated in Figure 8. Meanwhile, following the shock to real foreign output, government revenue increase significantly for the initial two quarters, reaching its peak in the second quarter after the shock, as shown in Figure 9.

3.3 Variance decomposition

3.3.1 With government expenditure included in the SVAR model

In Table 3, the variance decomposition of the variables when government expenditure is included in the SVAR model is presented. The variance decomposition shows the proportion of the variance of each variable that is attributable to shocks to each of the variables in the model. Panel A of Table 3 shows the results for the foreign variables, while Panel B of Table 3 presents the results for the domestic variables. Results are reported for forecast horizons 1,5,15 and 30 quarters ahead.

Focusing first on the variance decomposition of the foreign variables (Panel A of Table 3)[11], the decomposition shows that over the longer horizons, for Chinese steel production at 30 quarters, 98% of the variance is attributable to shocks to itself (61%), foreign liquidity (17%) and real commodity prices (20%). For foreign liquidity, 87% of the variance is accounted for by shocks to these same three variables, i.e., Chinese steel production (49%), shocks to itself (20%), and real commodity prices (18%). Real commodity prices is dominated by shocks to Chinese steel production (45%) and shocks to itself (26%), whereas for foreign output, 83% of the variance is attributable to shocks

[11] By definition, because of block exogeneity in which the six domestic variables do not affect the foreign variables contemporaneously or through the lags, the variance in each of the foreign variables that is explained by shocks to each of the domestic variables is equal to zero. These are then omitted from Panel A of Table 3.

to itself (54%) and shocks to Chinese steel production (29%). It is interesting to note the crucial importance of shocks to Chinese steel production in explaining the variance of these four foreign variables at longer horizons.

Turning now to the variance decomposition of the domestic variables presented in Panel B of Table 3 at longer horizon of 30 quarters, we can observe that for real commodity exports, it is the shocks to itself (41%) and Chinese steel production (33%) that are important. For real commodity output, it is shocks to itself that dominate (48%) followed by foreign output (21%) and foreign liquidity (18%). For government expenditure, it is shocks to itself that play a dominant role with a little more than 50% of the variance explained by shocks to this variable. Next is shocks to real domestic output which accounts for 10% of the variance. For real domestic output, 75% of the variance is attributable to shocks to foreign output (24%), Chinese steel production (20%), shocks to itself (18%) and real commodity output (13%). The variance accounted for by government expenditure at longer horizon is not negligible (8%). For inflation, shocks to itself (27%), Chinese steel production (18%), real domestic output (14%), foreign liquidity (11%) and real exchange rate (10%) play important roles. Finally, for the real exchange rate, apart from shocks to itself (28%), shocks to two foreign variables, namely, foreign liquidity (26%) and Chinese steel production (14%) mainly explain the variance of this variable. Overall, we can then observe that in almost all of our domestic variables, shocks to the foreign variables exert a major influence on the variance of the former at longer horizons.

3.3.2 With government revenue included in the SVAR model

In Table 4, the variance decomposition of the domestic variables when government revenue is included in the SVAR model is presented. Since the variance decomposition of the foreign variables are identical to those reported in Panel A of Table 3, these are not shown anymore. In terms of the variance decomposition of the domestic variables at the same longer horizon of 30 quarters, for the variables, real commodity exports and real commodity output, we essentially obtain results in Table 4 in which the shocks that dominate the variances of these two variables are consistent with those found in Panel B of Table 3. For real domestic output, in addition to shocks to foreign output (24%), Chinese steel production (23%), shocks to itself (16%), and real commodity output

(14%) all remain important with shocks to real commodity prices now also becoming important (11%). All together these shocks account for 88% of the variance in real domestic output. For inflation, shocks to real domestic output have this time taken a lesser important role, but shocks to itself (27%), Chinese steel production (25%), foreign liquidity (11%) and real exchange rate (11%) have all continue to dominate the variance (74%) of inflation. For the real exchange rate, apart from shocks to itself (36%) and the two foreign variables, namely, foreign liquidity (20%) and Chinese steel production (12%) remain to dominate the variance of this variable, another foreign variable, shocks to real commodity prices (11%) have now taken a more important role. Finally, for government revenue, shocks to itself and shocks to Chinese steel production account for 58% of the variance of this variable. Overall, again we note that for all the domestic variables, shocks to the foreign variables have all continue to play an important role in explaining the variance of the domestic variables at longer horizons.

3.4 Counterfactual analysis

3.4.1 With government expenditure included in the SVAR model

In this subsection and the next one, our aim is to address whether the direct responses of the fiscal authorities in Mongolia to the four individual external shocks (i.e., one-time unexpected changes in Chinese steel production, foreign liquidity, commodity prices and foreign output) mattered to real domestic output using the policy counterfactual proposed by Kilian and Lewis (2011). Figure 10 illustrates and compares the counterfactuals with the unconstrained responses[12] to the shock in Chinese steel production (Panel A), shock to foreign liquidity (Panel B), shock to real commodity prices (Panel C) and shock to foreign output (Panel D) when government expenditure is included in the SVAR model.

Recall from our analysis of the impulse responses presented in Figures 2 to 5 that these four external shocks were positive shocks to the economy of Mongolia, and the direct responses of fiscal policy via government expenditure to these shocks were counter-cyclical (i.e., a decrease in government expenditure). In Panel A, shutting down the direct response of government expenditure

[12] Based on our above discussion of the implementation of this counterfactual analysis, these unconstrained responses are the actual evolution of the impulse responses.

to the shock in Chinese steel production would have led to higher real domestic output. This arises since the external shock was positive and we are turning off a reduction in government expenditure. Because we are dealing with a linear VAR, the mirror image of this result is that in the face of a negative shock in Chinese steel production, shutting down an increase in government expenditure would have led to lower real domestic output.

In Panel B, a positive shock in foreign liquidity and shutting down a reduction in government expenditure would have led to lower real domestic output in the first four years from the onset of the shock. This is not as straightforward as the result we obtained in Panel A. However, in the subsequent years following the shock, the counterfactual outcome turns around to a more reasonable result when real domestic output would have been higher, and remaining above the baseline for the most part. In Panel C, shutting down a reduction in government expenditure to a positive shock in real commodity prices, would have led to higher real domestic output. This again means that the mirror image of this result is that against a negative shock in real commodity prices, shutting down an increase in government expenditure would have led to lower real domestic output. We should note though that the counterfactual outcome would indicate that real domestic output would become negative and fall below the baseline more than three years after the shock. In Panel D, a positive shock to foreign output and turning off a reduction in government expenditure would have again led to higher real domestic output. In contrast, when dealing with a negative shock to foreign output, shutting down an increase in government expenditure would have made real domestic output lower. Thus, based on the Kilian and Lewis (2011) approach of constructing policy counterfactuals, counter-cyclical fiscal policy through government expenditure generally mattered to Mongolian fiscal authorities in responding to external shocks.

3.4.2 With government revenue included in the SVAR model

We found from our analysis of the impulse responses shown in Figures 6 to 9 that the direct responses of government revenue to the same four positive external shocks were also counter-cyclical (i.e., an increase in government revenue), similar to the direct response of fiscal policy in Mongolia via government expenditure. Figure 11 illustrates and compares the counterfactuals with the unconstrained responses to the shock in Chinese steel production (Panel A), shock to foreign liquidity (Panel B), shock to real commodity prices (Panel C), and shock to foreign output (Panel D) when government revenue is included in the SVAR model.

In Panel A, shutting down the direct response of a rise in government revenue to the positive shock in Chinese steel production would have led to higher real domestic output in the first six years following the shock. Equivalently, for the same duration, shutting down a fall in government revenue against a negative shock in Chinese steel production would have led to lower real domestic output due to linearity. However, in the counterfactual outcome when we turn off an increase in government revenue to a positive shock in Chinese steel production, real domestic output would have become negative and fallen below the baseline at the end of the first year after the shock. In Panel B, shutting down the increase in government revenue from a positive liquidity shock does not make a difference counterfactually to real domestic output in the first two to three quarters after the shock because the blue solid line (unrestricted impulse responses) and the red dotted line (the Kilian-Lewis counterfactual outcome) are similar to each other. Between the first and third years following the shock, however, shutting down the counter-cyclical government revenue response to the positive liquidity shock would have made a difference since real domestic output would have been higher. After three years, counter-cyclical fiscal policy response does not make a difference with unrestricted and counterfactual impulse responses being similar to each other.

In Panel C, shutting down the increase in government revenue to a positive shock in real commodity prices would have led to higher real domestic output in the first three quarters following the shock. However, after three quarters and right up to the end of the third year after the shock, real domestic output would have been lower. Beyond this period, real domestic output would have been higher again but below the baseline. In Panel D, turning off the increase in government revenue to a positive shock in foreign output would have led to higher real domestic output in the first seven quarters following the shock. Beyond this point, however, there is an observed narrowing between the unrestricted and counterfactual responses with the counterfactual outcome being slightly lower than the unrestricted outcome. While these results are generally not as straightforward as those obtained in the case of government expenditure as a counter-cyclical device to external shocks, there are still a few instances where government revenue has also made a difference in responding to external shocks.

4 Robustness tests

We perform three sensitivity tests to check the robustness of our results. In our first sensitivity test, we relax our earlier restrictions that the following domestic variables, namely, commodity sector output, either of our two fiscal policy variables, domestic output, and inflation do not affect domestic resource exports through the lags. In our second sensitivity test, we estimated the model with one lag instead of two lags. In our third and final sensitivity test, we include a measure of the monetary policy rate in Mongolia in our SVAR model.

Our first sensitivity test implies that the identification restrictions through lags 1 to p pertaining to A_1 and A_p matrices when government expenditure ($gexp_t$) is included in the dataset will now be structured as follows:

$$A_pY_{t-p} = \begin{bmatrix} a^p_{1,1} & a^p_{1,2} & a^p_{1,3} & a^p_{1,4} & 0 & 0 & 0 & 0 & 0 & 0 \\ a^p_{2,1} & a^p_{2,2} & a^p_{2,3} & a^p_{2,4} & 0 & 0 & 0 & 0 & 0 & 0 \\ a^p_{3,1} & a^p_{3,2} & a^p_{3,3} & a^p_{3,4} & 0 & 0 & 0 & 0 & 0 & 0 \\ a^p_{4,1} & a^p_{4,2} & a^p_{4,3} & a^p_{4,4} & 0 & 0 & 0 & 0 & 0 & 0 \\ a^p_{5,1} & a^p_{5,2} & a^p_{5,3} & a^p_{5,4} & a^p_{5,5} & a^p_{5,6} & a^p_{5,7} & a^p_{5,8} & a^p_{5,9} & a^p_{5,10} \\ a^p_{6,1} & a^p_{6,2} & a^p_{6,3} & a^p_{6,4} & a^p_{6,5} & a^p_{6,6} & a^p_{6,7} & a^p_{6,8} & a^p_{6,9} & a^p_{6,10} \\ a^p_{7,1} & a^p_{7,2} & a^p_{7,3} & a^p_{7,4} & a^p_{7,5} & a^p_{7,6} & a^p_{7,7} & a^p_{7,8} & a^p_{7,9} & a^p_{7,10} \\ a^p_{8,1} & a^p_{8,2} & a^p_{8,3} & a^p_{8,4} & a^p_{8,5} & a^p_{8,6} & a^p_{8,7} & a^p_{8,8} & a^p_{8,9} & a^p_{8,10} \\ a^p_{9,1} & a^p_{9,2} & a^p_{9,3} & a^p_{9,4} & a^p_{9,5} & a^p_{9,6} & a^p_{9,7} & a^p_{9,8} & a^p_{9,9} & a^p_{9,10} \\ a^p_{10,1} & a^p_{10,2} & a^p_{10,3} & a^p_{10,4} & a^p_{10,5} & a^p_{10,6} & a^p_{10,7} & a^p_{10,8} & a^p_{10,9} & a^p_{10,10} \end{bmatrix} \begin{bmatrix} chsp_{t-p} \\ forliq_{t-p} \\ rcp_{t-p} \\ forout_{t-p} \\ commex_{t-p} \\ commout_{t-p} \\ gexp_{t-p} \\ domout_{t-p} \\ inflat_{t-p} \\ reer_{t-p} \end{bmatrix} \quad (12)$$

Just as before, a similar presentation of the restrictions through lags 1 to p pertaining to A_1 and A_p matrices can be made when government revenue ($grev_t$) is included instead in the dataset. In this sensitivity test, there is very little difference in the results compared to our baseline results. The responses of government expenditure and government revenue to the respective positive commodity shocks remain counter-cyclical, and the variance decomposition analysis also indicates that the foreign variables play important roles in explaining the variances of the domestic variables.[13] Figures A1 and A2 present the counterfactual analysis when government expenditure and government revenue are included, respectively, in the SVAR model. Compared to our baseline

[13] These results are available upon request from the authors.

results depicted in Figures 10 and 11, the results in all four panels indicate that there is very little difference. This suggests that our baseline results remain intact.

Figures A3 and A4 present the counterfactual analysis of our sensitivity test when we estimate the SVAR model using only one lag. Compared to our baseline results in Figures 10 and 11, there are some differences but the qualitative message of our study holds.[14] For instance, when we include government expenditure in the SVAR model, Figure A3 shows that although there is observed narrowing between the unrestricted and counterfactual responses in the latter part of the horizon, shutting down the direct counter-cyclical responses of government expenditure to the respective positive external commodity shocks would have led to higher real domestic output. It similarly follows just as in our baseline results that in the face of a negative commodity shock, shutting down an increase in government expenditure would have led to lower real domestic output because of linearity. Furthermore, the result shown in Panel C of Figure A3 is more straightforward compared to our baseline result in the same panel of Figure 10, as it clearly highlights the overall key message in Panel C of our baseline counterfactual results that turning off a counter-cyclical response of government expenditure from a positive shock in foreign liquidity, would have led to higher real domestic output. When we include government revenue in the SVAR model, the results of the counterfactual analysis are again in line with the overall qualitative message coming out of our baseline counterfactual analysis. In fact, the results shown in Panels C and D of Figure A4 are more straightforward compared to the same two panels in our baseline results shown in Figure 11. These two panels in this part of our sensitivity test make it clear that shutting down the increase in government revenue to a positive shocks in real commodity prices (Panel C) and foreign output (Panel D) would have led to higher real domestic output in the first few years following the pertinent shock.

Finally, our third and final sensitvity test is to include a measure of the monetary policy rate ($cbrate_t$) in Mongolia in our SVAR model. We include $cbrate_t$ by placing this variable after $inflat_t$ and before $reer_t$. In this regard, the general ordering of the domestic variables becomes $\begin{bmatrix} gexp_t & domout_t & inflat_t & cbrate_t & reer_t \end{bmatrix}'$ when the ratio of government expenditure to domestic output is included in the vector autoregression (VAR), or when the ratio of government revenue

[14] The impulse responses and the variance decomposition analysis are available upon request from the authors.

to domestic output is included in the VAR $\left[grev_t \quad domout_t \quad inflat_t \quad cbrate_t \quad reer_t\right]'$. Figures A5 and A6 present the counterfactual analysis of this third sensitivity test. Compared to our baseline results in Figures 10 and 11, the results in each of the panels of Figures A5 and A6 show that there is again very little difference. The notable exception that further reinforce our findings is panel B of Figure A6 which now shows that shutting down the increase in government revenue from a positive liquidity shock does make a difference counterfactually to real domestic output in the first to second years after the shock. Overall, this sensitivity test indicate that including the monetary policy rate along with our respective fiscal policy variables in the SVAR model does not overturn our baseline results.

5 Conclusion

Our study sheds light on the intricate relationship between fiscal policy and external commodity shocks in Mongolia, an economy that is intimately acquainted with the volatile dynamics of commodity markets. Our analysis reveals that Mongolia's fiscal policy responds counter-cyclically to external commodity shocks, marked mostly by appropriate adjustments in government expenditure and to a lesser extent, government revenue. This counter-cyclical stance, in line with established economic theory, serves as a stabilising force on the country's real output.

Our findings have significant implications for policymakers in Mongolia and beyond. First and foremost, they underscore the importance of maintaining a counter-cyclical fiscal policy stance during periods of external commodity shocks. Such an approach can help mitigate the adverse effects of volatile commodity markets on domestic output and, consequently, on welfare. Additionally, our study highlights the need for resource-rich economies to carefully tailor their fiscal responses to different types of external commodity shocks. While government expenditure plays a vital role in stabilising the economy, government revenue measures can also be effective in certain instances. Given the changing economic conditions, policymakers should maintain flexibility in their fiscal strategies. Our research provides valuable insights into the interplay between fiscal policy and external commodity shocks in Mongolia. This can motivate policymakers to enhance the resilience of their economies in the face of commodity market volatility. By adopting prudent fiscal measures that align with the specific characteristics of external shocks, economies like Mongolia can better safeguard their economic stability and welfare, ultimately paving the way for sustainable growth and development

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Table 1: Description of the variables

	Variables	Descriptions
Foreign variables	$chsp_t$	Chinese steel production and is collected at `www.tradingeconomics.com.`
	$forliq_t$	The sum of the real M2 money supply (in US dollars) of Brazil, China, India, Russia and the U.S. was used as the proxy for foreign liquidity. The domestic CPI in the respective countries was used to deflate the nominal M2, and the non-US real M2 was transformed into US dollars using the bilateral nominal exchange rate with the US dollar. The M2 data for Brazil, China and the US were obtained from the Federal Reserve Bank of St. Louis, while the M2 data for Russia and India were taken from the corresponding websites of their central banks. The CPI and exchange rate data were taken from FRED, the Federal Reserve Bank of St. Louis.
	rcp_t	The weighted average of the real commodity price index of the five principal commodity exports of Mongolia, namely, copper concentrate, coal, crude gold, crude oil and iron ore was constructed. The weights are computed each month by dividing the value of the exports of each commodity by the value of Mongolia's total commodity exports. US CPI was used to deflate the monthly nominal commodity price index in US dollars of the five major commodity exports. Quarterly values of the real commodity price index was obtained by taking the average of its monthly values over the relevant quarter. Data on commodity prices were obtained from the World Bank Pink Sheet, while data on Mongolian exports come from the Mongolian Customs General Administration.
	$forout_t$	The weighted average of the real GDP of Mongolia's thirteen largest trading partners were calculated. The average of Mongolia's exports to each of these thirteen countries was used as weights. Data on GDP in real time, seasonally adjusted and in constant US dollars were obtained from the World Bank's Global Economic Monitor.
Domestic variables	$commex_t$	The real commodity exports by Mongolia of crude gold, crude oil, iron ore, copper concentrate, and coal, which are denominated in US dollars. To calculate this variable, the sum of the exports is deflated by the US CPI and seasonally adjusted using X-13ARIMA-SEATS.
	$commout_t$	The real value added in Mongolia's mining and quarrying sector (in 2010 prices). The data was taken from the National Accounts published by the National Statistical Office (NSO) of Mongolia. The data is seasonally adjusted using X-13ARIMA-SEATS.
	$gexp_t$	The ratio of government expenditure and output in Mongolia. The government expenditure data was taken from the NSO database.
	$grev_t$	The ratio of government revenue and output in Mongolia. The government revenue data was also obtained from the NSO database.
	$domout_t$	Mongolia's real GDP (also in 2010 prices). The data was also taken from the NSO database and seasonally adjusted using X-13ARIMA-SEATS.
	$inflat_t$	Mongolia's inflation rate measured by Mongolia's headline CPI-based annual inflation. The data comes from the Monthly Statistical Bulletin of the Bank of Mongolia.
	$reer_t$	The real effective exchange rate index of Mongolia. The nominal effective exchange rate index was obtained from the Bank of Mongolia and expressed in real terms using CPI.

Table 2: Unit root tests of the variables in the VAR

Series	Levels		First differences		Order of integration
	T_b	$t_{\tilde{\alpha}}$	T_b	$t_{\tilde{\alpha}}$	
$chsp_t$	2003Q1	-2.91	2008Q4	-10.42***	$I(1)$
$forliq_t$	2003Q1	-2.95	2008Q4	-6.93***	$I(1)$
rcp_t	2005Q2	-3.68	2008Q4	-8.02***	$I(1)$
$forout_t$	2005Q3	-3.81	2020Q1	-23.93***	$I(1)$
$commex_t$	2004Q1	-5.03**	2002Q1	-15.63***	$I(0)$
$commout_t$	2019Q2	-5.06**	2006Q4	-11.97***	$I(0)$
$gexp_t$	2002Q4	-7.00***	2009Q4	-17.58***	$I(0)$
$grev_t$	2012Q2	-6.33***	2021Q4	-17.26***	$I(0)$
$domout_t$	2010Q4	-4.41	2006Q4	-11.83***	$I(1)$
$inflat_t$	2007Q2	-5.78***	2008Q2	-8.49***	$I(0)$
$reer_t$	2016Q2	-4.28	2009Q1	-9.12***	$I(1)$

Notes:

1. The test is performed using the t-statistic for the null hypothesis that $\alpha = 1$ in the regression:
   $y_t = \mu + \theta DU_t + \beta t + \gamma DT_t + (T_b)_t + \alpha y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-i} + e_t$,
   where $DU_t = 1(t > T_b)$
   $(T_b)_t = 1(t = T_b + 1)$ and $DT_t = 1(t > T_b)$
2. The number of optimal lags is based on the Schwarz Bayesian criterion (BIC).
3. The break point selection, T_b is based on minimisation of the Dickey-Fuller t-statistic, $t_{\tilde{\alpha}}$.
4. ***, **, * represent $p < 0.01$; $p < 0.05$; $p < 0.10$.

Figure 1: Inverse roots of AR characterristic polynomial of VAR(1)

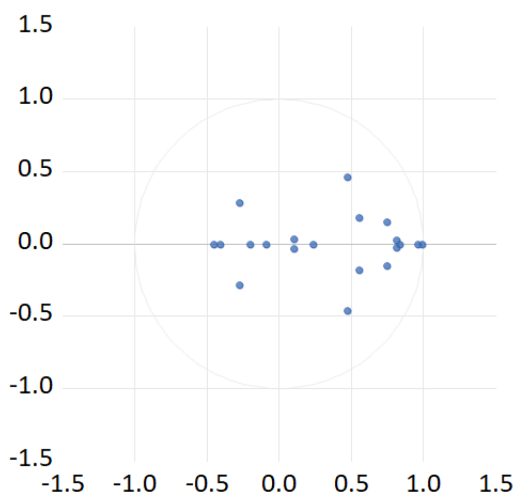


Table 3: **Panel A**: Forecast error variance decomposition of the *foreign variables* (*with government expenditure (as a percentage of GDP)*)

Variable	Shock	1	5	15	30	Variable	Shock	1	5	15	30
$chsp_t$	$chsp_t$	100.00	88.91	66.79	61.45	rcp_t	$chsp_t$	25.29	49.38	48.90	45.29
	$forliq_t$	0.00	4.34	13.82	16.73		$forliq_t$	22.57	20.42	15.53	14.55
	rcp_t	0.00	6.18	17.49	19.89		rcp_t	52.15	29.28	26.51	26.19
	$forout_t$	0.00	0.58	1.90	1.93		$forout_t$	0.00	0.92	9.05	13.97
$forliq_t$	$chsp_t$	14.41	43.83	53.79	49.12	$forout_t$	$chsp_t$	6.15	15.89	24.33	29.11
	$forliq_t$	85.59	53.78	24.81	20.08		$forliq_t$	1.61	1.28	6.10	12.33
	rcp_t	0.00	1.81	13.48	17.97		rcp_t	1.85	1.38	2.10	4.05
	$forout_t$	0.00	0.58	7.92	12.83		$forout_t$	90.39	81.45	67.46	54.51

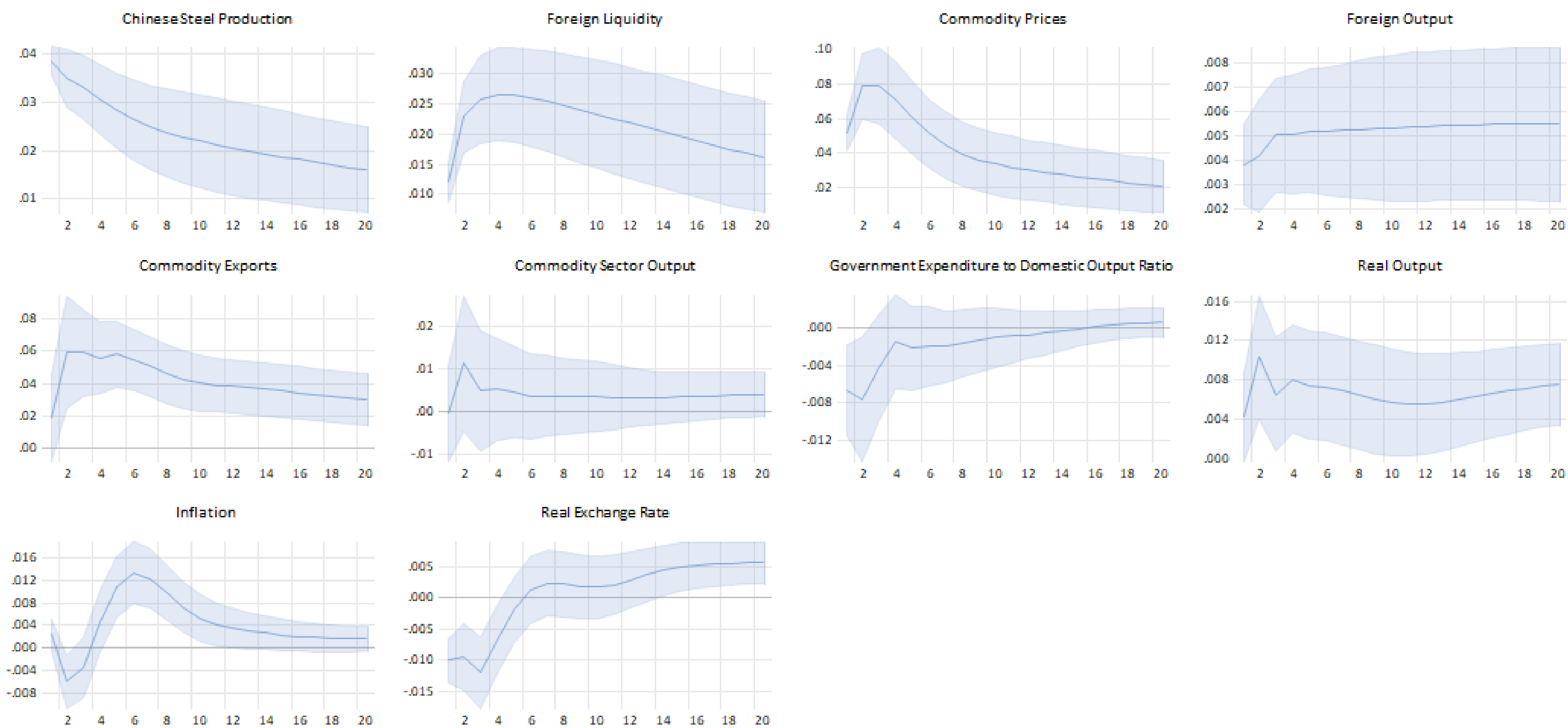
Table 3: **Panel B**: Forecast error variance decomposition of the *domestic variables* (*with government expenditure (as a percentage of GDP)*)

Variable	Shock	1	5	15	30	Variable	Shock	1	5	15	30
$commex_t$	$chsp_t$	0.62	16.25	28.71	32.58	$domout_t$	$chsp_t$	1.04	7.43	11.06	20.41
	$forliq_t$	0.19	7.34	7.64	10.02		$forliq_t$	1.05	2.30	2.58	3.10
	rcp_t	3.42	3.75	7.44	10.46		rcp_t	0.09	5.36	4.77	6.91
	$forout_t$	6.80	6.91	5.60	5.00		$forout_t$	12.25	17.25	24.68	24.00
	$commex_t$	88.96	64.94	49.95	41.38		$commex_t$	7.96	3.94	2.79	2.20
	$commout_t$	0.00	0.02	0.02	0.02		$commout_t$	37.13	21.01	16.16	12.99
	$gexp_t$	0.00	0.01	0.01	0.01		$gexp_t$	2.38	6.74	9.17	7.56
	$domout_t$	0.00	0.01	0.01	0.01		$domout_t$	38.10	33.38	23.31	18.33
	$inflat_t$	0.00	0.17	0.16	0.13		$inflat_t$	0.00	0.89	0.63	0.50
	$reer_t$	0.00	0.59	0.46	0.38		$reer_t$	0.00	1.70	4.84	3.99
$commout_t$	$chsp_t$	0.00	1.08	1.54	2.45	$inflat_t$	$chsp_t$	0.94	6.25	17.84	17.75
	$forliq_t$	6.68	13.54	17.15	18.29		$forliq_t$	0.87	12.26	11.96	11.33
	rcp_t	1.42	4.85	4.66	4.42		rcp_t	1.93	4.30	5.65	6.73
	$forout_t$	11.58	16.92	19.15	21.36		$forout_t$	2.28	1.30	4.69	7.07
	$commex_t$	0.37	0.48	0.47	0.44		$commex_t$	4.40	2.67	2.06	1.95
	$commout_t$	79.94	58.98	52.21	48.35		$commout_t$	0.13	1.70	2.06	2.10
	$gexp_t$	0.00	1.20	1.38	1.39		$gexp_t$	0.05	1.27	1.54	1.72
	$domout_t$	0.00	2.18	2.70	2.54		$domout_t$	10.01	17.47	14.40	13.62
	$inflat_t$	0.00	0.07	0.09	0.08		$inflat_t$	79.38	39.33	29.21	27.57
	$reer_t$	0.00	0.70	0.65	0.66		$reer_t$	0.00	13.46	10.59	10.17
$gexp_t$	$chsp_t$	2.21	3.65	3.73	3.75	$reer_t$	$chsp_t$	9.49	11.67	9.11	13.89
	$forliq_t$	8.66	5.56	5.17	5.40		$forliq_t$	7.38	12.67	29.19	25.69
	rcp_t	6.61	4.79	5.05	5.03		rcp_t	2.47	3.26	4.49	7.05
	$forout_t$	0.01	5.60	5.35	5.32		$forout_t$	0.00	2.16	2.21	6.69
	$commex_t$	0.07	2.41	2.30	2.29		$commex_t$	0.41	0.87	0.69	0.58
	$commout_t$	1.37	8.22	8.38	8.42		$commout_t$	0.12	2.60	3.29	2.83
	$gexp_t$	81.08	58.04	53.54	53.21		$gexp_t$	0.40	4.92	6.27	5.32
	$domout_t$	0.00	5.80	9.96	9.92		$domout_t$	0.08	0.67	0.91	0.77
	$inflat_t$	0.00	0.44	0.51	0.51		$inflat_t$	8.52	15.24	10.13	8.59
	$reer_t$	0.00	5.49	6.00	6.14		$reer_t$	71.13	45.93	33.71	28.58

Table 4: Forecast error variance decomposition of the *domestic variables* (*with government revenue (as a percentage of GDP)*)

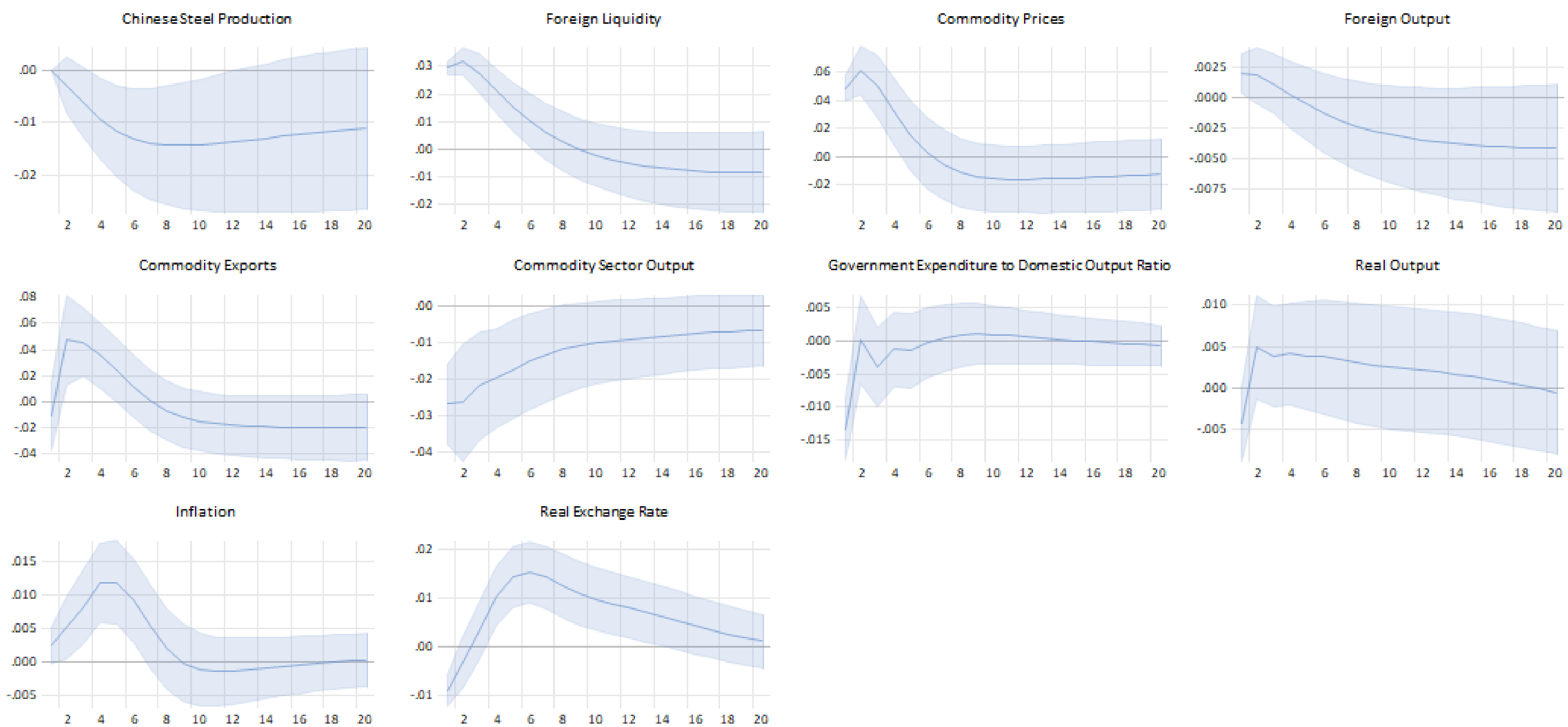
Variable	Shock	1	5	15	30	Variable	Shock	1	5	15	30
$commex_t$	$chsp_t$	0.62	16.45	28.67	32.61	$domout_t$	$chsp_t$	1.15	10.73	15.90	22.56
	$forliq_t$	0.19	7.16	7.50	9.86		$forliq_t$	1.33	1.01	1.01	2.31
	rcp_t	3.42	3.88	7.64	10.64		rcp_t	1.24	9.55	9.52	10.95
	$forout_t$	6.80	6.81	5.52	4.92		$forout_t$	12.35	18.44	25.01	24.31
	$commex_t$	88.96	64.88	50.00	41.42		$commex_t$	8.33	4.02	2.79	2.25
	$commout_t$	0.00	0.02	0.02	0.02		$commout_t$	44.12	25.05	17.44	14.18
	$grev_t$	0.00	0.02	0.02	0.02		$grev_t$	0.33	1.59	2.03	1.65
	$domout_t$	0.00	0.02	0.02	0.01		$domout_t$	31.15	27.01	19.21	15.57
	$inflat_t$	0.00	0.14	0.13	0.11		$inflat_t$	0.00	1.01	0.71	0.58
	$reer_t$	0.00	0.61	0.48	0.40		$reer_t$	0.00	1.60	6.39	5.65
$commout_t$	$chsp_t$	0.09	0.78	0.80	1.88	$inflat_t$	$chsp_t$	1.29	8.43	25.67	25.46
	$forliq_t$	6.66	14.53	18.39	19.53		$forliq_t$	0.60	10.29	11.57	11.19
	rcp_t	1.84	4.61	4.91	4.85		rcp_t	0.40	3.60	5.51	5.78
	$forout_t$	10.99	17.48	19.05	21.18		$forout_t$	0.68	1.42	2.42	4.48
	$commex_t$	0.19	0.46	0.50	0.46		$commex_t$	4.08	1.72	1.28	1.24
	$commout_t$	80.23	56.12	49.61	45.65		$commout_t$	2.12	4.11	3.98	3.85
	$grev_t$	0.00	1.18	1.34	1.24		$grev_t$	2.92	5.17	4.90	4.74
	$domout_t$	0.00	2.73	3.33	3.08		$domout_t$	1.89	7.51	6.19	5.98
	$inflat_t$	0.00	0.13	0.19	0.18		$inflat_t$	86.02	41.88	27.79	26.77
	$reer_t$	0.00	1.96	1.89	1.94		$reer_t$	0.00	15.86	10.70	10.51
$grev_t$	$chsp_t$	5.48	23.39	25.54	25.41	$reer_t$	$chsp_t$	7.75	9.01	7.30	11.64
	$forliq_t$	0.01	8.53	9.10	9.09		$forliq_t$	7.91	10.34	23.89	20.19
	rcp_t	0.15	7.18	7.88	7.85		rcp_t	0.92	6.57	6.71	10.91
	$forout_t$	0.05	4.74	5.38	5.89		$forout_t$	0.19	1.13	1.85	7.78
	$commex_t$	1.81	1.57	1.51	1.50		$commex_t$	0.29	0.79	0.58	0.48
	$commout_t$	3.04	8.35	7.88	7.82		$commout_t$	0.45	2.98	2.58	2.13
	$grev_t$	89.46	35.77	32.77	32.53		$grev_t$	2.11	1.38	1.28	1.08
	$domout_t$	0.00	0.94	0.96	0.96		$domout_t$	0.00	0.57	1.09	1.01
	$inflat_t$	0.00	3.56	3.40	3.38		$inflat_t$	8.46	14.70	10.44	8.53
	$reer_t$	0.00	6.06	5.58	5.55		$reer_t$	71.92	52.53	44.29	36.25

Figure 2: Impulse responses to a one standard deviation shock in Chinese steel production
(*with government expenditure (as a percentage of GDP) included in the SVAR model*)



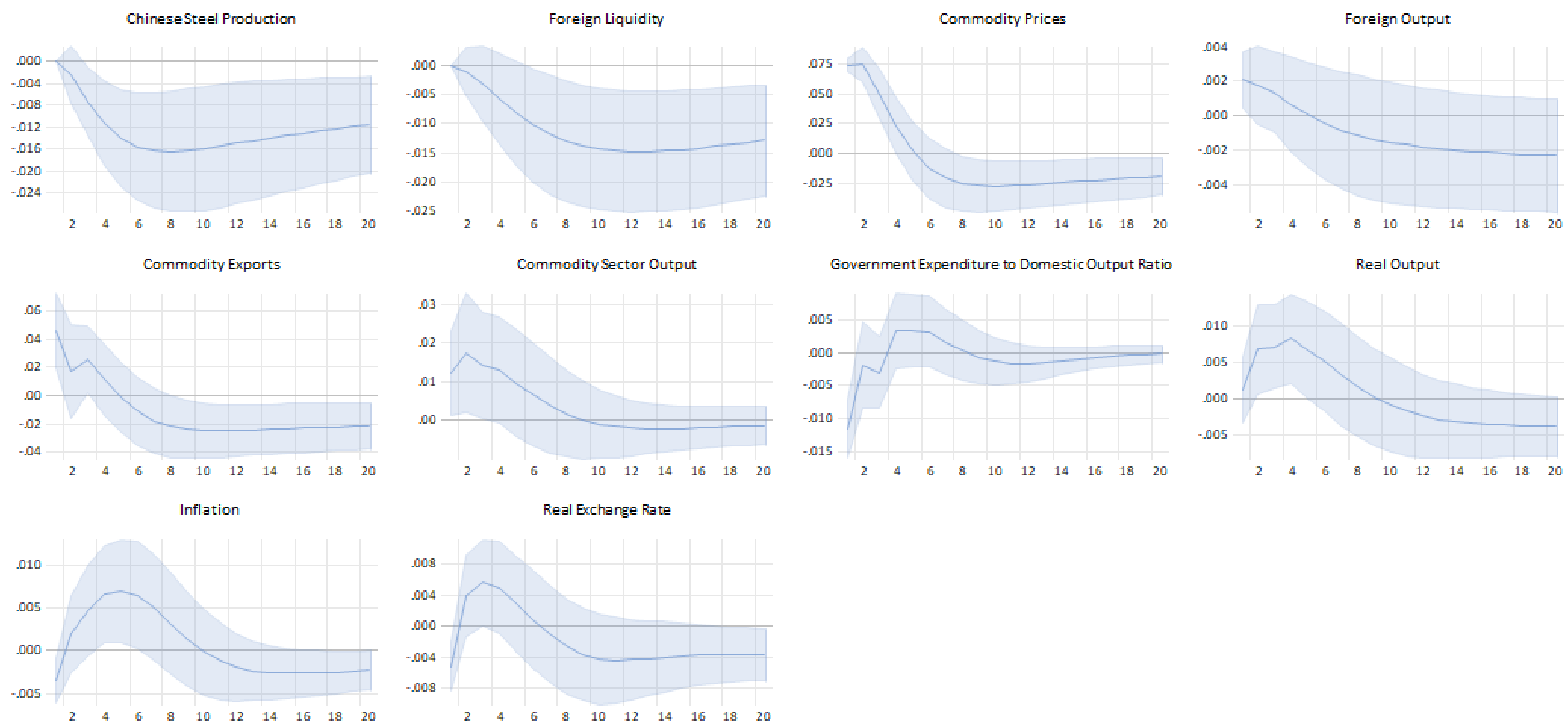
Notes: The x-axes show the number of quarters that have passed from the shock. The figure show the impulse response functions and their corresponding 68 percent confidence intervals.

Figure 3: Impulse responses to a one standard deviation shock in foreign liquidity
(*with government expenditure (as a percentage of GDP) included in the SVAR model*)



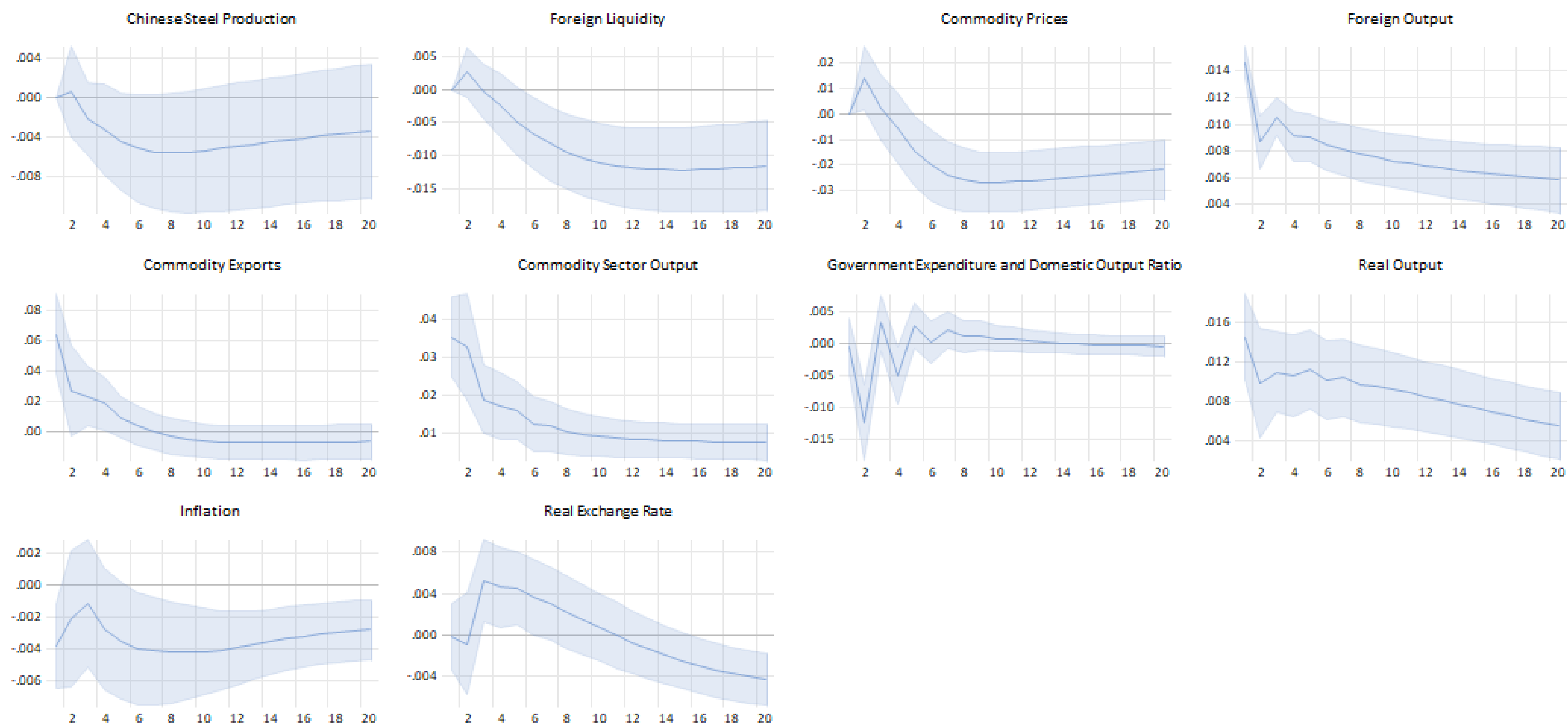
Notes: The x-axes show the number of quarters that have passed from the shock. The figure show the impulse response functions and their corresponding 68 percent confidence intervals.

Figure 4: Impulse responses to a one standard deviation shock in commodity prices
(*with government expenditure (as a percentage of GDP) included in the SVAR model*)



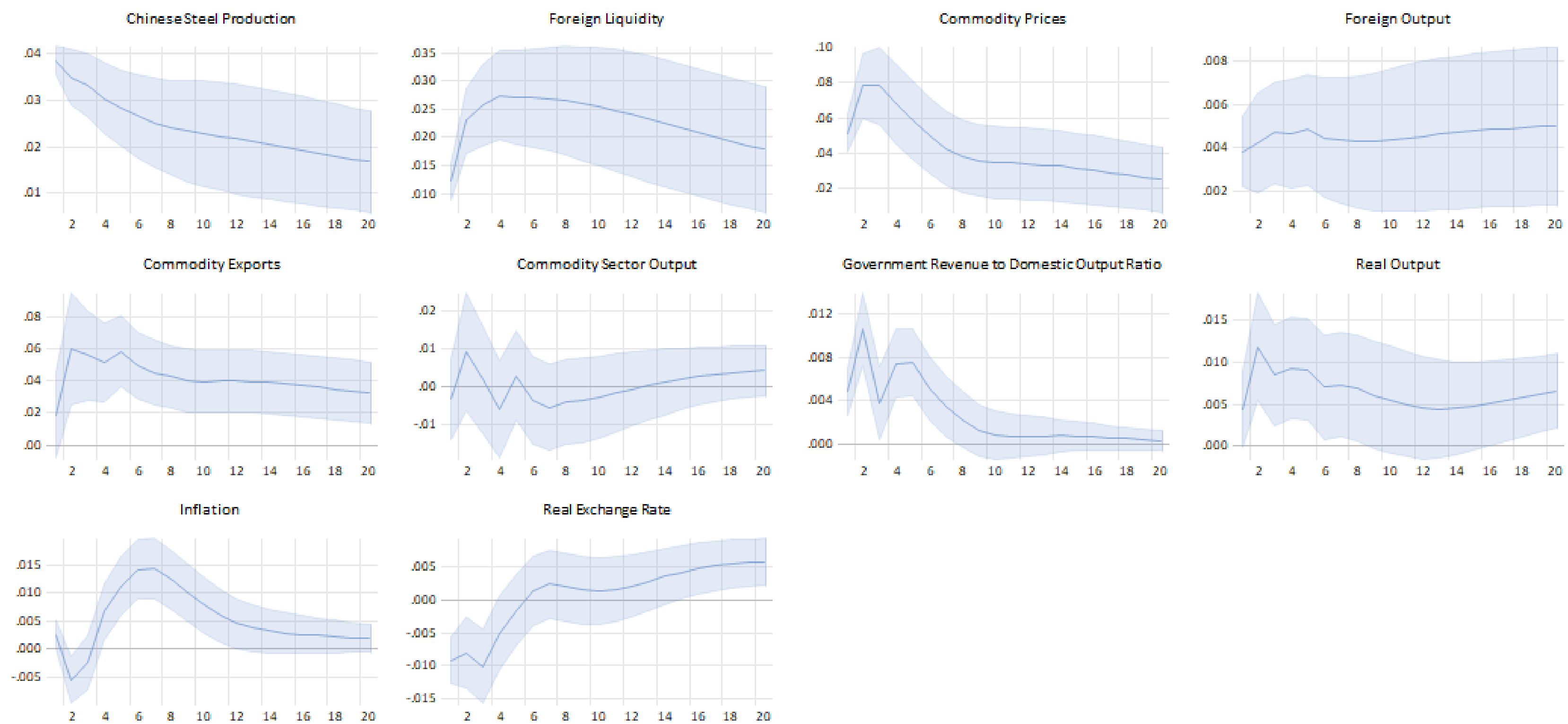
Notes: The x-axes show the number of quarters that have passed from the shock. The figure show the impulse response functions and their corresponding 68 percent confidence intervals.

Figure 5: Impulse responses to a one standard deviation shock in foreign output
(*with government expenditure (as a percentage of GDP) included in the SVAR model*)



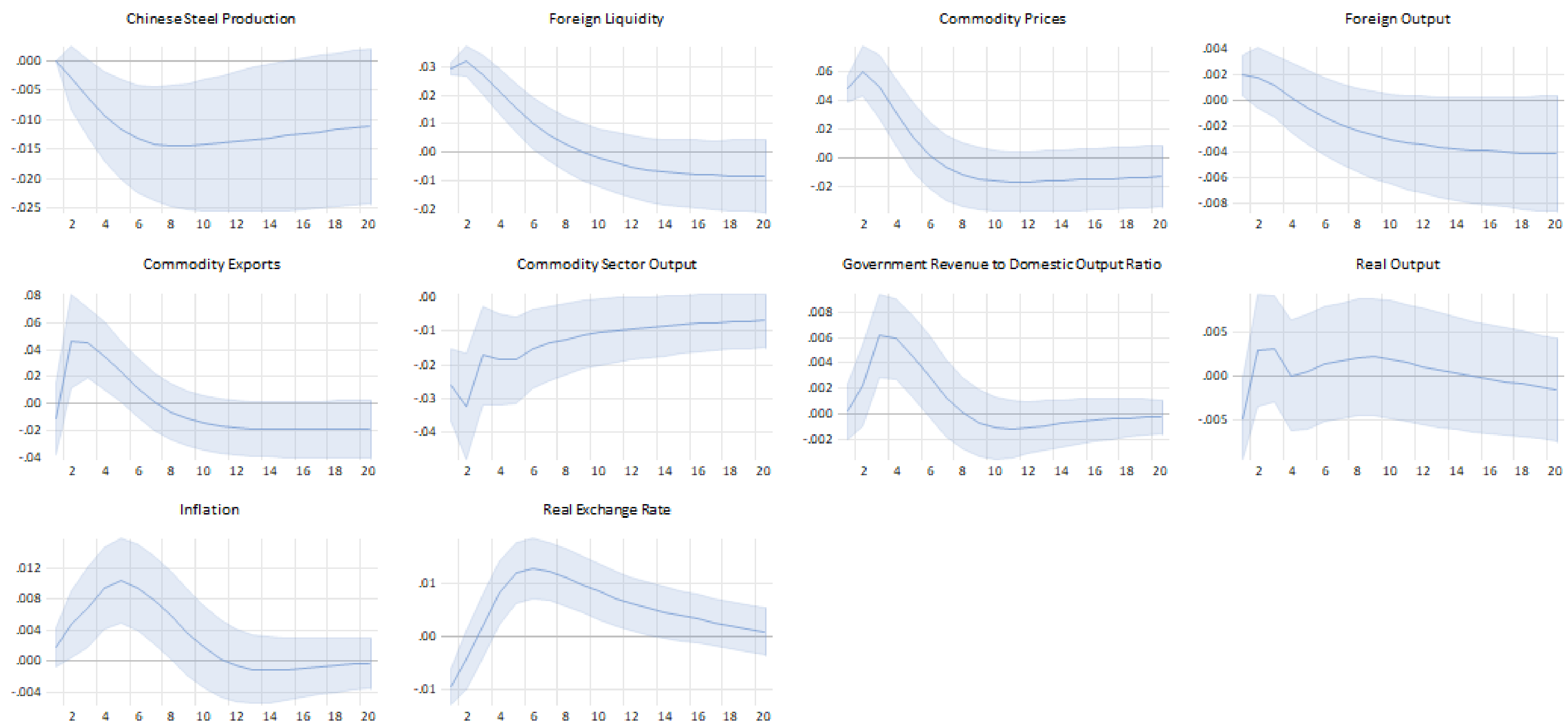
Notes: The x-axes show the number of quarters that have passed from the shock. The figure show the impulse response functions and their corresponding 68 percent confidence intervals.

Figure 6: Impulse responses to a one standard deviation shock in Chinese steel production
(*with government revenue (as a percentage of GDP) included in the SVAR model*)



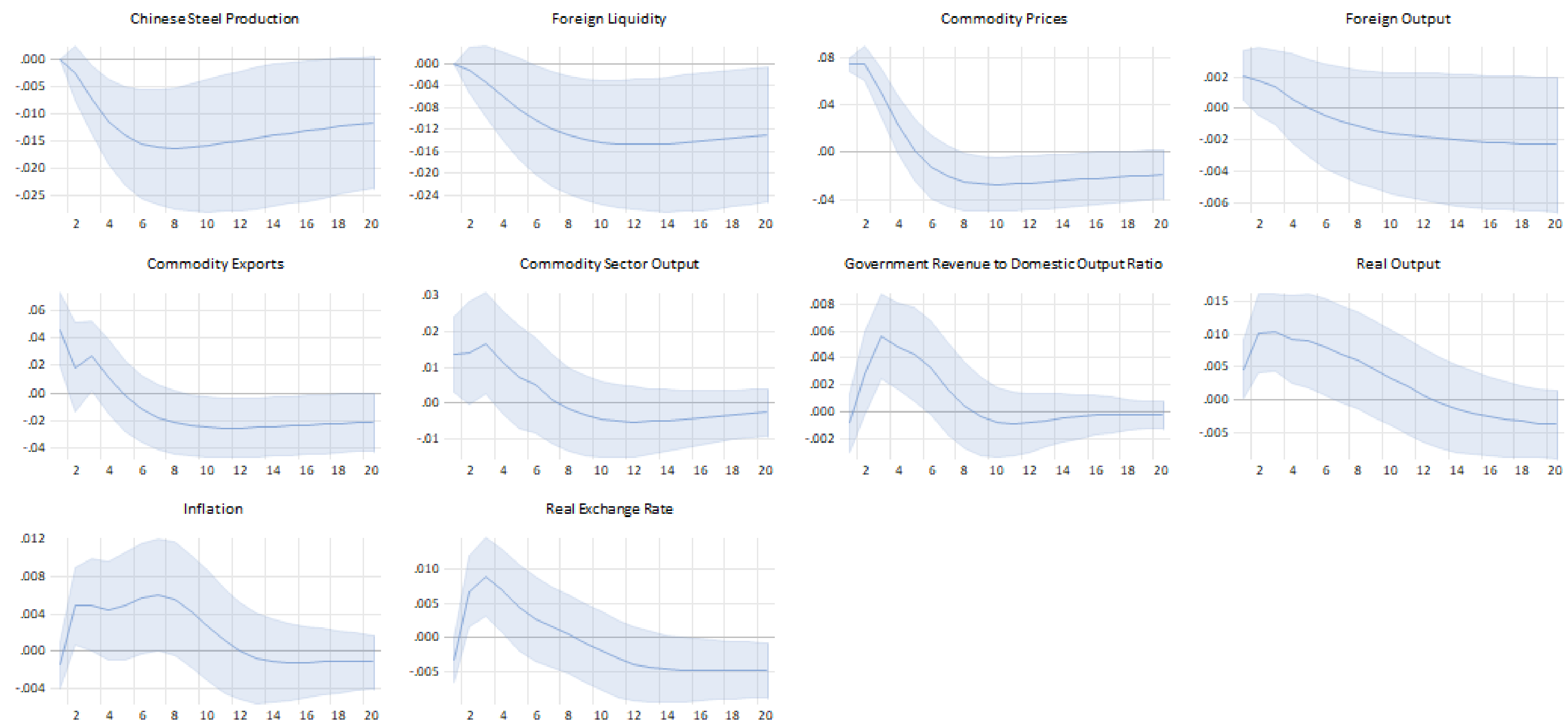
Notes: The x-axes show the number of quarters that have passed from the shock. The figure show the impulse response functions and their corresponding 68 percent confidence intervals.

Figure 7: Impulse responses to a one standard deviation shock in foreign liquidity
(*with government revenue (as a percentage of GDP) included in the SVAR model*)



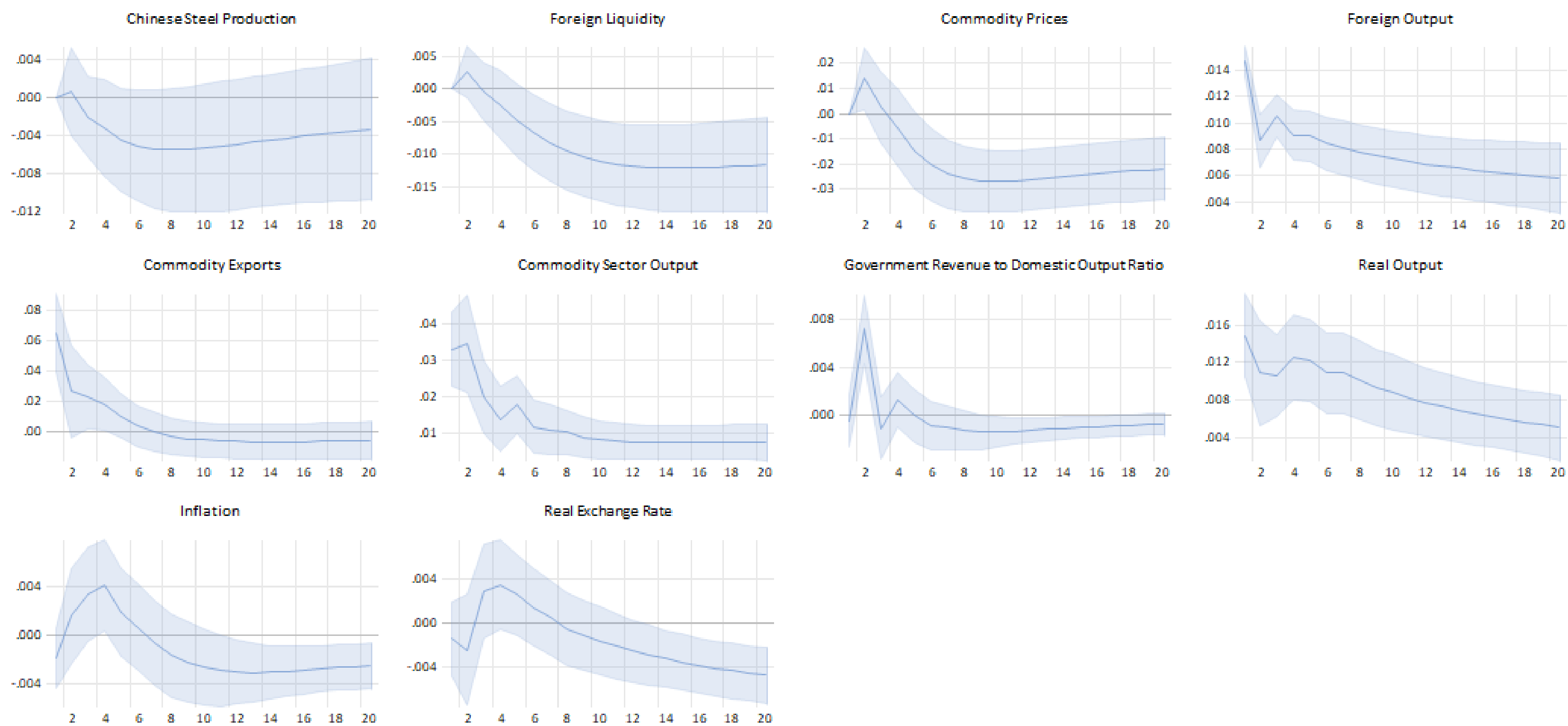
Notes: The x-axes show the number of quarters that have passed from the shock. The figure show the impulse response functions and their corresponding 68 percent confidence intervals.

Figure 8: Impulse responses to a one standard deviation shock in commodity prices
(*with government revenue (as a percentage of GDP) included in the SVAR model*)



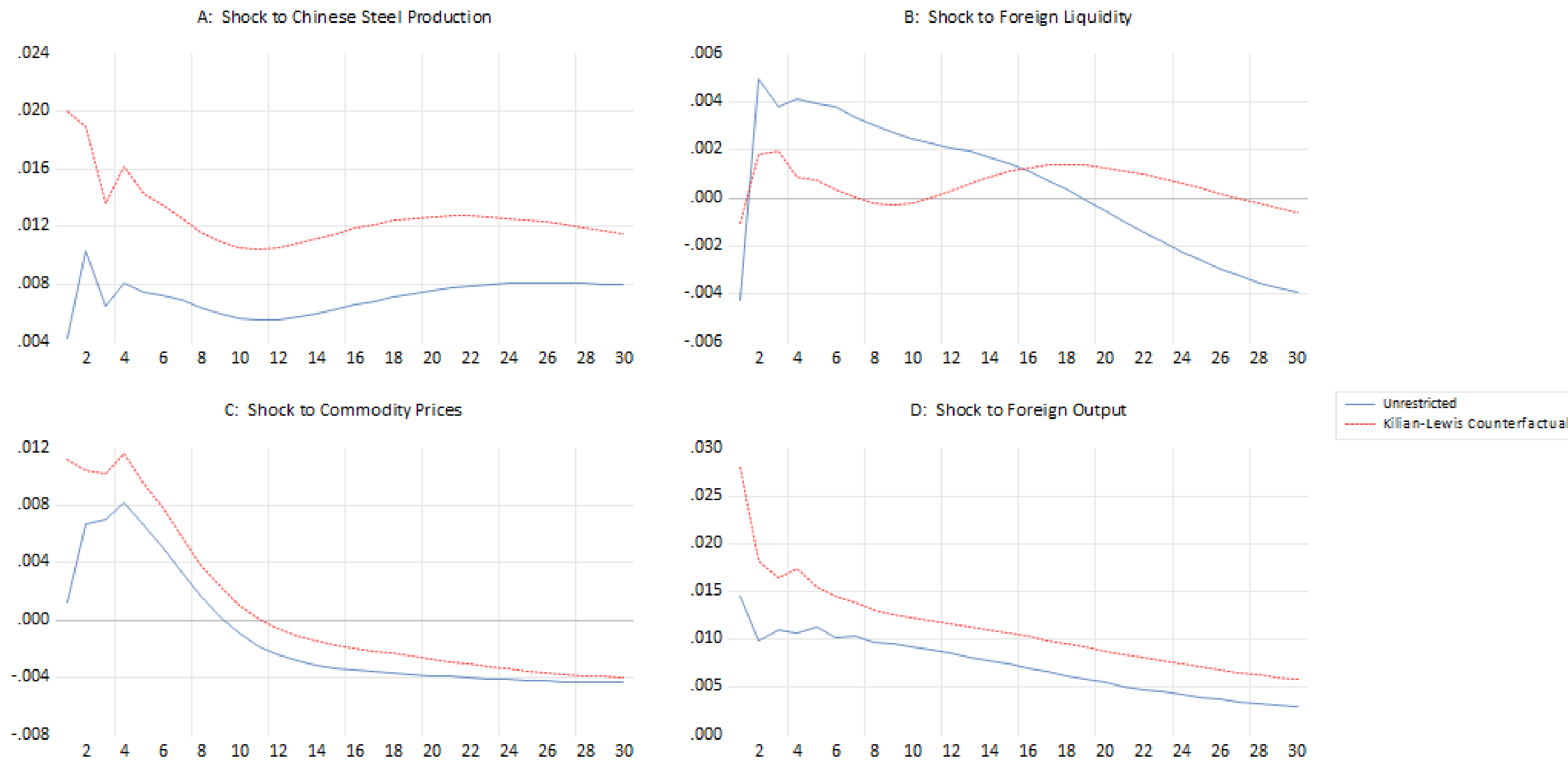
Notes: The x-axes show the number of quarters that have passed from the shock. The figure show the impulse response functions and their corresponding 68 percent confidence intervals.

Figure 9: Impulse responses to a one standard deviation shock in foreign output
(*with government revenue (as a percentage of GDP) included in the SVAR model*)



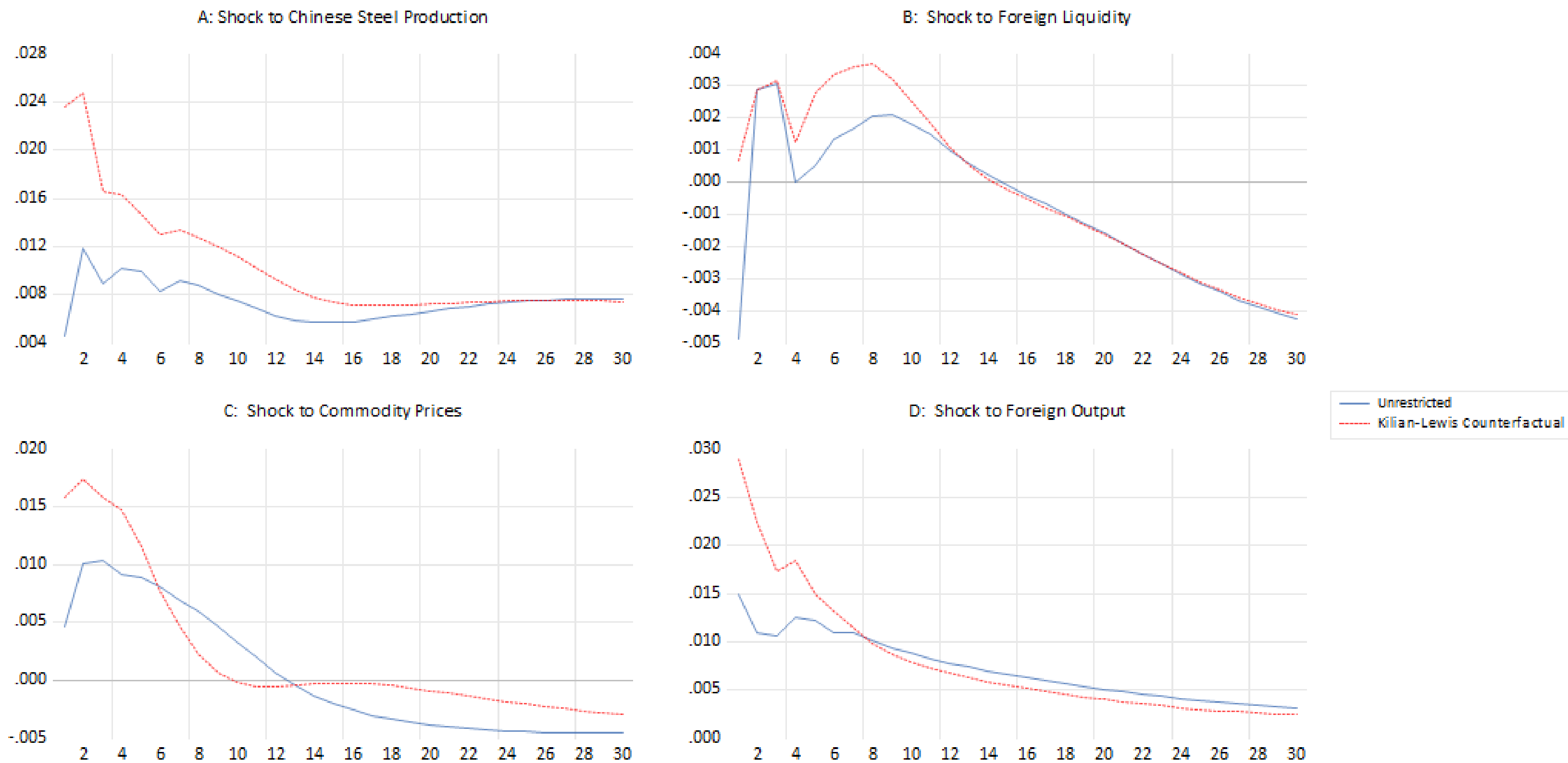
Notes: The x-axes show the number of quarters that have passed from the shock. The figure show the impulse response functions and their corresponding 68 percent confidence intervals.

Figure 10: Impulse responses of real output to various external shocks: Unrestricted versus Kilian-Lewis counterfactual (*with government expenditure (as a percentage of GDP) included in the SVAR model*)



Notes: The x-axes show the number of quarters that have passed from the shock. The Kilian-Lewis counterfactual refers to the counterfactual of shutting down the direct fiscal policy (measured by government expenditure to domestic output ratio) responses to a one standard deviation shock in Chinese steel production (Panel A), foreign liquidity (Panel B), commodity prices (Panel C) and foreign output (Panel D).

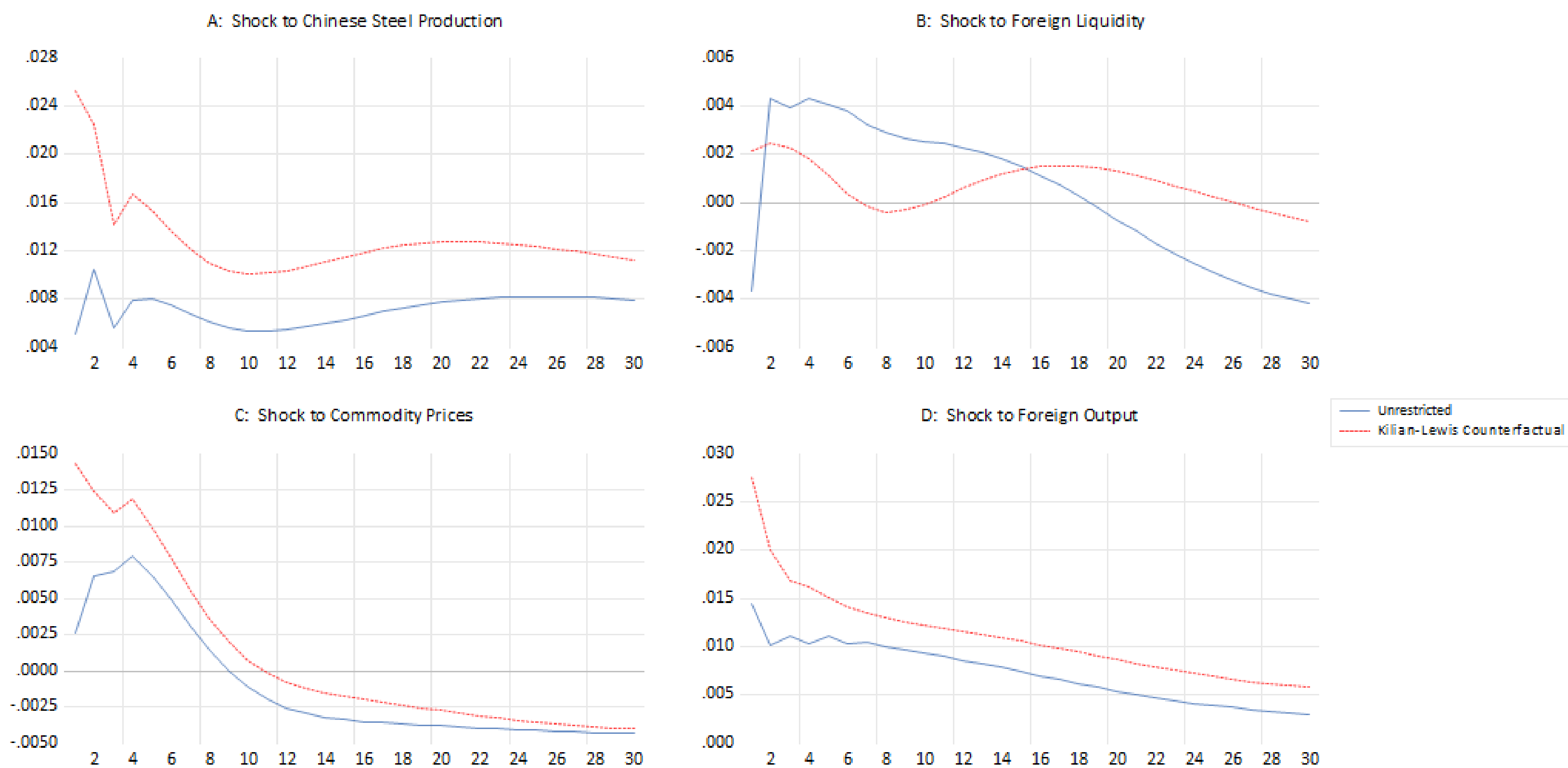
Figure 11: Impulse responses of real output to various external shocks: Unrestricted versus Kilian-Lewis counterfactual
(*with government revenue (as a percentage of GDP) included in the SVAR model*)



Notes: The x-axes show the number of quarters that have passed from the shock. The Kilian-Lewis counterfactual refers to the counterfactual of shutting down the direct fiscal policy (measured by government revenue to domestic output ratio) responses to a one standard deviation shock in Chinese steel production (Panel A), foreign liquidity (Panel B), commodity prices (Panel C) and foreign output (Panel D).

Figure A1: Impulse responses of real output to various external shocks: Unrestricted versus Kilian-Lewis counterfactual: Robustness test I

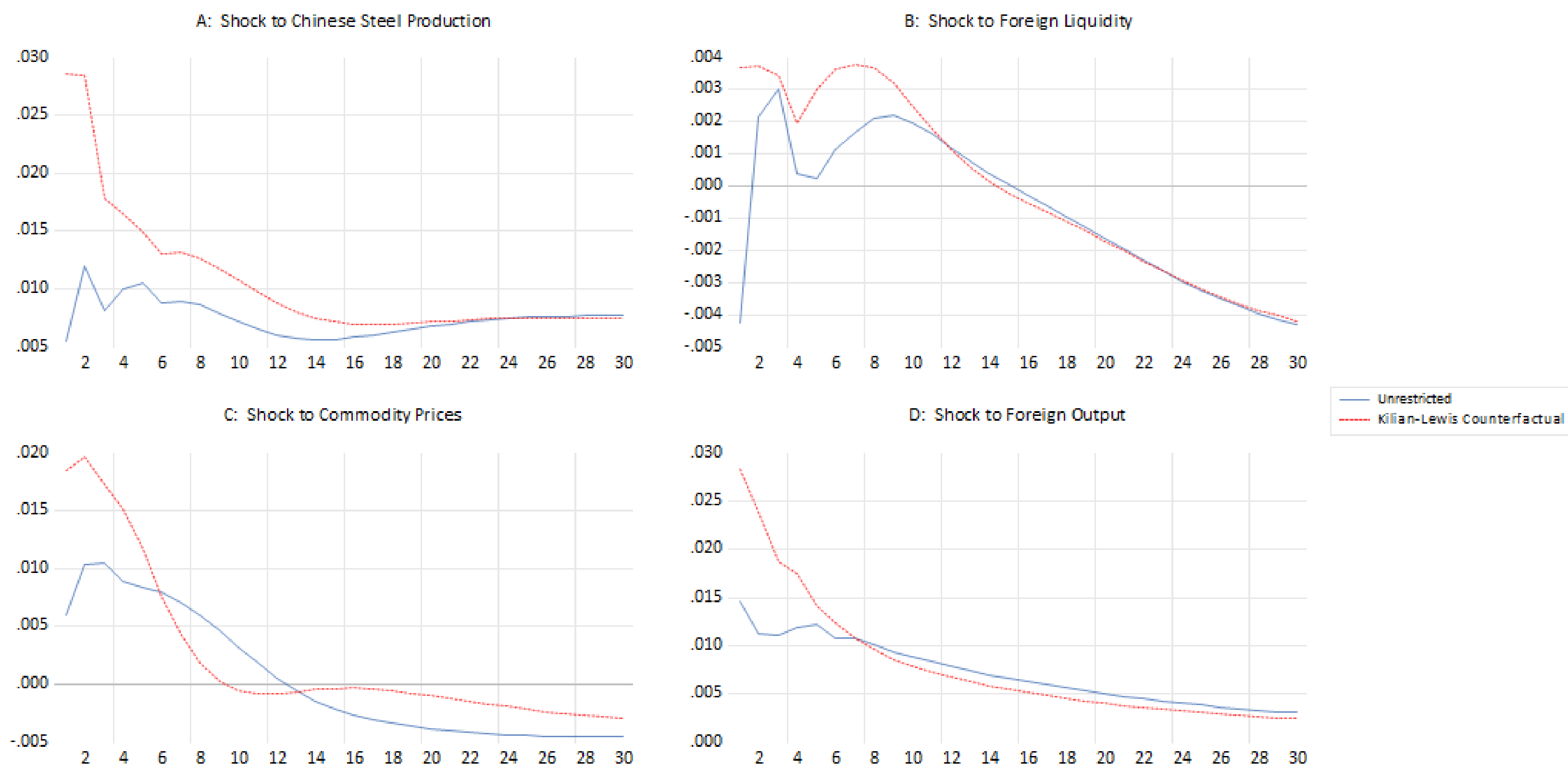
(*with government expenditure (as a percentage of GDP) included in the SVAR model*)



Notes: The x-axes show the number of quarters that have passed from the shock. The Kilian-Lewis counterfactual refers to the counterfactual of shutting down the direct fiscal policy (measured by government expenditure to domestic output ratio) responses to a one standard deviation shock in Chinese steel production (Panel A), foreign liquidity (Panel B), commodity prices (Panel C) and foreign output (Panel D).

Figure A2: Impulse responses of real output to various external shocks: Unrestricted versus Kilian-Lewis counterfactual: Robustness test I

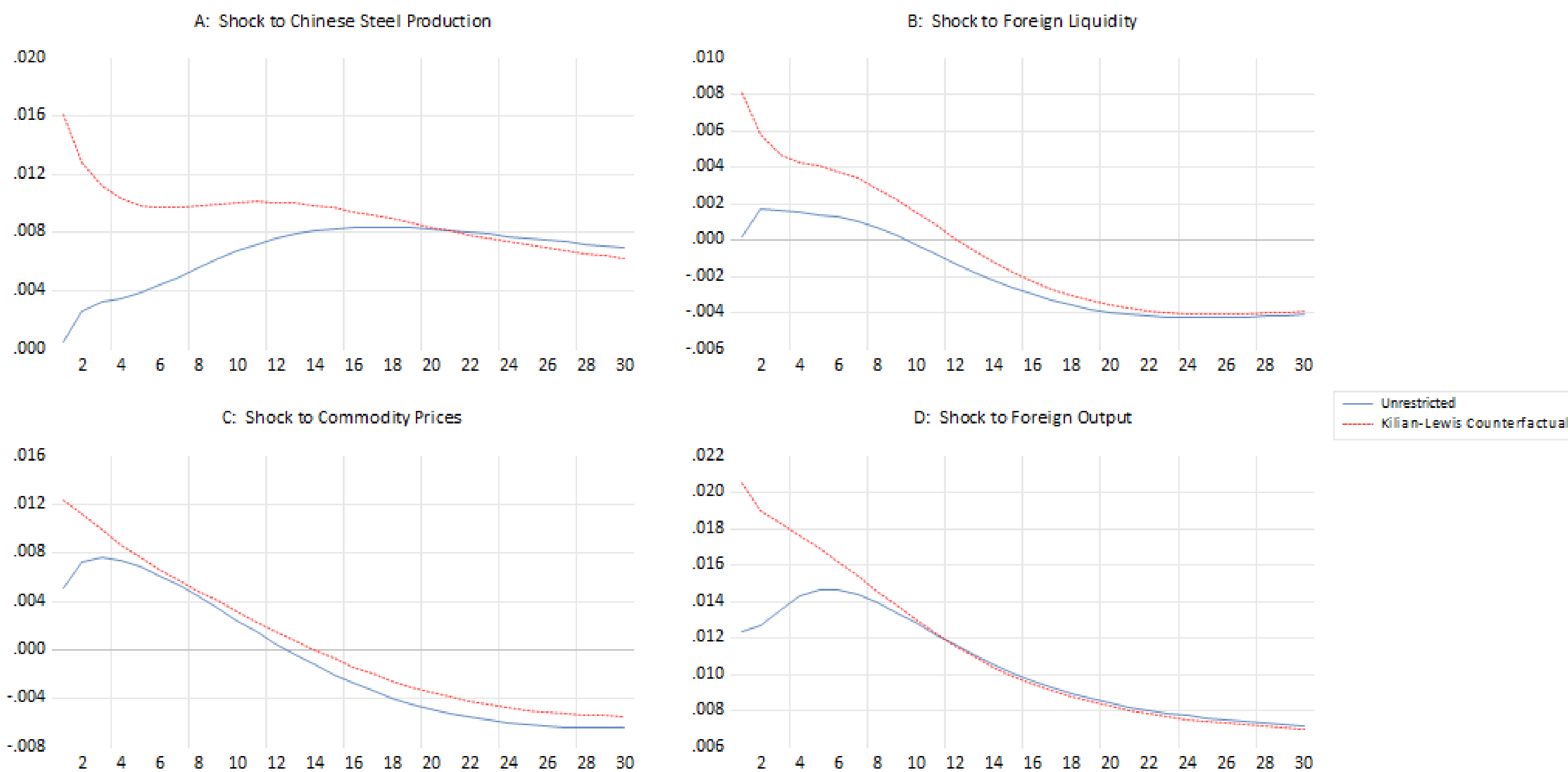
(*with government revenue (as a percentage of GDP) included in the SVAR model*)



Notes: The x-axes show the number of quarters that have passed from the shock. The Kilian-Lewis counterfactual refers to the counterfactual of shutting down the direct fiscal policy (measured by government revenue to domestic output ratio) responses to a one standard deviation shock in Chinese steel production (Panel A), foreign liquidity (Panel B), commodity prices (Panel C) and foreign output (Panel D).

Figure A3: Impulse responses of real output to various external shocks: Unrestricted versus Kilian-Lewis counterfactual: Robustness test II

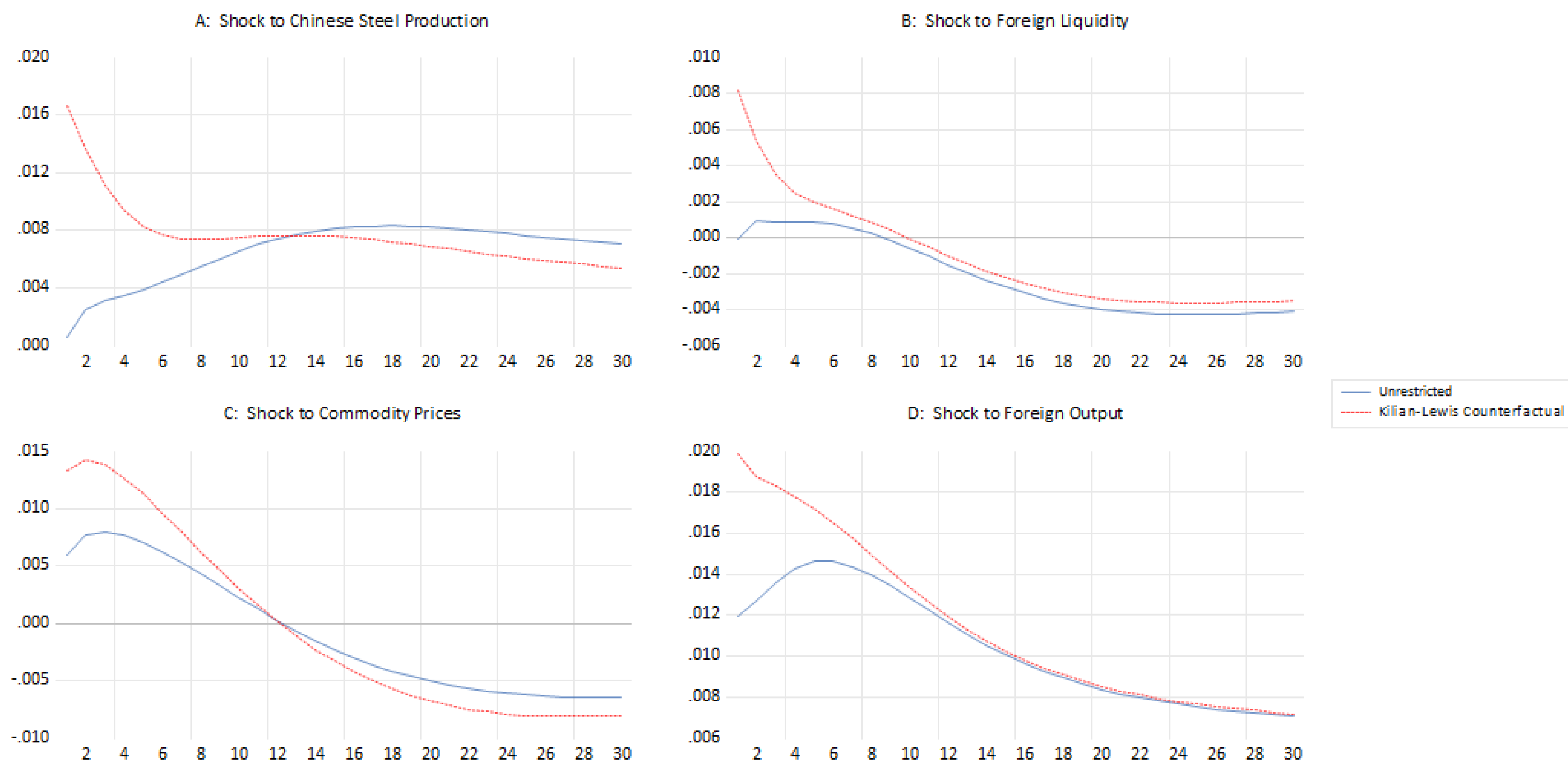
(*with government expenditure (as a percentage of GDP) included in the SVAR model*)



Notes: The x-axes show the number of quarters that have passed from the shock. The Kilian-Lewis counterfactual refers to the counterfactual of shutting down the direct fiscal policy (measured by government expenditure to domestic output ratio) responses to a one standard deviation shock in Chinese steel production (Panel A), foreign liquidity (Panel B), commodity prices (Panel C) and foreign output (Panel D).

Figure A4: Impulse responses of real output to various external shocks: Unrestricted versus Kilian-Lewis counterfactual: Robustness test II

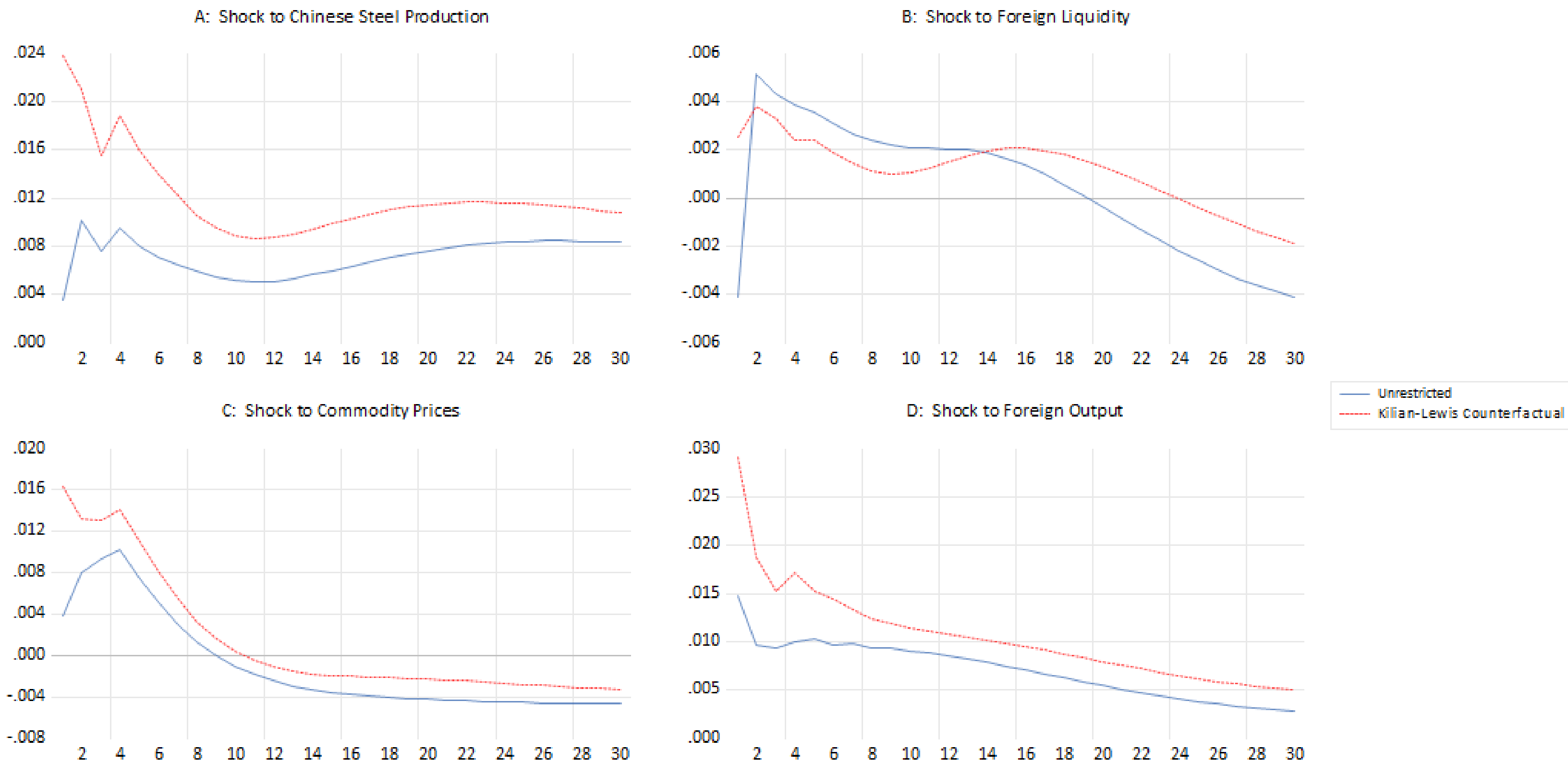
(*with government revenue (as a percentage of GDP) included in the SVAR model*)



Notes: The x-axes show the number of quarters that have passed from the shock. The Kilian-Lewis counterfactual refers to the counterfactual of shutting down the direct fiscal policy (measured by government revenue to domestic output ratio) responses to a one standard deviation shock in Chinese steel production (Panel A), foreign liquidity (Panel B), commodity prices (Panel C) and foreign output (Panel D).

Figure A5: Impulse responses of real output to various external shocks: Unrestricted versus Kilian-Lewis counterfactual: Robustness test III

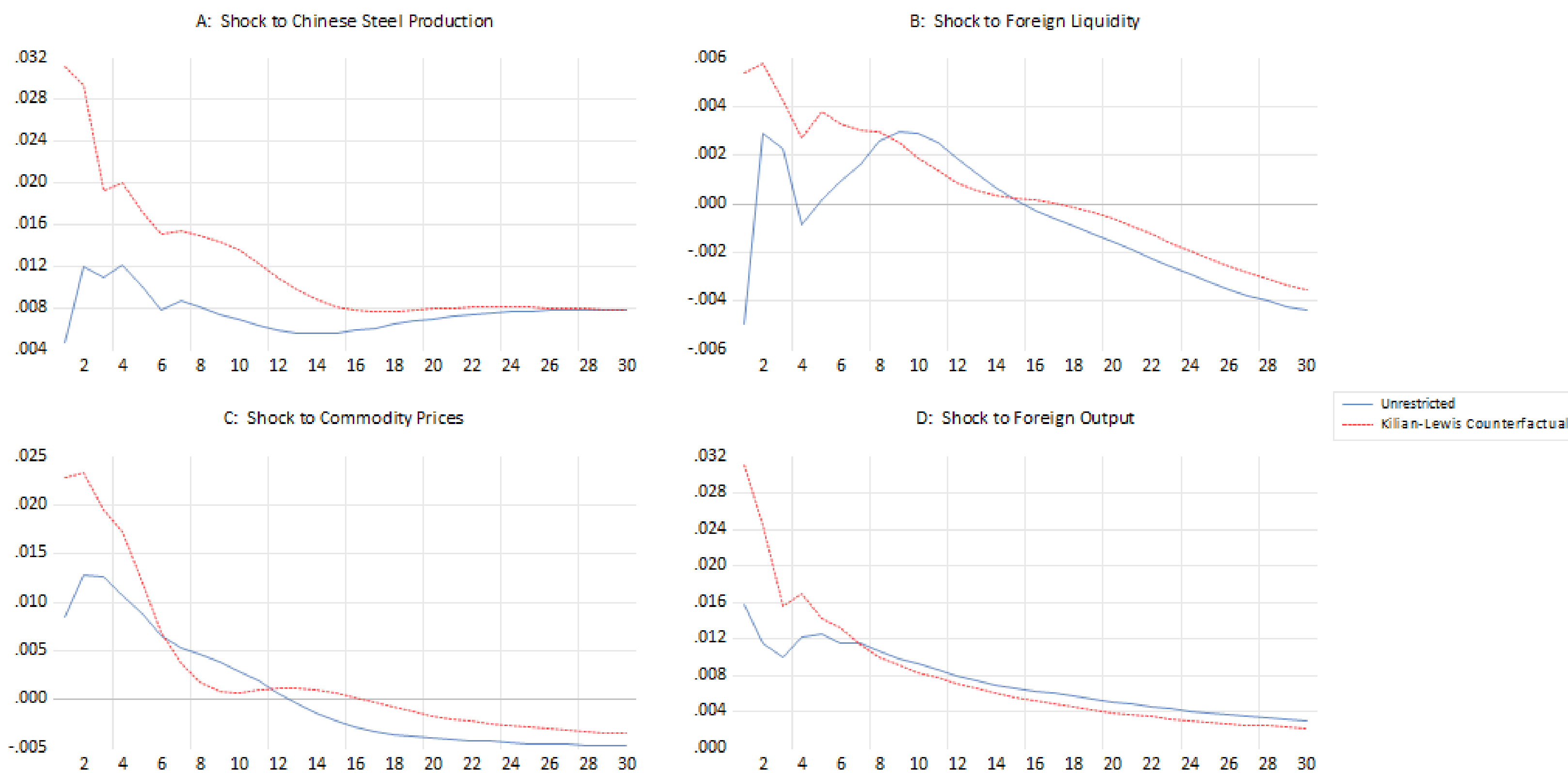
(*with government expenditure (as a percentage of GDP) included in the SVAR model*)



Notes: The x-axes show the number of quarters that have passed from the shock. The Kilian-Lewis counterfactual refers to the counterfactual of shutting down the direct fiscal policy (measured by government expenditure to domestic output ratio) responses to a one standard deviation shock in Chinese steel production (Panel A), foreign liquidity (Panel B), commodity prices (Panel C) and foreign output (Panel D).

Figure A6: Impulse responses of real output to various external shocks: Unrestricted versus Kilian-Lewis counterfactual: Robustness test III

(*with government revenue (as a percentage of GDP) included in the SVAR model*)



Notes: The x-axes show the number of quarters that have passed from the shock. The Kilian-Lewis counterfactual refers to the counterfactual of shutting down the direct fiscal policy (measured by government revenue to domestic output ratio) responses to a one standard deviation shock in Chinese steel production (Panel A), foreign liquidity (Panel B), commodity prices (Panel C) and foreign output (Panel D).