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The Rise of China and its Implications for Emerging Markets - Evidence from a GVAR model

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Contents

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Abstract

This paper studies empirically the role of China in the world economy. We examine both the way the Chinese economy reacts to selected exogenous macroeconomic shocks and the repercussions for the world economy of a shock emanating from China. With regard to the latter, we focus on the responses of emerging markets, in particular those in Europe. Based on a global VAR (GVAR) model and a new data set that excels in country coverage and covers the most recent time period including the global financial crisis, our results are threefold: First, we show that a +1% shock to Chinese output translates to a permanent increase of 1.2% in Chinese real GDP and a 0.1% to 0.5% rise in output for most large economies. The countries of Central Eastern Europe (CEE) and the former Commonwealth of Independent States (CIS) also experience an output rise of 0.2%, while countries in South-Eastern Europe see a permanent 0.1% reduction in output. Secondly, to benchmark the shock to Chinese output, we examine the response to a +1% shock to US GDP. The results show that the US economy remains dominant in the world economy despite the rapid rise of China in recent years. In this vein, output rises in advanced economies by 1% to 1.4% and in the CIS and CEE regions by 1.5% and 0.7% respectively. By contrast China seems to be little affected by the US shock. Finally, we examine the effect of a +50% hike in oil prices on China and emerging economies. As one of the largest oil exporters, Russia's real output increases by about 6%. In contrast, the surge in oil prices puts a drag on Chinese output, amounting to 4.5% in the long-run.

Keywords: China, macroeconomic shocks, foreign shock, GVAR, great recession
JEL Classification: C32, F44, E32, O54

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1 Introduction – The rise of China and its role in the global economy

China's economic growth since the 1980s has been enormous. The Chinese growth miracle has been fueled by a large investment share coupled with strong growth in exports. Even during the global financial crisis, with the global economy sliding into recession and global trade collapsing, the Chinese economy was able to post healthy growth rates. Many other emerging markets have also grown rapidly in recent years, which has shifted the balance of power in the global economy towards middle-income countries and away from high-income OECD countries.

This change in the composition of global output and trade makes analysis of the larger emerging markets, and especially China, even more important than before. Our contribution concerns the role of China in the global economy, but also the effects of the global economy on China. At the same time we aim to address a question that so far has received scant attention in the literature, namely China's impact on the Central and European countries. Many of these countries have also grown rapidly in the last few years, but unlike China they suffered from large output losses during the 2008-2009 economic crisis. Many of these countries also remain potential competitors for China, which makes the analysis interesting.

The rise of the Chinese economy is accompanied by a steady increase in its trade integration with the world economy. Figure 1 depicts the share of trade (goods imports and exports) with China in total trade over the period from 1995 to 2011. The graph illustrates a surge in China's trade integration with Asia, especially with Japan, whose the share in China trade bounded from 10% in 1995 to 25% in 2011. Trade integration with other large economies such as the US, India, Brazil and Russia rose to around 10% in 2011, while that of the euro area increased to about 5%.

[FIGURE 1 TO BE INSERTED HERE]

There are several studies that examine the impact of macroeconomic shocks on China, but there are only a few that embed the Chinese economy into a global context.

On one hand, trade and consequently the relocation of productivity based on comparative advantage, fosters economic growth across the globe. On the other hand, the recent global financial crisis produced evidence of the danger of stress spilling over via the trade channel. It is thus natural to study the impact of macroeconomic shocks by means of a global model that includes the interdependencies among the economies. There are two recent studies that look at the impact of an increase in Chinese real output on the world economy, using a global vector autoregressive (GVAR) model. Cesa-Bianchi et al. (2011) demonstrated the growing importance of China for the region of Latin America. In particular, they show that the impact of a positive shock to Chinese output has increased almost threefold compared to the same shock in the context of the 1990s' trade flows in accounting for the integration of China with the world economy. In the same vein, Cesa-Bianchi et al. (2011) demonstrate that the response of the Latin American region to a shock emanating from the US has halved as a consequence of the rise of China in the world economy.[1] Using the same empirical framework, Dreger and Zhang (2011) trace the impact of a +1% change in Chinese GDP on inflation and real economic performance in the industrialized countries. Their results show that the impact on output is substantial for the Asian region, while the effects on the US economy and the euro area are less pronounced.

In this paper we first study the impact of a shock emanating from the Chinese economy on the real economies of emerging markets, particularly those in Eastern Europe. For that purpose we extended the country coverage of the data set used in Cesa-Bianchi et al. (2011) and Dreger and Zhang (2011), to include 52 advanced and emerging economies. Secondly we look at potential threats to the Chinese growth miracle by examining a revaluation of the renminbi as well as a hike in oil prices. The paper is structured as follows. The next section briefly introduces the empirical framework. Section 3 presents the data and model specification along with a range of empirical tests, to ensure the model's statistical verity. In Section 4 we introduce four macroeconomic shocks and examine their spatial and dynamic propagation. Section 5 concludes.

[1] Interestingly, Fidrmuc et al. (2012) report that OECD countries that trade more with China have seen their business cycle correlation with other OECD countries decrease.

2 Empirical approach – the GVAR model

The global vector autoregressive (GVAR) model is a compact representation of the world economy, which highlights the economic and financial interdependencies in the global economy. The GVAR model has been successfully employed in the study of propagation of macroeconomic shocks (see e.g. Dees et al., 2007, Pesaran et al., 2004, Pesaran et al. 2007) and financial stress (Chudik and Fratzscher, 2011 and Sgherri and Galesi, 2009).

The model comprises *two layers*[2] that account for cross-sectional linkages among the economies. First, there are *N* country-specific submodels that link each economy to the world by allowing for foreign and global factors. Since macroeconomic time series predominantly share common stochastic trends, these country models are typically specified in vector error correction form. For a particular country *i*, and $z_t = (y_t, x_t)$ comprising the data, the following system of equations is estimated:

$$\begin{aligned} \Delta y_t &= c_0 + c_1 t + \Pi_y z_{t-1} + \sum_{i=1}^{p-1} \Gamma_{yy,i} \Delta y_{t-i} + \sum_{i=1}^{q-1} \Gamma_{yx,i} \Delta x_{t-i} + \sum_{i=1}^{lex-1} \Psi_i \Delta d_{t-i} + \Lambda_x \Delta \mathrm{x}_t + \Lambda_d \Delta \mathrm{d}_t + e_{yt} \\ \Delta x_t &= c_{x0} + c_{x1} t + \sum_{i=1}^{p-1} \Gamma_{xy,i} \Delta y_{t-i} + \sum_{i=1}^{q-1} \Gamma_{xx,i} \Delta x_{t-i} + e_{xt} \end{aligned} \tag{1}$$

with $u_t = (e_{yt}, e_{xt})$ and $u_t \sim N(0, \Sigma_u)$. We distinguish between four variable types: First, y_t denotes the set of domestic (endogenous) variables, which is enlarged by controlling for external factors x_t. This set of 'foreign' (weakly exogenous) variables is constructed as a cross-country weighted average of its domestic counterparts $x_t^i = \sum_{j \neq i} w_{ij} y_t^j$, with $w_{ij} \geq 0$; $w_{ii} = 0$; $\sum_{j=1}^{N} w_{ij} = 1$. The weights $w_{ij} \in W_b$ represent economic ties between countries and are typically based on bilateral trade flows, which are captured in an N x N matrix W_b. Thirdly, d_t denotes global (exogenous) variables that are not determined within the country systems. In the empirical application we control for the global business cycle by including the price of oil as an exogenous variable for all other countries except the US. Note that both weakly exogenous and exogenous variables enter the conditional model for Δy_t, both *contemporaneously* and in lagged form p, lex >1. Finally, each country model contains a trend and/or intercept term.

[2] For an excellent textbook exposition of the GVAR see Garrat et al. (2006).

The system of equations comprises information about both the long-run, $\Pi = \begin{pmatrix} \Pi_y \\ \Pi_x \end{pmatrix} = \begin{pmatrix} \Pi_{yy} & \Pi_{yx} \\ \Pi_{xy} & \Pi_{xx} \end{pmatrix}$, and short-run, $\Gamma = \begin{pmatrix} \Gamma_{yy} & \Gamma_{yx} \\ \Gamma_{xy} & \Gamma_{xx} \end{pmatrix}$. Note that $\Pi_x = 0$, which means that information from the conditional model for Δy_t is redundant for Δx_t. Furthermore, this assumption implies that the vector of foreign variables is not cointegrated (Assenmacher-Wesche and Pesaran, 2008). The way common stochastic trends are accounted for in the GVAR resembles a cointegration system approach akin to Johansen (1995). Should the domestic variables be cointegrated, the 'long-run' matrix Π is rank deficient, which in turn prevents straightforward economic interpretation of the coefficients describing the long-run equilibrium.

In the *second layer* of the GVAR framework, the single-country models are 'stacked' to yield a coherent global macro-model that is able to capture the dynamics and spatial propagation of macroeconomic shocks to the system:

$$\mathrm{G} y_t = c_0 + c_1 t + \sum_{k=1}^{P} \mathrm{H}_k\, y_{t-k} + \sum_{k=1}^{L} \Upsilon_k\, d_{t-k} + u_t \qquad (2)$$

with H and Υ containing the stacked coefficient matrices from the single countries and $P = \max(p_i, q_i)$, $L = \max\,(lex_i)$. G contains the stacked weighted coefficients, i.e., $G^i = (I, -\Lambda_x) z^i W^i_{global}$. The models are thus linked via W^i_{global} which is a $K_i \; x \; K$ matrix with K_i being the sum of endogenous and weakly exogenous variables in country model *i* and $K = \sum_{i=1}^{N} K_i$ is the total number of endogenous and weakly exogenous variables in the system. As is evident from above the matrix, W^i_{global} is a crucial element of the GVAR framework in the sense that it links the single country models and thus governs the propagation of a shock. Note that the weigths in W^i_{global} need not match those used to construct the foreign variables. Since the square matrix *G* is non-singular, equation (2) can be left-multiplied by G^{-1} to yield the GVAR model:

$$y_t = \tilde{c}_0 + \tilde{c}_0 t + \sum_{k=1}^{r} \widetilde{H}_k\, y_{t-k} + \sum_{k=0}^{p} \widetilde{\Upsilon}_k \Delta d_{t-k} + \tilde{u}_t \qquad (3)$$

3 Data and Model Specification

3.1 Data

We extended the data used in Cesa-Bianchi et al. (2011) and Dreger and Zhang (2011) to cover N=52 economies, comprising 51 single countries and the euro area (EA)[3] as a regional aggregate:

Table 1 Country coverage

1.) Advanced Economies & BRIC (8):	US, EA, UK, JP, BR, RU, IN, CN
2.) CEE and Baltics (8):	CZ, HU, PL, SK, SI, LT, LV, EE
3.) SEE (5):	BG, RO, HR, AL, RS
4.) CIS (9):	UA, BY, KG, TJ, MN, GE, AM, AZ, MD
5.) Emerging Asia (6):	KR, PH, SG, TH, ID, MY
6.) Latin America (4):	AR, CL, MX, PE
7.) Middle East and Africa (4):	EG, NG, SA, TR
8.) ROW (8):	CA, AU, NZ, CH, NO, SE, DK, IS

Source: Authors' calculations.

The focus of our analysis is on the first four groups of advanced-economy countries (to cross-check our results with the established literature) and the largest emerging countries (BRIC); as well as the emerging countries of Central Eastern Europe (CEE), South-Eastern Europe (SEE) and the former Commonwealth of Independent States (CIS) region. Thus our data set spans a very heterogeneous set of countries including advanced economies, catching-up economies and the most important oil producers and consumers. The inclusion of European emerging economies limits the time span of the analysis to the period subsequent to the transition to market-based economies. We thus have quarterly data from 1995Q1 to 2011Q4, which gives us 68 quarterly observations per variable. To the best of

[3] Note that the country composition on which data for the euro area are based changes over time. That is, while historical time series are based on data for the 10 original member states, the most recent data are based on 17 countries. Nevertheless we report separate results for Estonia, Slovenia and Slovakia since we are also interested in the emerging Europe. Our results are qualitatively unchanged if we use instead of the rolling country composition for the data on the euro area a consistent set of 14 euro area states throughout the sample period, as these three economies are of roughly the same magnitude.

our knowledge this data set excels in terms of both country coverage and inclusion of the most recent data available on a global scale.

We include the following five *domestic variables*[4]: Real GDP (y), inflation (Dp), the nominal exchange rate vis-à-vis the USD deflated by national price levels (rer), short-term interest rates (stir) and long-term interest rates (ltir). Among the variables, only real GDP, inflation and the real exchange rate are available for all 52 countries. In particular, long-term interest rates are often not available for emerging economies. The set of domestic variables is complemented by oil prices.

Economic ties among countries are captured by bilateral flows of exports and imports of goods, which are available on an annual basis. These trade flows are captured in row-standardized link matrices denoted by $W_{b,t} \in \{W_{b,1995}, \cdots, W_{b,2011}\}$.

All variables are tested for a unit root via an augmented Dickey-Fuller test. We follow Pesaran et al. (2004) in allowing for a trend and intercept term in the ADF regression in levels for all variables except interest rates and inflation. These are modeled with an intercept term only. The results are presented in Table B.4 in the appendix. For most variables the ADF test could not reject the null-hypothesis of a unit root. One notable exception is the long-term interest rate in the euro area. This also skews the results for foreign long-term interests for emerging economies in Europe due to the regions' strong trade integration with the euro area. Table B.5 contains the results of the ADF test on first differences of the data. Note that we specified the ADF test here without a trend term for all variables. The test results show that most of the variables are stationary after first differencing. Together with the results on the levels, this implies roughly that all variables are integrated of order 1, which lends support to the cointegration framework employed here.

3.2 Model Specification and Specification Tests

Based on trade weights, *foreign variables* are constructed to account for global and regional factors. Economic activity seems to be generally assumed to be the channel via which spillovers take place. However, spillovers could in principle take place via any of the domestic variables. For degrees of freedom considerations, we aim at keeping the

[4] See appendix, Table A.1 for details.

number of variables per country small. We thus allow for spillovers via real GDP (y*) and interest rates (stir*, ltir*) only. Note that co-movements of these variables are strong, with cross-sectional correlations ranging from 0.5 (short-term interest rates) to 0.9 (real GDP), while cross-country correlation of inflation is rather low (0.2). Following Cesa-Bianchi et al. (2011) foreign variables x_t are constructed using *time varying* trade weights. This allows us to empirically keep track with the rise of the Chinese economy in the global economy. The weights for stacking the single models are based on trade flows in 2011.

As outlined in Pesaran et al. (2000) we test for specification of the deterministic terms (trend and intercept) in equation (1). For the majority of the countries (34 of 52) the likelihood ratio test lent empirical support to including an unrestricted intercept and a trend term restricted to lie in the cointegration space (Case IV)[5]. Note that this is the specification one would expect during 'normal' times since most macroeconomic variables are trending (see e.g. Cesa-Bianchi et al., 2001, Dees et al. 2007). For the remaining countries the test revealed a zero intercept, zero trend model (Case I, 8 times), a restricted intercept, zero trend model (Case II, 6 times) and an unrestricted intercept, zero trend model (Case III, 4 times).

The number of the long-run relationships is tested by means of the trace statistic test (Juselius, 2006). The trace statistic is preferred to the maximum eigenvalue statistic since it has better small sample properties (Cesa-Bianchi et al., 2011). In order to achieve a parsimonious model and ensure stability of the global model, we examine the long-run properties for each country model in more detail. More specifically, we assess the dynamics of a global shock[6] to the country specific long-run equilibria by means of persistence-profiles (see Pesaran et al., 2003). Following Cesa-Bianchi et al. (2011) the cointegration rank has then been reduced as long as the economy is restored to an equilibrium within 10-15 quarters. Note that we have set the lag length for domestic, foreign and global variables to one in equation (1). Finally, the modeling of the global variable (oil prices) is discussed in detail in the next section. Table B.1 in the appendix summarizes the specification for each country model.

Our final model passed several specification tests. First, it is globally stable in that all its roots lie either on or inside the unit circle. Secondly, we tested whether the foreign variables can be considered as weakly exogenous. The results provided in Table B.2 show

[5] See Juselius, 2006 for a textbook discussion on trends and intercepts in VECMs.
[6] Full results are available from the authors upon request.

that weak exogeneity is by and large met in all the country models. Finally we carried out an F test for residual serial correlation (Pesaran et al., 2004). Although our hands are tied in the sense that increasing the number of lags in the GVAR would require longer time series, we feel that testing for autocorrelation in a time series model is necessary. Of the 220 equations in the model, 161 pass the F test for first order serial autocorrelation, which gives us further confidence in the statistical properties of the model.

4 Macroeconomic Shocks

We are interested in propagation of three different macroeconomic shocks in the global economy and their impact on the real economy[7]:

1. A +1% shock to Chinese GDP
2. A +1% shock to US GDP
3. A +50% increase of oil prices

Besides assessing the dynamics of a shock locally, the GVAR framework allows us to trace out the spatial shock propagation. For this purpose we follow the bulk of the literature in employing the Generalized Impulse Response Functions (GIRF) put forward in Pesaran and Shin (1998):

$$\mathrm{GIRF}(y_t, u_t, n) = \frac{F_n G^{-1} \Sigma_u s_j}{\sqrt{s'_j \Sigma_u s_j}}$$

with s_j denoting a binary shock indicator vector, n the shock horizon, Σ_u the corresponding variance covariance matrix of the GVAR and $F = G^{-1}H$. As noted in Pesaran and Shin (1998) the generalized impulse responses are not sensitive to the ordering of the variables in the country models – in contrast to the standard VAR analysis. However, this comes at the cost of having non-orthogonalized impulse responses. That is, shocks cannot be isolated since the variables in the system are typically correlated. Lastly, note that the dynamic analysis in a GVAR is carried out on the *levels* of the variables, which implies that the effects of a given shock are typically permanent.

4.1 Shock to China's output

We first assess the impact of a positive +1% shock to real Chinese output to the global economy that is depicted in Figure 2. The initial shock translates into a 1.2% permanent increase of GDP in the Chinese economy. The long-run boost to Chinese real output goes in parallel with a decrease in inflation and an increase in the short-term interest rate. This particular behavior of the Chinese economy with regard to the shock transmission is in line with findings of Chen et al. (2012).

[FIGURE 2 TO BE INSERTED HERE]

Among the remaining BRIC countries, Brazil shows a very pronounced response of 0.5% increase in GDP, while India's and Russia's reactions to the Chinese GDP increase are rather contained. Our estimate for the effects on the US and euro area (GDP increase between 0.1% and 0.15%) are relatively close to those in Cesa-Bianchi et al (2011). The bottom panel of Figure 2 displays PPP aggregated impulse responses for the countries belonging to the six regions in Table 1. Note that the results are aggregated to make the exposition simpler.[8] The 1% increase in Chinese GDP translates to a 0.2% permanent increase for output in Latin America, followed by a somewhat smaller effect on the CEE region. Surprisingly the results for the Asian region are smaller, which could be seen as an indication of competition in the region.

4.2 Shock to US output

To obtain a benchmark for the China real GDP shock, we conduct a +1% shock to US real output. The initial shock translates to a 1.2% increase in US real GDP in the first year and 1.3% in the long-run. In contrast to the Chinese economy, inflation ticks up, and both short and long-term interest rates increase. One particular feature of the US country model is that it includes oil prices as an endogenous variable. The strong US economy spurs the demand for oil, which is mirrored in a remarkable 15% increase in oil prices in the long-run.

[7] As a robustness check, we also assess the impact of two kinds of exchange rate shocks in our GVAR. These results are reported in Appendix C.

The dominance of the US economy can also be seen in the response of other countries' real output to the growing US economy. The results are shown in Figure 3.

[FIGURE 3 TO BE INSERTED HERE]

Naturally, the effects are larger for the major trading partners of the US: Mexico (1.45%), UK (1.3%) and Canada (1.35%). The euro area sees its real output rising by about 1% in the long-run. With the exception of Japan (1%), the large Asian countries such as India and China are rather insulated from the shock (0.08% and -0.12% respectively). This finding is in line with Chen et al. 2012 and Cesa-Bianchi et al. (2011). Russia (2%) and the CIS region (1.5%) react strongly to the positive US output shock. The pronounced reaction of the region to movements in the oil price - as demonstrated in the next sub-section - explains this strong response. Real output in the CEE and SEE region rises by about 0.7%. These results show that - despite China's rapid emergence as an economic powerhouse at the global level - the US still exerts the largest influence on other countries' economic fortunes. This is true despite the relatively closed nature of the US economy. It is worth noting again that our simulations are performed with the 2011 trade weights, which already take into account China's strong position in global trade.

4.3 Shock to oil price

Thirdly, we look at the response of the global economy to a +50% hike in oil prices. On the one hand, positive oil price shocks are expected to deter economic activity in oil importing countries by dampening the global economy. On the other hand, oil price hikes are expected to boost real GDPs of oil exporting countries, with the potential for spillovers to countries with which they have strong economic ties. Following the literature we opted to model the oil price as an endogenous variable in the US country model. This might be justified since the US is the dominant economy in the GVAR system as well as among the largest oil producers, and is by the far the largest oil importer.

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[8] Results for the single countries are available from the authors upon request.

In contrast to Dees et al. (2007) and Cesa-Bianchi et al. (2011), we opted for excluding oil prices as a conditioning variable from the long-run equilibrium. Thus oil prices are assumed to have a short-run influence on the domestic variables only. We relax this assumption for the largest oil exporters (Saudi Arabia, Russia, US, Norway, Canada, Mexico, Nigeria and Azerbaijan) and importers (euro area, China and India) where oil price is included as an additional foreign variable.

The effect of the +50% increase in oil prices is shown in Figure 4.

[FIGURE 4 TO BE INSERTED HERE]

As expected, the Russian economy sees a permanent and large increase in real GDP. After 10 quarters, real output in Russia rises by 6%. This result is in line with Korhonen and Ledyaeva (2010) who use a trade-linkage approach to capture economic ties between countries. As expected, oil importers, such as the US, India and the euro area are negatively affected on impact by increases in oil prices. However, this negative effect disappears after approximately 4 quarters. In contrast, China experiences a permanent and pronounced drag on real output amounting to approximately 5.5%. The negative response of Chinese output to the oil price hike is in line with Tan et al. (2010). Among the emerging economies, the CIS aggregate - representing both oil importing and exporting countries – shows a positive output response to the 50% surge in oil prices of close to 2%. A booming Russian economy is likely to generate positive growth spillovers to the CIS region, which are transmitted through the trade linkages.

The Latin American region displays a rather contained response, while the Asian economies show a slightly positive reaction. Strikingly, the Middle East-African countries react negatively to the oil price hike, although Saudi Arabia and Nigeria, which together make up close to 40% of the regional aggregate, are both important oil exporters. Investigating the respective country models reveals that oil prices negatively influence the short run GDP dynamics, which seems counterintuitive at first sight. However, as a consequence of the global recession oil prices were declining in 2009, while Saudi Arabia and Nigeria both were relatively sheltered from the crisis. This might partially account for the negative association of oil prices and GDP growth in these countries.

The countries belonging to the SEE and CEE region are all oil importers. Consequently the oil price hike translates to a permanent drag on real output that amounts to 1%.

This negative effect is reinforced by the drop in output in the euro area, which comprises the countries' largest trading partner. On the other hand, trade ties with Russia slightly mitigate these negative effects.

5 Conclusions

We assessed the role of China in the global economy with the help of a GVAR model. Our primary focus was on the effects of Chinese economic performance on other emerging market countries in different parts of the world, an issue that has not so far received attention in the literature. Furthermore, our GVAR model has larger country coverage and is estimated on a more recent data sample than other models attempting to tackle similar issues.

We find that developments in the Chinese economy have very clear and often large effects on other countries. For example, Brazil, which has increased its exports to China tremendously during the past decade, is perhaps the largest outside beneficiary of higher Chinese GDP. Usually those countries or country groups trading more with China will benefit from higher Chinese GDP, but China's smaller neighbors in Asia are a partial exception to the rule. However, we need to remember that the US economy, roughly three times the size of the Chinese economy, still exerts the strongest influence on other countries.

As China and other large emerging markets have grown, so has their demand for raw materials. To proxy for this trend, we have examined a large positive shock to the price of oil. As expected, this has a retarding effect on the growth of most oil-importing countries, while oil-exporters (especially Russia) benefit. Interestingly, China is the largest sufferer from this shock to oil price.

Our results emphasize the pre-eminent role the large and open Chinese economy has assumed in recent years. China's economic fortunes have large effects on other countries, developed and developing alike. As China's growth continues, these effects will only become more pronounced and closer in magnitude to the current impact of the US economy.

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Appendix A – Data Description

Table A.1: Data Description

Variable	*Description*	*Source*	*Min.*	*Mean*	*Max*	*Coverage*
y	Real GDP, average of 2005=100. Seasonally adjusted, in logarithms.	IMF, IFS database. Data for China is from BOFIT, Finland	3.253	4.499	5.375	100%
Dp	First differences of Consumer price inflation, seasonally adjusted, in logarithms.	IMF, IFS database and OECD.	-0.2578	0.02195	1.194	100%
rer	Nominal Exchange Rate vis-a-vis the USD, deflated by national price levels.	IMF, IFS database, Thomson data stream, Eurostat.	-5.699	-2.172	5.459	98.1%
stir	3 months money market rate. For some countries, overnight deposit rates / treasury bill rate.	IMF, IFS database	1	1.105	5.332	90.4%
ltir	Government bond yield.	IMF, IFS database, OECD.	1	1.059	1.777	32.7%
poil	Price of oil, seasonally adjusted, in logarithms.	IMF, IFS database.	-	-	-	-
Trade flows	Exports and Imports of Goods and services, annual data.	IMF, DOTS database.	-	-	-	-

Note: Data span is from 1995Q1-2011Q4, 68 quarterly observations. Data on bilateral trade flows is annual. Coverage refers to the availability of a particular variable in all the country models of the GVAR, in %.

Appendix B – Model Specification

Table B.1: Specification of country models

Country	*Domestic Variables*	*Foreign Variables*	*Coint. Rank*	*Trend / Intercept*	*p=q=lex*
AL	y, Dp, rer, stir	y*, stir*, ltir*	2	IV	1
AM	y, Dp, rer, stir	y*, stir*, ltir*	1	I	1
AR	y, Dp, rer, stir	y*, stir*, ltir*	2	II	1
AU	y, Dp, rer, stir, ltir	y*, stir*, ltir*	2	IV	1
AZ	y, Dp, rer	y*, stir*, ltir*	1	IV	1
BG	y, Dp, rer, stir, ltir	y*, stir*, ltir*	2	IV	1
BR	y, Dp, rer, stir	y*, stir*, ltir*, poil*	1	IV	1
BY	y, Dp, rer, stir	y*, stir*, ltir*	3	IV	1
CA	y, Dp, rer, stir, ltir	y*, stir*, ltir*, poil*	1	IV	1
CH	y, Dp, rer, stir, ltir	y*, stir*, ltir*	2	IV	1
CL	y, Dp, rer	y*, stir*, ltir*	2	IV	1
CN	y, Dp, rer, stir	y*, stir*, ltir*, poil*	1	IV	1
CZ	y, Dp, rer, stir	y*, stir*, ltir*	2	IV	1
DK	y, Dp, rer, stir, ltir	y*, stir*, ltir*	3	IV	1
EA	y, Dp, rer, stir, ltir	y*, stir*, ltir*, poil*	1	IV	1
EE	y, Dp, rer, stir	y*, stir*, ltir*	1	IV	1
EG	y, Dp, rer	y*, stir*, ltir*	1	III	1
GE	y, Dp, rer, stir	y*, stir*, ltir*	3	I	1
HR	y, Dp, rer, stir	y*, stir*, ltir*	1	IV	1
HU	y, Dp, rer, stir	y*, stir*, ltir*	1	IV	1
ID	y, Dp, rer, stir	y*, stir*, ltir*	1	II	1
IN	y, Dp, rer, stir	y*, stir*, ltir*, poil*	1	III	1
IS	y, Dp, rer, stir, ltir	y*, stir*, ltir*	3	IV	1
JP	y, Dp, rer, stir, ltir	y*, stir*, ltir*, poil*	1	III	1
KG	y, Dp, rer, stir	y*, stir*, ltir*	1	IV	1
KR	y, Dp, rer, stir, ltir	y*, stir*, ltir*	1	III	1
LT	y, Dp, rer, stir	y*, stir*, ltir*	2	I	1
LV	y, Dp, rer, stir	y*, stir*, ltir*	2	IV	1
MD	y, Dp, rer, stir	y*, stir*, ltir*	1	IV	1
MN	y, Dp, rer, stir	y*, stir*, ltir*	2	IV	1
MX	y, Dp, rer, stir, ltir	y*, stir*, ltir*, poil*	2	II	1
MY	y, Dp, rer, stir, ltir	y*, stir*, ltir*	1	I	1
NG	y, Dp, rer, stir	y*, stir*, ltir*, poil*	1	IV	1
NO	y, Dp, rer, stir, ltir	y*, stir*, ltir*, poil*	2	IV	1
NZ	y, Dp, rer, stir, ltir	y*, stir*, ltir*	2	II	1
PE	y, Dp, rer, stir	y*, stir*, ltir*	1	IV	1
PH	y, Dp, rer, stir	y*, stir*, ltir*	1	IV	1
PL	y, Dp, rer, stir	y*, stir*, ltir*	2	IV	1
RO	y, Dp, rer, stir	y*, stir*, ltir*	2	I	1

RS	y, Dp, rer	y*, stir*, ltir*	1	I	1
RU	y, Dp, rer, stir	y*, stir*, ltir*, poil*	2	I	1
SA	y, Dp, rer	y*, stir*, ltir*, poil*	1	IV	1
SE	y, Dp, rer, stir, ltir	y*, stir*, ltir*	1	IV	1
SG	y, Dp, rer, stir	y*, stir*, ltir*	1	I	1
SI	y, Dp, rer, stir	y*, stir*, ltir*	2	IV	1
SK	y, Dp, rer, stir	y*, stir*, ltir*	1	II	1
TH	y, Dp, rer, stir, ltir	y*, stir*, ltir*	1	II	1
TJ	y, Dp, rer, stir	y*, stir*, ltir*	2	IV	1
TR	y, Dp, rer, stir	y*, stir*, ltir*	1	IV	1
UA	y, Dp, rer, stir	y*, stir*, ltir*	2	IV	1
UK	y, Dp, rer, stir, ltir	y*, stir*, ltir*	1	IV	1
US	y, Dp, stir, ltir, poil	y*, ltir*	1	IV	1

Source: Authors' calculations.

Table B.2: Test of weak exogeneity assumption.

Country	DoF	F-crit. (0.95)	y*	stir*	ltir*	poil*
EA	F(1,55)	4.0162	1.96696	0.32856	1.09617	1.77878
-	-	-	(0.166)	(0.569)	(0.300)	(0.188)
US	F(1,56)	4.01297	3.64463	-	3.40914	-
-	-	-	(0.061)	-	(0.070)	-
UK	F(1,55)	4.0162	2.35300	0.04144	0.68865	4.95456
-	-	-	(0.131)	(0.839)	(0.410)	(0.030)
JP	F(1,55)	4.0162	0.78281	0.37040	0.00002	0.72773
-	-	-	(0.380)	(0.545)	(0.996)	(0.397)
CN	F(1,56)	4.01297	0.92011	0.59097	0.75680	0.09353
-	-	-	(0.342)	(0.445)	(0.388)	(0.761)
CZ	F(2,55)	3.16499	1.95806	4.59723	0.59779	0.47253
-	-	-	(0.151)	(0.014)	(0.554)	(0.626)
HU	F(1,56)	4.01297	3.99728	0.07630	0.04179	2.82760
-	-	-	(0.050)	(0.783)	(0.839)	(0.098)
PL	F(2,55)	3.16499	0.55663	6.37082	0.08101	2.65687
-	-	-	(0.576)	(0.003)	(0.922)	(0.079)
SI	F(2,55)	3.16499	2.35668	6.05846	2.17366	1.85291
-	-	-	(0.104)	(0.004)	(0.123)	(0.166)
SK	F(1,56)	4.01297	6.21822	0.14444	1.44328	1.06542
-	-	-	(0.016)	(0.705)	(0.235)	(0.306)
BG	F(2,54)	3.16825	1.34741	0.61846	0.92060	0.74797
-	-	-	(0.269)	(0.543)	(0.404)	(0.478)
RO	F(2,55)	3.16499	0.09716	3.91042	0.56428	1.97560
-	-	-	(0.908)	(0.026)	(0.572)	(0.148)
HR	F(1,56)	4.01297	1.26964	5.97495	4.23664	9.37572
-	-	-	(0.265)	(0.018)	(0.044)	(0.003)
AL	F(2,55)	3.16499	0.42867	0.46565	0.41674	0.67887
-	-	-	(0.654)	(0.630)	(0.661)	(0.511)
RS	F(1,57)	4.00987	0.12692	0.13589	0.64095	0.74933
-	-	-	(0.723)	(0.714)	(0.427)	(0.390)
MD	F(1,56)	4.01297	0.44810	2.19501	1.20486	0.00564
-	-	-	(0.506)	(0.144)	(0.277)	(0.940)
LT	F(2,55)	3.16499	3.19002	1.25578	0.17428	1.83305
-	-	-	(0.049)	(0.293)	(0.841)	(0.170)
LV	F(2,55)	3.16499	0.12948	9.04428	1.00630	2.51195
-	-	-	(0.879)	(0.000)	(0.372)	(0.090)
EE	F(1,56)	4.01297	0.68916	0.03576	0.00108	0.91571
-	-	-	(0.410)	(0.851)	(0.974)	(0.343)
RU	F(2,55)	3.16499	4.24151	0.14361	2.60750	0.36841
-	-	-	(0.019)	(0.867)	(0.083)	(0.694)
UA	F(2,55)	3.16499	2.63835	0.35587	2.86326	0.04677
-	-	-	(0.081)	(0.702)	(0.066)	(0.954)

BY	F(3,54)	2.77576	0.97716	0.37060	1.98583	1.23803
-	-	-	(0.410)	(0.775)	(0.127)	(0.305)
GE	F(3,54)	2.77576	3.56617	1.86399	1.57789	2.52249
-	-	-	(0.020)	(0.147)	(0.205)	(0.067)
AM	F(1,56)	4.01297	4.40742	5.24995	0.37818	1.84421
-	-	-	(0.040)	(0.026)	(0.541)	(0.180)
AZ	F(1,57)	4.00987	0.01148	0.03189	0.27800	0.23942
-	-	-	(0.915)	(0.859)	(0.600)	(0.627)
MN	F(2,55)	3.16499	0.78759	0.20422	0.26778	1.37948
-	-	-	(0.460)	(0.816)	(0.766)	(0.260)
KG	F(1,56)	4.01297	0.80706	0.10154	0.72925	0.64975
-	-	-	(0.373)	(0.751)	(0.397)	(0.424)
TJ	F(2,55)	3.16499	1.00962	1.02990	0.49088	1.03101
-	-	-	(0.371)	(0.364)	(0.615)	(0.363)
AR	F(2,55)	3.16499	1.25351	1.08513	1.97427	0.76521
-	-	-	(0.294)	(0.345)	(0.149)	(0.470)
BR	F(1,56)	4.01297	0.75995	0.00676	0.03405	0.40630
-	-	-	(0.387)	(0.935)	(0.854)	(0.526)
CL	F(2,56)	3.16186	2.46626	1.15155	1.41692	0.62297
-	-	-	(0.094)	(0.324)	(0.251)	(0.540)
MX	F(2,54)	3.16825	0.77501	0.15740	1.00074	0.21843
-	-	-	(0.466)	(0.855)	(0.374)	(0.804)
PE	F(1,56)	4.01297	0.02324	0.01595	2.20966	0.47510
-	-	-	(0.879)	(0.900)	(0.143)	(0.493)
KR	F(1,55)	4.0162	3.42283	0.00000	0.01650	4.76902
-	-	-	(0.070)	(0.999)	(0.898)	(0.033)
PH	F(1,56)	4.01297	0.93767	1.12850	0.06377	0.13541
-	-	-	(0.337)	(0.293)	(0.802)	(0.714)
SG	F(1,56)	4.01297	1.07623	1.96508	0.64429	0.93103
-	-	-	(0.304)	(0.166)	(0.426)	(0.339)
TH	F(1,55)	4.0162	5.55020	2.86487	0.04479	0.52321
-	-	-	(0.022)	(0.096)	(0.833)	(0.473)
IN	F(1,56)	4.01297	3.29447	2.37544	1.37775	1.26074
-	-	-	(0.075)	(0.129)	(0.245)	(0.266)
ID	F(1,56)	4.01297	0.00083	1.31275	1.83449	0.67599
-	-	-	(0.977)	(0.257)	(0.181)	(0.414)
MY	F(1,55)	4.0162	0.42877	0.86653	0.78701	0.05229
-	-	-	(0.515)	(0.356)	(0.379)	(0.820)
AU	F(2,54)	3.16825	0.36304	0.06401	1.37374	0.48910
-	-	-	(0.697)	(0.938)	(0.262)	(0.616)
NZ	F(2,54)	3.16825	0.95963	0.53812	0.61638	0.92512
-	-	-	(0.389)	(0.587)	(0.544)	(0.403)
TR	F(1,56)	4.01297	0.91710	1.31130	0.40093	0.04006
-	-	-	(0.342)	(0.257)	(0.529)	(0.842)
EG	F(1,57)	4.00987	6.69551	1.32871	1.06253	11.53355

-	-	-	(0.012)	(0.254)	(0.307)	(0.001)
NG	F(1,56)	4.01297	0.03394	0.05435	1.70727	2.90764
-	-	-	(0.854)	(0.817)	(0.197)	(0.094)
SA	F(1,57)	4.00987	0.07958	0.22875	0.17318	0.00260
-	-	-	(0.779)	(0.634)	(0.679)	(0.960)
CA	F(1,55)	4.0162	2.85534	7.29358	2.26026	1.28618
-	-	-	(0.097)	(0.009)	(0.138)	(0.262)
CH	F(2,54)	3.16825	6.33325	1.19812	0.38082	7.54456
-	-	-	(0.003)	(0.310)	(0.685)	(0.001)
NO	F(2,54)	3.16825	1.07473	0.08114	0.25042	1.07754
-	-	-	(0.349)	(0.922)	(0.779)	(0.348)
SE	F(1,55)	4.0162	0.37969	0.69049	0.05593	0.02393
-	-	-	(0.540)	(0.410)	(0.814)	(0.878)
DK	F(3,53)	2.77911	0.94920	1.15182	1.29221	1.82517
-	-	-	(0.424)	(0.337)	(0.287)	(0.154)
IS	F(3,53)	2.77911	1.51577	2.24424	1.77417	4.26881
-	-	-	(0.221)	(0.094)	(0.163)	(0.009)

Note: Weak exogeneity test. P-values at 5% significance level in parentheses.
Source: Authors' calculations.

Table B.3: Serial autocorrelation test.

Country	*DoF*	*F-crit. (0.95)*	*y*	*Dp*	*rer*	*stir*	*ltir*	*poil*
EA	F(1,60)	4.00119	9.54841	8.14755	6.65700	0.15699	0.01742	-
-	-	-	(0.003)	(0.006)	(0.012)	(0.693)	(0.895)	-
US	F(1,62)	3.99589	29.66541	0.08317	-	21.18373	5.81331	2.43547
-	-	-	(0.000)	(0.774)	-	(0.000)	(0.019)	(0.124)
UK	F(1,60)	4.00119	20.38726	0.88512	5.32330	0.05681	8.81658	-
-	-	-	(0.000)	(0.351)	(0.025)	(0.812)	(0.004)	-
JP	F(1,60)	4.00119	0.11818	18.80690	1.51567	4.42996	0.16579	-
-	-	-	(0.732)	(0.000)	(0.223)	(0.040)	(0.685)	-
CN	F(1,60)	4.00119	9.10103	4.89257	2.80551	2.39136	-	-
-	-	-	(0.004)	(0.031)	(0.099)	(0.127)	-	-
CZ	F(1,59)	4.00398	0.02637	0.35914	3.35404	6.72358	-	-
-	-	-	(0.872)	(0.551)	(0.072)	(0.012)	-	-
HU	F(1,60)	4.00119	15.40696	1.13277	4.19465	4.38900	-	-
-	-	-	(0.000)	(0.291)	(0.045)	(0.040)	-	-
PL	F(1,59)	4.00398	0.36210	0.06816	1.01515	1.44023	-	-
-	-	-	(0.550)	(0.795)	(0.318)	(0.235)	-	-
SI	F(1,59)	4.00398	0.11372	0.78171	2.95243	0.88414	-	-
-	-	-	(0.737)	(0.380)	(0.091)	(0.351)	-	-
SK	F(1,61)	3.99849	0.05964	2.47305	2.97667	1.07308	-	-
-	-	-	(0.808)	(0.121)	(0.090)	(0.304)	-	-
BG	F(1,59)	4.00398	2.13353	1.21932	21.50645	0.61380	0.03424	-
-	-	-	(0.149)	(0.274)	(0.000)	(0.436)	(0.854)	-
RO	F(1,60)	4.00119	0.36946	0.45970	0.25542	0.20821	-	-
-	-	-	(0.546)	(0.500)	(0.615)	(0.650)	-	-
HR	F(1,60)	4.00119	0.05907	0.35171	3.31934	0.01557	-	-
-	-	-	(0.809)	(0.555)	(0.073)	(0.901)	-	-
AL	F(1,59)	4.00398	0.32533	0.43143	12.73369	0.00001	-	-
-	-	-	(0.571)	(0.514)	(0.001)	(0.998)	-	-
RS	F(1,61)	3.99849	1.03628	0.04042	0.10255	-	-	-
-	-	-	(0.313)	(0.841)	(0.750)	-	-	-
MD	F(1,60)	4.00119	24.28499	0.19531	1.67837	0.01560	-	-
-	-	-	(0.000)	(0.660)	(0.200)	(0.901)	-	-

LT	F(1,60)	4.00119	0.07250	0.15796	2.64269	0.00215	-	-
-	-	-	(0.789)	(0.692)	(0.109)	(0.963)	-	-
LV	F(1,59)	4.00398	3.45391	0.11939	6.14980	3.60590	-	-
-	-	-	(0.068)	(0.731)	(0.016)	(0.062)	-	-
EE	F(1,60)	4.00119	0.46254	0.31566	4.70003	0.09808	-	-
-	-	-	(0.499)	(0.576)	(0.034)	(0.755)	-	-
RU	F(1,60)	4.00119	0.85588	0.01125	5.50937	0.17262	-	-
-	-	-	(0.359)	(0.916)	(0.022)	(0.679)	-	-
UA	F(1,59)	4.00398	0.82343	0.06992	0.26450	0.05901	-	-
-	-	-	(0.368)	(0.792)	(0.609)	(0.809)	-	-
BY	F(1,58)	4.00687	7.25435	0.09144	0.44298	0.00301	-	-
-	-	-	(0.009)	(0.763)	(0.508)	(0.956)	-	-
GE	F(1,59)	4.00398	0.46932	0.03516	0.38889	0.00520	-	-
-	-	-	(0.496)	(0.852)	(0.535)	(0.943)	-	-
AM	F(1,61)	3.99849	82.47449	5.10349	5.38831	3.65830	-	-
-	-	-	(0.000)	(0.027)	(0.024)	(0.060)	-	-
AZ	F(1,60)	4.00119	217.70178	0.18319	2.62015	-	-	-
-	-	-	(0.000)	(0.670)	(0.111)	-	-	-
MN	F(1,59)	4.00398	3.84831	3.69444	5.69927	0.65224	-	-
-	-	-	(0.055)	(0.059)	(0.020)	(0.423)	-	-
KG	F(1,60)	4.00119	0.17996	3.38957	0.51417	0.67622	-	-
-	-	-	(0.673)	(0.071)	(0.476)	(0.414)	-	-
TJ	F(1,59)	4.00398	71.00536	0.00799	0.13116	1.60401	-	-
-	-	-	(0.000)	(0.929)	(0.719)	(0.210)	-	-
AR	F(1,60)	4.00119	2.30209	0.68333	5.68188	0.93154	-	-
-	-	-	(0.134)	(0.412)	(0.020)	(0.338)	-	-
BR	F(1,60)	4.00119	1.62774	0.11728	0.90347	4.38931	-	-
-	-	-	(0.207)	(0.733)	(0.346)	(0.040)	-	-
CL	F(1,59)	4.00398	0.45450	0.92837	4.47086	-	-	-
-	-	-	(0.503)	(0.339)	(0.039)	-	-	-
MX	F(1,60)	4.00119	3.28262	0.39554	0.97505	0.09152	0.26860	-
-	-	-	(0.075)	(0.532)	(0.327)	(0.763)	(0.606)	-
PE	F(1,60)	4.00119	4.70721	3.68226	3.67603	0.91657	-	-
-	-	-	(0.034)	(0.060)	(0.060)	(0.342)	-	-

KR	F(1,60)	4.00119	0.21125	0.32879	2.01956	4.91745	8.22326	-
-	-	-	(0.647)	(0.569)	(0.160)	(0.030)	(0.006)	-
PH	F(1,60)	4.00119	5.58439	6.10217	0.00173	1.18412	-	-
-	-	-	(0.021)	(0.016)	(0.967)	(0.281)	-	-
SG	F(1,61)	3.99849	2.04114	5.46891	1.20341	7.98401	-	-
-	-	-	(0.158)	(0.023)	(0.277)	(0.006)	-	-
TH	F(1,61)	3.99849	0.43707	0.04650	4.63933	9.39118	1.39122	-
-	-	-	(0.511)	(0.830)	(0.035)	(0.003)	(0.243)	-
IN	F(1,60)	4.00119	0.05522	0.83771	1.76432	1.97372	-	-
-	-	-	(0.815)	(0.364)	(0.189)	(0.165)	-	-
ID	F(1,61)	3.99849	5.83540	0.37519	3.31697	0.07976	-	-
-	-	-	(0.019)	(0.542)	(0.073)	(0.779)	-	-
MY	F(1,61)	3.99849	0.09108	3.13833	6.67933	0.09144	0.21369	-
-	-	-	(0.764)	(0.081)	(0.012)	(0.763)	(0.646)	-
AU	F(1,59)	4.00398	1.24787	0.75027	1.41422	1.54098	0.94825	-
-	-	-	(0.268)	(0.390)	(0.239)	(0.219)	(0.334)	-
NZ	F(1,60)	4.00119	2.48239	0.00723	5.70756	3.28745	0.19933	-
-	-	-	(0.120)	(0.933)	(0.020)	(0.075)	(0.657)	-
TR	F(1,60)	4.00119	0.54989	2.44480	0.06431	1.37171	-	-
-	-	-	(0.461)	(0.123)	(0.801)	(0.246)	-	-
EG	F(1,60)	4.00119	2.42758	0.00001	6.83578	-	-	-
-	-	-	(0.124)	(0.998)	(0.011)	-	-	-
NG	F(1,60)	4.00119	35.01954	6.67239	0.37814	4.03374	-	-
-	-	-	(0.000)	(0.012)	(0.541)	(0.049)	-	-
SA	F(1,60)	4.00119	61.77756	0.25091	0.26816	-	-	-
-	-	-	(0.000)	(0.618)	(0.606)	-	-	-
CA	F(1,60)	4.00119	1.24118	0.82877	1.77255	10.98086	3.17686	-
-	-	-	(0.270)	(0.366)	(0.188)	(0.002)	(0.080)	-
CH	F(1,59)	4.00398	5.24743	0.50777	0.03054	2.14604	0.02032	-
-	-	-	(0.026)	(0.479)	(0.862)	(0.148)	(0.887)	-
NO	F(1,59)	4.00398	19.67493	7.77609	0.04074	5.20441	2.28482	-
-	-	-	(0.000)	(0.007)	(0.841)	(0.026)	(0.136)	-
SE	F(1,60)	4.00119	2.87089	0.01845	5.09645	1.41885	15.18612	-
-	-	-	(0.095)	(0.892)	(0.028)	(0.238)	(0.000)	-

DK	F(1,58)	4.00687	3.83915	7.08498	0.98146	11.95102	0.44263	-
-	-	-	(0.055)	(0.010)	(0.326)	(0.001)	(0.508)	-
IS	F(1,58)	4.00687	1.39595	0.01835	0.12165	0.04167	0.02806	-
-	-	-	(0.242)	(0.893)	(0.729)	(0.839)	(0.868)	-

Note: Test for first order serial autocorrelation, p-values at 5% significance level in parentheses.
Source: Authors' calculations.

Appendix C – Shocks to the Real Exchange Rate

As a robustness check, we also model effects from a revaluation of the Chinese renminbi. The nominal exchange rate of the renminbi has appreciated over the sample period by about 20% versus the USD and by about 40% versus the euro. In the same period, the average annual growth rate of real output was close to 10%. There is an intense debate on whether the Chinese growth miracle was partially fueled by the undervalued renminbi and how large the potential undervaluation of the renminbi might be. While most of the empirical contributions suggest that the renminbi has been undervalued in recent years (Feng and Wu, 2008), others seem conclude the reverse (Cheung et al., 2007). Korhonen and Ritola (2011) provide a meta-analysis of studies on the renminbi's misalignment vis-à-vis its equilibrium value. They find that the renminbi may have been undervalued, especially against the dollar, but the degree of this undervaluation has decreased in recent years. In a recent contribution, Zhang and Sato (2012) show that the effect of a revaluation of the renminbi on China's trade balance is very limited. The trade balance in China seems to be largely determined by world demand.

On top of that, the literature on the direct impact of a renminbi revaluation on real output is scarce. Cheung et al. (2012) show that Chinese exports are well-behaved in the sense that they rise with foreign GDP and fall when the renminbi appreciates. However, imports often behave counterintuitively - responding positively to a depreciation of the renminbi and negatively to an increase in Chinese GDP. García Herrero and Koivu (2008) arrive at the same conclusion as to the link between imports and exchange rate, which they attribute to the special role of processing trade in China.

In the context of a GVAR model, the interpretation of currency shocks is notoriously difficult. Since there is no foreign counterpart of the real exchange rate variable that soaks up cross-country correlation in the system, cross-country residual correlations of the marginal models for real exchange rates are typically non-negligible[9]. Given these caveats and noting the backdrop of not having data on exports and imports available, we try to assess the impact of a Chinese revaluation with two different shocks.

Given that the nominal exchange rate (vs USD) has been broadly stable over the last few years (Zhang and Sato, 2012), we induce a small shock to the renminbi-USD cur-

[9] The mean of the average pair-wise cross-country correlations of the residuals from the marginal model for the real exchange rate is 0.2, standard deviation 0.13.

rency pair. The response of the Chinese economy to a 3% appreciation of the renminbi (deflated by national price levels) is as follows: In the first quarter, real activity ticks up by 1%, while in the long-run real output increases markedly, by 3%. Abstaining from a structural interpretation, we note that renminbi appreciation parallels an increase in the domestic short-term interest, while inflation declines sharply. The real exchange rate itself appreciates by 7.5% in the first year and by 10% in the long-run (after 5 years).

[FIGURE 5 TO BE INSERTED HERE]

The rise in Chinese output does not leave the other countries unaffected. The US and the euro area display increases in real output of close to 0.3 to 0.4%, while the increase for Japan is slightly more contained. Among emerging economies, Russia shows the largest response, with output edging up by close to 1% in the long-run. Real output in the CEE and the SEE region increases in the long-run by about 0.3%, while output in the CIS region is rather resilient to the shock. Consistent with our previous findings examining the positive shock to Chinese real output, the response of Asian countries is somewhat negative. Taken at face value, these results would suggest that a sizeable exchange rate appreciation in China would be welfare-enhancing for almost everyone in the global economy. However, the problems mentioned above (e.g. Cheung et al. (2012) and García Herrero and Koivu (2008)) regarding exchange rate, imports and GDP in China are almost certainly affecting our empirical results.

Lastly, we also implemented a renminbi revaluation shock from a European perspective, to gain a better understanding of the issue at hand. For that purpose we carried out a 10% depreciation shock to the euro (deflated by national price levels) vis-à-vis the USD. The size of the shock was calibrated to match the long-run appreciation of the renminbi carried out in scenario 3 above. In fact, the 10% depreciation of the euro (on impact) translates to a permanent 10% depreciation of the euro versus the USD in real terms. If we assume that the renminbi remains tightly linked to the USD, this translates to a 10% appreciation of the real exchange rate of China versus the euro in the long-run.

[FIGURE 6 TO BE INSERTED HERE]

A 10% depreciation of the real euro rate against the USD results in an increase in euro area output of 0.4% in the long-run. For Russia, Japan and the US the effect lies in the range of 0.1% to 0.4%. Chinese GDP is more strongly affected by a bilateral currency appreciation of the renminbi vis-à-vis the euro, with the impact being around -0.2% in the first four quarters, converging to -0.4% in the long-run. This shows that the exchange rate does play a large role in the open Chinese economy.

The SEE and CIS countries show the expected negative response to a depreciation of the euro, while the CEE countries show a positive response. That is, the euro area's increase in output spreads to the CEE region, thus outweighing the loss of competitiveness for the region due to the real depreciation of the euro. The Latin American region seems to benefit from a depreciation of the euro, which again might be attributed to the particular time period of our sample. In particular, the Mexican economy. which is by far the region's largest country in terms of economic activity, reacts strongly to foreign GDP. This strong reaction might have been reinforced by the fact that the economic crisis hit the US, Mexico and the euro area in a highly synchronized manner, while the other Latin American countries have been more resilient. That is, this general strong reaction of Mexico to foreign GDP, which is reinforced by an increase in US GDP as a consequence of the euro depreciation, might explain the positive response of the Latin American regional aggregate to a depreciation of the euro.

Comparing these two exchange rate shocks, it is clear that China's exchange rate policy has a decisive influence on the shock transmission. Also the problems regarding the link between imports and exchange rate mentioned earlier will have an effect on our estimations as well.

As the renminbi has been linked to the US dollar in one way or another practically throughout the sample period, the effects from euro shock may be more indicative of a shock e.g. to China's real effective exchange rate, especially since the euro area has been China's most important trading partner for most of that time.[10] By contrast, the shock to the euro has a more structural interpretation, which is reflected in the clear and predicted effect on Chinese output.

[10] Moreover, overall residual correlation in the euro area country model is much smaller than in the China model, where especially the real exchange rate is strongly correlated with inflation. This might blur the interpretation of the exchange rate shock that emanates from the China model.

Table B.4 ADF test in levels

	EA	US	UK	JP	CN	CZ	HU	PL	SI	SK	BG	RO	HR	AL	RS	MD	LT	Nr. > CV
	-0.874	-1.292	0.369	-1.732	-3.11	-2.185	-0.179	-2.168	0.637	-1.256	-0.747	-2.771	0.44	-2.165	-1.385	-2.288	-0.829	0
	-3.078	-2.874	-0.841	-3.119	-3.213	-2.725	-3.121	-2.835	-1.836	-2.029	-2.415	-1.565	-3.015	-3.314	-2.656	-2.544	-4.621	7
	-2.152	-	-2.093	-1.75	-0.69	-1.993	-1.827	-1.999	-2.049	-2.101	-2.716	-1.897	-1.941	-1.725	-2.425	-2.229	-1.875	0
	-1.344	-1.462	-1.035	-2.36	-5.082	-1.469	-2.93	-1.339	-2.83	-1.145	-2.011	-0.994	-5.047	-2.002	-	-2.063	-5.172	4
	-3.119	-1.557	-1.561	-2.998	-	-	-	-	-	-	-3.283	-	-	-	-	-	-	3
	-2.083	-2.576	-1.808	-2.164	-1.841	-1.921	-1.719	-1.205	-1.064	-1.297	-1.049	-1.178	-1.879	-2.364	-1.118	-1.233	-1.84	0
	-1.621	-1.89	-1.626	-1.732	-2.18	-1.829	-2.602	-2.314	-1.968	-3.089	-2.445	-2.424	-2.338	-1.83	-1.526	-2.615	-2.992	2
	-1.972	-1.626	-2.968	-2.634	-2.45	-3.113	-3.141	-3.074	-3.084	-3.16	-3.156	-3.16	-3.086	-3.229	-3.652	-3.959	-3.01	13
	LV	EE	RU	UA	BY	GE	AM	AZ	MN	KG	TJ	AR	BR	CL	MX	PE	KR	Nr. > CV
	-0.871	-1.369	-1.898	-1.35	-1.781	-1.994	-1.482	-1.76	-1.948	-2.625	-0.597	-1.126	-1.004	-1.92	-1.917	-0.625	-2.184	0
	-3.613	-5.223	-2.468	-3.608	-1.196	-4.3	-4.178	-2.134	-3.085	-2.676	-9.313	-2.116	-2.926	-2.794	-3.754	-2.764	-3.131	10
	-2.009	-2.041	-2.429	-2.62	-2.324	-1.986	-1.816	-2.019	-1.461	-2.046	-2.682	-1.516	-1.152	-1.339	-2.379	-0.959	-2.586	0
	-6.448	-2.693	-3.519	-2.087	-1.95	-4.603	-4.508	-	-4.227	-2.189	-2.341	-3.084	-2.65	-	-2.205	-1.352	-1.386	6
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-1.599	-	-1.354	0
	-2.104	-1.136	-1.822	-1.735	-1.629	-2.13	-1.866	-2.021	-1.915	-0.535	-0.857	-1.275	-1.773	-1.059	-1.354	-2.467	-1.736	0
	-3.207	-2.866	-2.072	-3.115	-3.288	-2.767	-3.544	-2.787	-3.607	-3.307	-2.389	-2.27	-2.162	-1.753	-1.258	-1.455	-1.92	6
	-2.929	-2.899	-3.097	-3.291	-2.973	-4.468	-3.328	-4.097	-1.527	-2.391	-2.89	-3.115	-2.796	-2.269	-1.774	-2.797	-2.521	8
	PH	SG	TH	IN	ID	MY	AU	NZ	TR	EG	NG	SA	CA	CH	NO	SE		Nr. > CV
	-1.452	-1.606	-1.903	-1.213	-1.836	-2.305	0.138	0.05	-1.645	-1.231	-2.432	-1.661	-1.024	-1.791	-1.373	-1.573	-	0
	-3.249	-2.109	-2.779	-2.141	-2.402	-3.099	-2.705	-3.204	-1.068	-1.369	-3.989	-1.139	-3.346	-3.065	-4.371	-2.769	-	7
	-1.472	-1.012	-2.104	-1.461	-2.769	-2.059	-1.771	-2.105	-2.074	-1.346	-1.774	0.422	-1.982	-2.462	-2.095	-2.092	-	0
	-1.124	-1.474	-1.788	-4.429	-2.687	-2.164	-2.919	-1.355	-1.027	-	-2.079	-	-1.785	-2.489	-2.118	-2.743	-	2
	-	-	-1.571	-	-	-1.209	-3.123	-1.234	-	-	-	-	-1.401	-0.883	-0.755	-2.266	-	1
	-2.738	-2.25	-2.075	-2.042	-1.953	-1.896	-1.645	-2.742	-2.09	-2.543	-3.067	-2.209	-1.771	-1.271	-1.006	-1.196	-	0
	-1.33	-2.027	-1.54	-2.125	-1.857	-1.543	-1.63	-2.017	-2.686	-1.741	-1.711	-2.019	-1.425	-1.46	-1.582	-1.438	-	0
	-2.289	-2.637	-2.199	-2.68	-2.772	-2.467	-2.437	-2.657	-3.135	-2.989	-2.498	-2.807	-1.974	-3.131	-2.752	-2.733	-	3
*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-2.389	0

Note: ADF tests on variables in levels. T-statistics reported. The regressions for all variables except interest rates and inflation together with its foreign counterparts contain a constant and a trend term. ADF tests for interest rates and inflation are based on a constant in the ADF regression only. The 5% critical value of the ADF statistic including trend and intercept is -3.47, the one without trend is -2.91.
Source: Authors' calculations.

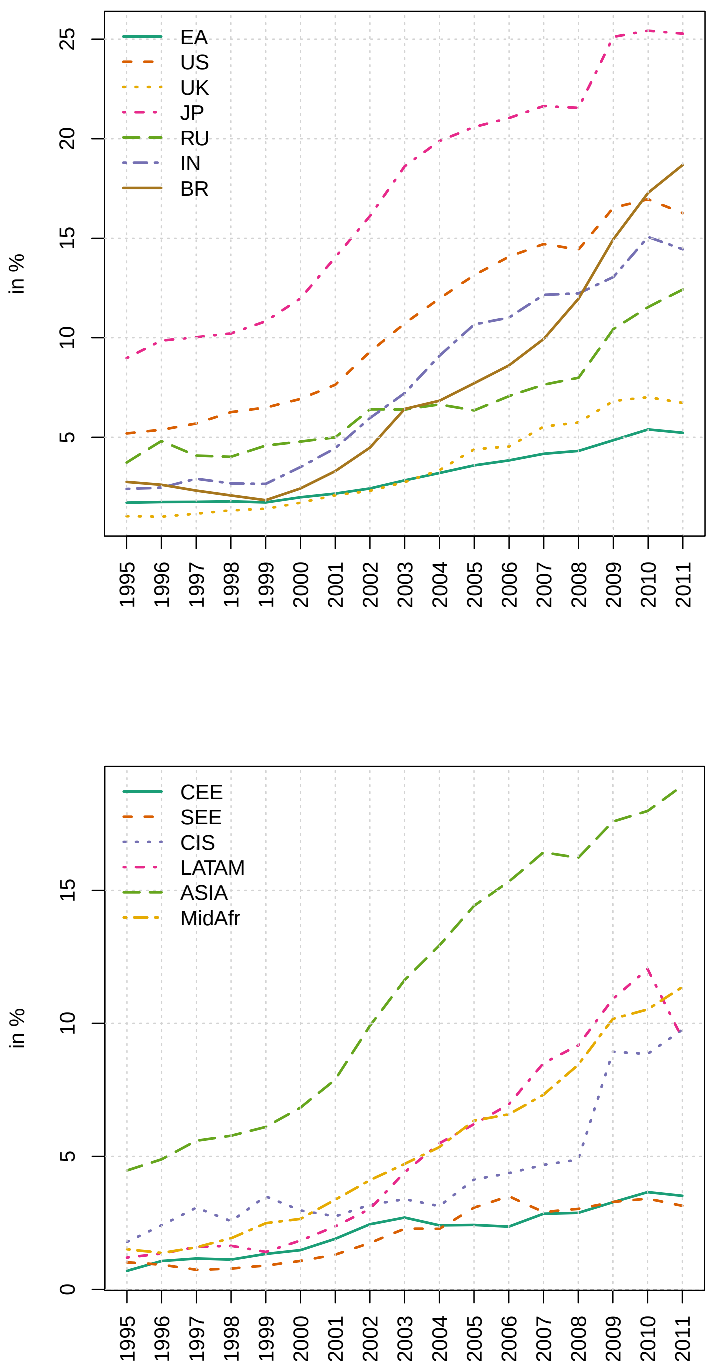
Table B.5 ADF test in first differences

	EA	US	UK	JP	CN	CZ	HU	PL	SI	SK	BG	RO	HR	AL	RS	MD	LT	Nr. > CV
	-2.391	-2.313	-1.838	-3.912	-3.174	-2.253	-2.086	-4.113	-2.049	-2.88	-2.903	-2.55	-3.138	-3.973	-4.08	-1.764	-3.112	7
p	-5.774	-6.152	-7.209	-6.435	-4.304	-6.663	-4.751	-5.115	-6.047	-6.829	-5.32	-4.911	-5.659	-4.167	-4.542	-4.615	-4.845	17
r	-2.876	-	-3.138	-2.704	-2.186	-3.504	-3.096	-3.919	-2.919	-2.403	-4.272	-3.636	-2.763	-3.599	-4.415	-3.218	-3.517	11
ir	-3.476	-3.419	-3.856	-3.719	-2.822	-2.846	-4.045	-4.458	-4.13	-2.816	-4.871	-4.258	-4.309	-4.367	-	-4.277	-2.158	12
ir	-3.017	-3.38	-3.248	-4.1	-	-	-	-	-	-	-3.676	-	-	-	-	-	-	5
*	-3.69	-3.687	-2.977	-4.328	-3.357	-3.318	-3.293	-2.772	-2.868	-3.116	-3.405	-3.049	-3.396	-3.312	-3.356	-3.259	-3.282	15
ir*	-4.447	-4.595	-4.05	-4.626	-3.746	-4.366	-3.992	-4.249	-4.08	-4.481	-4.755	-4.72	-4.071	-4.288	-5.143	-4.633	-5.014	17
ir*	-3.336	-5.484	-3.268	-3.983	-4.488	-2.994	-3.037	-3.125	-3.008	-2.911	-3.154	-2.738	-2.986	-1.851	-7.439	-1.309	-2.895	13
	LV	EE	RU	UA	BY	GE	AM	AZ	MN	KG	TJ	AR	BR	CL	MX	PE	KR	Nr. > CV
	-2.49	-2.642	-2.935	-2.531	-4.589	-3.958	-1.592	-1.296	-3.358	-4.234	-2.665	-2.252	-3.471	-3.324	-3.273	-3.003	-3.996	10
p	-4.69	-5.8	-5.049	-5.283	-4.485	-5.415	-8.149	-6.359	-4.498	-5.523	-7.129	-4.718	-4.648	-5.191	-5.651	-5.361	-5.89	17
r	-2.97	-3.381	-3.475	-3.404	-3.525	-3.888	-3.619	-1.962	-4.925	-3.652	-7.554	-3.484	-3.083	-3.683	-3.492	-2.848	-3.6	15
ir	-3.382	-3.82	-4.846	-3.821	-4.3	-5.61	-4.444	-	-4.223	-4.282	-2.911	-4.631	-4.942	-	-4.154	-5.693	-3.488	15
ir	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-6.562	-	-4.913	2
*	-3.5	-3.076	-3.377	-3.367	-2.898	-3.832	-4.324	-2.825	-3.473	-3.822	-2.177	-3.62	-4.078	-3.618	-3.266	-3.634	-4.019	14
ir*	-4.706	-4.814	-3.645	-4.821	-4.841	-5.41	-5.143	-4.668	-4.836	-5.304	-5.046	-5.119	-3.806	-3.861	-3.66	-4.022	-3.776	17
ir*	-2.897	-3.071	-2.713	-2.051	-2.636	-1.617	-3.887	-2.66	-5.041	-5.642	-2.902	-3.269	-3.419	-4.141	-3.431	-3.544	-3.732	10
	PH	SG	TH	IN	ID	MY	AU	NZ	TR	EG	NG	SA	CA	CH	NO	SE		Nr. > CV
	-3.062	-4.061	-2.186	-2.608	-2.279	-3.849	-2.567	-2.806	-3.581	-3.328	-1.285	-1.913	-2.11	-2.534	-3.454	-4.049	-	7
p	-5.531	-5.99	-6.518	-7.225	-4.677	-5.873	-5.773	-6.533	-6.224	-5.737	-5.265	-5.876	-6.796	-6.558	-7.138	-5.935	-	16
r	-3.717	-2.804	-3.684	-3.435	-3.788	-3.44	-3.336	-3.107	-3.528	-2.011	-3.434	-1.159	-4.182	-3.225	-3.721	-3.126	-	13
ir	-4.869	-3.686	-4.423	-5.552	-4.73	-4.035	-3.877	-4.148	-5.361	-	-4.32	-	-3.844	-2.771	-3.538	-3.669	-	13
ir	-	-	-4.837	-	-	-4.021	-3.43	-5.26	-	-	-	-	-2.87	-3.805	-2.926	-3.326	-	7
*	-4.167	-4.05	-3.97	-4.223	-4.012	-3.663	-4.936	-4.512	-3.168	-3.444	-4.171	-4.521	-2.821	-2.916	-2.881	-2.921	-	14
ir*	-4.609	-4.594	-4.121	-3.763	-4.273	-4.371	-4.81	-4.413	-5.129	-4.609	-3.978	-4.359	-3.751	-4.014	-4.093	-3.979	-	16
ir*	-4.497	-4.73	-4.286	-3.681	-4.955	-4.636	-4.51	-3.842	-2.786	-3.313	-3.359	-4.198	-3.355	-3.196	-3.107	-3.027	-	15
oil**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-3.321	11

Note: ADF tests on variables in first differences. T-statistics reported. The regressions for all variables contain a constant term in the ADF regression only. The 5% critical value of the ADF statistic including trend and intercept is -3.48, that without trend is -2.91.
Source: Authors' calculations

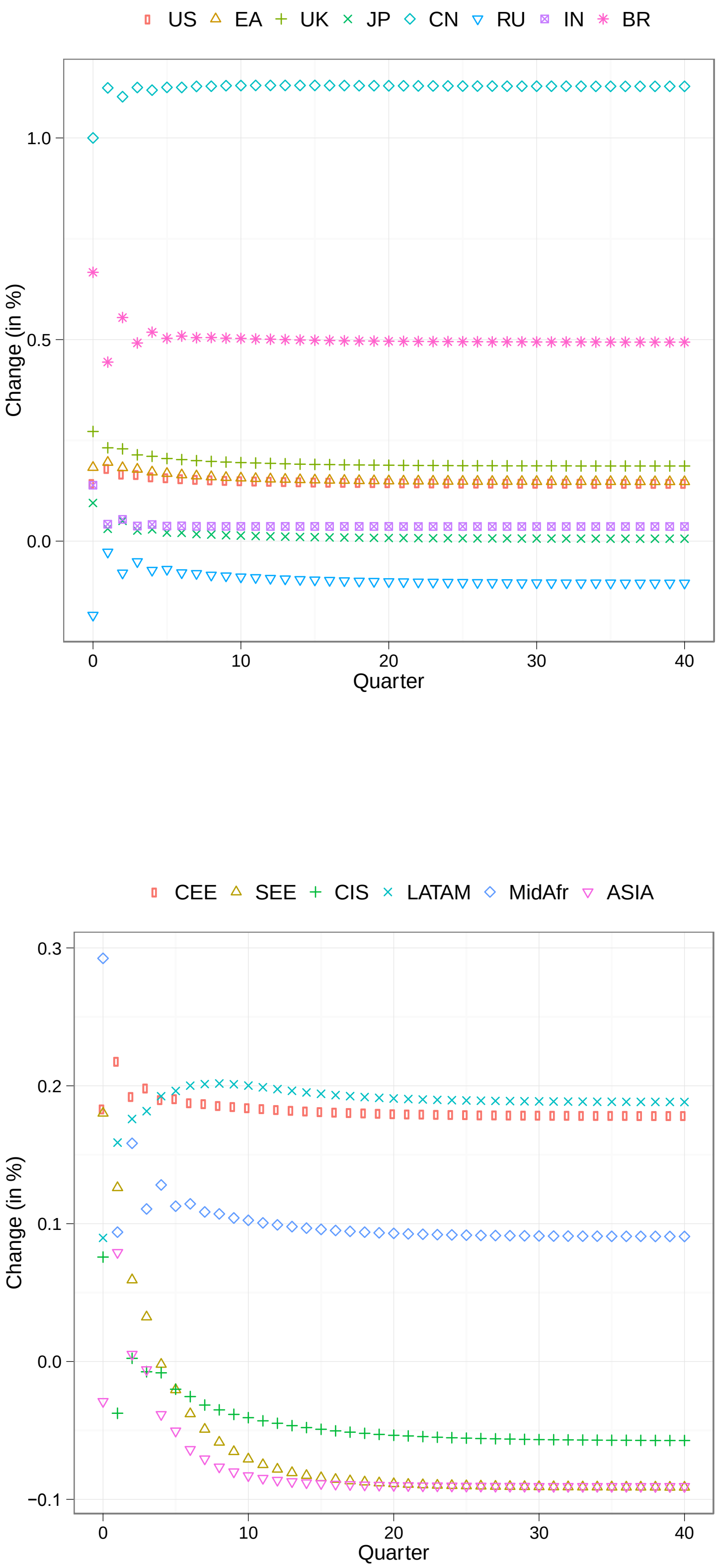
Appendix D – Figures

Figure 1: Country shares in China's total trade, %



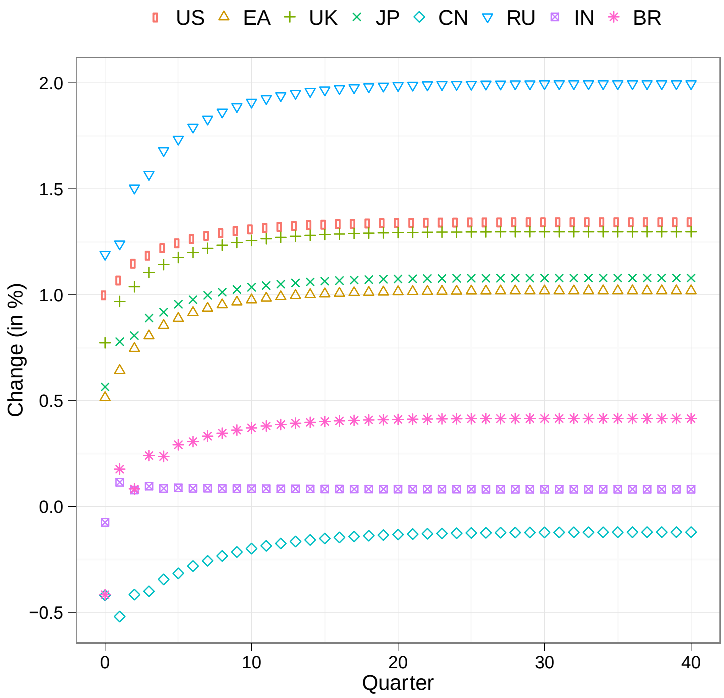
Source: Authors' calculations.

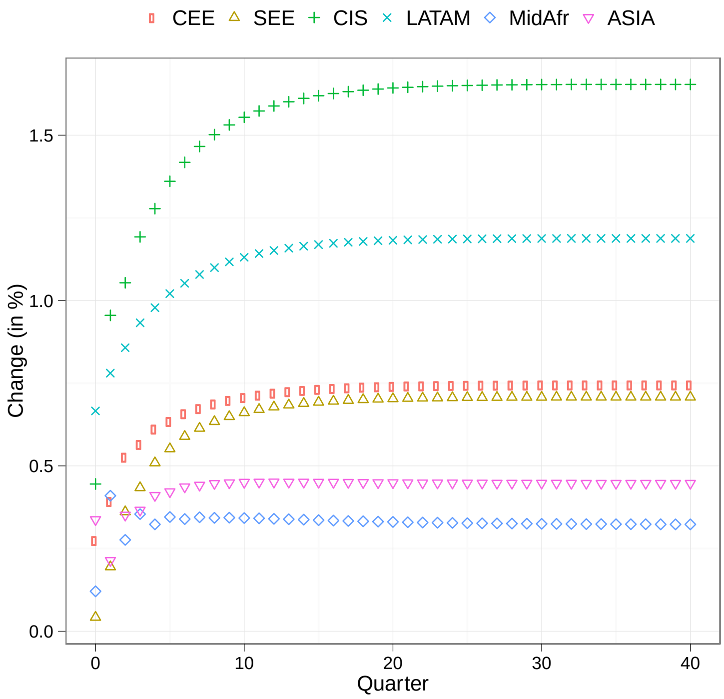
Figure 2: Country-output impact responses to 1% positive shock to Chinese output



Source: Authors' calculations.

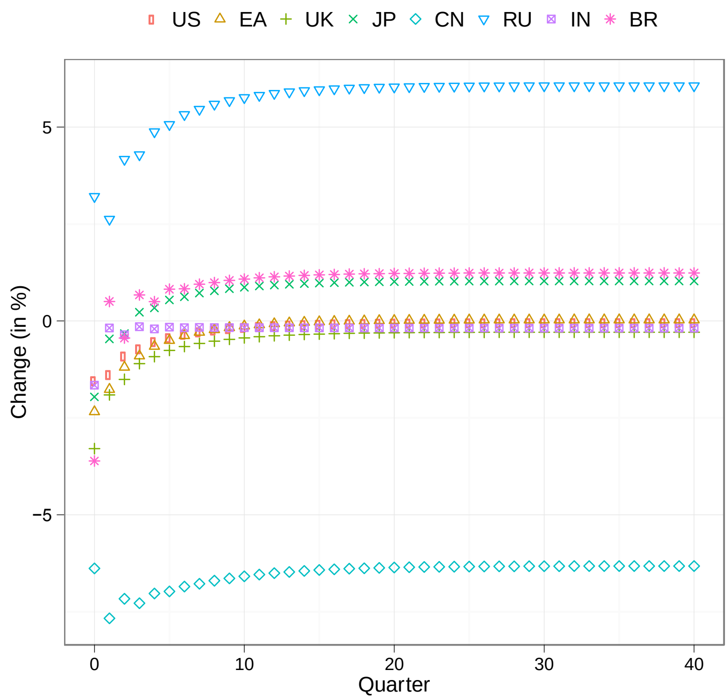
Figure 3: Country-output impact responses to positive 1% shock to US Output

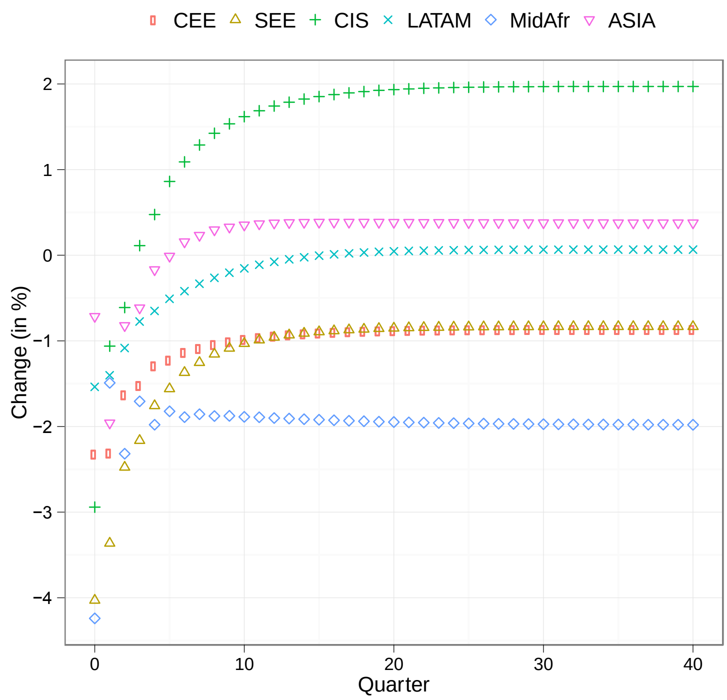




Source: Authors' calculations.

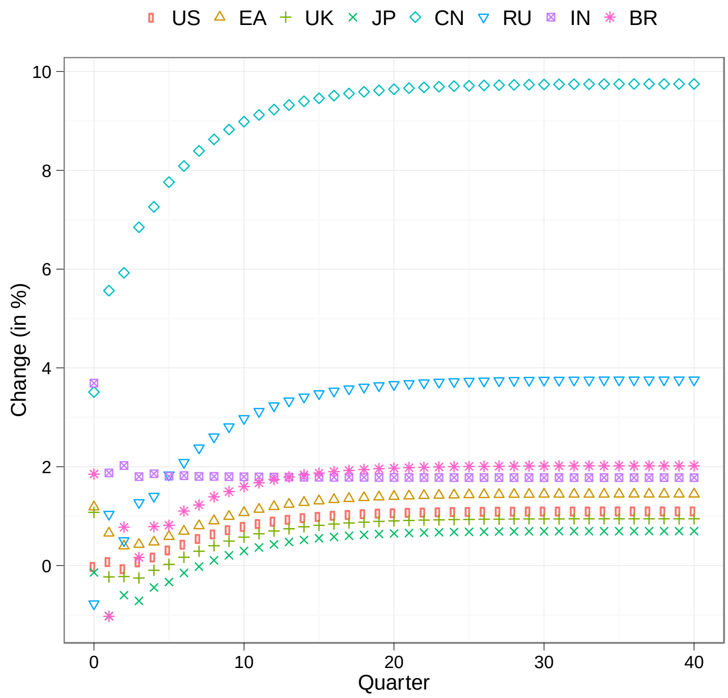
Figure 4: Country-output impact responses to 50% hike in oil price

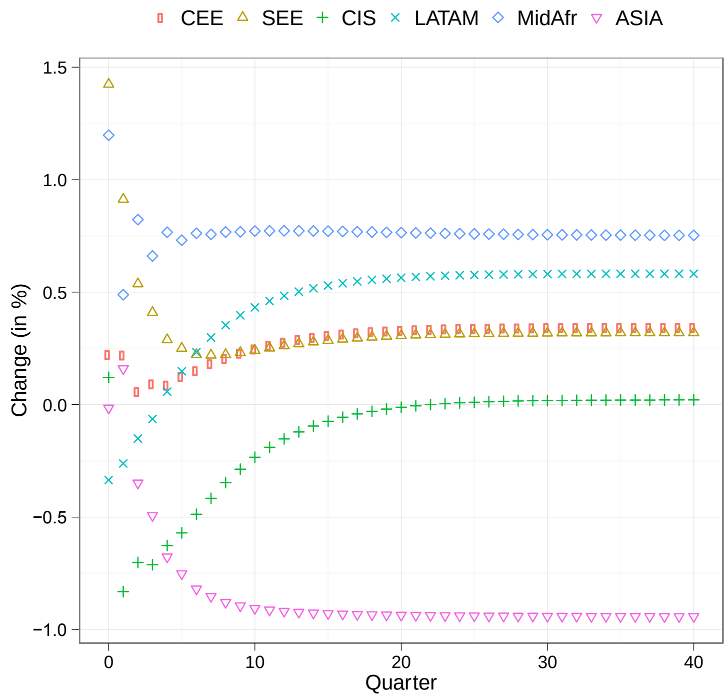




Source: Authors' calculations.

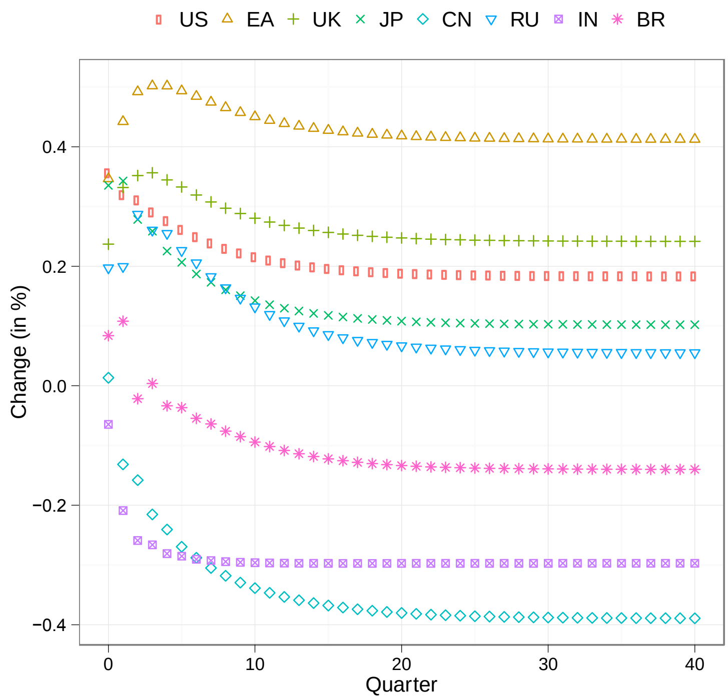
Figure 5: Country-output impact responses to 3% renminbi appreciation vs USD

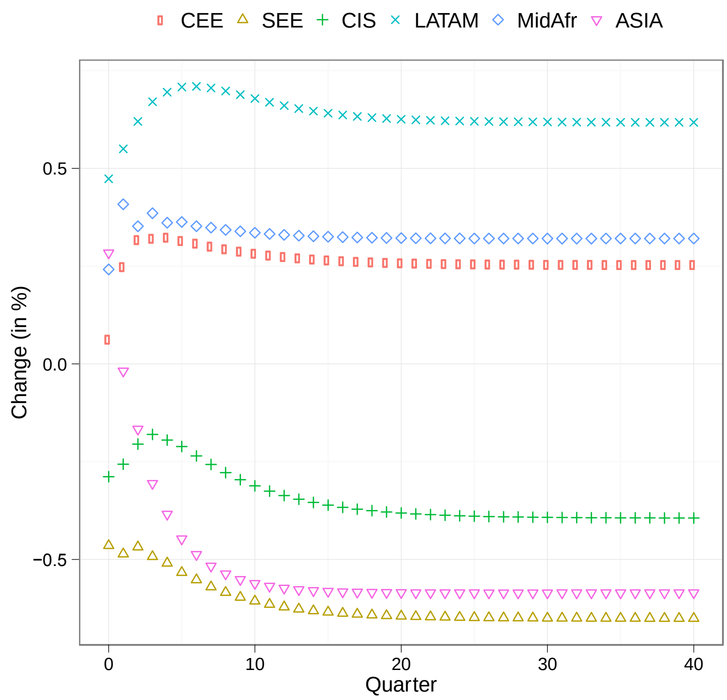




Source: Authors' calculations.

Figure 6: Country-output impact responses to 10% euro depreciation vs USD





Source: Authors' calculations.

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