Explaining the impact of the global financial crisis on European transition countries: a GVAR approach

Arta Hoxha[1]

This study investigates how GDP and financial shocks in the EU-15 are transmitted to European transition countries, using a global vector autoregression (GVAR) approach. Our GVAR model is estimated for 32 countries over the period from Q1 1999 to Q4 2014. The results indicate that, while the estimated spillovers from negative shocks to GDP and financial stress in the EU-15 to European transition countries are always negative, the size of these effects varies considerably across regions. Notably, the Baltic countries' GDP levels show the most severe and statistically significant impact from the shocks to both GDP and the financial stress index in the EU-15. Both types of shocks to the EU-15 appear to be propagated mainly through foreign credit flows, FDI and remittances, suggesting that the financial channel, particularly foreign credit flows, play a major role in the transmission of shocks to the Baltic countries. The examined Southeastern European (SEE) countries, on the other hand, are affected mainly by shocks to EU-15 GDP, which are propagated predominantly through exports, FDI and foreign credit flows. EU Member States in Central, Eastern and Southeastern Europe (CESEE) are less severely affected by shocks to EU-15 GDP, possibly because they represent more advanced transition countries and are better able to offset crisis effects and thus contribute to the resilience of the region.

JEL classification: F15, F30, G01
Keywords: global financial crisis, transition countries, GVAR

Although a large number of empirical studies have investigated the international transmission of the global financial crisis (GFC) (Claessens et al., 2010; Cetorelli and Goldberg, 2011; Chudik and Fratzscher, 2011; Haas and Lelyveld, 2014; Chen et al., 2016), the literature is still unable to provide conclusive results on the determinants of crisis severity in different transition countries (Berglöf et al., 2009; Berkmen et al., 2009; Blanchard et al., 2010; Lane and Milesi-Ferretti, 2011; Rose and Spiegel, 2009a, 2009b, 2011). This study aims to enhance knowledge in this area by providing analyses of the international transmission of shocks to European transition countries[2], employing the global vector autoregression (GVAR) approach developed by Pesaran et al. (2004).

A distinguishing feature of the recent GFC was the speed and synchronicity with which it spread around the world. The European transition countries were severely affected by the GFC with an average GDP decline of around 7% in 2009, experiencing a more severe impact than any other region in the world, including the EU-15, where output decline averaged 5% in 2009. The impact of the crisis on economic activity varied extensively across countries. Slovenia, Croatia, Romania and the Baltic countries were more severely affected by the GFC, with 2009 output

[1] *Winner of the 2017 Olga Radzyner Award. Staffordshire University, arta.hoxha@research.staffs.ac.uk.* *Opinions expressed by the author of this study do not necessarily reflect the official viewpoint of the Oesterreichische Nationalbank (OeNB), the Eurosystem or Staffordshire University. The author would like to thank Geoff Pugh and Nick Adnett (both Staffordshire University) and Valentin Toçi (University of Prishtina) as well as Martin Feldkircher (OeNB) for helpful comments and valuable suggestions.*

[2] *The GVAR model is estimated for 32 countries, including 17 European transition economies: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Kosovo, Latvia, Lithuania, the former Yugoslav Republic of Macedonia (FYR Macedonia), Montenegro, Poland, Romania, Serbia, Slovakia and Slovenia; and 15 advanced European economies (EU-15): Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxemburg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom.*

decline ranging from 6.5% (Romania) to 18% (Latvia), while Albania was less severely affected, recording 3% output growth in 2009.

One of the key outcomes of the transition process in the European transition countries has been deeper international integration through trade and financial flows. The rapid increase in exports has led to a significant expansion of the exports-to-GDP ratio, which has made these countries vulnerable to a decrease in export demand. A large proportion of exports is directed toward the EU, exposing these countries to shocks in the EU. In addition, evidence suggests that countries with stronger trade linkages have more synchronized business cycles (Juvenal and Monteiro, 2017). Moreover, cross-border bank acquisitions have been an important component of financial integration.

By 2009, the average asset share of foreign banks in European transition countries had reached more than 82%. Cross-border lending and foreign bank ownership resulted in a pre-GFC credit boom in these countries, which boosted investment and output growth, but also led to large external imbalances financed by cross-border capital flows. In most of these countries, debt was mainly denominated in foreign currency, which made borrowers vulnerable to a depreciation of the exchange rate. Furthermore, even though remittances are an important source of capital flows in many transition countries, they have made these countries more vulnerable to external shocks by creating an additional potential channel for contagion. Consequently, despite the well-known benefits of economic integration, it also appears to have made these countries more vulnerable to the effects of global shocks by creating or strengthening potential channels for contagion through trade, foreign banks, FDI, remittances and cross-border bank flows. On the other hand, countries that made more progress with EU integration and institutional reforms may have been better able to deal with external shocks, since their higher quality institutions may be expected to contribute to output stability (Balavac and Pugh, 2016).

The aim of this study is to investigate how GDP and financial shocks in the EU-15 are transmitted to European transition countries. To this end, the study will examine the aforementioned potential channels for contagion through trade and financial flows. It begins with a discussion of the modeling framework, its structure and applications. The methodology rests on four stages. First, guided by the underlying theory, the variables that enter each country model are selected and the vector autoregression (VAR) model is extended with a set of country-specific foreign variables. These foreign variables are computed as weighted averages of the respective domestic variables, based on certain weights. In the next stage, the weights for constructing the country-specific foreign variables are calculated. Considering the importance of both trade and financial linkages between European transition countries and advanced European economies (EU-15), trade, FDI and remittance weights are computed and considered for the model. In the third stage, each variable in the model is tested for stationarity. Next, the vector error correction model (VECM) is specified for each country. Particular attention has been paid to diagnostic tests and stability conditions to ensure the model is statistically well specified and capable of producing valid estimates. In the final stage, the GVAR is solved and results from the estimated model are interpreted by means of impulse response functions.

In using GVAR, the limited and quite recent body of literature that uses this modeling framework is extended in several important aspects. First, this is the first study that uses the GVAR to model the transmission of financial shocks to European transition countries. Second, weights based on bilateral remittance flows, to our knowledge, represent an original contribution to the GVAR modeling framework. Third, unlike several other GVAR studies on the transmission of crises, our model has been developed to deal with country heterogeneity. Last but not least, the model specifications and variable definitions rely on arguments put forward in the extensive literature on the transmission of the GFC, which is not always the case in the relatively small body of GVAR studies.

The main finding highlights the importance of the trade channel in the international transmission of shocks. The transmission of shocks affecting the EU-15's GDP to European transition countries' GDP is stronger in all regions when using trade weights to construct the foreign country-specific variables, indicating that trade linkages are the main channel of shock transmission from advanced EU economies to European transition countries.

The paper is structured as follows: Section 1 provides an overview of the GVAR modeling framework, its structure and applications. Section 2 specifies the variables and data to be used in this investigation. Section 3 provides details of the estimation technique adopted and presents the empirical findings, and section 4 concludes.

1 The GVAR methodology

The GVAR approach, established by Pesaran et al. (2004) and further developed by Dées et al. (2007) and Dées et al. (2009), can be used to investigate the international interdependencies among countries and international channels of shock transmission (Dovern and van Roye, 2013). For a detailed description of the methodology, this study refers to Di Mauro and Pesaran (2013). GVAR combines separately estimated country-specific VARs into a global model. In such a model, domestic variables are linked to country-specific foreign variables. The latter are constructed from the domestic variables of other countries based on certain weights that account for the international trade, international finance or other interdependencies between countries. The country-specific foreign variables themselves serve as a proxy for common unobserved factors, such as the diffusion of technological progress, or investors' behavior during times of financial crisis or other determinants that we may not be able to measure but of which we know that they are present and that they affect all countries. However, even when all these commonalities are accounted for, there might still be some residual interdependencies due to policy or trade spillover effects. Therefore, in a GVAR model the weighted combinations of observable factors are assumed to take into account the unobservable factors. All country-specific variables are treated as endogenous variables. Country-specific foreign variables are calculated and allowed to directly influence domestic variables in the model. The foreign variables and global variables are assumed to be weakly exogenous, assuming that every individual country is a small economy compared to the rest of the world. This is the key assumption of the GVAR modeling strategy since it allows country models to be estimated individually and to be combined only at a later stage (Di Mauro and Pesaran, 2013). For every country, the standard VAR augmented with foreign variables is estimated. The augmentation takes place at the country

level, but once the system as a whole is solved, we end up with a simple VAR. The general specification of a country specific VARX*[3] model is described below:

Suppose there are $N+1$ countries in the global economy, indexed by $i=0,1,2,\ldots,N$, where $N=18$ and country 0 is treated as the reference country (EU-15 in our case). For each country i an augmented $VARX^*(q_i, q_i^*)$ model, where q_i and q_i^* are the lag orders of the domestic and foreign variables, respectively, can be written as follows:

$$x_{it} = a_{i,0} + a_{i,1}t + \sum_{j=1}^{q_i} \alpha_{i,j} x_{i,t-j} + \sum_{j=0}^{q_i^*} \beta_{i,j} x^*_{i,t-j} + \sum_{j=0}^{q_i} \gamma_{i,j} d_{t-j} + u_{i,t,} \qquad (1)$$

for $t=0,1,2,\ldots,T$, and $N=0,1,2,\ldots,N$, where x_{it} is the k_i x 1 vector of country-specific domestic or endogenous variables, x_{it}^* is the k_i^*x 1 vector of country-specific foreign variables (weakly exogenous), d_t a vector of global exogenous variables (that exist in every country VARX*, a_{i0} is a constant, t is a linear trend, and $u_{i,t}$ is the k_ix 1 vector of idiosyncratic, serially uncorrelated, country-specific shocks. Foreign-specific variables are constructed as weighted averages across the domestic variables of all countries, with the weights also being country-specific:

$$x_{it}^* = \sum_{j=0}^{N} w_{ij}\, x_{jt} \qquad (2)$$

where w_{ij} are a set of weights such that w_{ii} and the sum of all weights equals 1. The weights are determined so as to capture the importance of country j in the economy of country i. The country-specific VAR models can be transformed into error correction forms (VECMX*), which makes it possible to distinguish between short-run and long-run relationships and to treat the long-run relationships as co-integrating.

The GVAR model allows interactions between countries through three different channels: dependence of the domestic variables on foreign country-specific variables and their lags; dependence of the domestic variables on global exogenous variables such as oil prices; and dependence of shocks in country i on shocks in country j (Di Mauro and Pesaran, 2013). Even though the VECMX* models are separately estimated on a country-by-country basis taking potential cointegration between x_{it} and x_{it}^* into account (Smith and Galesi, 2014), the GVAR model is solved for the whole system, in which all variables are endogenous. Accordingly, after estimating the individual country VECMX* models as described, the corresponding VARX* models are recovered as the basis for impulse response analysis.

2 Model specification

The first GVAR model is estimated for 32 countries, i.e. 17 European transition economies and 15 advanced European economies (EU-15), using quarterly data for the period from Q1 2003 to Q4 2014. The variables used to capture the potential channels of international transmission of shocks are derived from the theory on financial contagion as well as the recent experience of the examined countries with the GFC. First, theory on financial contagion distinguishes between two main channels of international shock transmission: the trade channel and the financial

[3] * *represents the foreign country-specific variables included in the model.*

channel (Eichengreen et al., 1996; Glick and Rose, 1999; Corsetti et al., 2000; Dornbusch et al., 2000; Forbes, 2002). Second, European transition countries were severely affected by the GFC with an average GDP decline of around 7% in 2009 and other macroeconomic variables also experiencing a sharp decline. The following variables were most severely affected during 2009: Exports of goods and services dropped by around 10%; cross-border bank flows' decline averaged 13%; FDI inflows dropped by around 57%; and remittance inflows were also severely affected, falling sharply in Albania, Bosnia and Herzegovina, Poland, Romania and Slovenia.

Therefore, we will use two main groups of variables in this study to capture the main channels of financial contagion, i.e. the trade channel and the financial channel. The variable used to capture the trade channel is exports. Since the theory on financial contagion implies that exports represent one of the main channels of international shock transmission (Eichengreen et al., 1996; Glick and Rose, 1999; Corsetti et al., 2000; Forbes, 2002; Juvenal and Monteiro, 2017) shocks in advanced European economies are expected to more severely affect European transition countries that have stronger trade links with them. Quarterly data on exports have been obtained from Eurostat, the World Bank and central banks.

The second group of variables will capture the international transmission of global financial shocks through financial linkages. A financial crisis in one country can lead to direct financial effects, including reductions in FDI and other capital flows abroad. Since the global financial crisis affected the EU-15 financial sectors, transition countries with strong financial links with these advanced economies are expected to have been more severely affected by the crisis. Therefore, following the literature on the transmission of global financial crises (Dornbusch et al., 2000; Rose and Spiegel, 2010; Cetorelli and Goldberg, 2011; Milesi-Ferretti and Tille, 2011; Fratzscher, 2012), the following variables are used to capture the effects of crisis transmission through the financial channel: inward FDI flows, foreign credit flows, credit flows in foreign currencies, and remittances. All these variables are expected to influence the international transmission of global financial shocks. FDI data have been obtained from the OECD, Eurostat and the European Commission. Data on foreign credit flows and credit flows in foreign currencies have been obtained from the Bank for International Settlements' international banking statistics (BIS IBS). This analysis is based on locational data, since these data are residence-based; therefore they are expected to reflect whether conditions in specific "financial center" countries affect flows to other countries, including flows to local subsidiaries. Data on remittances have been obtained from the World Bank database.

3 Empirical approach

Our methodology follows the following stages: First, the variables that enter each country model are selected and the VAR model is extended with a set of country-specific foreign variables. Second, the weights for constructing the country-specific foreign variables are computed. In the third stage, each variable in the model is tested for stationarity. Next, the VECM is specified for each country, which means determining the lag order of the underlying VAR models and testing for cointegration and the cointegrating ranks. Subsequently, different diagnostic tests are performed and the global GVAR is solved. In the final stage, results from the estimated model are interpreted by means of impulse response functions.

The foreign country-specific variables are constructed as weighted averages of the corresponding variables of other countries based on certain weighting schemes. Previous GVAR studies have mainly employed trade weights for constructing the foreign country-specific variables (Pesaran et al., 2004; Dées et al., 2007; Nickel and Vansteenkiste, 2013). In contrast, Eickmeier and Ng (2011) use a combination of trade and financial weights, namely inward and outward FDI positions, cross-country bilateral trade flows and bilateral financial claim positions[4]. Galesi and Sgherri (2009) employ weights based on bank lending data. Nevertheless, considering the importance of both trade and financial linkages between European transition countries and advanced European economies, we believe that it is necessary to consider both trade and financial weights and investigate which of these weights more accurately capture the transmission channels between European transition countries and advanced European economies. The trade weights are computed using cross-country exports and imports data for the period 2005–2007. The first type of the financial weights is based on FDI. FDI weights are computed based on the average inward and outward FDI positions during the period 2003–2007[5]. Considering the large share of remittance income in European transition countries' GDP, in particular in SEE countries, we decided to employ a second type of financial weights in our model based on bilateral remittance flows among countries[6]. Weights based on bilateral remittance flows, to our knowledge, represent an original contribution to the GVAR modeling framework; they are available from the author upon request.

3.1 GVAR model specification

We use the GVAR Toolbox 2.0 developed by Smith and Galesi (2014) to estimate the model. At the onset of the analysis, we aggregate the examined EU countries into a region in order to be able to treat them as one base "country" so as to capture their collective impact on the European transition countries. With the exception of the EU model, all country models include the same set of variables, where data are available. The following domestic variables enter into each country model: GDP, exports, inward FDI flows, foreign credit flows, remittances and foreign credit flows in foreign currency. Following the GVAR literature, the global variable price of oil (*Poil*) enters all country models as a weakly exogenous variable. Considering the importance of the EU-15 variables for the rest of the examined countries and the EU-15's size and dominance compared to the transition countries, European transition countries' variables are not expected to affect the EU variables; therefore, following the GVAR literature, the foreign country-specific variables are not included in the EU model. Other country models include all the foreign country-specific variables. GDP (*gdp*), exports (*exp*), FDI (*fdi*), foreign credit flows (*fcf*), credit flows in foreign currencies (*eur*) and remittances (*rem*) are measured in real terms and transformed to logs. The variable specifications are presented in table 1 below.

[4] *The bilateral financial claims positions are not used in this study to compute weights due to lack of data for some of the examined countries.*

[5] *These specific periods for computing trade and FDI weights were chosen for two reasons: data availability and to cover the period before the global financial crisis.*

[6] *Bilateral remittance estimates have been obtained from the World Bank database. They have been constructed based on a methodology developed by Ratha and Shaw (2007). The earliest year for which bilateral remittance flow data are available is 2010, hence we use this year for constructing remittance weights in this study.*

Table 1

Variable specification of country-specific VARX*[1] models

Non-EU models			EU model		
Domestic variables	Foreign variables	Global variables	Domestic variables	Foreign variables	Global variables
gdp	*gdp**	*Poil*	*gdp*	-	*Poil*
exp	*exp**	-	*exp*	-	-
fdi	*fdi**	-	*fdi*	-	-
fcf	*fcf**	-	*fcf*	-	-
rem	*rem**	-	*rem*	-	-
eur	*eur**	-	*eur*	-	-

Source: Author's compilation.

[1] **represents the foreign country-specific variables included in the model.*

Before proceeding with the next stage of GVAR estimation, we examine the time series properties of the underlying data. Standard Dickey-Fuller unit-root tests and weighted symmetric augmented Dickey-Fuller (ADF) tests (Park and Fuller, 1995) suggest that at the 5% significance level, for the majority of the variables, we are unable to reject the null of non-stationarity.[7] Next, different information criteria are checked and, based on the results, the benchmark model with respect to weighting schemes is selected. More specifically, the performance of the GVAR model in terms of stability (related to its eigenvalues), persistence profiles and impulse response functions is compared under different weighting schemes. These three indicators are crucial with regard to the overall stability and performance of the GVAR model (Pesaran et al., 2004; Eickmeier and Ng, 2011; Smith and Galesi, 2014). In the case of I(1) cointegrated variables, the eigenvalues should lie on or inside the unit circle, i.e. no eigenvalue should be above 1. The persistence profiles refer to the time profiles of the effects of system- or variable-specific shocks on the cointegrating relations in the GVAR model (Pesaran and Shin, 1996, 1998) and they have a value of unity on impact, while they should tend to zero as $t \rightarrow \infty$. It was observed that the GVAR model that uses only trade weights provides the best performance in terms of these indicators (no eigenvalues that lie above the unit circle, persistence profiles converge to zero, while the impulse responses, which will be discussed latter, are statistically and economically more significant); hence, it was selected as the benchmark model. All models are estimated using $p_i = q_i = 1$ lags[8] and the final specification passes a range of diagnostic checks (more detailed information available from the author upon request).[9]

[7] *Leybourne et al. (2005) provide evidence of the superior performance of the weighted symmetric test statistic compared to the standard ADF test or the generalized least squares ADF test proposed by Elliot et al. (1996). The lag length employed in the ADF and weighted symmetric unit root tests is set at 1 for all countries.*

[8] *Considering the small number of observations, the results of the serial correlation diagnostics as well as eigenvalues of the model and persistence profiles, we reduce the number of lags to 1 for both domestic and foreign variables in all countries (which is a common approach in the GVAR literature when dealing with a small number of observations).*

[9] *As such we test the weak exogeneity assumption employing a test developed by Johansen (1992) and Harbo et al. (1998) which checks the joint significance of the estimated error correction terms in auxiliary equations for the country-specific foreign variables. Nevertheless, the weak exogeneity assumption is rejected at the 5% significance level for the following two variables: exports in Macedonia and foreign credit flows in Montenegro. Even though, based on the results of the test, weak exogeneity holds for all variables of the EU-15, we decided to exclude all the foreign variables in the EU model, since the EU-15 are considered the dominant "country" in our model and we would not expect other smaller countries to affect its variables. Finally, we also found that for most variables no serial autocorrelation is left in the residuals of the country models.*

3.2 Dynamic analysis with generalized impulse response functions

This section investigates the dynamic properties of the GVAR model based on generalized impulse response functions (GIRFs). Identifying shocks in a GVAR is difficult, similarly as in standard VARs, and is further complicated by the cross-country interactions and the high dimensionality of the model (Chudik and Pesaran, 2016). Hence, in the absence of strong a priori beliefs on the ordering of the variables and countries in the GVAR model, the GIRFs provide useful information about the dynamics of the transmission of shocks although they cannot identify the origin of shocks. In this study, the EU-15 region is considered as the possible source of shocks. The GIRFs are provided for a period of 40 quarters. However, only the impulse responses of the first 8 to 10 quarters are considered for interpretation. Due to the relatively large number of countries included in our model, we aggregate the examined European countries into four subregions in order to simplify the discussion of the impulse responses and focus our interpretation on the common patterns of responses based on specific regions. Our four subregions are defined as follows: Baltic countries, i.e. Estonia, Latvia and Lithuania; SEE countries, i.e. Albania, Bosnia and Herzegovina, FYR Macedonia, Montenegro, Kosovo and Serbia; CESEE EU countries, which include: the Czech Republic, Bulgaria, Hungary, Poland, Romania, Slovakia, Slovenia and Croatia; and the previously aggregated EU-15 countries.

The results presented in charts 1 and 2 show that the impulse responses stabilize relatively quickly, suggesting that the estimated GVAR model is stable. This is confirmed by the eigenvalues of the GVAR model, which are all within the unit circle and by the persistence profiles, which converge to zero relatively quickly. However, it should be pointed out that the bootstrap simulation provides rapidly widening confidence bands around the impulse responses, which is most likely the result of the short time series included in the model.

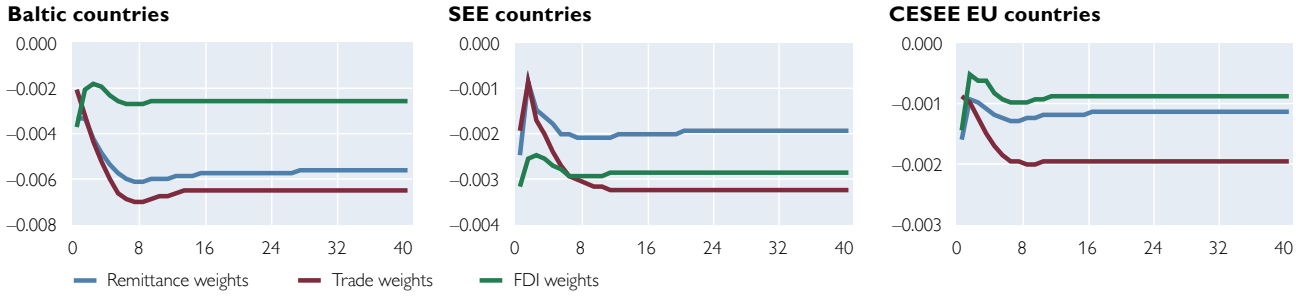
3.2.1 Impulse response functions of a one-standard-error shock to EU-15 GDP

This subsection reports the effects of a one-standard-error negative shock to EU-15 GDP, which corresponds to a 0.3% decline, on five variables in the European transition economies: GDP, exports, FDI, foreign credit flows and remittances. Chart 1 reports the regional impulse response functions (point estimates) of GDP following a shock in EU-15 GDP using trade weights, FDI weights and remittance weights. The graphs indicate that the effect of the GDP shock is stronger in all regions when using trade weights to construct the foreign country-specific variables, indicating that trade represents the strongest linkage between European transition countries and advanced European economies. In addition, as discussed in the previous section, it is observed that the GVAR model that uses only trade weights provides the best performance in terms of persistence profiles and eigenvalues, which is why it is selected as the benchmark model.

Next, we discuss the impulse response functions of the variables of interest, keeping in mind that trade weights were used to construct the foreign country-specific variables. Although the 90% confidence intervals presented in chart 2 suggest statistical insignificance or borderline significance of the impulse response functions in some cases, there is an economic interest in analyzing whether the dynamic behavior of the variables used in the model is synchronized across countries. The Baltic countries' GDP shows the most severe and statistically significant impact

Chart 1

Regional impulse response functions (point estimates) of GDP following a one-standard-error shock to EU-15 GDP



Source: Author's calculations.

Note: The impact is in percentages and the horizon is quarterly.

from the shock in EU-15 GDP, possibly due to these countries' stronger trade links with the EU-15 countries[10]. Their GDP experiences a decline of 0.3% on impact, which then reaches 0.7% by the seventh quarter, after which the effect dissipates in the following periods. The SEE transition countries also display a severe impact from the shock to EU-15 GDP, with a decline in their GDP by 0.3% on impact, which then increases to 0.5% and stabilizes by the eighth quarter. In the CESEE EU countries, GDP falls by 0.15% on impact, with its decline stabilizing in the eighth quarter at about 0.3%.

As expected, exports are also negatively affected by a GDP shock in the EU-15. From a regional perspective, exports from SEE countries appear to be most severely affected by the shock in the EU-15, even though the impact is at the borderline of the 10% level of statistical significance. The CESEE EU countries' exports also display a severe and statistically significant impact from a shock to EU-15 GDP, which stabilizes at a 0.6% decline by the eighth quarter. Contrary to the strong and synchronized regional GDP and exports responses to the EU-15 GDP shock, the generalized impulse responses of FDI to the GDP shock are statistically insignificant or close to borderline significance at the 10% level, indicating that economic shocks in the EU-15 may not have a severe impact on FDI flows. The SEE transition countries display the most severe and statistically significant impact from the shock in EU-15 GDP, with a decline of their FDI by 0.5% on impact, which then rises to 1% by the fifth quarter and stabilizes in the following periods.

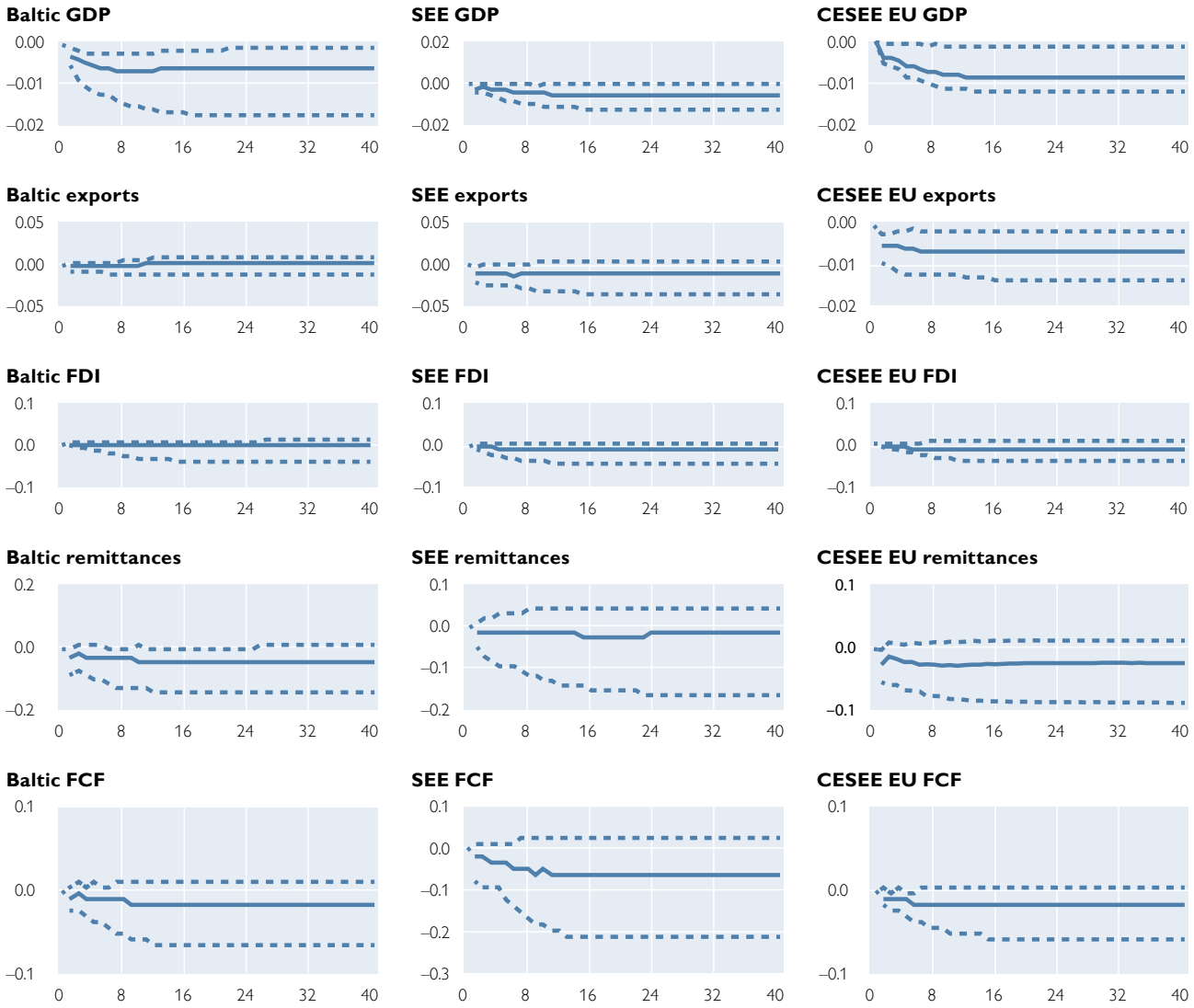
On average, all regions experience a fall in foreign credit flows of 1% to 5% following a negative shock to EU-15 GDP. The impulse response functions stabilize after about 8 quarters. The effect is strongest in the SEE countries; however, it appears to be statistically insignificant, though close to the 10% borderline of statistical significance, across all regions.

All regions experience a fall in remittances of 1% to 5% following a negative shock to EU-15 GDP. The impulse response functions stabilize after about 8 quarters. However, the effect appears to be statistically insignificant across all regions except for the Baltic countries, where it appears to be at the 10% borderline of statistical significance.

[10] *The average share of exports from the Baltic countries to the EU-15 during the period 2005–2007 was 65% of their total exports.*

Chart 2

Regional impulse response functions of GDP, exports, FDI, remittances and foreign credit flows following a one-standard-error shock to EU-15 GDP



Source: Author's calculations.

Note: The chart shows median generalized impulse responses following a one-standard-error fall in EU-15 GDP, together with the 90% confidence bands. The impact is in percentages and the horizon is quarterly. FCF = foreign credit flows.

Finally, we analyze the impact of GDP shocks in advanced EU countries on European transition countries' output in subsamples which are defined by various country characteristics: EU membership, level of foreign bank ownership and level of openness. Consequently, we address one of the main aims of this study, i.e. to analyze whether a country's structural characteristics influence the transmission of global shocks. In addition, splitting the sample in various ways also enables us to deal with country heterogeneity in a more careful manner, since the subsamples analyzed here consist of more homogenous groups than the entire sample of 17 transition countries. The results suggest that non-EU members, countries with higher levels of foreign bank ownership and more open transition countries experience a more

severe output decline as a result of shocks in EU-15 GDP. Impulse response functions are presented in chart A1 in the annex.

3.2.2 The effects of increased financial stress in the EU-15

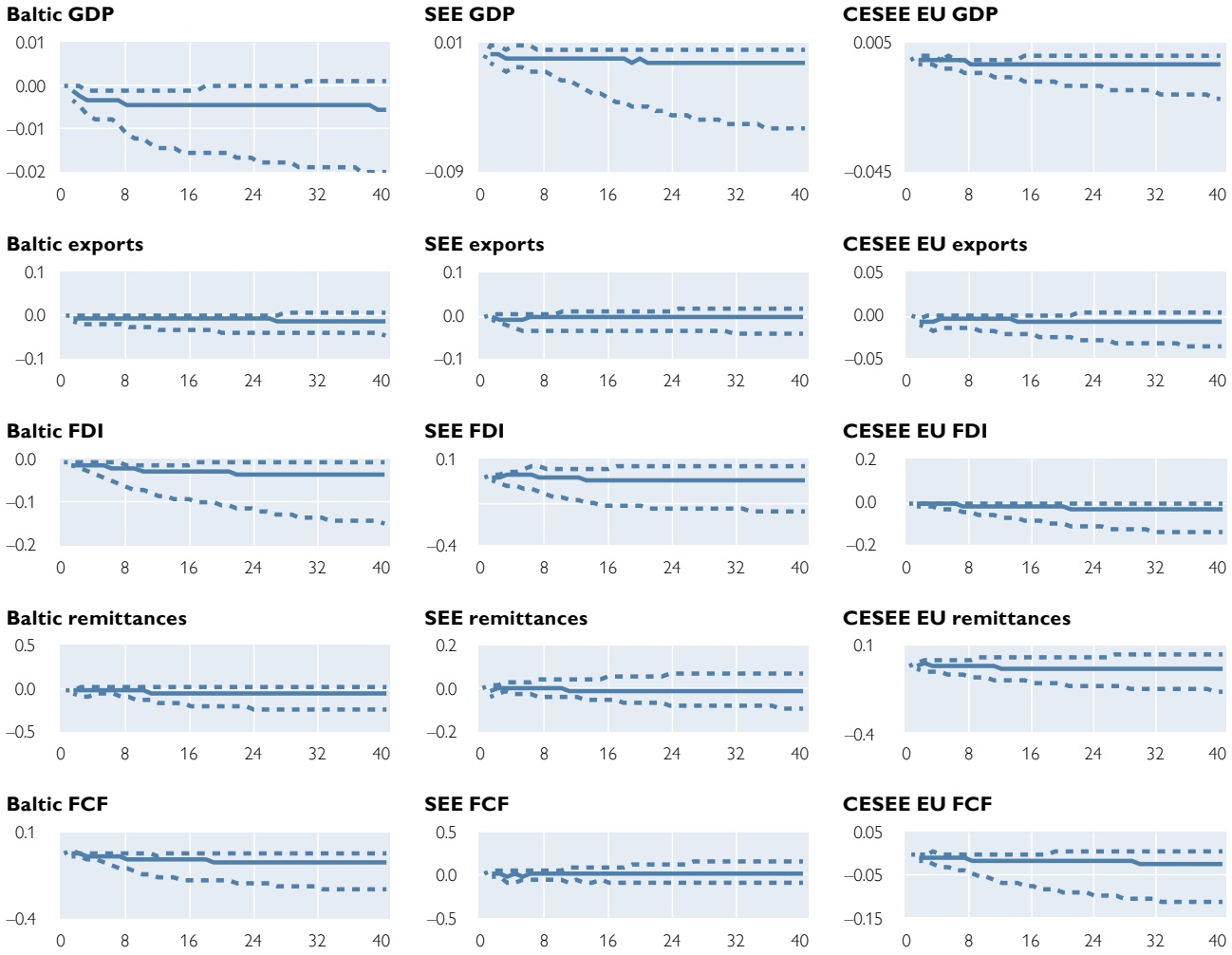
In this subsection, the baseline model is modified in two ways. First, given the relatively small number of observations included in the baseline model, the dataset is extended by using observations from the first quarter of 1999 to the fourth quarter of 2014 to estimate the 16 country/region-specific VARX* models. However, due to lack of data, two countries were dropped from the estimation (Kosovo and Montenegro). Second, given this study's objective of analyzing the macroeconomic effects of increased global financial market volatility, we include an indicator to measure the systemic stress in advanced economies in our framework. This indicator for advanced economies is the composite indicator of systemic stress (CISS), constructed by Holló et al. (2012), which measures the contemporaneous state of instability in the financial system. The CISS can be interpreted as a measure of systemic risk that has already materialized (Holló et al., 2012).

The CISS is composed of 15 mostly market-based financial stress measures, equally split into five categories: the financial intermediaries sector, money markets, equity markets, bond markets and foreign exchange markets. Together, these represent the most important segments of an economy's financial system.

The rest of this subsection reports the effects of a one-standard-error positive shock to the CISS in the EU-15 on five variables of interest: GDP, exports, FDI, foreign credit flows and remittances. The generalized impulse responses of GDP to the shock in the EU-15 CISS are presented in chart 3 below. As can be seen in this chart, the positive shock to the EU-15 CISS results in GDP decreases in all regions included in our model. The Baltic countries display the most severe and statistically significant impact from the shock in their GDP, with a decline of 0.1% on impact, which intensifies to 0.5% by the eighth quarter and then stabilizes in the following periods. The CESEE EU countries also show a severe impact from the shock to the EU-15 CISS, with a decline of their GDP by 0.1% on impact, which doubles to 0.2% by the eighth quarter. The effect is not statistically significant in SEE countries. As expected, exports are also negatively affected by the CISS shock in the EU-15, their decline ranging from 0.5% to 1%. Their impulse response pattern is similar across all regions, showing an initial decline in exports of 0.5% during the first two quarters following the shock, and then oscillating and dissipating in about five to eight quarters. From a regional perspective, exports from Baltic countries appear to be most severely affected by a shock to the EU-15 CISS, even though the impact is at the borderline of the 10% statistical significance level. The exports of CESEE EU countries also display a severe and statistically significant impact from a shock to the EU-15 CISS. The effect is less significant statistically in the SEE region. When it comes to FDI, the Baltic countries display the most severe and statistically significant impact from the shock in the EU-15 CISS, with an FDI decline of 1% on impact, which then rises to 3% by the eighth quarter. Similar behavior of the impulse response is observed across the examined CESEE EU countries. The generalized impulse responses of FDI are weaker and clearly statistically insignificant for the SEE countries. The generalized impulse responses of remittances are clearly statistically insignificant for all regions. The generalized impulse responses of foreign credit flows are the strongest in the Baltic countries;

Chart 3

Regional impulse response functions of GDP, exports, FDI, remittances and foreign credit flows following a one-standard-error shock to the EU-15 CISS



Source: Author's calculations.

Note: The chart shows median generalized impulse responses following a one-standard-error fall in the EU CISS, together with the 90% confidence bands. The impact is in percentages and the horizon is quarterly. FCF = foreign currency flows.

foreign credit flows decline by 5% by the eighth quarter, while their response is weaker and clearly statistically insignificant for SEE countries. CESEE EU countries also show a decline in foreign credit flows following a shock in the CISS of the EU-15.

4 Conclusions

Employing a GVAR approach, we analyzed the international transmission of shocks from advanced EU economies to European transition countries. Our findings suggest that the transmission of shocks from EU-15 GDP to European transition countries' GDP is stronger in all regions when using trade weights to construct the foreign country-specific variables, indicating that trade linkages represent a significant channel of shock transmission from advanced EU economies to European transition countries.

While the estimated spillovers from shocks to GDP and the financial stress index in the EU-15 to European transition countries are negative, they vary considerably

across regions. More specifically, the Baltic countries' GDP shows the most severe and statistically significant impact from the shocks to both GDP and the financial stress index in the EU-15. The shocks appear to be propagated to the Baltic countries mainly through foreign credit flows, FDI and remittances, suggesting that the financial channel, particularly foreign credit flows, played a major role in the transmission of shocks to these countries. An important transmission mechanism of the recent GFC previously identified in the literature is the global restriction of credit. It is well known that a higher level of foreign bank presence[11] may expose a country to foreign shocks and may tighten liquidity conditions during a crisis, as parent banks reallocate capital across borders, and therefore capital may be withdrawn from a transition country when it is needed in the bank's home country (Cetorelli and Goldberg, 2011). In addition, previous empirical studies (Popov and Udell, 2012; Haas and Lelyveld, 2014) have shown that foreign bank subsidiaries in emerging Europe reduced lending earlier and faster than domestic banks. Further investigation revealed evidence consistent with this conjecture. The results of the impulse response functions of shock transmission from advanced EU economies to European transition countries, when broken down in subsamples defined by the level of foreign bank ownership, suggest that shocks in EU-15 GDP cause a more severe and statistically significant output decline in countries with higher levels of foreign bank ownership.

The SEE transition countries also display a severe impact from the shock to EU-15 GDP, with a decline of their GDP by 0.3% on impact, which increases to 0.6% and stabilizes by the eighth quarter. The shock is propagated to the SEE countries through exports, FDI and foreign credit flows. However, the examined SEE countries do not appear to be affected by a shock to the EU-15 CISS; the impulse response functions are clearly statistically insignificant for all the variables, possibly due to the relative lack of development of the financial sector, which in the main has not been affected by risky and unsafe financial instruments.

The CESEE EU countries are less severely affected by the shock to EU-15 GDP, possibly because they represent more advanced transition countries. Belke et al. (2009) have shown that a more advanced level of development has a positive effect on institutional quality as measured by the World Bank's Worldwide Governance Indicators, which increases countries' ability to deal with external shocks. In general, the institutional characteristics that may shape the impact of external shocks are related to the quality of developed institutions, progress with transition to a market economy and the quality of government policymaking. Therefore it seems that CESEE EU countries are more able to offset crisis effects and thus contribute to the resilience of European transition countries. This argument is supported by further investigation in this study. Compared to non-EU transition countries, EU transition countries display a more severe and statistically significant output decline as a result from the shock in EU-15 GDP. The shock is mainly propagated to CESEE EU countries through the export channels, probably due to stronger trade linkages with the EU-15.

For SEE countries, there may have been some advantages to their lack of financial development. Conversely, our findings for the CESEE EU countries suggest that

[11] *The average share of foreign bank assets in the Baltic region during the period 2000–2014 was 83%.*

there are advantages to institutional development. This contrast may suggest that, while institutional development with respect to governance – including a capacity for monetary and fiscal stabilization through policymaking – and well-functioning markets are unambiguously positive from the perspective of being able to adjust to external shocks, financial development may be a "mixed blessing," bringing both benefits and costs.

References

Andrews, D. W. and W. Ploberger. 1994. Optimal tests when a nuisance parameter is present only under the alternative. In: Econometrica 62(6). 1383–1414.

Balavac, M. and G. Pugh. 2016. The link between trade openness, export diversification, institutions and output volatility in transition countries. In: Economic Systems 40(2). 273–287.

Belke, A., I. Bordon, I. Melnykovska and R. Schweickert. 2009. Prospective membership and institutional change in transition countries. Kiel Working Paper 1562.

Berglöf, E., Y. Korniyenko, J. Zettelmeyer and A. Plekhanov. 2009. Understanding the crisis in emerging Europe. EBRD Working Paper 108.

Berkmen, P., G. Gelos, R. Rennhack and J. Walsh. 2009. The global financial crisis: Explaining cross-country differences in the output impact. IMF Working Paper 280.

Blanchard, O., M. Das and H. Faruquee. 2010. The initial impact of the crisis on emerging market countries. In: Brookings Papers on Economic Activity. Spring 2010. 263–307.

Bussière, M., A. Chudik and G. Sestieri. 2009. Modelling global trade flows: results from a GVAR model. ECB Working Paper Series No. 1087.

Cetorelli, N. and L. S. Goldberg. 2011. Global banks and international shock transmission: Evidence from the crisis. In: IMF Economic Review 59(1). 41–76.

Chen, Q., A. Filardo, D. He and F. Zhu. 2016. Financial crisis, US unconventional monetary policy and international spillovers. Journal of International Money and Finance 67(2016). 62–81.

Chudik, A. and M. Fratzscher. 2011. Identifying the global transmission of the 2007–2009 financial crisis in a GVAR model. In: European Economic Review 55(3). 325–339.

Chudik, A. and M. H. Pesaran. 2016. Theory and practice of GVAR modelling. In: Journal of Economic Surveys 30(1).165–197.

Claessens, S., G. Dell'Ariccia, D. Igan and L. Laeven. 2010. Cross-country experiences and policy implications from the global financial crisis. In: Economic Policy 25(62). 267–293.

Corsetti, G., P. Pesenti and C. Tille. 2000. Competitive Devaluations: Toward a Welfare-Based Approach. In: Journal of International Economics 51(1). 217–41.

Davidson, J. 2002. A model of fractional cointegration, and tests for cointegration using the bootstrap. In: Journal of Econometrics 110(2). 187–212.

Dées, S., F. Di Mauro, M. H. Pesaran and L. V. Smith. 2007. Exploring the international linkages of the euro area: a global VAR analysis. In: Journal of Applied Econometrics 22 (32). 1–38.

Dées, S., M. H. Pesaran, L. V. Smith and R. P. Smith. 2009. Identification of new Keynesian Phillips curves from a global perspective. In: Journal of Money, Credit and Banking 41(7). 1481–1502.

Di Mauro, F. and M. H. Pesaran. 2013. The GVAR Handbook: Structure and Applications of a Macro Model of the Global Economy for Policy Analysis. Oxford: Oxford University Press.

Dornbusch, R., Y. C. Park and S. Claessens. 2000. Contagion: understanding how it spreads. In: The World Bank Research Observer 15(2). 177–197.

Dovern, J. and B. van Roye. 2013. International transmission of financial stress: evidence from a GVAR. Kiel Working Paper 1844.

Eichengreen, B., A. K. Rose and C. Wyplosz. 1996. Contagious currency crises. National Bureau of Economic Research 5681.

Eickmeier, S. and T. Ng. 2011. How do credit supply shocks propagate internationally? A GVAR approach. Deutsche Bundesbank Discussion Paper Series 1 No. 27/2011.

Elliot, B. E., T. J. Rothenberg and J. H. Stock. 1996. Efficient tests of the unit root hypothesis. In: Econometrica 64(8). 13–36.

Forbes, K. J. 2002. Are trade linkages important determinants of country vulnerability to crises? In: Preventing currency crises in emerging markets (77–132). University of Chicago Press.

Fratzscher, M. 2012. Capital flows, push versus pull factors and the global financial crisis. In: Journal of International Economics 88(2). 341–356.

Galesi, A. and S. Sgherri. 2009. Regional financial spillovers across Europe: a global VAR analysis. International Monetary Fund Working Paper No. 09/23. 9–23.

Glick, R. and A. K. Rose. 1999. Contagion and trade: Why are currency crises regional? In: Journal of International Money and Finance 18(4). 603–617.

Haas, R. and I. Lelyveld. 2014. Multinational banks and the global financial crisis: Weathering the perfect storm? In: Journal of Money, Credit and Banking 46(s1). 333–364.

Harbo, I., S. Johansen, B. Nielsen and A. Rahbek. 1998. Asymptotic inference on cointegrating rank in partial systems. In: Journal of Business & Economic Statistics 16(4). 388–399.

Hollo, D., M. Kremer and M. Lo Duca. 2012. CISS – a composite indicator of systemic stress in the financial system. ECB Working Paper Series No. 1426.

Johansen, S. 1992. Cointegration in partial systems and the efficiency of single-equation analysis. In: Journal of Econometrics 52(3). 389–402.

Juvenal, L. and P. S. Monteiro. 2017. Trade and synchronization in a multi-country economy. In: European Economic Review 92. 385–415.

Kilian, L., A. Rebucci and N. Spatafora. 2009. Oil shocks and external balances. In: Journal of International Economics 77(2). 181–194.

Lane, P. R. and G. M. Milesi-Ferretti. 2011. The cross-country incidence of the global crisis. IMF Economic Review 59(1). 77–110.

Leybourne, S., T. H. Kim and P. Newbold. 2005. Examination of some more powerful modifications of the Dickey–Fuller test. In: Journal of Time Series Analysis 26(3). 355–369.

MacKinnon, J. G., A. A. Haug and L. Michelis, L. 1999. Numerical distribution functions of likelihood ratio tests for cointegration. Journal of Applied Econometrics 14(5). 563–577.

Milesi-Ferretti, G. M. and C. Tille. 2011. The great retrenchment: international capital flows during the global financial crisis. In: Economic Policy 26(66). 289–346.

Nickel, C. and I. Vansteenkiste. 2013. The international spillover of fiscal spending on financial variables. In: Di Mauro, F. and M. Hashem Pesaran. 2013. The GVAR Handbook: Structure and Applications of a Macro Model of the Global Economy for Policy Analysis. Oxford University Press.

Park, H. J. and W. A. Fuller. 1995. Alternative estimators and unit root tests for the autoregressive process. In: Journal of Time Series Analysis 16(4). 415–429.

Pesaran, M. H., T. Schuermann and S. M. Weiner. 2004. Modeling regional interdependencies using a global error-correcting macroeconometric model. In: Journal of Business and Economic Statistics 22(2). 129–162.

Pesaran, M. H., T. Schuermann, B. J. Treutler and S. S. Weiner. 2006. Macroeconomic dynamics and credit risk: a global perspective. In: Journal of Money, Credit and Banking 38(5). 1211–1261.

Pesaran, M. H., T. Schuermann and L. V. Smith. 2009. Forecasting economic and financial variables with global VARs. In: International Journal of Forecasting 25(4). 642–675.

Pesaran, M. H. and Y. Shin. 1996. Cointegration and speed of convergence to equilibrium. In: Journal of Econometrics 71(1). 117–143.

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

Pesaran, M. H., Y. Shin and R. J. Smith. 2000. Structural analysis of vector error correction models with exogenous I (1) variables. In: Journal of Econometrics 97(2). 293–343.

Pesaran, M. H. and R. Smith. 2006. Macroeconometric Modelling with a Global Perspective. In: The Manchester School 74(1). 24–49.

Ploberger, W. and W. Krämer. 1992. The CUSUM test with OLS residuals. In: Econometrica 60(2). 271–285.

Popov, A. and G. F. Udell. 2012. Cross-border banking, credit access, and the financial crisis. In: Journal of International Economics 87(1). 147–161.

Ratha, D. and W. Shaw. 2007. South–South Migration and Remittances, World Bank Working Paper 102.

Rebucci, A. and N. Spatafora. 2006. Oil prices and global imbalances. In: IMF World Economic Outlook 4(2006). 71–96.

Rose, A. and M. Spiegel. 2009a. Cross-Country Causes and Consequences of the 2008 Crisis: International Linkages and American Exposure. NBER Working Paper 15358.

Rose, A. and M. Spiegel. 2009b. Cross-Country Causes and Consequences of the 2008 Crisis: Early Warning. NBER Working Paper 15357.

Rose, A. and M. Spiegel. 2010. Cross-country causes and consequences of the 2008 crisis: International linkages and American exposure. In: Pacific Economic Review 5(3). 340–363.

Rose, A. and M. Spiegel. 2011. Cross-country causes and consequences of the crisis: An update. In: European Economic Review 55(3). 309–324.

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

Annex: model specification

Table A1

Chosen lag length and cointegration rank

Country	P	q	Number of cointegrating relations based on Johansen trace statistics	Final number of cointegrating relations
Albania	1	1	5	2
Bosnia and Herzegovina	1	1	3	2
Bulgaria	1	1	4	4
Croatia	1	1	3	3
Czech Republic	1	1	4	4
Estonia	1	1	3	3
EU-15	1	1	0	0
Hungary	1	1	2	2
Kosovo	1	1	2	2
Latvia	1	1	4	4
Lithuania	1	1	3	3
FYR Macedonia	1	1	3	3
Montenegro	1	1	4	1
Poland	1	1	3	3
Romania	1	1	3	3
Serbia	1	1	2	2
Slovakia	1	1	3	3
Slovenia	1	1	4	4

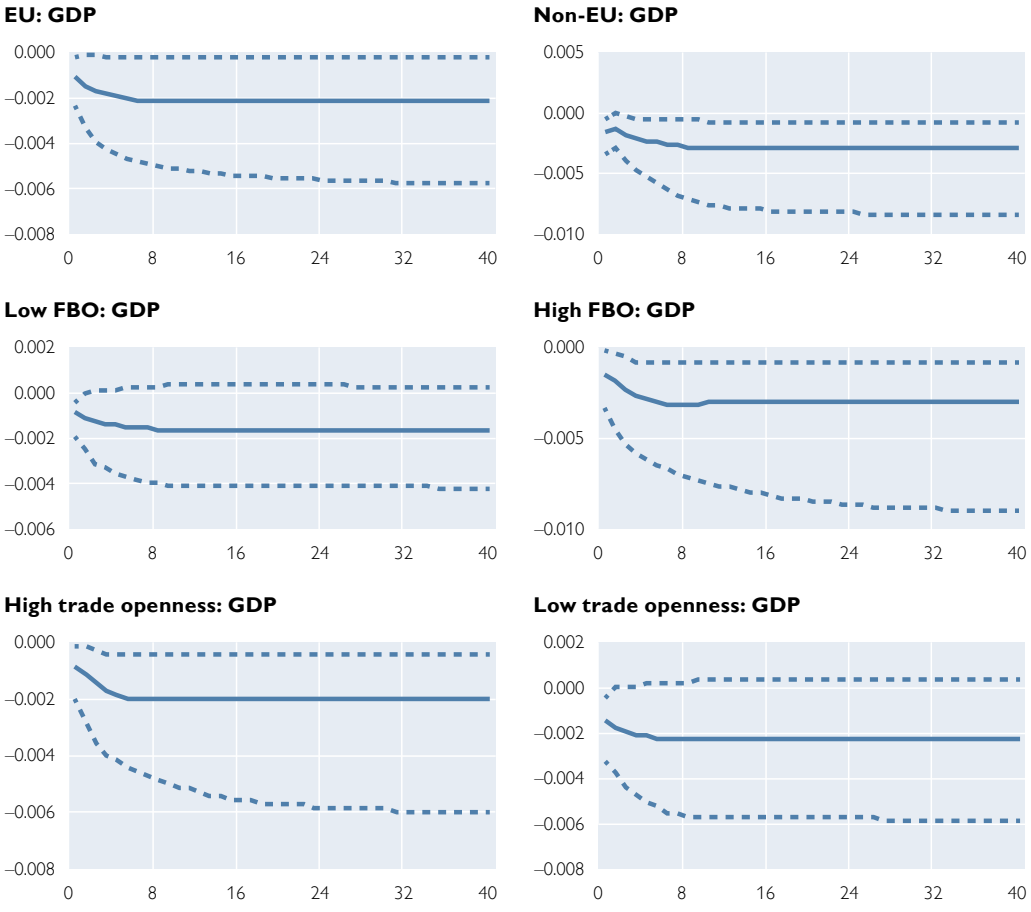
Source: Author's compilations.

The choice of cointegration rank is a crucial step in the empirical analysis since a misspecification of the long-run relationships can destabilize the GVAR model and distort the results and impulse response functions (Bussière et al., 2009). The formal test for cointegration, the trace test or the Johansen test, as set out in Pesaran et al. (2000) for models with weakly exogenous I(1) regressors, is based on the null of a unit root. The VARX* can manage within-country and between-country cointegration, and as a result country-specific foreign variables also need to be considered for long-run relationships (Pesaran and Smith, 2006), as there are many international long-run relationships, e.g. the relationship between remittances and remittance-sending countries' economic performance (GDP). The rank orders

of the VARX models are estimated based on Johansen's trace statistics, as set out in Pesaran et al. (2000) for models with weakly exogenous I(1) regressors. The critical values for models including weakly exogenous variables are obtained from MacKinnon et al. (1999). Because the GVAR model with the chosen number of cointegrating relations based on Johansen trace statistics was not stable, i.e. there were a number of eigenvalues lying above the unit circle and the persistent profiles did not converge to zero even after 40 periods, following Smith and Galesi (2013), we then decreased the number of cointegrating relations in the countries where the persistence profiles did not converge to zero after 40 periods, or where they did converge to zero in a manner that clearly indicated a problem in the underlying vector. Table A1 reports the final order of the VARX* models and the number of cointegration relations.

Chart A1

Impulse response functions of GDP following a one-standard-error shock to EU-15 GDP (EU membership, foreign bank ownership, trade openness)



Source: Author's calculations.

Note: The chart shows median generalized impulse responses to a one-standard-error fall in EU-15 GDP, together with the 90% confidence bands. The impact is in percentages and the horizon is quarterly. EU = European transition countries that are EU members; non-EU = European transition countries that are not yet members of the EU; FBO = foreign bank ownership.