The Transmission of International Shocks to CIS Economies: A Global VAR Approach

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April 2017

Draft Working Paper‡

Abstract

This paper studies the propagation of international shocks across countries taking into account cross-country linkages with particular attention on the implications for the Commonwealth of Independent States (CIS). We employ a Global Vector Auto Regressive (GVAR) framework and study the response of CIS economies to foreign real output shocks. We find that EA and US remain playing a dominant role for the CIS. Nevertheless, China and Russia have a sufficient impact on the region and may amplify regional response to foreign shocks. In addition, our analysis suggests that the sensitivity of the CIS as well as other economies to EA shock has increased since the global crisis which can be explained by structural changes in the global trade composition and reorientation of international trade to a more vulnerable emerging economies.

Keywords: international shocks, cross-country spillovers, CIS, Global VAR.

JEL codes: C32, F42, F43, E32

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‡ Work in progress – do not quote.

1. Introduction

After the breakup of Soviet Union, a number of newly minted economies have emerged on the global arena. Most of these countries formed a Commonwealth of Independent States (CIS) aimed to serve as a platform for coordination of regional economic and political developments. Over recent decades, an increasing integration to global economy has raised a set of concerns related to the vulnerability of CIS economies to international shocks. Moving from central planning towards market economies and following the liberalization of financial flows together with higher degree of openness, most of CIS countries experienced hard periods of economic slowdown, hyperinflation, as well as considerable volatility due to changing external environment. Although significant structural changes in domestic economies and global integration resulted in the development of a set of heterogeneous emerging economies with specific features, CIS countries are still deeply interrelated due to economical, geographical and political issues. In this respect, international shocks faced by individual country in the region may be amplified though various spillover channels. A special attention here should be drawn to the role of Russian Federation – the largest oil-driven economy in the region. Following a recent recession in Russia, induced by dramatic decline in oil prices, most of CIS economies also experienced macroeconomic turbulence and economic slowdowns which may indicate the dominant role of Russian Federation in the region. Hence, the multilateral perspective, which takes into account cross-country linkages, is crucial in analyzing the response of CIS economies to international shocks.

The literature which studies the transmission of foreign shocks to CIS economies considering cross-country spillovers is growing. Comunale & Simola (2016) find that spillovers and common factors appear to be important for the consumer price development of the CIS countries. Moreover, Dreger & Fidmuc (2011) argue that regional shocks within CIS countries have become more important than global shocks. Faryna (2016) also provides some evidence of bilateral spillover effects between certain CIS countries.

The global and regional interdependencies of CIS economies have been recently empirically studied within the Global Vector Auto Regressive (GVAR)

framework. Feldkircher (2013) employs a GVAR model, which comprises 43 countries, and studies the transmission of the US and EU shocks as well as oil price shocks to Central, Eastern and Southeastern Europe (CESEE) and CIS. The author also supports the importance of regional interdependencies within CIS and argues that the effect of oil price hikes for oil-importing countries in the region is compensated by economic expansion in Russia. In addition to important regional interdependencies and linkages to major developed economies, CIS countries are closely connected to other emerging world. A growing importance of Chinese economy in the globe has also increased its role for CIS region. Feldkircher and Korhonen (2012) study the transmission of Chinese shocks to the rest of the world. Their findings based on the GVAR models suggest that 1% shock to Chinese real output transmits to about 0.2% rise in output of CIS countries.

Although existing studies provide strong evidence on the importance of global and regional linkages of CIS, the transmission of Russian-specific shocks across other CIS economies requires additional analysis. Therefore, in our paper, we follow the approach similar to Feldkircher (2013) and Feldkircher and Korhonen (2012) and employ a Global VAR model in order to examine the extent to which CIS economies respond to global as well as regional shocks taking into account cross-country linkages. In particular, we focus on studying the response of CIS's real economies to output shocks in the US, euro area, China, and Russian Federation. We extend our analysis and study the relative importance of the Russian economy for other CIS countries. In addition, given that global and regional trade composition has changed dramatically since the crisis of 2007-2008, we explore how structural changes in trade relationships affected the long run sensitivity of CIS to internal shocks. Lastly, our analysis contributes to existing literature by using an updated dataset which includes recent period of Russian recession.

The rest of the paper proceeds as follows. ***Section 2*** provides analytical framework. Results can be found in the ***3rd section***. ***Section 4*** concludes.

2. Analytical Framework

In this section, we describe analytical framework used for studying the transmission of international shocks to CIS economies from the global perspective. In addition, we explore data properties and outline model specification.

Given that CIS economies are closely linked with each other as well as integrated to the rest of the world, our analysis requires a tool which explicitly takes into account cross-unit interdependencies. One way of examining economic issues in the interdependent world is the development of Panel VAR (PVAR) models being considered as a powerful tool to study the transmission of shocks across units[1]. Complexity of panel VARs generates several estimation problems related to the dimensionality[2] and shock identification[3] issues. Thus, empirical literature usually does not utilize all distinguishing features of PVARs simultaneously. In particular, a Global VAR model provides a practical macroeconomic framework which accounts for cross-country interdependencies while maintaining a simple structure and dealing with dimensionality problems. Chudik and Pesaran (2016) provide a comprehensive survey of GVAR modeling examining both the theoretical foundations of the approach and its numerous empirical applications.

2.1. The Global VAR approach

We follow the GVAR approach presented in Pesaran, Schuermann and Weiner (2004), and further developed in D´ees, di Mauro, Pesaran and Smith (2007, hereafter DdPS)[4]. DdPS model has become a starting point for various

[1] For further discussion on Panel VAR and its practical implications see Canova & Ciccarelli (2013).

[2] This problem may arise as the number of endogenous variables may easily exceed the number of observations.

[3] As argued by Galesi & Lombardi (2009), given that in a multi-country panel VAR setting there is not a clear economical *a priori* knowledge which can establish a reasonable ordering of the countries for shock orthogonalization.

[4] For the technical procedure of model estimation, we use an open source Matlab toolbox for modeling DdPS-GVAR provided by Smith, L.V. and A. Galesi (2014).

studies[5] which deal with GVAR models. The model is usually elaborated by composing a set of individual VAR models representing each N country in the panel. Each individual model includes domestic endogenous variables as well as weakly exogenous foreign and global variables. This implies the following structure of VARX*(p_i, q_i)[6] model:

$$\Phi_i(L, p_i)x_{it} = a_{i0} + \Lambda_i(L, q_i)x_{it}^* + \Psi_i(L, q_i)d_t + u_{it},$$

for $i = 1, 2, 3, \dots, N$ and $t = 1, \dots, T$, where x_{it} is a set of country specific variables (domestic) and $\Phi_i(L, p_i)$ is the matrix lag polynomial of related coefficients; a_{i0} is a $k_i \times 1$ vector of fixed intercepts; x_{it}^* is a set of foreign-specific variables and $\Lambda_i(L, q_i)$ is the matrix lag polynomial of the associated coefficients; d_t is a set of common global variables and $\Psi_i(L, q_i)$ is the matrix lag polynomial of the associated coefficients; u_{it} is a $k_i \times 1$ vector of idiosyncratic, serially uncorrelated country-specific shocks with $u_{it} \sim iid(0, \sum_{ii})$.

The lag order of p_i is associated with domestic variables and may differ for each i. For foreign-specific and global variables the lag order is determined by q_i. For each country i, p_i and q_i are chosen by minimizing the Akaike information criterion (AIC) with the assumption that $p_i \geq q_i$ in order to ensure the relative importance of domestic variables. Recent studies which utilize GVAR framework find that cross-country data share common stochastic trend and, hence, including cointegration relationships in each individual model is required. This, in turn, results in the estimation of a set of individual vector error correction models with weakly exogenous components (VECMX*). In this type of models, weakly exogenous variables are included to the cointegration equation which allows to account for the log-run relationships between domestic variables and their foreign counterparts.

A set of domestic variables x_{it} typically includes inflation, real output, real exchange rate, nominal short-term interest rate, and other key macroeconomic indicators (see for example Pesaran, Schuermann and Weiner, 2004; DdPS, 2007). Global variables usually include oil prices or/and prices for other commodities. A

[5] See, for example Galesi & Lombardi (2009), Harahap et. al (2016), Feldkircher (2013).

[6] VARX* framework with weakly exogenous I (1) regressors have been developed by Harbo et al. (1998) and Pesaran et al. (2000).

set of foreign specific variables x_{it}^{*} are constructed by weighting corresponding domestic variables of other countries in the panel. More specifically, each foreign-specific variable for individual country is a weighted average of domestic variables of other countries:

$$x_{it}^{*} = \sum_{j=1}^{N} \omega_{ij} x_{it}$$

where $j = 1, 2, 3, \dots, N$; ω_{ij} is a set of weights such that $\sum_{j=1}^{N} \omega_{ij} = 1$ which are typically based on the bilateral trade flows across countries in the panel.

After the estimation of individual country-specific VECMX* models they are linked through weight matrix and then combined in a GVAR model. Weight matrix $\mathcal{W}$ comprises individual sets of weights ω_{ij} and represents the strength of cross-country relationships. Existing studies provide two ways of constructing weight matrix: fixed or time-varying. Fixed-weight matrix is constructed using the data for cross-country weights for specific year or a period average. In this respect, weights are constant for the entire period of the estimation. On the contrary, time-varying matrix comprises a set of weight matrices computed for each period of the dataset which enables to capture structural changes in cross-country relationships. The assumption of constant weights might be too restrictive for CIS economies given that their international trade composition varies over time which can affect the robustness of results. In addition, trade composition of major developed economies has changed for recent years resulting in the growing importance with China and other emerging world. Hence, we use time-varying weights for each specific period and analyze how structural changes in trade composition affect the propagation of foreign output shocks to specific countries.

Thereafter, estimated GVAR model can be used to compute Generalized Impulse Response Functions (GIRFs) taking into account important interdependencies across countries as in Pesaran and Shin (1998). GIRFs are insensitive to ordering of variables and, hence, are not use for the identification of structural shocks in the VAR model. However, the GVAR framework incorporates the weak exogeneity assumption which allows the identification of country-specific shocks given that cross-country residual correlation as well as country-specific serial residual correlation is low.

2.2. The Data

In this paper, we employ the GVAR model which includes 8 CIS economies: Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyz Republic, Moldova, Russian Federation, and Ukraine.[7] In addition, we include 28 other developed, developing, and emerging economies: United States, euro area (modeled as a single region), Australia, Brazil, Bulgaria, Canada, Chile, China, Czech Republic, Denmark, Hungary, Iceland, India, Indonesia, Japan, Kazakhstan, Korea, Malaysia, Mexico, New Zealand, Norway, Peru, Philippines, Poland, Romania, Singapore, Sweden, Turkey, and United Kingdom. Therefore, the total number of cross-section units in the GVAR model is 36 which covers about 81% of the world PPP-GDP according to the World Bank database.[8]

Each individual county model includes four domestic variables: consumer inflation, real output, nominal short-term interest rate, and real exchange rate. Our dataset covers the period 2001Q1 – 2016Q2 with 62 quarterly observations. The time span for the analysis includes periods of the global crisis in 2007-2008 and recent recession in CIS economies. A starting point was chosen due to the data limitations for CIS economies. Most of the country data was taken from the IMF IFS database. Similar to Feldkircher (2013), we use regional aggregates for the euro area from the IMF IFS calculated on the rolling basis.

For the *real output* (y) we use logarithms of seasonally adjusted real GDP $y = \ln(GDP_t)$ indexed to annual average of 2005=100. The data for the euro area, United States, Australia, Japan, Mexico, Canada, New Zealand, and United Kingdom has been already taken in real terms and seasonally adjusted from the IMF IFS. The data for real GDP for Ukraine and Singapore comes from national sources. For Moldova, Kazakhstan, and Azerbaijan nominal GDP has been converted to real terms using consumer price index and seasonally adjusted using

[7] Note: Ukraine and Georgia are not official members of CIS. Nevertheless, we include these two countries as they might be deeply interrelated with other official members of CIS.

[8] Compared to existing studies, Feldkircher (2013) – 43 units and 90% world coverage; Bussière et. al. (2009) – 21 units; Dees et al. (2007) – 33 units and 78% world coverage.

X12 additive method. For the rest of countries, we use real GDP from IMF IFS[9] and seasonally adjust using similar approach.

Following existing studies which utilize GVAR approach, for *consumer inflation* (dp) we use first log-differences of seasonally adjusted Consumer Price Index: $\Delta p = \ln(CPI_t) - \ln(CPI_{t-1})$, which results in percentage change of consumer prices. For all countries we use CPI index from IMF IFS. For Azerbaijan and Belarus, we convert the data on CPI monthly change to levels. For Chile and China, missing observations for 2001q1-2008q4 and 2001q1-2010q4 respectively were derived using the data on CPI corresponding period changes. All CPI time series has been seasonally adjusted using X12 additive method.

For *real exchange rate* (ep), we use logarithms of nominal exchange rate indexed to 2005 average deflated by domestic consumer price index: $ep = \ln(NFX_t) - \ln(CPI_t)$. The data on nominal bilateral exchange rate with respect to the US dollar comes from IMF IFS.

For *nominal short-term interest rates* (r) we typically use data for money market interest rate[10]. For Azerbaijan, Belarus, China, Hungary, Kyrgyz Republic, and Moldova we use deposit rate due to the data limitations. For India we use lending rate for the same reason. For euro area we use EURIBOR 3-month interest rate. All data comes from IMF IFS except of Kazakhstan and Norway which data has been taken from national sources.

Global variables in GVAR models are commonly expressed by *oil prices*. In our analysis, we use logarithms of seasonally adjusted Brent oil price indexed to 2005 average. We include oil price variable as weakly endogenous in all models except of the US. In the US specification oil price is used as endogenous given that the US is the largest oil consuming economy. For foreign-specific variables, we follow Feldkircher (2013) and use weighted *foreign output* (y^*) and *interest rates* (r^*) as weakly exogenous variables. The weights are based on annual bilateral

[9] For some countries, missing observations for last periods have been taken from national sources.

[10] National currency, percent per Annum.

trade flows (e.g., exports plus imports in US dollars) for each specific year. The data for constructing time-varying weight matrices comes from IMF DOTS.[11]

Summary descriptive statistics of individual county data is presented in ***Table 1***.

2.3. Model Setup

Before setting up individual VECMX* models and combining them to a global model, we first run a set of statistical tests to explore data properties and ensure the relevance of our analytical framework.

First, in order to test for stationarity of variables we run Augmented Dickey-Fuller (ADF) unit-root tests. Summary results for variables in levels and first differences are presented in ***Table 2*** and ***Table 3*** respectively. Results suggest that real output, real exchange rate, and interest rate as well as their foreign counterparts in levels are integrated of first order for most countries. Meanwhile, unit root hypothesis for consumer inflation together with its foreign counterpart in levels can be rejected for some cases. In particular, inflation time series seems to be stationary in levels for 21 out of 36 countries. Nevertheless, following existing studies on GVAR modeling and pursuing VECM econometric framework, we conclude that most time series are integrated of order one which ensures the stationarity of the final GVAR model[12].

Second, we choose the lag length for domestic, foreign, and global variables in each individual VECMX* model. Although the lag length is usually determined by minimizing AIC, in our analysis we set the lag length for domestic, foreign as well as global variables equal to one due to a relatively short dataset. However, we determine the rank of cointegration relationships according to the Johansen's trace statistics[13] and the type of deterministic components using the Likelihood-Ratio

[11] IMF Direction of Trade Statistics database.

[12] 56 out of 251 time series are stationary in levels, while 236 out of 251 time series are stationary in first differences.

[13] See Pesaran, Shin and Smith (2000) for further details.

(LR) test[14]. ***Table 4*** and ***Table 5*** present summery results for the choice of cointegration rank and the type o deterministic components. Individual VECMX* specifications are then provided in ***Table 6***.

Thereafter, we run a set of diagnostics tests in order to verify the final specifications of individual VECMX* models. We test foreign variables for weak exogeneity which in VECMX* framework implies no feedback from domestic variables to its foreign counterparts in the long run. Results for the test, presented in ***Table 7***, suggest that the hypothesis of no weak exogeneity can be rejected for most countries which supports the econometric approach used in this paper.[15] In addition to weak exogeneity tests, we test each individual VECMX* models for residual serial correlation. As mentioned previously, a relatively short dataset limits the ability to include additional lags to deal with residual serial correlation. Following the results on F-test (see ***Table 8***), the hypothesis of first order serial correlation can be rejected for 116 out of 144 equations at 5% significance level. Lastly, we test for the cross-country correlation of the residuals. Average pairwise cross-section correlations are presented in ***Table 9***. Our results are in general very similar to those in Feldkircher (2013). In particular, cross-country correlations are low except of the equation of the real exchange rate which range from 0.3 to 0.4 for some countries.

To sum up, diagnostic tests carried out in the paper in general support the final setup of the GVAR model. Foreign specific counterparts of domestic variables in each individual model deal with cross-country residual correlation. Nevertheless, a relatively high number of individual country models with first order serial correlation of residuals limits the ability for structural interpretation of exogenous shocks.

[14] We distinguish three cases II-IV of deterministic components in the cointegration relationship. See for example Pesaran, Shin and Smith (2000) and MacKinnon, Haug, and Michelis (1999) for details.

[15] F-test rejects the hypothesis of no weak exogeneity for 98 out of 107 foreign variables at 5% significance level.

3. Results

In this section, we compute generalized impulse response functions (GIRFs) to study the propagation of foreign exogenous shocks across CIS economies. In particular, we explore the response of real activity in CIS region to output shocks in the US, euro area, China, as well as Russian Federation. In addition, we explore how structural changes in the global and CIS's trade composition over recent years influenced their sensitivity to foreign output shocks.

GIRFs are computed over 40 periods using a trade-weight matrix for 2016 which implies that cross-country linkages remain unchanged for the entire forecast horizon. Responses of real activity to 1% real output shocks in the US, euro area, China, as well as Russian Federation are presented in ***Figure 1*** for CIS countries and ***Figure 2*** for major economies. Most CIS countries are much more sensitive to output shocks in the US and EA compared to other countries in the panel which is in line with Feldkircher (2013). However, our results suggest that the degree of sensitivity is somewhat higher. In particular, Feldkircher (2013) suggests that the average long-run response of CIS region to the US and EA output shocks is about 0.9% and 0.7%, respectively. On the contrary, we find that the long-run response to 1% US output shock ranges from 0% for Moldova to about 7% for Azerbaijan. The long-run response to 1% EA output shock, in turn, ranges from 0.4% for Moldova to about 13% for Azerbaijan. However, the data for the output in Moldova and Azerbaijan was initially collected in nominal terms and then deflated by domestic consumer price index which might influence the accuracy of estimates for these countries. Other CIS countries respond to about 2-6%. Relatively higher estimates compared to existing literature can be partly explained by the higher response of the euro area and the US to their own shocks (e.g., 1.5% for the US and 1.9% for EA). In addition, our analysis covers the post-crises period which might be characterized by the growing importance of emerging world being more sensitive to foreign shocks. Meanwhile, despite that the CIS economies are closely connected in terms of trade with Russian Federation and China, their shocks have much lower effect[16]. Nevertheless, the effect might be high enough to amplify

[16] Interestingly, although the overall trade of Belarus with Russian Federation exceeds 50%, Russian shock has insignificant effect on real economy in Belarus.

global shocks faced by other CIS and, hence, a considerable role of Russian Federation and China[17] for the CIS can not be neglected.

In order to explore how the global as well as regional linkages have changed over time, we analyze the trade composition of the CIS (see ***Figure 3***) and other major economies (see ***Figure 4***) for different years. For the entire period of our analysis, trade interrelations of major economies with China has increased dramatically. This indicates that the sensitivity to Chinese shocks may have increased. Similar trends can be observed in CIS's trade composition. In addition, one could notice that trade linkages between major economies and Russian Federation has increased since the global crisis and then rapidly decreased after imposed sanctions and trade restrictions in 2014. A high sensitivity of Russian Federation to the euro are and the US shocks can, in turn, spill over to other countries as well as spill back to economies where shocks were initially originated. However, an opposite dynamics can be observed for the CIS region except of Ukraine.

Therefore, in order to consider structural changes of trade relationships, we compute long-run GIRFs using trade-weight matrices for different years. Results are presented in ***Figure 5*** for CIS countries and ***Figure 6*** for major economies. While relatively stable estimates are observed for the US and Russian shocks, changes in cross-country trade relationships affected the response of most economies to the euro area shock. The long-run sensitivity to the EA shock has increase dramatically for most cases since the global crisis in 2007. On the one hand, this might be explained by the growing importance of emerging world being more sensitive to foreign shocks. However, the results for the transmission of Chinese shock – the largest emerging economy – show that despite the growing trade relationships with China, the response of major economies as well as CIS region remains stable for the entire period of the analysis. A special attention should be drawn to linkages with Russian Federation being a large and sensitive emerging economy. In particular, euro area output shock affects Russian real economy to a large extent which, subsequently, transmits back to the euro area

[17] Our findings for the transmission of Chinese output shock are in line with Feldkircher and Korhonen (2012).

and other countries. The dynamics of estimated GIRFs follow changes in trade interrelations between euro area and Russia which has increased significantly since the global crisis and then rapidly decreased after imposing sanctions and trade restrictions in 2014. Hence, our analysis may indicate that Russian Federation might play an important role in the transmission and amplification of foreign shocks through the globe.

4. Conclusions

To sum up, our general findings are as follows. We find that EA and US remain playing a dominant role for the CIS. Nevertheless, China and Russia have a sufficient impact on the region and may amplify regional response to foreign shocks. In addition, our analysis suggests that the sensitivity of the CIS as well as other economies to EA shock has increased since the global crisis which can be explained by structural changes in the global trade composition and reorientation of international trade to a more vulnerable emerging economies.

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References

Beckmann, E., and J. Fidrmuc (2013). "Exchange Rate Pass-Through in CIS Countries." Comparative Economic Studies, 55(4), 705-720.

Bussière, M., A. Chudik, G. Sestieri (2009). "Modelling Global Trade Flows: Results From a GVAR Model." ECP Working Paper, 1087.

Canova, F., and M. Ciccarelli (2013). "Panel Vector Autoregressive models: A survey." European Central Bank Working Paper, 1507.

Chudik, A. and M.H. Pesaran (2014). "Theory and Practice of GVAR Modeling", Journal of Economic Surveys, vol. 30(1), 165-197.

Comunale, M., and H. Simola (2016). "The Pass-Through to Consumer Prices in CIS Economies: The Role of Exchange Rates, Commodities and Global Factors." BOFIT Discussion Paper (forthcoming).

Dees, S., F. diMauro, M.H. Pesaran, and L.V. Smith (2007). "Exploring the International Linkages of the Euro Area: A Global VAR Analysis", Journal of Applied Econometrics, 22, pp. 1-38.

Dreger, C., and J.Fidmuc (2011). "Drivers of Exchange Rate Dynamics in Selected CIS Countries: Evidence from a Factor-Augmented Vector Autoregressive (FAVAR) Analysis." Emerging Markets Finance and Trade, 47:4, 49-58

Faryna, O. (2016). "Exchange Rate Pass-Through and Cross-Country Spillovers: Some Evidence from Ukraine and Russia." BOFIT Discussion Paper (forthcoming).

Feldkircher, M. (2013). "A global macro model for Emerging Europe", Oesterreichische Nationalbank Working Papers, 185.

Feldkircher, M. and I. Korhonen (2012). "The rise of China and its implications for emerging markets - evidence from a GVAR model", BOFIT Discussion Papers, 20/2012.

Galesi, A., and M. J. Lombardi (2009). "External Shocks and International Inflation Linkages." European Central Bank Working Paper, 1062.

Harahap, B. A., P. Bary, L. N. Panjaitan, and R. Satyanugroho (2016). "Spillovers of United States and People's Republic of China Shocks on Small Open Economies: The Case of Indonesia." ADBI Working Paper 616.

MacKinnon, J.G., A.A. Haug, and L. Michelis (1999). "Numerical Distribution Functions of Likelihood Ratio Tests for Cointegration", Journal of Applied Econometrics, 14, pp. 563-577.

Pesaran, M. H. and Shin, Y. (1998). "Generalized impulse response analysis in linear multivariate models." Economics Letters, 58(1), 17–29.

Pesaran, M. H., Schuermann, T., and Smith, L. V. (2007). "What if the UK or Sweden had joined the euro in 1999? An empirical evaluation using a Global VAR", International Journal of Finance and Economics, 12(1), 55–87.

Pesaran, M. H., Schuermann, T., and Weiner, S. M. (2004). "Modelling Regional Interdependencies Using a Global Error-Cointegration Macro-Econometric Model." Journal of Applied Econometrics, 14(5), 563-577.

Smith, L.V. and A. Galesi (2014). GVAR Toolbox 2.0, ***https://sites.google.com/site/gvarmodelling/gvar-toolbox***

Figures and Tables

Table 1. Country data summary statistics

COUNTRY	REAL GDP				INFLATION			
	Min	Mean	Max	S.D.	Min	Mean	Max	S.D.
AUSTRALIA	4.451	4.691	4.895	0.128	0.000	0.006	0.014	0.003
AZERBAIJAN	3.937	4.987	5.631	0.570	-0.028	0.014	0.079	0.019
BELARUS	4.292	4.785	5.070	0.268	0.002	0.049	0.242	0.046
BRAZIL	4.471	4.724	4.926	0.153	0.005	0.016	0.055	0.008
BULGARIA	4.360	4.679	4.846	0.151	-0.008	0.009	0.054	0.012
CANADA	4.493	4.647	4.779	0.084	-0.011	0.005	0.014	0.005
CHILE	4.412	4.725	4.996	0.189	-0.022	0.008	0.026	0.007
CHINA	4.204	4.976	5.663	0.474	-0.011	0.006	0.026	0.007
CZECH REPUBLIC	4.439	4.666	4.838	0.119	-0.004	0.005	0.028	0.006
DENMARK	4.541	4.617	4.684	0.041	-0.001	0.004	0.014	0.003
GEORGIA	4.276	4.768	5.125	0.258	-0.044	0.012	0.046	0.016
HUNGARY	4.427	4.597	4.711	0.071	-0.006	0.010	0.028	0.008
ICELAND	4.381	4.644	4.835	0.119	0.000	0.012	0.052	0.011
INDIA	4.301	4.850	5.388	0.334	-0.002	0.017	0.047	0.009
INDONESIA	4.402	4.790	5.197	0.246	0.000	0.018	0.093	0.013
JAPAN	4.542	4.608	4.667	0.036	-0.009	0.000	0.020	0.004
KAZAKHSTAN	3.873	4.888	5.596	0.508	0.004	0.020	0.084	0.014
KOREA	4.406	4.724	4.979	0.168	0.000	0.006	0.019	0.004
KYRGYZ REPUBLIC	4.417	4.766	5.086	0.199	-0.017	0.017	0.105	0.022
MALAYSIA	4.376	4.750	5.114	0.220	-0.014	0.006	0.038	0.007
MEXICO	4.489	4.679	4.878	0.110	0.003	0.010	0.017	0.003
MOLDOVA	4.270	4.745	5.097	0.225	-0.017	0.020	0.059	0.014
NEW ZEALAND	4.416	4.658	4.850	0.107	-0.003	0.005	0.028	0.005
NORWAY	4.496	4.638	4.757	0.068	-0.019	0.005	0.027	0.006
PERU	4.387	4.818	5.204	0.263	-0.008	0.007	0.018	0.005
PHILIPPINES	4.398	4.769	5.194	0.232	-0.001	0.010	0.032	0.007
POLAND	4.456	4.748	5.013	0.178	-0.007	0.005	0.016	0.006
ROMANIA	4.373	4.692	4.908	0.154	-0.015	0.018	0.078	0.019
RUSSIA	4.350	4.700	4.881	0.171	0.004	0.025	0.071	0.011
SINGAPORE	4.338	4.790	5.146	0.264	-0.011	0.004	0.023	0.007
SWEDEN	4.485	4.653	4.824	0.090	-0.009	0.003	0.014	0.004
TURKEY	4.288	4.730	5.144	0.246	0.005	0.032	0.196	0.033
UKRAINE	4.295	4.605	4.803	0.131	-0.021	0.027	0.202	0.033
UNITED KINGDOM	4.484	4.624	4.741	0.065	-0.003	0.005	0.017	0.004
UNITED STATES	4.487	4.631	4.758	0.076	-0.022	0.005	0.014	0.006
EURO AREA	4.551	4.638	4.715	0.048	-0.004	0.004	0.012	0.003

COUNTRY	REAL EXCHANGE RATE				INTEREST RATE			
	Min	Mean	Max	S.D.	Min	Mean	Max	S.D.
AUSTRALIA	4.098	4.726	5.123	0.307	1.840	4.407	7.250	1.439
AZERBAIJAN	4.390	4.949	5.412	0.389	7.700	10.053	12.540	1.421
BELARUS	4.142	4.594	4.932	0.209	6.967	15.981	42.433	8.052
BRAZIL	3.979	4.804	5.313	0.371	7.130	13.833	26.238	4.453
BULGARIA	4.053	4.772	5.113	0.320	-0.328	1.713	5.553	1.720
CANADA	4.248	4.684	4.941	0.216	0.240	2.038	5.325	1.404
CHILE	4.289	4.715	5.022	0.224	0.427	4.062	8.994	1.838
CHINA	4.526	4.842	5.177	0.244	1.500	2.566	4.140	0.671
CZECH REPUBLIC	4.041	4.748	5.127	0.305	0.287	2.049	5.410	1.425
DENMARK	4.176	4.662	4.900	0.199	-0.552	1.969	5.262	1.780
GEORGIA	4.206	4.769	5.149	0.310	0.000	9.537	30.333	6.648
HUNGARY	4.012	4.655	5.024	0.259	0.473	5.997	11.245	2.774
ICELAND	3.987	4.420	4.771	0.178	3.767	8.626	20.017	4.412
INDIA	4.371	4.781	5.083	0.247	8.000	11.172	13.750	1.187
INDONESIA	4.106	4.810	5.157	0.265	3.830	7.355	17.057	3.235
JAPAN	4.427	4.663	4.951	0.141	-0.050	0.110	0.514	0.151
KAZAKHSTAN	4.233	4.779	5.143	0.308	8.567	13.574	18.833	2.416
KOREA	4.237	4.604	4.840	0.175	1.420	3.305	5.160	1.096
KYRGYZ REPUBLIC	4.276	4.843	5.200	0.310	1.483	2.797	10.939	1.713
MALAYSIA	4.527	4.770	5.010	0.171	1.999	2.926	3.502	0.381
MEXICO	4.488	4.644	4.797	0.088	3.293	6.555	18.007	2.724
MOLDOVA	4.180	4.823	5.227	0.366	4.953	12.281	23.770	4.432
NEW ZEALAND	3.976	4.640	5.019	0.290	2.163	4.642	8.194	2.077
NORWAY	4.198	4.652	4.902	0.193	0.500	2.954	7.000	1.994
PERU	4.449	4.768	5.074	0.209	1.203	4.119	16.021	2.095
PHILIPPINES	4.498	4.890	5.241	0.278	2.013	5.439	11.415	2.257
POLAND	4.264	4.674	5.073	0.220	1.467	5.194	19.863	3.745
ROMANIA	4.045	4.662	5.004	0.288	0.220	11.433	47.667	11.092
RUSSIA	4.028	4.760	5.190	0.356	1.067	6.099	15.667	3.413
SINGAPORE	4.480	4.825	5.149	0.236	0.041	0.951	3.439	1.008
SWEDEN	4.215	4.649	4.895	0.184	-0.550	2.087	4.807	1.521
TURKEY	3.848	4.641	5.002	0.311	12.130	25.360	87.363	16.483
UKRAINE	4.250	4.652	5.114	0.249	1.626	9.311	34.201	7.468
UNITED KINGDOM	4.300	4.601	4.778	0.130	0.383	2.588	5.979	2.158
UNITED STATES	-	-	-	-	0.073	1.564	5.593	1.816
EURO AREA	4.164	4.656	4.907	0.202	-0.258	1.963	4.977	1.598

GLOBAL VARIABLES	Min	Mean	Max	S.D.
FUEL PRICE	3.615	4.696	5.403	0.535

Table 2. ADF unit-root test for variables in levels

	AUS	AZE	BLR	BRA	BGR	CAN	CHL	CHN	Nr. < CV
y	-2.219	-0.621	1.420	-0.188	-1.612	-2.379	-1.538	-0.307	0
Dp	-5.152*	-3.635*	-2.815	-2.074	-2.868	-6.668*	-4.012*	-4.439*	5
ep	-1.799	0.091	-0.686	-0.624	0.017	-1.271	-1.056	-2.450	0
r	-0.583	-1.550	-2.520	-1.526	-1.523	-1.292	-3.941*	-2.064	1
y*	-2.934	-1.966	-1.704	-3.707*	-2.637	-2.683	-3.966*	-2.353	2
r*	-1.355	-2.481	-3.324*	-1.670	-2.146	-1.809	-1.545	-2.230	1
pf	-1.474	-1.474	-1.474	-1.474	-1.474	-1.474	-1.474	-1.474	0

	CZE	DNK	GEO	HUN	ISL	IND	IDN	JPN	Nr. < CV
y	-1.821	-2.443	-1.879	-2.410	-1.437	-1.633	-1.874	-2.473	0
Dp	-3.79*	-3.62*	-4.257*	-3.679*	-2.182	-1.666	-4.241*	-4.268*	6
ep	-0.041	-0.755	-1.461	-1.223	-3.376	-1.947	-2.086	-2.390	0
r	-2.806	-1.909	-1.797	-1.410	-1.866	-1.954	-2.971*	-2.040	1
y*	-2.829	-2.780	-0.865	-1.910	-2.588	-4.144*	-3.938*	-2.361	2
r*	-2.356	-1.538	-5.063*	-2.416	-1.524	-2.281	-1.700	-2.039	1
pf	-1.474	-1.474	-1.474	-1.474	-1.474	-1.474	-1.474	-1.474	0

	KAZ	KOR	KGZ	MYS	MEX	MDA	NZL	NOR	Nr. < CV
y	-1.090	-2.441	-5.584*	-3.549*	-3.551*	-3.868*	-2.864	-1.818	4
Dp	-4.599*	-3.501*	-4.319*	-5.698*	-2.772	-3.988*	-4.149*	-6.247*	7
ep	0.748	-2.467	-0.865	-1.030	-2.245	-0.743	-2.520	-0.447	0
r	-2.110	-1.526	-7.6*	-3.183*	-1.906	-2.500	-0.986	-2.291	2
y*	-1.620	-3.832*	-2.092	-3.786*	-2.718	-1.401	-3.005	-2.814	2
r*	-4.959*	-2.229	-3.33*	-1.525	-1.850	-4.427*	-1.082	-1.403	3
pf	-1.474	-1.474	-1.474	-1.474	-1.474	-1.474	-1.474	-1.474	0

	PER	PHL	POL	ROU	RUS	SGP	SWE	TUR	Nr. < CV
y	-1.768	-1.359	-1.522	-1.797	-1.316	-2.092	-3.319	-2.089	0
Dp	-4.503*	-3.929*	-3.095*	-3.294*	-3.823*	-3.49*	-4.255*	-3.815*	8
ep	-1.444	-1.456	-1.112	-0.751	-0.188	-1.534	-1.750	-0.825	0
r	-2.069	-1.065	-4.567*	-3.315*	-2.551	-2.402	-2.084	-4.676*	3
y*	-3.622*	-3.102	-2.151	-2.529	-2.735	-4.229*	-2.609	-3.163	2
r*	-1.918	-1.575	-2.454	-2.215	-3.165*	-1.743	-1.662	-2.623	1
pf	-1.474	-1.474	-1.474	-1.474	-1.474	-1.474	-1.474	-1.474	0

	UKR	GBR	USA	EUA	-	-	-	-	Nr. < CV
y	-1.677	-2.121	-2.267	-2.671	-	-	-	-	0
Dp	-3.156*	-2.661	-5.128*	-3.11*	-	-	-	-	3
ep	-0.633	-2.437	0.000	-	-	-	-	-	0
r	-3.456*	-1.436	-1.997	-1.916	-	-	-	-	1
y*	-1.596	-3.238	-3.210	-3.113	-	-	-	-	0
r*	-5.217*	-2.111	-1.698	-2.420	-	-	-	-	1
pf	-1.474	-1.474	-1.474	-1.474	-	-	-	-	0

Note. ADF tests for inflation and interest rate include constant term (Fcrit. 0.05 = -2.89), while tests for output, real exchange rate, and fuel prices include constant as well as trend term (Fcrit. 0.05 = -3.45). Significant statistics are marked by a " * ".

Table 3. ADF unit-root test for variables in first differences

	AUS	AZE	BLR	BRA	BGR	CAN	CHL	CHN	Nr. < CV
Dy	-5.032*	-5.236*	-2.428	-4.373*	-1.884	-4.833*	-4.626*	-2.492	5
DDp	-6.169*	-6.484*	-6.861*	-6.873*	-6.125*	-7.284*	-6.211*	-6.027*	8
Dep	-5.633*	-0.136	-4.271*	-6.013*	-2.635	-5.091*	-5.682*	-3.056*	6
Dr	-4.835*	-6.544*	-4.168*	-4.721*	-2.296	-4.114*	-3.858*	-4.212*	7
Dy*	-4.407*	-3.847*	-3.677*	-3.98*	-3.857*	-4.198*	-4.854*	-5.031*	8
Dr*	-3.603*	-3.557*	-3.757*	-3.087*	-4.397*	-3.108*	-3.974*	-3.784*	8
Dpf	-5.065*	-5.065*	-5.065*	-5.065*	-5.065*	-5.065*	-5.065*	-5.065*	8

	CZE	DNK	GEO	HUN	ISL	IND	IDN	JPN	Nr. < CV
Dy	-3.627*	-4.683*	-3.659*	-2.971*	-2.936*	-3.053*	-6.429*	-4.799*	8
DDp	-5.119*	-8.23*	-6.931*	-6.711*	-5.41*	-7.483*	-6.175*	-9.216*	8
Dep	-6.11*	-3.232*	-4.54*	-6.256*	-4.429*	-4.469*	-3.818*	-3.191*	8
Dr	-3.085*	-4.397*	-5.415*	-4.417*	-1.800	-5.87*	-5.127*	-3.898*	7
Dy*	-3.144*	-4.203*	-4.028*	-4.127*	-3.62*	-4.318*	-4.656*	-3.764*	8
Dr*	-3.917*	-3.429*	-4.065*	-3.908*	-3.181*	-3.661*	-2.607	-3.63*	7
Dpf	-5.065*	-5.065*	-5.065*	-5.065*	-5.065*	-5.065*	-5.065*	-5.065*	8

	KAZ	KOR	KGZ	MYS	MEX	MDA	NZL	NOR	Nr. < CV
Dy	-5.705*	-5.222*	-7.133*	-5.714*	-3.581*	-4.682*	-3.474*	-5.814*	8
DDp	-6.368*	-8.754*	-5.477*	-6.551*	-11.41*	-6.379*	-6.411*	-6.069*	8
Dep	-5.392*	-5.227*	-2.888	-4.207*	-5.873*	-3.229*	-5.11*	-5.425*	7
Dr	-2.753	-5.141*	-4.653*	-4.744*	-6.401*	-3.771*	-3.517*	-4.163*	7
Dy*	-3.831*	-4.698*	-5.097*	-4.685*	-4.312*	-4.59*	-4.652*	-3.477*	8
Dr*	-3.43*	-3.281*	-6.252*	-2.863	-3.044*	-5.389*	-4.122*	-3.088*	7
Dpf	-5.065*	-5.065*	-5.065*	-5.065*	-5.065*	-5.065*	-5.065*	-5.065*	8

	PER	PHL	POL	ROU	RUS	SGP	SWE	TUR	Nr. < CV
Dy	-4.09*	-4.853*	-3.101*	-5.627*	-2.706	-5.644*	-4.055*	-3.921*	7
DDp	-6.658*	-6.31*	-7.765*	-4.894*	-7.686*	-5.079*	-8.24*	-7.484*	8
Dep	-4.75*	-4.527*	-6.417*	-5.71*	-5.181*	-4.272*	-5.782*	-3.973*	8
Dr	-3.133*	-4.951*	-4.874*	-3.524*	-5.085*	-3.155*	-3.747*	-4.918*	8
Dy*	-4.616*	-5*	-4.107*	-3.922*	-4.393*	-4.388*	-3.632*	-4.558*	8
Dr*	-3.657*	-2.798	-3.639*	-3.788*	-3.026*	-4.424*	-3.449*	-3.946*	7
Dpf	-5.065*	-5.065*	-5.065*	-5.065*	-5.065*	-5.065*	-5.065*	-5.065*	8

	UKR	GBR	USA	EUA	-	-	-	-	Nr. < CV
Dy	-4.036*	-3.768*	-3.893*	-3.504*	-	-	-	-	4
DDp	-6.666*	-6.48*	-6.487*	-5.28*	-	-	-	-	4
Dep	-5.297*	-6.824*	0.000	-	-	-	-	-	2
Dr	-8.235*	-3.719*	-3.094*	-3.37*	-	-	-	-	4
Dy*	-2.813	-4.411*	-4.633*	-4.27*	-	-	-	-	3
Dr*	-3.052*	-3.162*	-4.68*	-4.219*	-	-	-	-	4
Dpf	-5.065*	-5.065*	-5.065*	-5.065*	-	-	-	-	4

Note. ADF test for variables in first differences include a constant term only (Fcrit. 0.05 = -2.89). Significant statistics are marked by a " * ".

Table 4. Likelihood Ratio test on the type of deterministic components in the cointegration equations

COUNTRY	H0: Case III; H1: Case IV		H0: Case II; H1: Case III		Case
	LR	CV	LR	CV	
AUSTRALIA	0.97	(3.84)	36.15	(12.59)	III
AZERBAIJAN	3.72	(5.99)	3.64	(11.07)	II
BELARUS	9.65	(3.84)	7.18	(12.59)	IV
BRAZIL	5.53	(7.82)	0.46	(9.49)	II
BULGARIA	29.13	(7.82)	3.70	(9.49)	IV
CANADA	0.07	(3.84)	3.19	(12.59)	II
CHILE	7.59	(5.99)	7.94	(11.07)	IV
CHINA	4.43	(5.99)	12.73	(11.07)	III
CZECH REPUBLIC	13.79	(3.84)	6.27	(12.59)	IV
DENMARK	16.48	(3.84)	4.08	(12.59)	IV
GEORGIA	3.47	(7.82)	0.37	(9.49)	II
HUNGARY	8.41	(5.99)	1.04	(11.07)	IV
ICELAND	4.49	(5.99)	1.08	(11.07)	II
INDIA	5.68	(3.84)	39.85	(12.59)	IV
INDONESIA	5.92	(7.82)	23.70	(9.49)	III
JAPAN	2.79	(3.84)	0.95	(12.59)	II
KAZAKHSTAN	6.19	(5.99)	1.04	(11.07)	IV
KOREA	7.16	(5.99)	11.68	(11.07)	IV
KYRGYZ REPUBLIC	11.34	(5.99)	1.68	(11.07)	IV
MALAYSIA	17.06	(5.99)	10.74	(11.07)	IV
MEXICO	16.01	(7.82)	2.96	(9.49)	IV
MOLDOVA	26.38	(7.82)	0.63	(9.49)	IV
NEW ZEALAND	11.20	(7.82)	0.43	(9.49)	IV
NORWAY	15.33	(7.82)	0.18	(9.49)	IV
PERU	22.19	(5.99)	6.92	(11.07)	IV
PHILIPPINES	20.00	(3.84)	18.00	(12.59)	IV
POLAND	17.70	(5.99)	17.65	(11.07)	IV
ROMANIA	0.21	(3.84)	4.36	(12.59)	II
RUSSIA	1.95	(5.99)	0.17	(11.07)	II
SINGAPORE	9.70	(3.84)	2.76	(12.59)	IV
SWEDEN	2.21	(3.84)	4.66	(12.59)	II
TURKEY	0.00	(3.84)	4.37	(12.59)	II
UKRAINE	16.78	(7.82)	5.68	(9.49)	IV
UNITED KINGDOM	1.18	(3.84)	5.80	(12.59)	II
UNITED STATES	6.67	(5.99)	2.37	(9.49)	IV
EURO AREA	8.70	(3.84)	12.31	(12.59)	IV

Note. Critical values for the 5% significance level are in parentheses. The case (II-IV) of deterministic components implied by the test is presented in the right column.

Table 5. Trace statistics for testing the cointegration rank

COUNTRY	# end. var.	# exo. var.	H0: r=1; H1: r≥2		H0: r=2; H1: r≥3		H0: r=3; H1: r≥4	
			Trace	CV	Trace	CV	Trace	CV
AUSTRALIA	4	3	41.7*	(54.3)	15.2	(34)	2.7	(17.2)
AZERBAIJAN	4	3	79.7	(57.2)	38.7	(35.9)	9.9*	(18.1)
BELARUS	4	3	54.3*	(64.5)	26.0	(41)	9.0	(21)
BRAZIL	4	3	79.2	(57.2)	33.4*	(35.9)	4.7	(18.1)
BULGARIA	4	3	83.7	(64.5)	46.6	(41)	11.7*	(21)
CANADA	4	3	50.7*	(57.2)	17.4	(35.9)	5.9	(18.1)
CHILE	4	3	78.7	(64.5)	35.3*	(41)	8.3	(21)
CHINA	4	3	71.1	(54.3)	29.3*	(34)	4.9	(17.2)
CZECH REPUBLIC	4	3	58.1*	(64.5)	28.6	(41)	5.6	(21)
DENMARK	4	3	54.1*	(64.5)	31.9	(41)	13.0	(21)
GEORGIA	4	3	77.0	(57.2)	36.0	(35.9)	10.4*	(18.1)
HUNGARY	4	3	68.4	(64.5)	33.8*	(41)	12.6	(21)
ICELAND	4	3	75.7	(57.2)	39.7	(35.9)	15.5*	(18.1)
INDIA	4	3	57.9*	(64.5)	21.6	(41)	4.2	(21)
INDONESIA	4	3	67.9	(54.3)	33.8*	(34)	4.3	(17.2)
JAPAN	4	3	47.4*	(57.2)	24.4	(35.9)	9.5	(18.1)
KAZAKHSTAN	4	3	76.7	(64.5)	35.3*	(41)	11.0	(21)
KOREA	4	3	80.0	(64.5)	30.7*	(41)	8.2	(21)
KYRGYZ REPUBLIC	4	3	70.7	(64.5)	36.8*	(41)	14.2	(21)
MALAYSIA	4	3	71.4	(64.5)	36.6*	(41)	13.5	(21)
MEXICO	4	3	120.4	(64.5)	61.0	(41)	13.9*	(21)
MOLDOVA	4	3	86.4	(64.5)	51.2	(41)	20.3*	(21)
NEW ZEALAND	4	3	79.1	(64.5)	47.3	(41)	21.5	(21)
NORWAY	4	3	102.1	(64.5)	44.1	(41)	17.2*	(21)
PERU	4	3	75.3	(64.5)	34.9*	(41)	15.7	(21)
PHILIPPINES	4	3	54.1*	(64.5)	30.1	(41)	12.4	(21)
POLAND	4	3	72.6	(64.5)	27.7*	(41)	10.5	(21)
ROMANIA	4	3	60.1	(57.2)	29.8*	(35.9)	11.8	(18.1)
RUSSIA	4	3	71.2	(57.2)	36.2	(35.9)	15.1*	(18.1)
SINGAPORE	4	3	52.9*	(64.5)	24.5	(41)	4.0	(21)
SWEDEN	4	3	59.7	(57.2)	25.4*	(35.9)	10.7	(18.1)
TURKEY	4	3	61.2	(57.2)	26.5*	(35.9)	10.1	(18.1)
UKRAINE	4	3	80.1	(64.5)	45.7	(41)	16.2*	(21)
UNITED KINGDOM	4	3	64.7	(57.2)	37.2	(35.9)	14.5*	(18.1)
UNITED STATES	4	2	68.1	(57.5)	24.7*	(36.1)	6.8	(18.3)
EURO AREA	4	3	58.8*	(64.5)	26.7	(41)	9.8	(21)

Note. Critical values for the 5% significance level are in parentheses. The cointegration rank implied by the test statistic is marked by a " * ". The final specifications for the cointegration rank in VECMX* models might differ due to the additional analysis of persistence profile.

Table 6. Individual VECMX* specifications

COUNTRY	Domestic	p	Foreign	q	r	Case	Estimation Statistics		
							logLik	Akaike	Schwartz
AUSTRALIA	y, dp, ep, r	1	y*, r*, pf*	1	1	III	640.72	620.72	599.77
AZERBAIJAN	y, dp, ep, r	1	y*, r*, pf*	1	1	II	285.78	269.78	253.02
BELARUS	y, dp, ep, r	1	y*, r*, pf*	1	1	IV	260.14	240.14	219.2
BRAZIL	y, dp, ep, r	1	y*, r*, pf*	1	2	II	458.27	438.27	417.32
BULGARIA	y, dp, ep, r	1	y*, r*, pf*	1	2	IV	474	450	424.86
CANADA	y, dp, ep, r	1	y*, r*, pf*	1	1	II	658.79	642.79	626.04
CHILE	y, dp, ep, r	1	y*, r*, pf*	1	2	IV	530.92	506.92	481.78
CHINA	y, dp, ep, r	1	y*, r*, pf*	1	2	III	653.81	629.81	604.68
CZECH REPUBLIC	y, dp, ep, r	1	y*, r*, pf*	1	1	IV	575.67	555.67	534.73
DENMARK	y, dp, ep, r	1	y*, r*, pf*	1	1	IV	644.56	624.56	603.61
GEORGIA	y, dp, ep, r	1	y*, r*, pf*	1	3	II	322.67	298.67	273.53
HUNGARY	y, dp, ep, r	1	y*, r*, pf*	1	1	IV	478.03	458.03	437.08
ICELAND	y, dp, ep, r	1	y*, r*, pf*	1	2	II	361.75	341.75	320.8
INDIA	y, dp, ep, r	1	y*, r*, pf*	1	1	IV	492.57	472.57	451.63
INDONESIA	y, dp, ep, r	1	y*, r*, pf*	1	1	III	448.81	428.81	407.87
JAPAN	y, dp, ep, r	1	y*, r*, pf*	1	1	II	673.34	657.34	640.58
KAZAKHSTAN	y, dp, ep, r	1	y*, r*, pf*	1	2	IV	306.97	282.97	257.84
KOREA	y, dp, ep, r	1	y*, r*, pf*	1	2	IV	654.32	630.32	605.19
KYRGYZ REPUBLIC	y, dp, ep, r	1	y*, r*, pf*	1	1	IV	331.16	311.16	290.22
MALAYSIA	y, dp, ep, r	1	y*, r*, pf*	1	2	IV	648.61	624.61	599.48
MEXICO	y, dp, ep, r	1	y*, r*, pf*	1	3	IV	517.2	489.2	459.88
MOLDOVA	y, dp, ep, r	1	y*, r*, pf*	1	2	IV	362.37	338.37	313.23
NEW ZEALAND	y, dp, ep, r	1	y*, r*, pf*	1	2	IV	594.66	570.66	545.53
NORWAY	y, dp, ep, r	1	y*, r*, pf*	1	2	IV	532.99	508.99	483.86
PERU	y, dp, ep, r	1	y*, r*, pf*	1	2	IV	582.92	558.92	533.79
PHILIPPINES	y, dp, ep, r	1	y*, r*, pf*	1	1	IV	594.78	574.78	553.83
POLAND	y, dp, ep, r	1	y*, r*, pf*	1	2	IV	575.26	551.26	526.13
ROMANIA	y, dp, ep, r	1	y*, r*, pf*	1	1	II	385.82	369.82	353.07
RUSSIA	y, dp, ep, r	1	y*, r*, pf*	1	2	II	393.14	373.14	352.2
SINGAPORE	y, dp, ep, r	1	y*, r*, pf*	1	1	IV	563.74	543.74	522.79
SWEDEN	y, dp, ep, r	1	y*, r*, pf*	1	1	II	616.47	600.47	583.71
TURKEY	y, dp, ep, r	1	y*, r*, pf*	1	1	II	348.08	332.08	315.32
UKRAINE	y, dp, ep, r	1	y*, r*, pf*	1	2	IV	221.44	197.44	172.31
UNITED KINGDOM	y, dp, ep, r	1	y*, r*, pf*	1	1	II	655.81	639.81	623.05
UNITED STATES	y, dp, r, pf*	1	y*, r*	1	1	IV	528.89	512.89	496.14
EURO AREA	y, dp, ep, r	1	y*, r*, pf*	1	1	IV	700.81	680.81	659.87

Table 7. Test for weak exogeneity of foreign-specific variables

COUNTY	p*	q*	Fcrit 0.05	y*	r*	pf*
AUSTRALIA	1	1	4.030	0.538*	0.029*	0*
AZERBAIJAN	1	1	4.030	0.326*	0.132*	0.446*
BELARUS	1	1	4.030	0.549*	0.485*	1.525*
BRAZIL	1	1	3.187	0.197*	2.423*	0.262*
BULGARIA	1	1	3.183	0.806*	0.617*	0.497*
CANADA	1	1	4.034	4.700	1.494*	8.323
CHILE	1	1	3.183	1.236*	0.006*	0.366*
CHINA	1	1	3.187	0.891*	1.881*	0.171*
CZECH REPUBLIC	1	1	4.030	0.071*	0.146*	0.024*
DENMARK	1	1	4.030	0.002*	1.282*	6.812
GEORGIA	1	1	2.794	1.248*	0.96*	0.746*
HUNGARY	1	1	4.030	0.01*	3.778*	1.791*
ICELAND	1	1	3.183	1.595*	0.045*	1.586*
INDIA	1	1	4.034	0.929*	0.011*	0.825*
INDONESIA	1	1	4.030	1.828*	0.014*	0.101*
JAPAN	1	1	4.034	3.461*	3.491*	4.658
KAZAKHSTAN	1	1	3.183	0.284*	0.757*	0.35*
KOREA	1	1	3.183	0.851*	3.024*	6.336
KYRGYZ REPUBLIC	1	1	4.030	2.225*	2.175*	0.156*
MALAYSIA	1	1	3.183	5.097	1.626*	6.866
MEXICO	1	1	2.798	1.859*	1.504*	1.101*
MOLDOVA	1	1	3.183	0.913*	1.648*	0.609*
NEW ZEALAND	1	1	3.183	0.549*	0.493*	1.992*
NORWAY	1	1	3.187	0.06*	0.654*	2.978*
PERU	1	1	3.183	1.057*	5.403	1.411*
PHILIPPINES	1	1	4.030	0.619*	0.249*	0.128*
POLAND	1	1	3.183	3.432	0.306*	1.477*
ROMANIA	1	1	4.030	0.558*	0.012*	0.004*
RUSSIA	1	1	3.187	1.269*	0.536*	1.066*
SINGAPORE	1	1	4.030	0.001*	0.421*	0*
SWEDEN	1	1	4.030	3.094*	0.286*	3.541*
TURKEY	1	1	4.030	1.547*	0.158*	1.931*
UKRAINE	1	1	3.183	0.198*	0.639*	0.398*
UNITED KINGDOM	1	1	4.030	1.174*	0.563*	0.966*
UNITED STATES	1	1	4.030	0.373*	0.832*	-
EURO AREA	1	1	4.034	0.062*	0.661*	2.773*

Note. Significant statistics are marked by a " * ".

Table 8. F-test for the serial correlation of the VECMX residuals

COUNTRY	Fcrit 0.05	y	dp	e	r	f
AUSTRALIA	2.553	1.344*	1.523*	0.411*	5.035	-
AZERBAIJAN	2.550	1.689*	4.704	10.891	1.078*	-
BELARUS	2.553	3.320	3.978	1.845*	4.460	-
BRAZIL	2.553	0.52*	2.629	3.204	3.597	-
BULGARIA	2.557	3.020	1.345*	1.808*	2.336*	-
CANADA	2.550	0.161*	1.996*	1.101*	2.602	-
CHILE	2.557	0.805*	1.84*	0.773*	0.931*	-
CHINA	2.557	1.247*	2.173*	0.717*	0.716*	-
CZECH REPUBLIC	2.553	2.313*	0.878*	1.033*	0.623*	-
DENMARK	2.553	0.436*	0.734*	2.032*	0.873*	-
GEORGIA	2.557	0.336*	1.561*	0.356*	1.439*	-
HUNGARY	2.553	2.513*	1.082*	1.104*	2.700	-
ICELAND	2.553	2.336*	2.452*	0.841*	0.447*	-
INDIA	2.553	1.115*	4.735	1.8*	2.692	-
INDONESIA	2.553	1.33*	2.291*	0.984*	0.43*	-
JAPAN	2.550	1.139*	1.495*	4.254	2.273*	-
KAZAKHSTAN	2.557	1.222*	0.865*	5.021	1.474*	-
KOREA	2.557	3.260	1.804*	1.545*	0.694*	-
KYRGYZ REPUBLIC	2.553	2.747	2.039*	0.974*	0.898*	-
MALAYSIA	2.557	0.168*	0.04*	0.87*	1.754*	-
MEXICO	2.561	7.073	2.616	0.823*	1.558*	-
MOLDOVA	2.557	0.525*	1.912*	2.833	1.892*	-
NEW ZEALAND	2.557	0.901*	1.124*	0.664*	0.636*	-
NORWAY	2.557	1.472*	1.046*	0.145*	6.295	-
PERU	2.557	1.171*	1.7*	1.967*	0.582*	-
PHILIPPINES	2.553	1.739*	1.329*	0.507*	0.515*	-
POLAND	2.557	0.776*	0.269*	0.503*	0.763*	-
ROMANIA	2.550	0.619*	1.758*	2.134*	0.685*	-
RUSSIA	2.553	1.988*	1.083*	2.182*	3.276	-
SINGAPORE	2.553	2.786	1.181*	0.898*	1.554*	-
SWEDEN	2.550	2.969	1.118*	1.702*	1.171*	-
TURKEY	2.550	0.219*	1.618*	0.255*	0.415*	-
UKRAINE	2.557	0.104*	0.996*	1.662*	2.509*	-
UNITED KINGDOM	2.550	1.287*	0.241*	1.76*	0.515*	-
UNITED STATES	2.550	1.609*	2.845	-	8.454	4.173
EURO AREA	2.553	1.722*	0.643*	1.216*	0.587*	-

Note. Significant statistics are marked by a " * ".

Table 9. Average Pairwise Cross-Section Residual Correlations

COUNTRY	y	dp	e	r
AUSTRALIA	-0.01	0.08	0.37	0.00
AZERBAIJAN	0.05	0.00	0.01	-0.02
BELARUS	0.04	0.00	0.11	-0.03
BRAZIL	0.03	0.07	0.25	-0.04
BULGARIA	0.00	-0.01	0.38	0.02
CANADA	0.02	0.04	0.28	0.00
CHILE	0.06	0.10	0.24	0.02
CHINA	-0.04	-0.03	0.06	-0.04
CZECH REPUBLIC	0.03	0.00	0.39	0.01
DENMARK	-0.02	0.08	0.37	-0.02
GEORGIA	0.01	0.04	0.23	-0.04
HUNGARY	0.08	0.00	0.35	0.01
ICELAND	0.00	0.04	0.13	0.00
INDIA	-0.01	0.04	0.27	0.00
INDONESIA	-0.02	0.07	0.17	-0.02
JAPAN	0.04	0.04	0.08	0.04
KAZAKHSTAN	0.01	0.06	0.04	0.01
KOREA	0.05	0.11	0.21	0.04
KYRGYZ REPUBLIC	0.04	0.08	0.25	-0.02
MALAYSIA	0.05	0.04	0.25	0.03
MEXICO	0.03	0.01	0.22	-0.03
MOLDOVA	-0.02	0.04	0.17	0.02
NEW ZEALAND	0.05	0.07	0.29	0.03
NORWAY	-0.02	0.06	0.29	0.01
PERU	0.02	0.05	0.14	0.00
PHILIPPINES	0.04	0.03	0.16	0.00
POLAND	-0.01	0.05	0.31	0.01
ROMANIA	0.07	0.03	0.35	-0.02
RUSSIA	0.06	0.03	0.18	-0.04
SINGAPORE	0.02	0.00	0.27	-0.04
SWEDEN	0.03	0.12	0.34	0.00
TURKEY	-0.01	0.07	0.20	0.00
UKRAINE	0.03	0.04	0.07	-0.04
UNITED KINGDOM	0.02	0.08	0.30	-0.02
UNITED STATES	0.04	0.04	-	-0.04
EURO AREA	0.00	0.06	0.37	0.03

Figure 1. Response of real activity to foreign output shocks (CIS countries), %

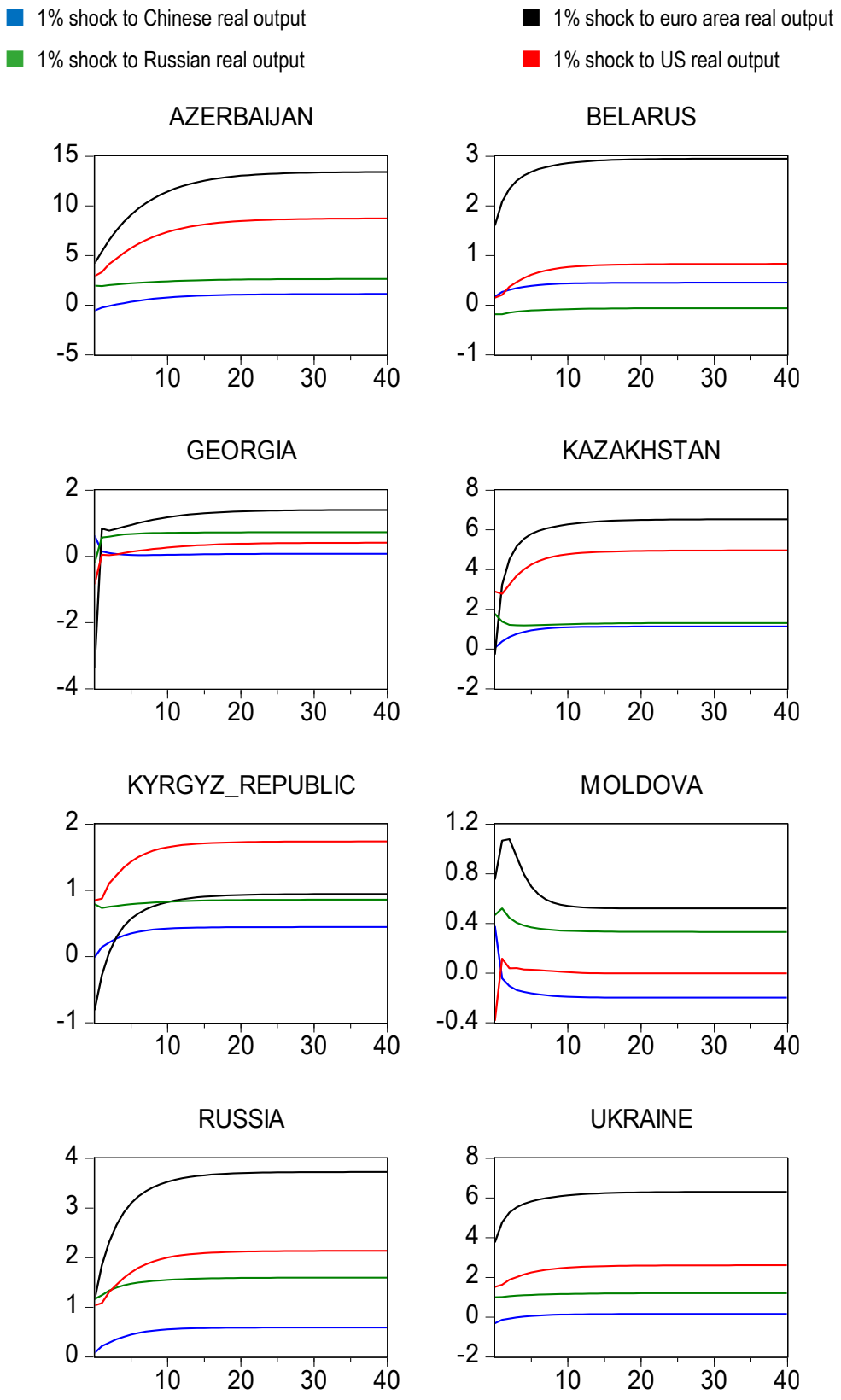


Figure 2. Response of real activity to foreign output shocks (other economies), %

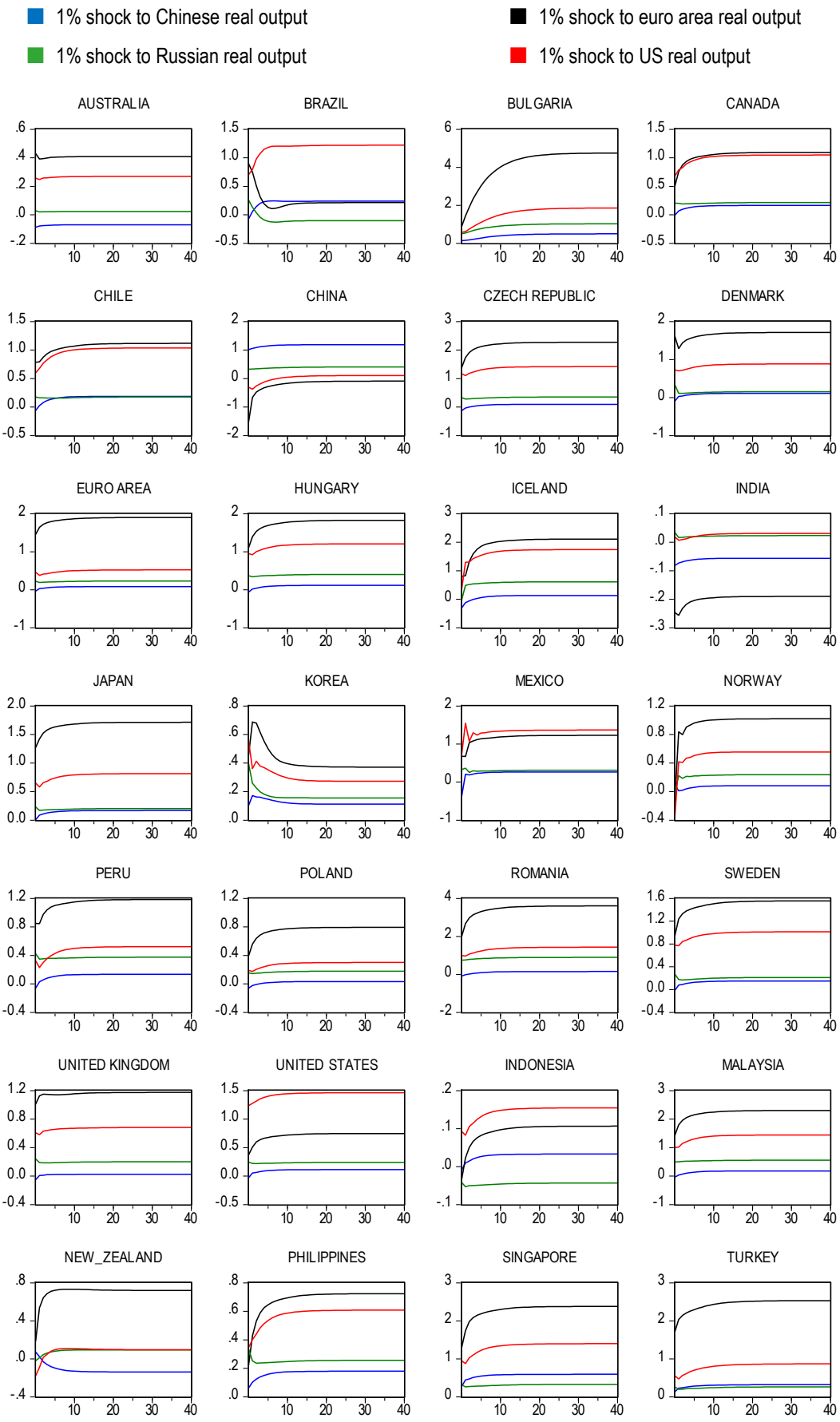
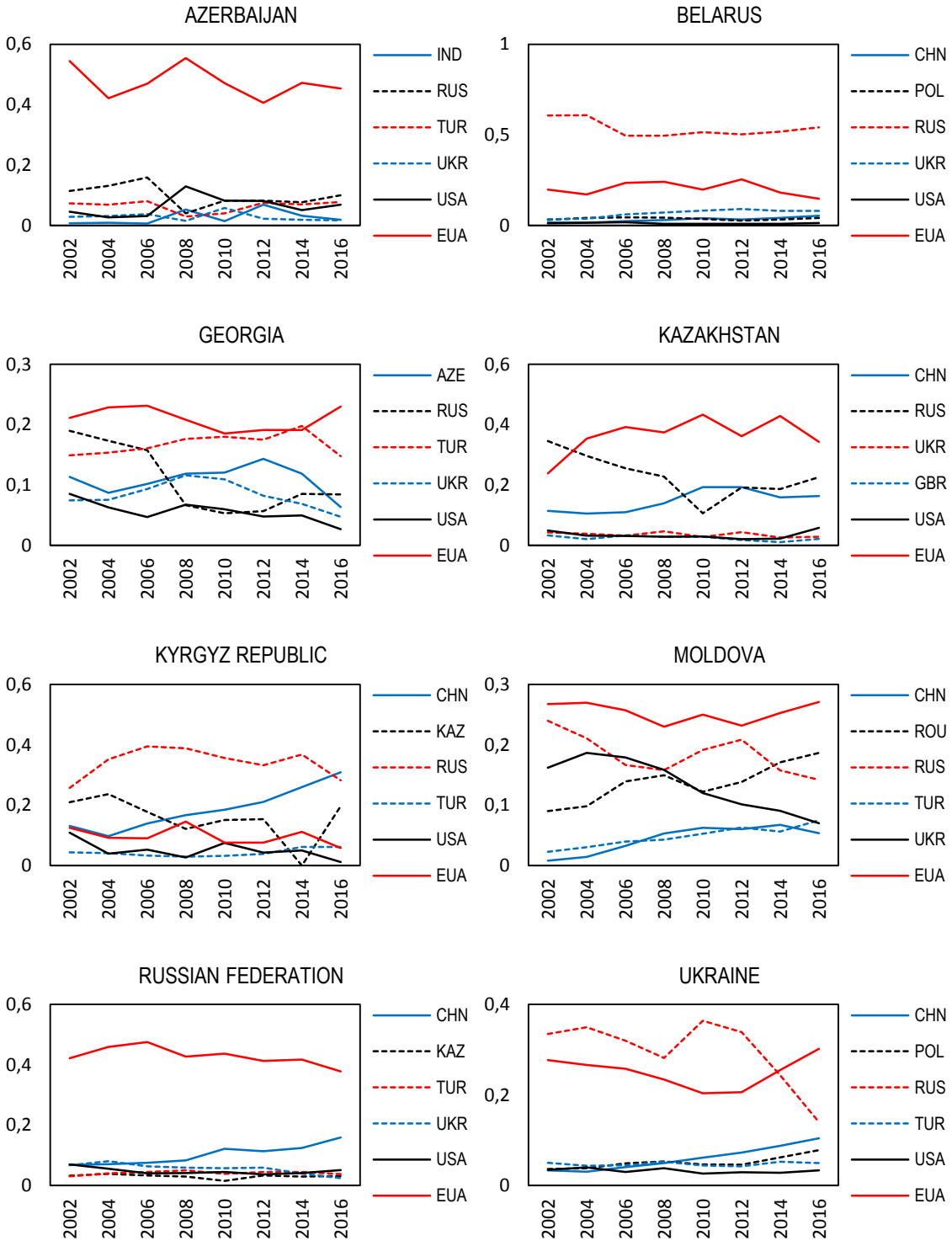
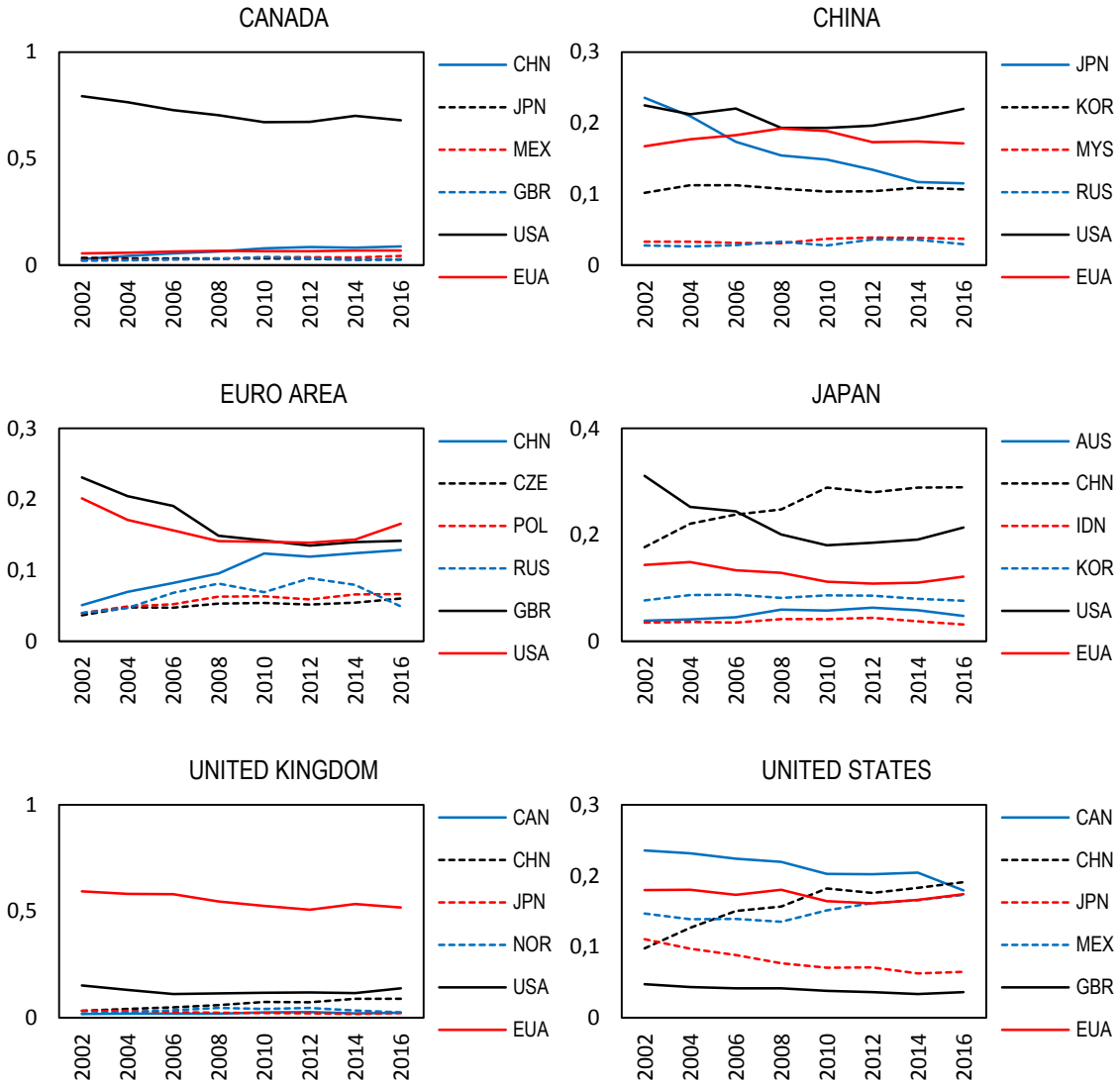


Figure 3. Time-varying trade composition with major partners (CIS countries)



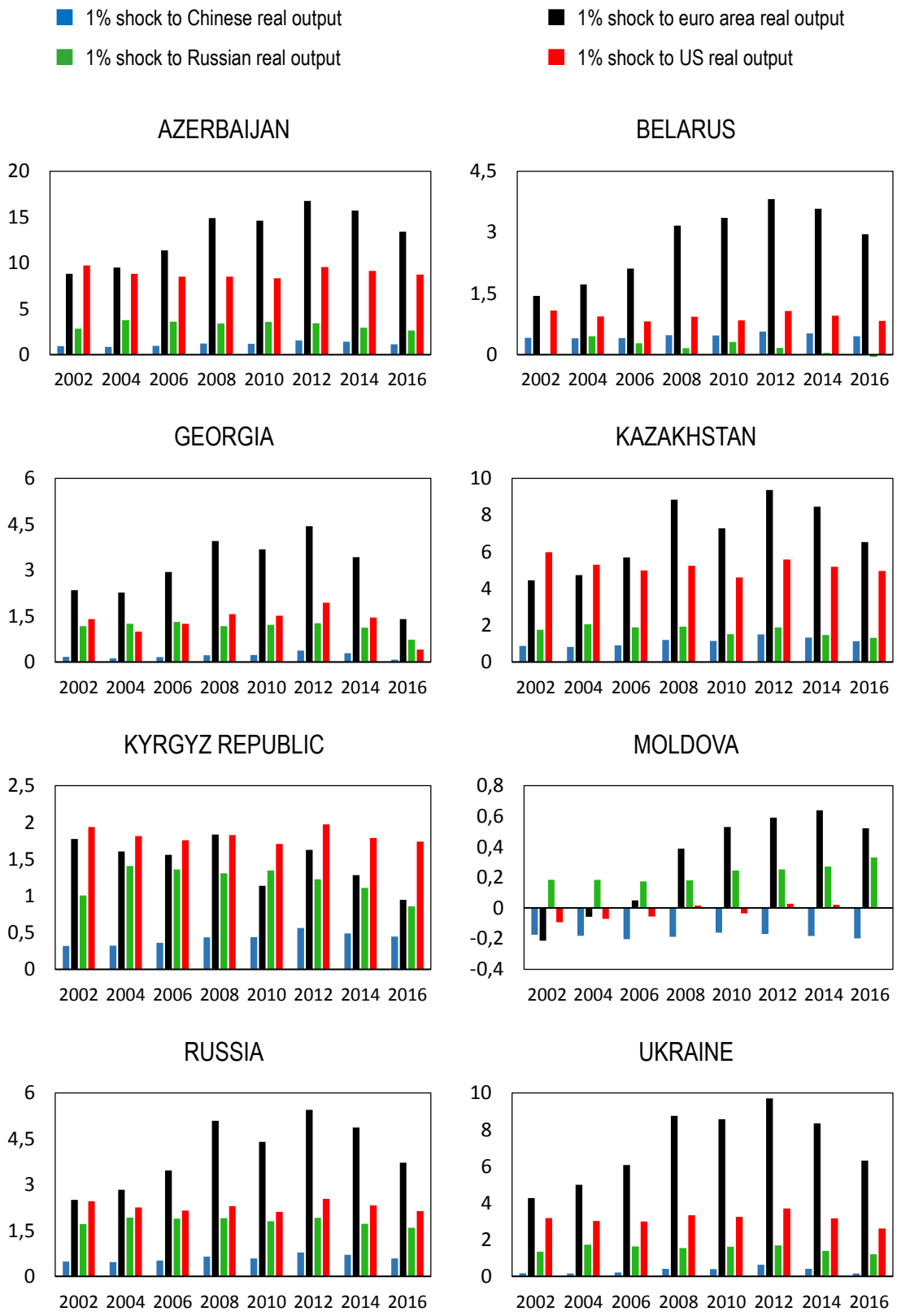
Note. Figures represent shares of trade with major partners to total trade within all countries in the sample.

Figure 4. Time-varying trade composition with major partners (major economies)



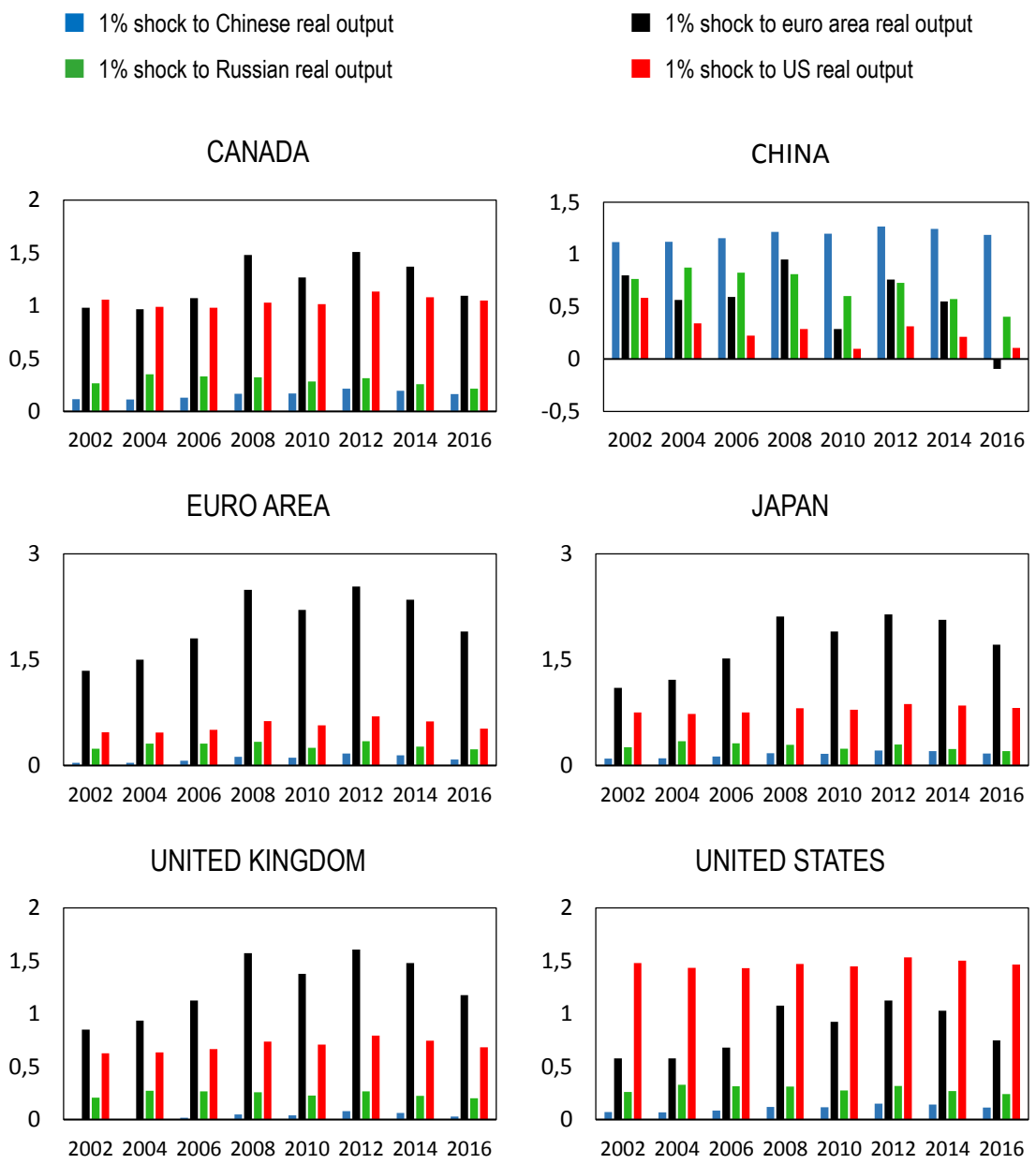
Note. Figures represent shares of trade with major partners to total trade within all countries in the sample.

Figure 5. Long-run response of real activity to foreign output shocks considering changes in trade composition (CIS countries), %



Note. Long-run response corresponds to GIRFs at 40th horizon.

Figure 6. Long-run response of real activity to foreign output shocks considering changes in trade composition (major economies), %



Note. Long-run response corresponds to GIRFs at 40th horizon.