Global Spillover Effects of China Uncertainty Shocks

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Abstract

Using a Bayesian panel VAR, this paper empirically examines international spillover effects of China uncertainty shocks. We find that an unexpected increase in China uncertainty has a large and statistically significant impact on the global economy. It leads to a reduction in output and consumer prices, an exchange rate depreciation, a sudden decline in stock prices, and an increase in long-term rate spreads. More importantly, these effects are stronger for emerging markets, commodity-exporting countries, countries with tighter trade linkages to the China, and countries with high external imbalances. These results have important implications for policy makers who react to the increased risk in the Chinese economy in recent years.

JEL Classification Numbers: C11; C32; F41

Keywords: China uncertainty shock, Bayesian panel VAR, Global spillovers

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1 Introduction

Over the past few decades, China has been the main engine of global economic growth, contributing significantly to the expansion in world GDP and trade. Having reached over 14% in 2007, however, China's real GDP growth continues to slow, falling to 6% level in recent years. As pointed out by Cashin et al. (2017), the growth slowdown is mainly due to China's gradual rebalancing from exports to domestic demand, from manufacturing to services, and from investment to consumption. At the same time, as documented by Dieppe et al. (2018), domestic imbalances in China have been widening with excessive reliance on investment and credit, and consequently, fragilities have been heightened because of rapid credit growth and increased complexity and leverage in the financial system. Especially, market concerns about the Chinese economy have also recently elevated with a collapsing real estate market, raising the alarm for a potential spillover effect across the world.

Given the China's significance for the world economy, this paper aims to empirically investigate the international repercussions of the increased macroeconomic uncertainty in China. Specifically, using key macroeconomic and financial variables, we attempt to identify the China uncertainty shock and uncover the main transmission channels of the shock for the global economy. Furthermore, we conduct subgroup analysis by dividing sample countries based on their structural characteristics and examine the potential heterogeneity in responses. These results have crucial implications for monetary and fiscal policy makers in each country who seek to react to the increased macroeconomic risk in China in recent years.

Our empirical strategy is to first develop a structural vector-autoregression (VAR) model for the Chinese economy to estimate the China uncertainty shock, using the stock market volatility measure. Consistent with the well-documented literature, the China uncertainty shock is identified via sign restrictions on short-run impulse response functions, which is assumed to have adverse effects on both the real economy and financial markets in China. We then examine its international implications using a panel VAR model for advanced and emerging market economies. The panel VAR model includes the estimated China uncertainty shock as an external regressor and allows us to estimate macroeconomic and financial spillover effects of the shock across the world. More importantly, we attempt to explain cross-country differences in responses with differences in a country's structural characteristics such as economic development, commodity dependence in exports, the degree of trade integration to the China, and external imbalances.

We find that an unexpected rise in China's economic uncertainty has a large and statistically significant impact on the global economy. An unanticipated increase in China uncertainty leads to a sudden decline in stock prices, an exchange rate depreciation, and an increase in long-term interest rate spreads vis-á-vis the US, reflecting the increased global financial risks. Moreover, in response to the China uncertainty shock, output falls by more than 0.7%, consumer prices drop by approximately 0.1% and decrease persistently, and net exports decline markedly due to the decreased global demand caused by the slowdown in China. Overall, the China uncertainty shock adversely affects the global economy not only through a significant reduction in aggregate spending of the world economy, but also through a deterioration in global financial conditions.

In addition, we analyze possible heterogeneity in responses across different subgroups of countries based on economic development, commodity dependence in exports, trade linkages to the China, and external imbalances. We find that the negative effects of the China uncertainty shock on macroeconomic and financial variables are generally stronger for emerging markets, commodity-exporting countries, countries with tighter trade linkages to the China, and countries with high external imbalances. These results have important implications for policy makers who react to the increased risk in the Chinese economy in recent years.

Most of existing studies on cross-border spillovers have focused on the spillover effects from the US economy to emerging markets (e.g. Canova (2005); Uribe and Yue (2006); Maćkowiak (2007); Feldkircher and Huber (2016); Dedola et al. (2017); Bhattarai et al. (2020); Bhattarai et al. (2021)). With the emergence of China as a global force in the world in recent decades, however, much research attention has been directed to empirically assessing the role of China in the world economy. In particular, our paper is closely related to the recent empirical literature on international spillovers from an unexpected shock in the Chinese economy (e.g. Feldkircher and Korhonen (2014); Inoue et al. (2015); Cashin et al. (2017); Eickmeier and Kühnlenz (2018); Sznajderska (2019); Sznajderska and Kapuściński (2020)). For example, using a Global VAR (GVAR) model, Cashin et al. (2017) analyze the global macroeconomic implications of China's slowdown. The results indicate that a 1% negative Chinese GDP shock reduces global growth by 0.23% point and countries with large trade exposures to China are the most affected. Sznajderska (2019) also employs the GVAR model and shows that a 1% negative GDP shock in China reduces global growth by 0.22% point in the short run and emerging economies are more strongly affected than advanced economies.

This paper makes several contributions to the growing body of literature on spillovers from China. First, this paper is the first to study the international effects of identified structural uncertainty shocks, unlike most previous studies that focus on nonstructural GDP shocks, which are hard to interpret economically. Second, instead of using the GVAR model, our paper employs a panel VAR model that allows us to include several key macroeconomic and financial variables from many advanced and emerging countries and hence to investigate not only the global spillover effects of China uncertainty shocks, but also the propagation mechanism in more details than most existing papers. Lastly, we analyze potential sources of heterogeneity among countries in their responses to an unanticipated rise in China uncertainty, which has important policy implications for each country.

The rest of the paper is organized as follows. Section 2 describes the empirical methodology and data. Section 3 presents our main empirical results. Section 4 concludes.

2 Empirical Methodology and Data

Our empirical study proceeds in the following two steps. We first estimate a structural VAR for the Chinese economy including key macroeconomic and financial variables to identify the China uncertainty shock. In the second step, treating the estimated China shock as an exogenous regressor, we estimate a Bayesian panel VAR for advanced and emerging market economies to analyze the international spillover effects of the China uncertainty shock.

2.1 China uncertainty shock

A VAR model for the China economy is constructed to estimate China uncertainty shocks. Specifically, the structural representation of the VAR model of order p is given by:

$$A_0 y_t = c + \sum_{j=1}^{k} A_j y_{t-j} + \varepsilon_t, \tag{1}$$

where y_t is a vector of endogenous variables, c is a vector of intercepts, A_j, $j = 0, 1, \cdots, k$, is a coefficient matrix, and ε_t is a vector of structural innovations. In the baseline specification, y_t includes the following five variables: the China industrial production (IP) index as a proxy for output, the China consumer price index (CPI), nominal effective exchange rate (NEER), Shanghai composite stock index, long-term rate spreads (vis-á-vis the 10-year Treasury yield in the US), and stock market volatility as a measure of China uncertainty.[1] All data are monthly covering the periods from January 2000 to December 2022, and all variables are expressed in log level, except for the long-term rate spreads and stock market volatility. The stock market volatility is measured as the realized volatility of daily returns from the Shanghai Composite index.[2] More precisely, we construct the annualized realized volatility (RV) at a monthly frequency as follows:

$$RV_t = 100 \times \sqrt{252/T \sum_{s=1}^{n} (r_s - \overline{r}_t)^2}, \tag{2}$$

where r_s is the log daily returns from each trading day s, $\overline{r}_t$ is the average return for a month t, and T is the number of trading days in a given month.

To identify a structural shock to the realized stock volatility, we impose sign restrictions on short-run impulse response functions as demonstrated in Table 1, which are broadly consistent with the well-documented theoretical literature. That is, the uncertainty shock should reduce both the output and price simultaneously and have adverse impacts on finan-

[1] The sources of the data include OECD, Bloomberg, and Global Insight.

[2] Like the VIX, the implied stock market volatility is commonly used as a proxy for uncertainty about both the US and global financial markets. However, since the availability of implied volatility of the Chinese stock market is very limited covering a much shorter period, we decide to employ realized volatility based on the empirical evidence on the high correlation between the two indices as shown by Bloom (2009).

Table 1: Sign restrictions on impulse response functions

	China uncertainty shock
Industrial production	≤ 0
Consumer price index	≤ 0
Nominal effective exchange rate	≤ 0
Shanghai composite stock index	≤ 0
Long-term rate spreads	≥ 0
Stock market volatility	≥ 0

cial markets concurrently. In particular, the sign restrictions on real variables such as output and inflation are assumed to bind at least for one quarter, while those on financial variables such as exchange rates, stock prices, and long-term spreads are imposed only on impact. These identifications are implemented using the algorithm proposed by Rubio-Ramírez et al. (2010).

Following Bańbura et al. (2010), we estimate the VAR model via the Bayesian method using a Normal invese Wishart prior suggested by Kadiyala and Karlsson (1997). The Normal invese Wishart prior basically retains the principle of the Minnesota prior, but relaxes the assumption on the covariance matrix of residuals to allow for their possible correlations. The lag length in the model is set to $k = 6$ based on the Schwarz and Hannan-Quinn information criterion.[3] A standard Gibbs sampling method is employed to approximate the posterior distributions of the parameters in the model. The total number of Gibbs replications is set to 25,000 with a burn-in of 20,000, and the remaining 5,000 samples are used for posterior inference.

2.2 Panel VAR

After extracting the uncertainty shock from the China VAR model, we can evaluate its spillover effects on other countries by feeding it into a joint system of equations for their economies. Specifically, similar to Bhattarai et al. (2020, 2021), we construct a monthly

[3] Although Akaike information criterion suggests the lag length to be $k = 3$, we find that using different lags yields qualitatively and quantitatively comparable results.

Bayesian panel VAR model:

$$Y_{i,t} = \alpha_i + \beta_i t + \theta d_t + \sum_{j=0}^{q} \Psi_j \varepsilon_{CHN,t-j} + \sum_{j=1}^{p} \Phi_j Y_{i,t-j} + e_{i,t}, \tag{3}$$

where i indicates the country and t the month. $\varepsilon_{CHN,t}$ is the median of the uncertainty shock estimated in the China VAR. $Y_{i,t}$ is a vector of endogenous variables, α_i is a country-specific fixed effect, β_i is the coefficient of a country-specific linear time trend, d_t is a vector of seasonal dummies with a coefficient vector θ, and $e_{i,t} \sim N(0, \Sigma)$ is a vector of zero-mean, stationary reduced-form disturbances. The number of lags included in the panel VAR model for the uncertainty shock and the endogenous variables is denoted by q and p, respectively, and the matrix of coefficients associated with the q-th lag of the endogenous variables is denoted by Φ_j. Notice that consistent with Pesaran and Smith (1995) and Canova and Ciccarelli (2013), we do not allow for slope heterogeneity across countries due to the restricted sample size, and our focus is to estimate the average effects of groups of countries.[4] Instead, we account for heterogeneity through intercepts and linear time trends. The baseline specification for the panel VAR model features the following vector of variables of interest:

$$Y_{i,t} = [IP_{i,t},\ CPI_{i,t},\ STI_{i,t},\ SPR_{i,t},\ Stock_{i,t},\ NEER_{i,t},\ NTB_{i,t}]', \tag{4}$$

where $IP_{i,t}$ is the industrial production, $CPI_{i,t}$ is the consumer price index, $STI_{i,t}$ is the short-term interest rate, $SPR_{i,t}$ is the interest rate spread. $Stock_{i,t}$ is the stock market price, $NEER_{i,t}$ is the nominal effective exchange rate, and $NTB_{i,t}$ is the nominal trade balance scaled by the average of the sum of import and export over the whole sample, respectively. For a baseline specification, we opt for three lags of the endogenous variables and the China uncertainty shock ($p = q = 3$), resulting in a maximum lag length of one quarter. As we will show below, our main results are robust to different choices of the lag structure.

The panel VAR is also estimated via the Bayesian approach using our sample of 32

[4] As shown by Pesaran and Smith (1995) and Canova and Ciccarelli (2013), slope heterogeneity in panel data analysis can be efficiently addressed only when both the time series and cross-sectional dimensions are of at least moderate size. In particular, as will be discussed later, we conduct subgroup analysis by dividing countries based on their structural characteristics, which makes it harder to allow for slope heterogeneity due to the more restricted sample size.

countries over the period 2000:M1–2022:M12. Similar to the China VAR, following Bańbura et al. (2010), we employ a Normal-Inverse Wishart prior for the VAR parameters with the prior hyper-parameters set to reflect a loose prior belief. The posterior distribution for the panel VAR model is approximated through the Gibbs sampling algorithm. We generate 25,000 draws with a burn-in of the first 20,000 draws and use the last 5,000 draws for posterior inference. More detailed explanation for estimation is described in the Appendix.

2.3 Data

To assess the global spillover effects of a China uncertainty shock, we employ a large number of country-specific macroeconomic and financial variables at the monthly frequency from January 2000 to December 2022. Specifically, the sample country consists of the following 32 countries which represent more than 90% of the world GDP, namely: Australia, Austria, Belgium, Brazil, Canada, Chile, Colombia, Denmark, Finland, France, Germany, India, Indonesia, Ireland, Italy, Japan, Korea, Malaysia, Mexico, the Netherlands, Norway, Peru, the Philippines, Portugal, Russia, Spain, South Africa, Sweden, Taiwan, Thailand, Türkiye, and the United Kingdom.[5] For each country, we include the industrial production, consumer price index, short-term interest rates, long-term rate spreads (vis-á-vis the 10-year Treasury yield in the US), stock market prices, nominal effective exchange rates, and net trade balance (scaled by the average of the sum of import and export over the whole sample). All the data come from various sources such as Bloomberg, BIS, Global Insight, IMF, OECD, and for some countries, the central bank and the national statistics agency.

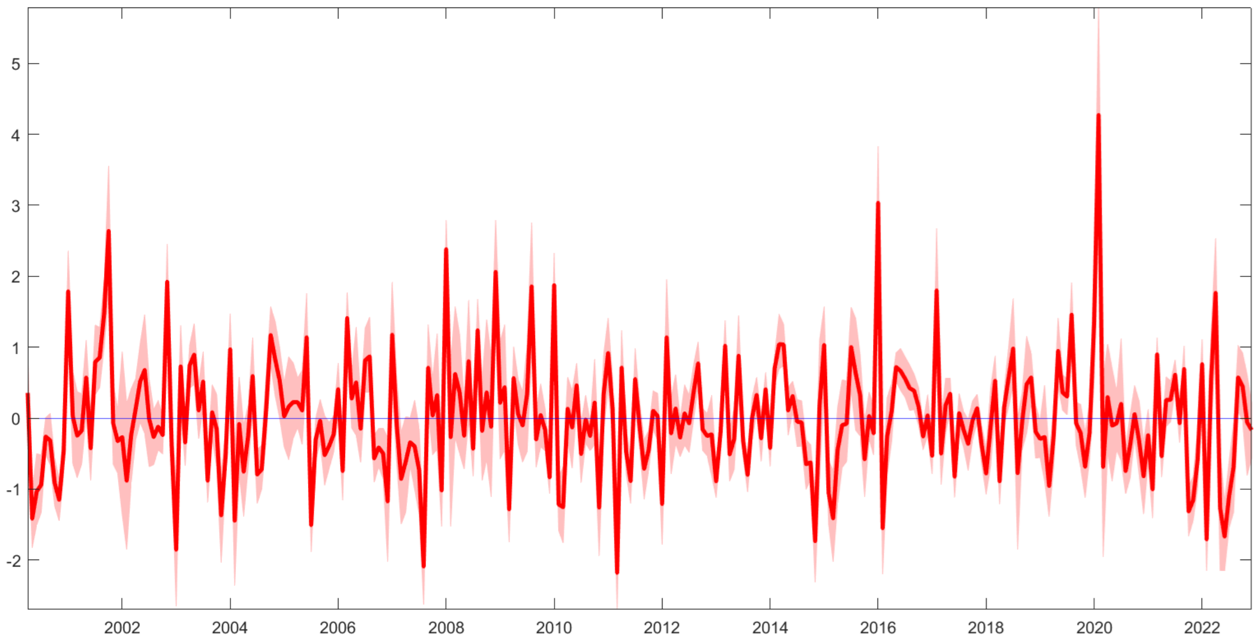
3 Results

3.1 The domestic effects of China uncertainty shock

Figure 1 plots the time series of the posterior median of the estimated China uncertainty shock, along with 68% credible intervals. The China uncertainty shock exhibits substantial fluctuations over time and seems to jump up markedly around the dates of economic crisis

[5]The United States is excluded due to its significant role for the global economy and financial markets.

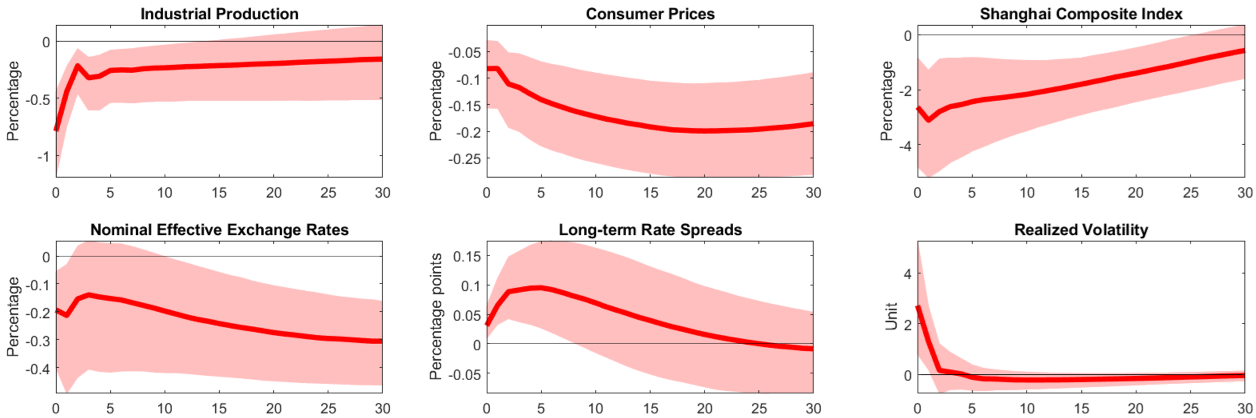
Figure 1: Estimated China uncertainty shocks



such as 2015-16 Chinese stock market turbulence and 2020 COVID-19 pandemic. In particular, because of the abnormality of the COVID-19 pandemic shock, we include a dummy variable for the date in the panel VAR in order to guarantee that our results are not driven by the exceptional event.

Figure 2 describes the impulse response of the China VAR to the estimated uncertainty shock. Overall, an unanticipated rise in China uncertainty has statistically and economically significant effects on the domestic economy. Specifically, China experiences a substantial reduction in industrial production by a maximum of 0.7% on impact, and consumer prices continues to fall with a maximum of 0.2% in 20 months. The increased uncertainty shock also has an adverse impact on financial markets. Stock market volatility jumps up significantly, stock market prices drops by more than 2.0% on impact, nominal effective exchange rates depreciate by 0.2% on impact, and the long-term rate spreads increase persistently for 5 months. Given the dominant role of the Chinese economy for the world trade and commodity markets, these contractionary effects of the China uncertainty shock provide an important empirical evidence of the spillover effects on the global economy shown next.

Figure 2: Impulse responses of the Chinese economy to the uncertainty shock



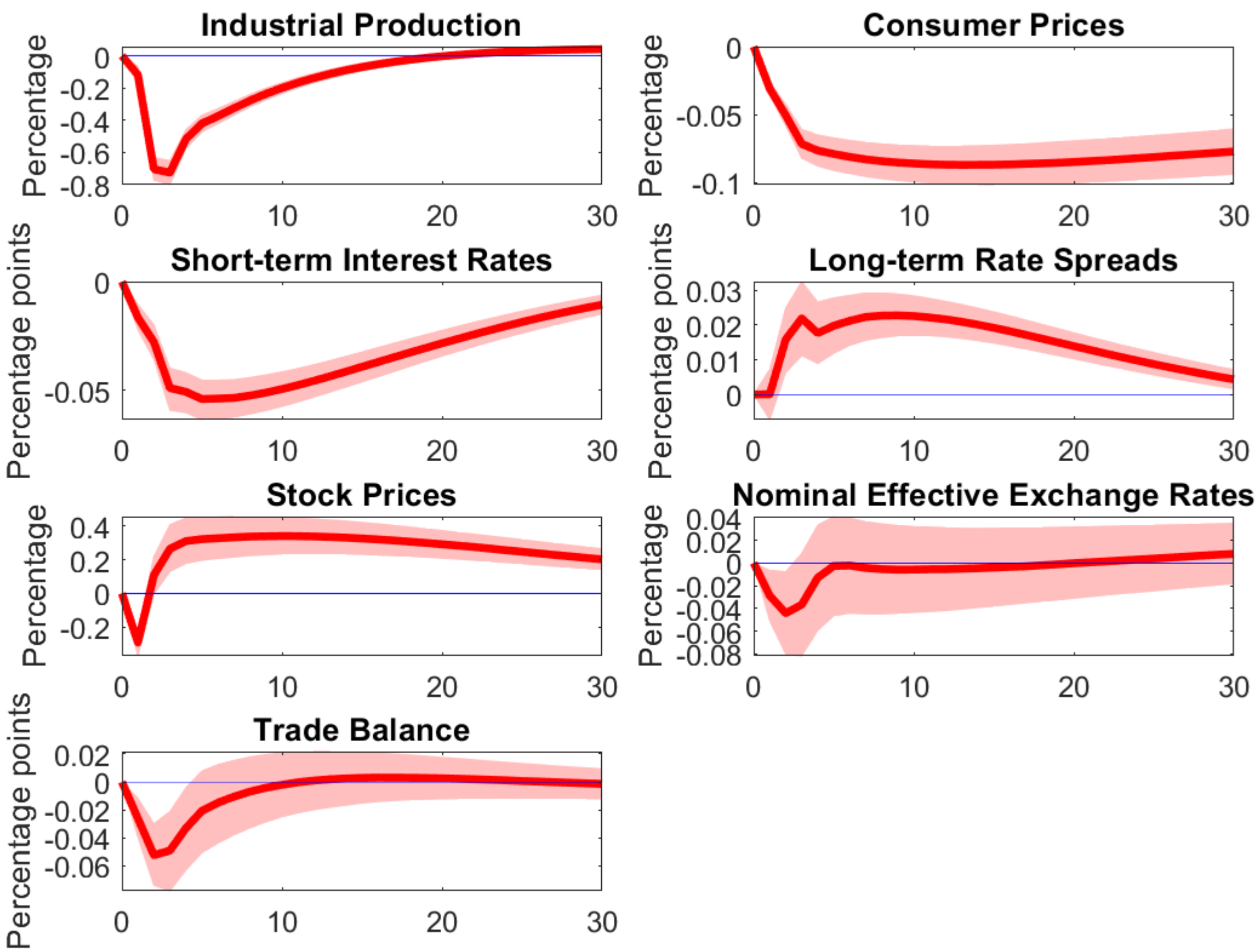
3.2 Spillover effects of China uncertainty shocks

This subsection reports the spillover effects of the China uncertainty shock on the global economy. We first show the global transmission of the China uncertainty shock. Then, we examine whether there exists any of systematic difference in responses by subgroups depending on their economic characteristics. The estimated impulse responses described in this subsection can be interpreted as the average effects of the China uncertainty shock across all countries in the baseline panel VAR specification and those among different subgroups, respectively.

3.2.1 Global transmission

Figure 3 presents the results from our baseline specification. Notice that an unexpected rise in China uncertainty leads to a substantial contraction in the world economy. Specifically, on average, the industrial production falls by roughly 0.8% on impact, consumer prices fall persistently by a maximum 0.1%, and net trade balance declines with a maximum 0.05% points. The China uncertainty shock also has an adverse effect on the global financial markets. For example, on average, stock market prices drop by more than 0.2% for the first few months, nominal effective exchange rates depreciate, even though the effects are marginally statistically significant, and long-term country spreads increase substantially, reflecting the increased global financial risks. Global short-term interest rates drop in response to economic disruptions caused by the increased uncertainty in China. Overall, the impacts of the China

Figure 3: Impulse responses of the panel VAR to the China uncertainty shock: Baseline specification

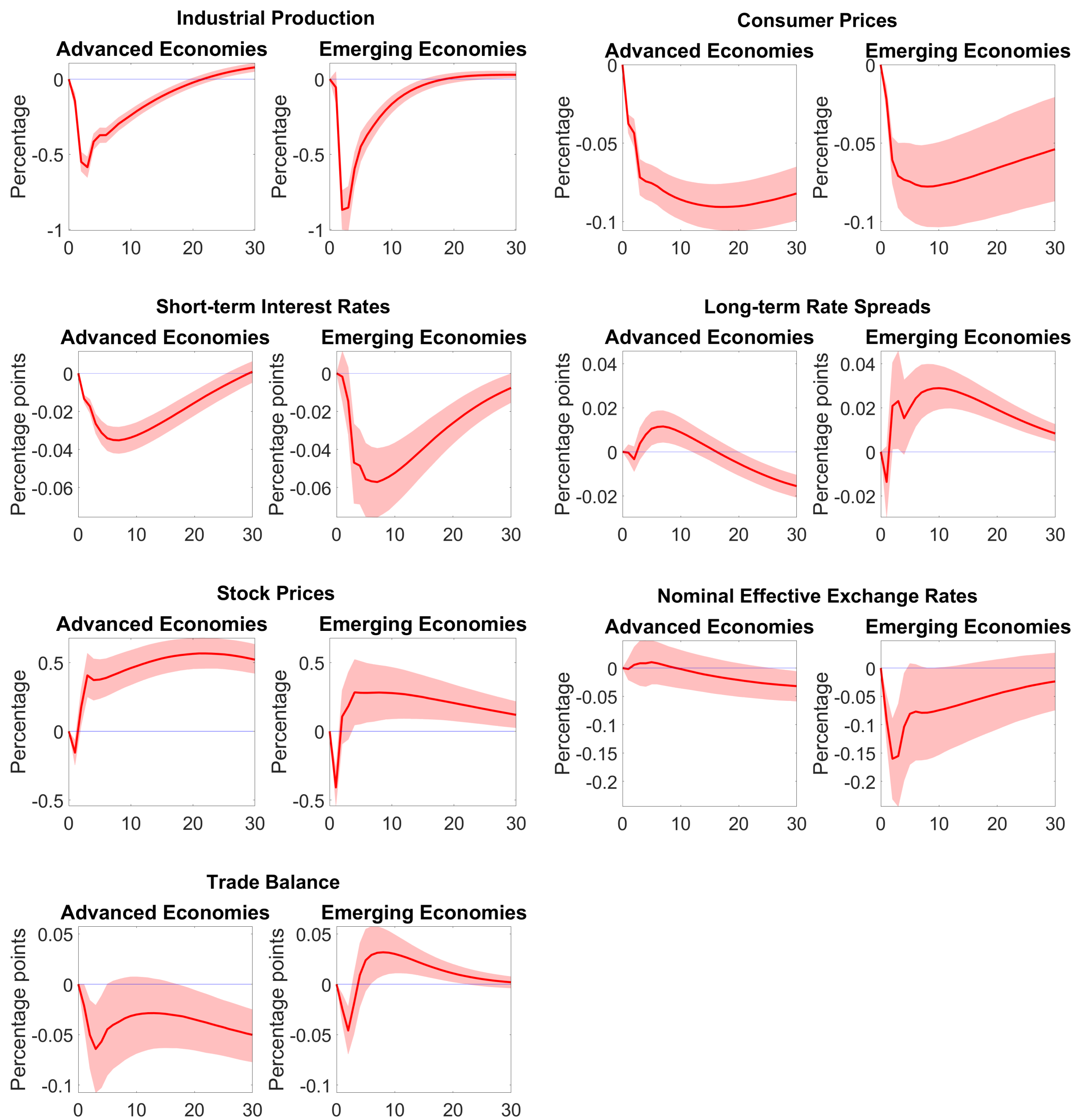


uncertainty shock transmits to the world economy not only through a significant reduction in aggregate spending, but also through a deterioration in global financial conditions.

3.2.2 Subgroup analysis

In this subsection, we examine the potential heterogeneity in the spillover effects of the China uncertainty shock across different subgroups of countries. To do so, we group the sample countries based on important sources of heterogeneity such as economic development, commodity dependence on exports, trade linkages to the China, and external imbalances. By comparing the impulse responses of different subgroups, we can investigate whether these subgroups are differentially sensitive to the China uncertainty shock.

Figure 4: Impulse responses of the panel VAR to the China uncertainty shock: Advanced Economies vs Emerging Economies

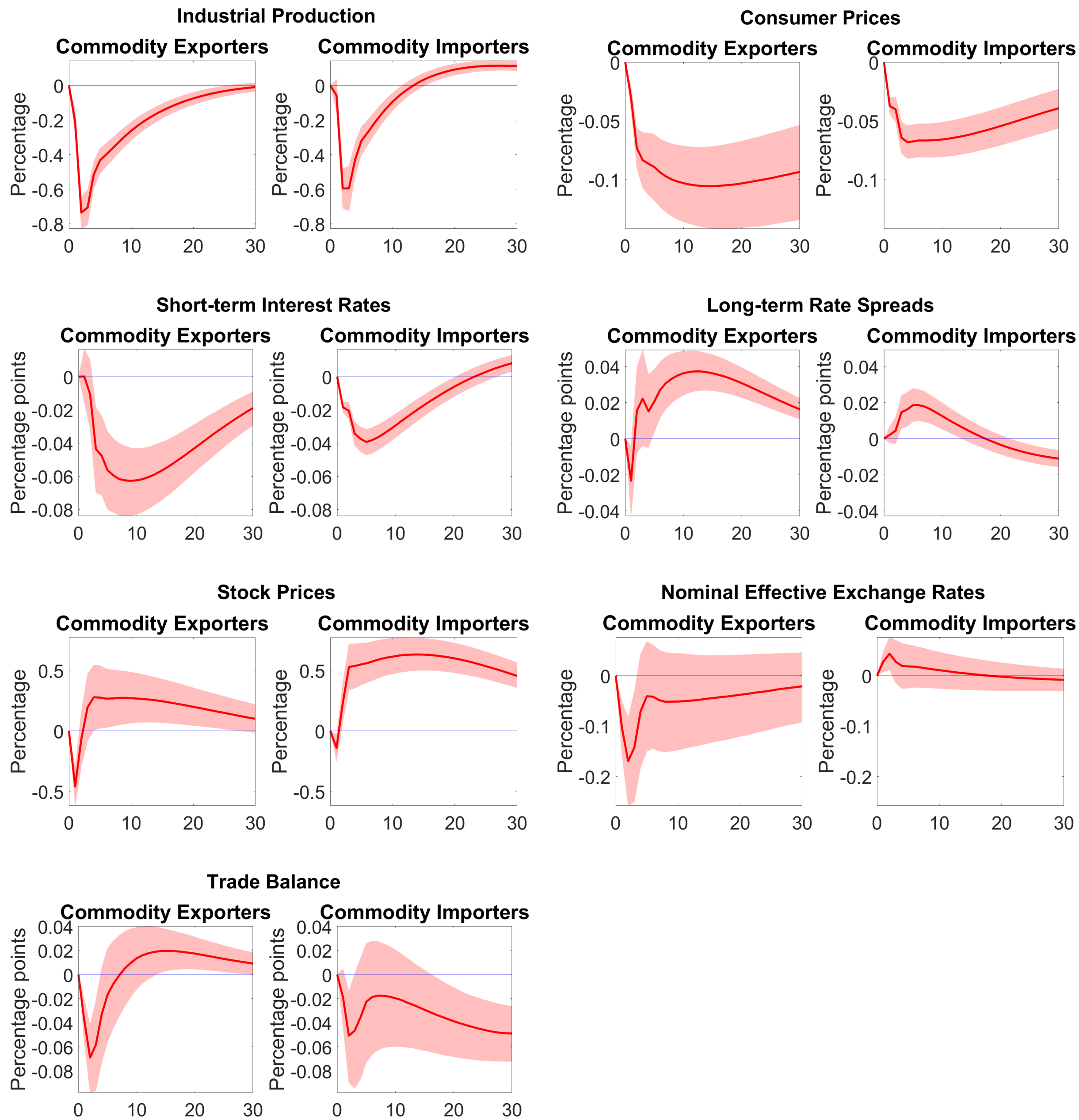


First, we split countries by economic development into two subgroups based on the IMF or World Bank classifications: Advanced economies and emerging market economies.[6]. As illustrated in Figure 4, there seems to be interesting heterogeneity between the two subgroups. The negative effects on industrial production, long-term interest rate spreads, stock market prices, and nominal exchange rates are greater and more persistent for emerging market economies compared to advanced economies. Specifically, industrial production declines by more than 0.8% in two months for emerging market economies, whereas it declines by approximately 0.6% for advanced economies. This result is mainly driven by the fact that emerging markets depend relatively more on external demands, suggesting that they are relatively more vulnerable to spillover effects from the China uncertainty shock, which is largely consistent with the findings by Gauvin and Rebillard (2018) and Sznajderska (2019). Long-term rate spreads increase in both groups of countries, but the peak effect is higher and more lasting for emerging market economies. Stock prices also drop for the two economies and recover very quickly, but the initial negative effects are bigger and the rebound of stock prices are relatively weak for emerging economies. In particular, the noticeable distinction arises in the impulse response of nominal effective exchange rate. The China uncertainty shock results in a currency appreciation in advanced economies for the first several months, even though it is not statistically significant, whereas it leads to a substantial depreciation in emerging economies. That is, a China uncertainty shock causes a flight to safety/quality phenomenon as investors prefer relatively safer assets in advanced economies to those of emerging economies that are perceived to be riskier.

Second, we explore whether there exist noticeable differences between countries with high commodity dependence in exports and those with low commodity dependence. This exercise is motivated by the significant role of China for commodity markets. Since China is one of the highest metal and oil consumer in the world, China's slowdown can have substantial impacts on international prices of commodities, and would affect commodity exporters more strongly through changes in international commodity prices, even though they do not participate in

[6] Advanced economies consist of Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, and the United Kingdom. Emerging market economies include Brazil, Chile, Colombia, India, Indonesia, Korea, Malaysia, Mexico, Peru, the Philippines, Russia, South Africa, Taiwan, Thailand, and Türkiye.

Figure 5: Impulse responses of the panel VAR to the China uncertainty shock: Commodity Exporters vs Commodity Importers



much direct trade with China. To test this hypothesis, we rank the countries by the ratio of total commodity exports to total exports over 2000–2022.[7] Figure 5 depicts the results. As expected, the negative effects on industrial production, consumer prices, and trade balance are larger and more persistent for commodity exporters. Financial markets are also affected more adversely for commodity exporters: The initial drop in stock prices is bigger and their rebound is relatively weak, long-term rate spreads increase markedly, and exchange rates depreciates significantly. Overall, the China uncertainty shock has greater negative effects on commodity exporters than commodity importers.

Third, we group the sample countries based on the degree of trade integration with the China. Intuitively, countries with the higher degree of trade integration to the China can be more sensitive to the China uncertainty shock due to the direct trade linkage. To measure the trade integration with the China, we rely on the trade data from IMF Direction of Trade Statistics and construct the total volume of trade with the China as a ratio of total trade with the world averaged over our sample periods. Based on the measure, we divide countries into the two subgroups: Countries with high degree of trade integration with the China and those with low degree of trade integration.[8] As shown in Figure 6, the China uncertainty shock has larger negative impacts on industrial production and trade balances for countries with high trade integration with the China. It also affects financial markets more adversely for the countries: Stock prices in these countries decline sharply for the first few months and their rebound is relatively weak, exchange rates depreciate markedly for the first few months, and long-term rate spreads jumps up significantly and lasts for longer periods.

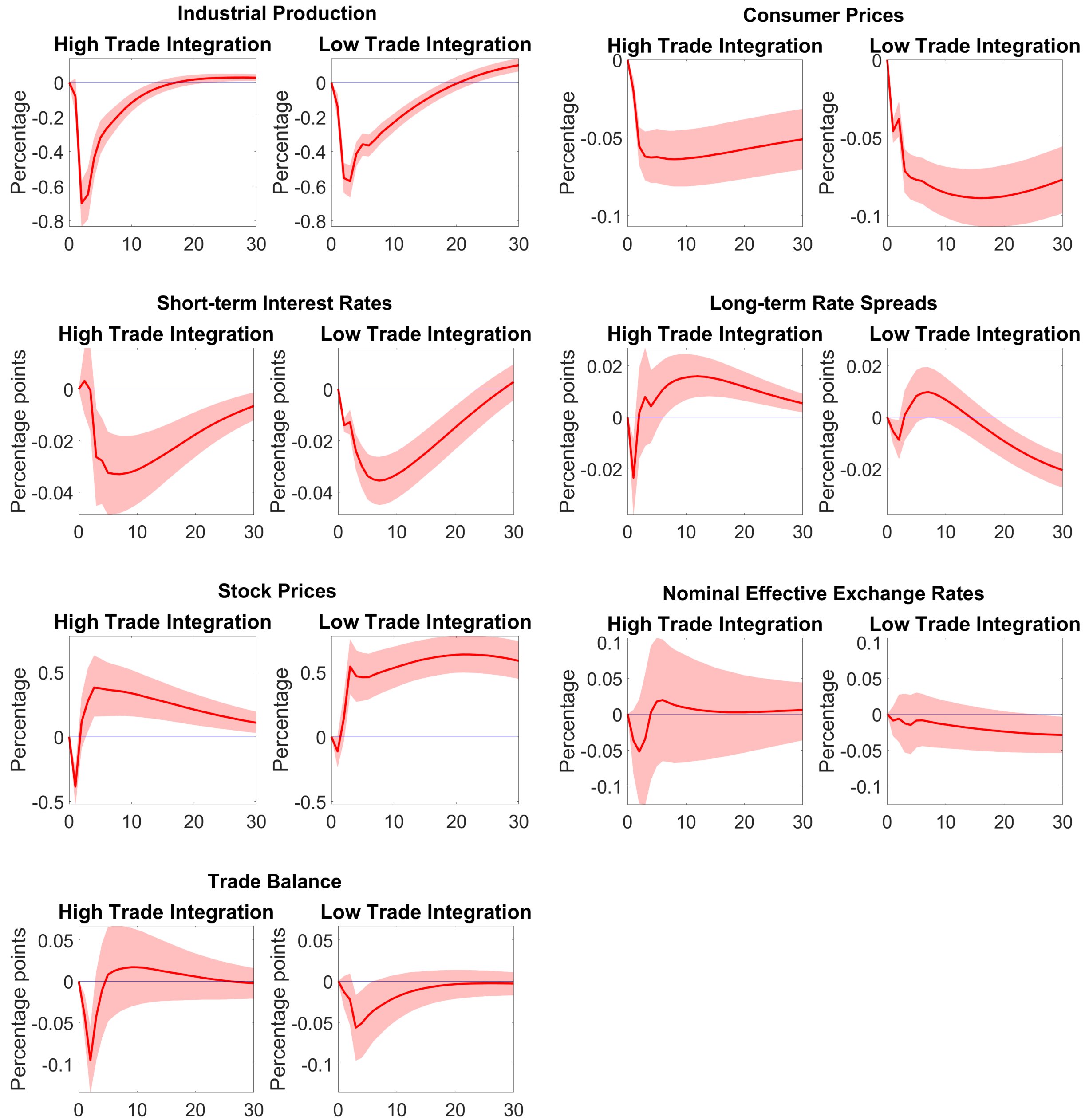
Lastly, we divide the countries based on external imbalances into two subgroups: Countries with high external imbalances and those with low external imbalances.[9] As documented

[7]The countries with high commodity dependence in exports are Australia, Brazil, Canada, Chile, Colombia, Indonesia, Malaysia, Mexico, Norway, Peru, Russia, South Africa, Thailand, and Türkiye. The countries with low commodity dependence in exports consist of Austria, Belgium, Denmark, Finland, France, Germany, India, Ireland, Italy, Japan, Korea, the Netherlands, the Philippines, Portugal, Spain, Sweden, and Taiwan.

[8]The countries with high degree of trade integration with the China are Australia, Brazil, Chile, Colombia, Indonesia, India, Japan, Korea, Mexico, Malaysia, Peru, the Philippines, Russia, South Africa, Thailand, and Taiwan. The countries with low degree of trade integration with the China consist of Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, and the United Kingdom.

[9]The countries with high external imbalances include Australia, Brazil, Chile, Colombia, France, India, Indonesia, Ireland, Mexico, Peru, Portugal, South Africa, Spain, Türkiye, and the United Kingdom. The

Figure 6: Impulse responses of the panel VAR to the China uncertainty shock: High vs low trade integration to the China



by Bhattarai et al. (2021), this is motivated by the fact that countries with better external soundness are likely to be less affected by external shocks. To measure external imbalances, we rely on net foreign asset-to-GDP ratio and current account-to-GDP ratio and construct averages over the sample periods (2000-2022) to rank the sample countries. Figure 7 shows the results. As expected, the negative effects on industrial production and consumer prices are bigger for countries with high external imbalances compared to those with low external imbalances. Financial markets are also affected more adversely for countries with high external imbalances: Stock prices decline markedly, exchange rates depreciates significantly, and long-term rate spreads increase sharply. This result empirically confirms the importance of a country's external soundness in alleviating external shocks.

3.2.3 Variance decomposition

TBD

3.2.4 Robustness checks

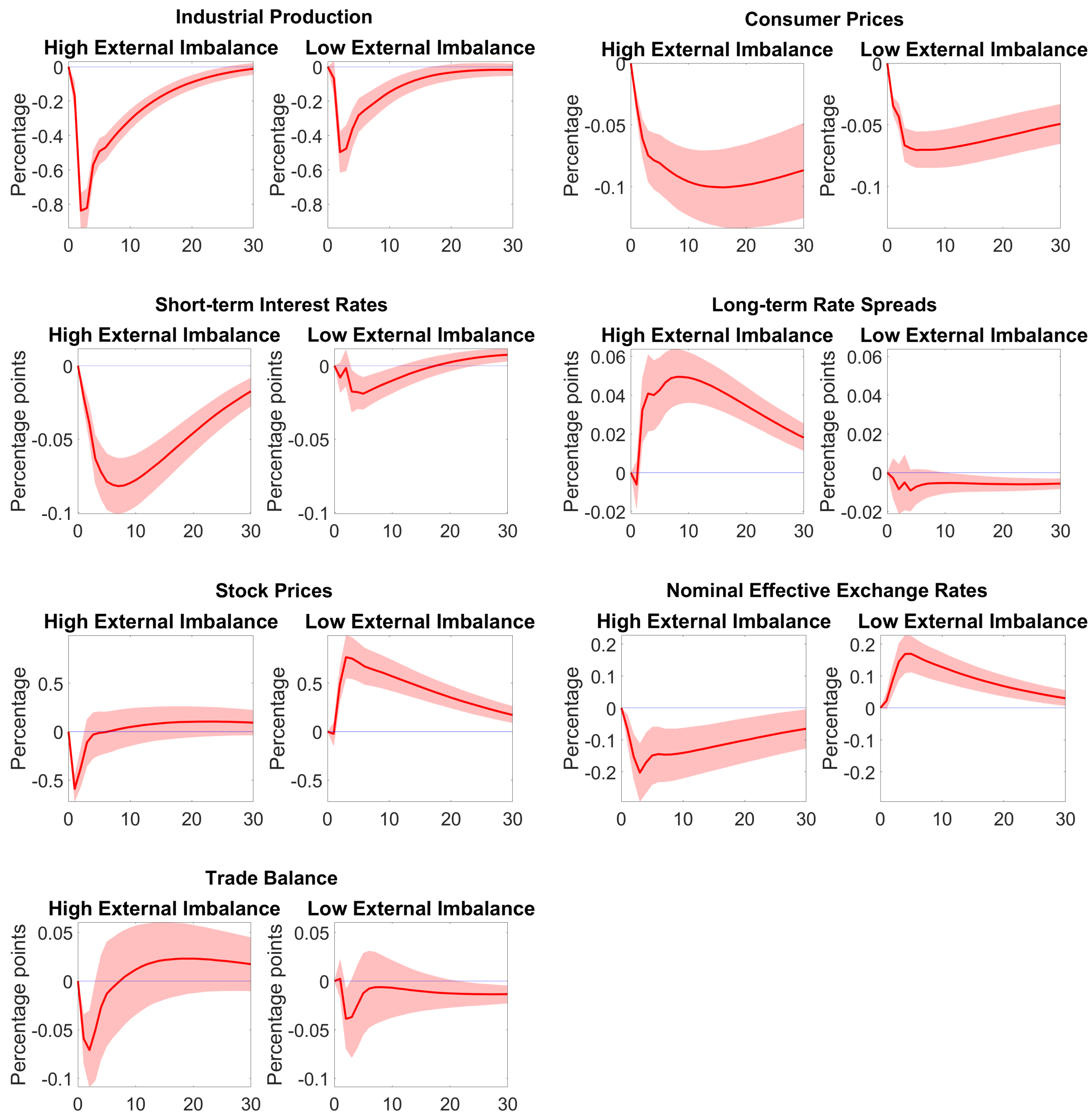
TBD

4 Conclusion

This paper empirically assesses the international spillover effects of China uncertainty shock on the global economy. Employing a VAR model for the Chinese economy with monthly macroeconomic and financial data, we first identify the China uncertainty shock via sign restrictions consistent with the well-documented theoretical literature. Using the extracted China uncertainty shock, we then study its spillover effects on the world economy within a panel VAR framework. We find that an unanticipated rise in China uncertainty has a large and statistically significant impact on the global economy not only through a significant reduction in aggregate spending, but also through a deterioration in global financial conditions. In particular, these effects are stronger for emerging countries, commodity-exporting

countries with low external imbalances consist of Austria, Belgium, Canada, Denmark, Finland, Germany, Italy, Japan, Korea, Malaysia, the Netherlands, Norway, the Philippines, Russia, Sweden, Taiwan, and Thailand.

Figure 7: Impulse responses of the panel VAR to the China uncertainty shock: High vs low trade imbalance



countries, countries with tighter trade linkages to the China, and countries with high external imbalances. These results have important implications for policy makers who react to the increased risk in the Chinese economy in recent years.

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Appendix

Panel VAR Estimation

TBD