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Modelling Export Dynamics in the CSEE Countries Using GVAR Model

S. Jakšić, B. Žmuk

***Abstract*—**The paper investigates the key factors of export dynamics for a set of Central and Southeast European (CSEE) countries in the context of current economic and financial crisis. In order to model the export dynamics a Global Vector Auto Regressive (GVAR) model is defined. As opposed to models which model each country separately, the GVAR combines all country models in a global model which enables obtaining important information on spillover effects in the context of globalisation and rising international linkages. The results of the study indicate that for most of the CSEE countries, exports are mainly driven by domestic shocks, both in the short run and in the long run. This study is the first application of the GVAR model to studying the export dynamics in the CSEE countries and therefore the results of the study present an important empirical contribution.

***Keywords*—**Export, GFEVD, Global VAR, International trade, weak exogeneity.

I. Introduction

ONE of the most important features of the recent global economic and financial crisis was the abrupt decline of the international trade. As active participants and members of economic and trade integrations, the countries of Central and Southeast Europe (CSEE) were no exception. However, while the decrease of exports was a common denominator to all of the CSEE countries, the pattern that followed in the aftermath of the crisis, varied across countries (Fig. 1). Fig. 1 illustrates the severity and synchronicity of the export decline in the CSEE countries, but also at the international level (world, USA, and European Union exports (EU-27) are also depicted for comparison purposes). All analysed countries experienced continuous growth of export until the beginning of 2008 when a sharp decrease in exports occurred. The decrease lasted approximately one year when the trend shifted its direction from downward to upward. World export is now 6% higher compared to pre-crisis peak in 2008 while the US export is now 18% higher than before the crisis. However, the upward trend did not last for long and turned to a stagnating pattern. On the other hand, the export of the European Union (the EU-27) has not yet returned to the pre-crisis level. Analysed CSEE countries share the same trends as the EU-27 with the exception of three countries (Slovak Republic, Bulgaria, and Romania) that have higher exports than before the crisis and Czech Republic and Poland that returned their exports to the pre-crisis level. The worst situation is in Croatia where recovery and return to the upward trend is still out of sight.

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Export dynamics of the CSEE countries is under the influence of the export dynamics in the EU-27 (its main trading partner) which is, in turn, influenced by crisis that originated in the US economy (one of the main trading partners of the EU-27). Therefore, Fig. 1 illustrates the complexity of the analysis of export dynamics and its key determinants, as well as the need for a global macroenometric model that would account for these complex interactions. Hence, in explaining the dynamics it is necessary to model the US economy as the country from which the recent crisis originated and Germany as a country through which the crisis was transmitted to the CSEE countries. The question that follows from the observed patterns in Fig. 1 is: why some countries saw almost immediate recovery in the aftermath of the crisis while others continue to struggle even few years following the start of the crisis? This article tries to shed light on this issue and tries to address the key determinants that could explain the difference in the pattern of the response. Considering the international linkages of the economies under study and increasing globalisation as well as economic and financial integration, it is obvious that spillovers have to be modelled. Therefore, GVAR approach [1] was applied because it enables modelling of the international linkages unlike the usual unrestricted VAR models that model each economy separately (thus neglecting possible interactions between economies) or panel models, where countries are often treated as independent units which could lead to neglectance of important spillovers among countries.

The results of this study point out the importance of domestic demand and diversification. Namely, countries in which domestic variables are the main determinant of export dynamics and that are not highly exposed to only one or two countries, managed to increase their exports above the pre-crisis peak. Countries in which German economy is one of the key factors of export dynamics did not manage to rise their exports above the pre-crisis value. Furthermore, the results of the study reveal that the real exchange rate is not the key factor of export dynamics (with the exception of Croatia).

The paper is organized as follows: following the literature review, the GVAR methodology applied in this paper is briefly described in Section III. Section IV presents a short description of the data set used in this study and lists the sources from which the data were obtained. The empirical results for the trade model are analysed in Section V. Section VI concludes with a brief summary of the main results and suggestions for further steps in research.

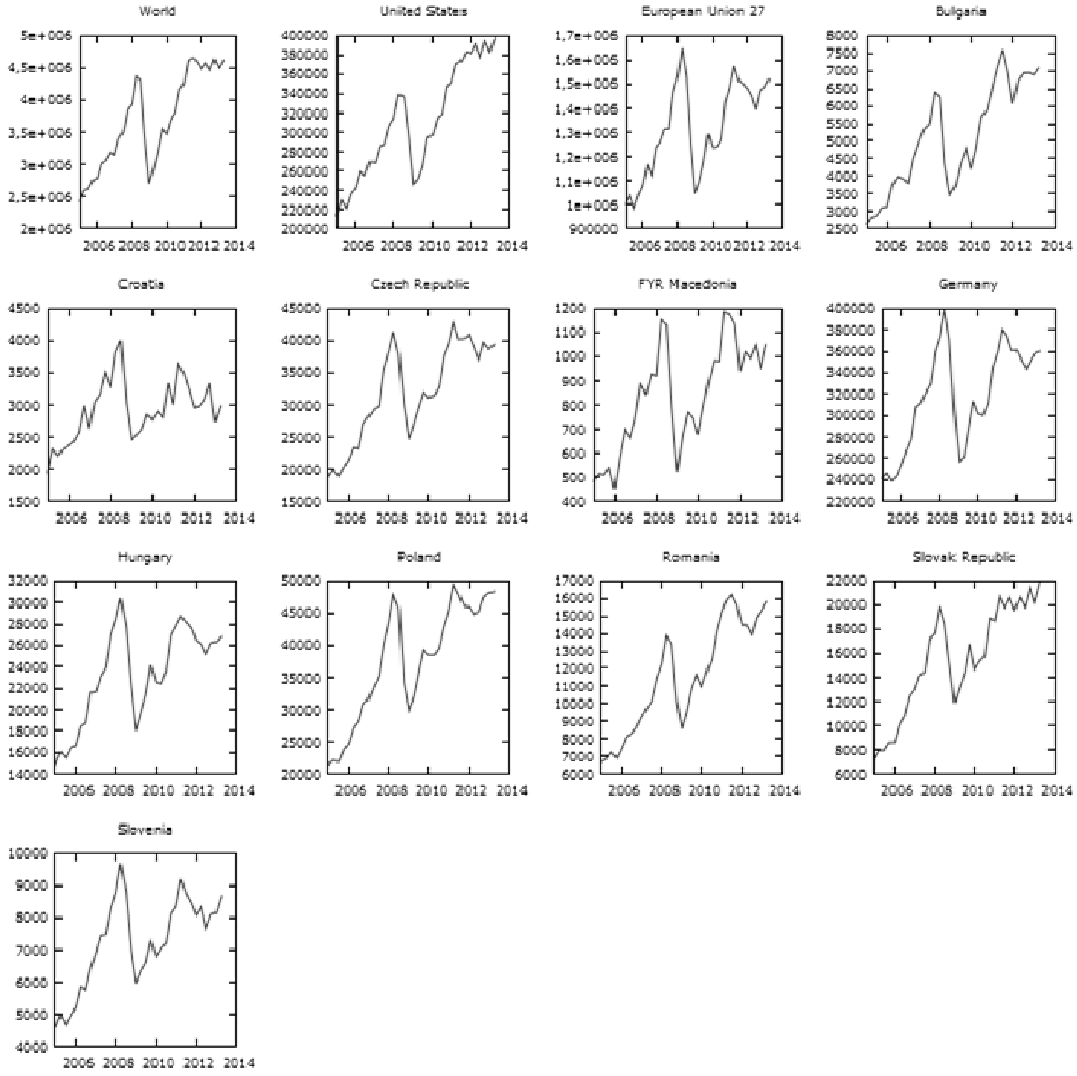

Fig. 1 Export in millions of dollars, selected countries, observed period 2005Q1-2013Q2 [2]

II. Review of the Literature

Instead of focusing on the vast literature regarding a wide range of topics on the international trade, the authors emphasised studies that analysed export dynamics in the CSEE countries. Moreover, the literature review includes studies that illustrate the main applications of the GVAR approach in the context of the international trade. This paper is the first attempt to model a set of CSEE countries in a global macroeconometric framework. There are papers that analyse CSEE countries' export dynamics but in separate models, thus ignoring possible interactions and spillovers. Reference [3] made an insight on Bulgaria's export competitiveness in the framework of EU accession. The analysis has shown low export performance in terms of diversification, factor intensity and technological sophistication and a significant lagging behind other CSEE countries. The authors concluded that the integration within the EU so far has not had significant positive effect on the Bulgaria's export growth especially considering high technology products. Reference [4] used constant market share method to compare the competitiveness of Romanian exports with five CSEE countries. The authors conclude that the Czech Republic, Poland and Slovakia have lower effect of competitiveness than the total effect, which means that the structural effect is positive. Reference [5] analyzed the relationship between exports, investments and economic development in Bulgaria and Romania using a multivariate autoregressive VAR model. The results of cointegration analysis and Granger causality tests showed strong causal relation between economic growth and exports as well as between investments and exports for the two countries. Reference [6] examines the structural characteristics of exports and imports of Croatian manufacturing. In the empirical analysis of the export and import trends various indicators were used. The indicators revealed an insufficient level of trade specialization in domestic manufacturing. Reference [7] used matched sampling techniques in order to

analyse whether firms that start exporting become more productive, controlling for the self-selection into export markets. The research was based on data of Slovenian manufacturing firms from 1994 to 2000. Findings showed that export entrants become more productive once they start exporting.

Although GVAR model was initially designed to study the effect of spillovers and international linkages on the propagation of credit risks, the approach has had numerous other applications and extensions. One of the applications is the analysis of different issues in the international trade. Reference [8] applied a GVAR model to analyse the role of global imbalances. They accounted for structural instability and computed forecasts for a range of events of interest, including the sign and trajectory of the balance of trade. Their analysis showed that GVAR model is being a useful forecasting tool for institutions operating at both the national and supra-national levels. Reference [9] analysed the implications of a slowdown in the US economy on the world economy. Using a GVAR model they measured how the response of exports and imports in third markets amplifies the transmission of demand shock from one country to another. They found that the US business cycle leads the cycles of the other regions, except in the case of the Asian region. Also the paper showed that for all regions, except emerging Asia, linkages with the US appeared stronger than suggested by pure bilateral trade channels. Reference [10] studied foreign direct investment (FDI) and export volume as proxies for two possible transmission channels of the financial shocks. Estimated GVAR model of 21 developing countries and 8 developed countries showed that financial channel has an immediate negative impact on unemployment in developing countries. Reference [11] used a GVAR model in a panel of 21 emerging market and advanced economies to investigate the factors behind the dynamics of global trade flows, with a particular view on the issue of global trade imbalances and on the conditions of their unwinding. The results indicated that the world exports respond much more to a shock to US output than to a real effective depreciation of the dollar. The GVAR model was also used to monitor trade developments. While the fall in imports seems well accounted for by the model, the fall in exports of several countries remains partly unexplained because of specific factors that appeared during the crisis. Reference [12] used a GVAR approach to analyse the effects of exogenous shocks (trade openness and technology) in labour market developments in 12 subsectors of US manufacturing. The results have shown that technology shocks have a more important impact. Reference [13] applied the GVAR model order to investigate the degree of trade linkages and shock transmission between South Africa and the BRIC (Brazil, Russia, India and China) countries. The results pointed out that the trade linkages exist but their magnitudes differ.

III. The GVAR Approach to Global Macroeconometric Modelling

The GVAR approach enables modelling interlinkages on various levels, both national and international [14]. The approach presents an original and practical solution to the "curse of dimensionality" problem that arises in the large scale global macroeconometric models due to the enormous amount of variables in a multi-country setting. Basically, GVAR approach can be summarized as a two step procedure. First, country-specific models are estimated, each containing domestic variables and foreign-specific variables. Although estimated separately country-specific models are connected by entering foreign-specific variables. Foreign-specific variables, defined as weighted averages of the corresponding domestic variables for the remaining countries, act as a proxy for common unobserved factors. Foreign-specific variables are modelled as weakly exogenous I(1) variables which is reasonable assumption considering that analysed CSEE countries are small open economies (SOE). Following that, coefficients estimated in the first step are stacked and solved in a global VAR model in the second step. From that point, solution of a global model can be used to generate forecasts and simulations for policy analysis.

GVAR approach is based on a modified and generalised version of Johansen maximum likelihood approach [15]-[17]. The "curse of dimensionality" problem is circumvented in the estimation stage, defining foreign specific variables by using predetermined coefficients such as trade weights. Under the weak exogeneity assumption, coefficients of the country specific models are estimated on the basis of reduced-rank approach developed by Johansen. Although Johansen's approach is based on the assumption that all variables are endogenous and I(1), the methodology was modified to allow for weakly exogenous I(1) variables [18], [19].

GVAR model analyses *N+1* economies, indexed by *i=0,1,2,…, N*, where index 0 denotes the reference country. In this paper index 0 denotes USA, because of its dominant role in the world economy and as a country from which the recent global crisis originated. Domestic macroeconomic variables are related to its lagged values, deterministic variables (such as trend), foreign-specific variables and with global variables. For country i a VARX*(2,2) model is defined that relates $k_i \times 1$ vector of domestic variables, x_{it}, with x_{it}^*, $k_i^* \times 1$ vector of foreign-specific variables as:

$$\boldsymbol{x}_{it} = \boldsymbol{a}_{i0} + \boldsymbol{a}_{i1}\boldsymbol{t} + \boldsymbol{\Phi}_{i1}\boldsymbol{x}_{i,t-1} + \Phi_{i2}\boldsymbol{x}_{i,t-2} + \boldsymbol{\Lambda}_{i0}\boldsymbol{x}_{it}^* + \boldsymbol{\Lambda}_{i1}\boldsymbol{x}_{i,t-1}^* + \boldsymbol{\Lambda}_{i2}\boldsymbol{x}_{i,t-2}^* + \boldsymbol{u}_{it} \quad (1)$$

for $t = 1,2,\dots,T$, $i = 0,1,2,\dots,N$, where $\boldsymbol{\Phi}_{i1}$ and $\boldsymbol{\Phi}_{i2}$ are $k_i \times k_i$ matrices of coefficients related to lagged domestic variables. $\boldsymbol{a}_{i0}$ and $\boldsymbol{a}_{i1}$ are $k_i \times 1$ vectors of coefficients related to deterministic variables (intercept and trend). $\boldsymbol{\Lambda}_{i0}$ and $\boldsymbol{\Lambda}_{i1}$ $k_i \times k_i^*$ matrices of fixed coefficients related to contemporaneous and lagged foreign-specific variables, and $\boldsymbol{u}_{it}$ (error terms for country specific models) is a $k_i \times 1$ vector of country specific shocks. The approach assumes that $\boldsymbol{u}_{it}$ is serially uncorrelated, with zero mean and non-singular covariance matrix, $\boldsymbol{\Sigma}_{ii} = (\sigma_{ii,\ell s})$, where $\sigma_{ii,\ell s} = cov(u_{i\ell t}, u_{ist})$. Specifically

$$\boldsymbol{u}_{it} \sim i.i.d.(\boldsymbol{0}, \boldsymbol{\Sigma}_{ii}) \tag{2}$$

Although model is estimated on a country-by-country basis, the approach allows for cross-country correlation among the idiosyncratic shocks. Namely,

$$\begin{aligned} E(\boldsymbol{u}_{it}\boldsymbol{u}_{jt}') &= \boldsymbol{\Sigma}_{ij} \text{ for } t = t' \\ &= 0 \text{ for } t \neq t' \end{aligned} \tag{3}$$

Foreign-specific variables, $\boldsymbol{x}_{it}^{*}$, are defined as

$$\boldsymbol{x}_{it}^{*} = \sum_{j=0}^{N} w_{ij}\boldsymbol{x}_{jt} \tag{4}$$

where $w_{ij} \geq 0, \ j = 0,1,2,\dots,N$ are weights such that: $\sum_{j=0}^{N} w_{ij} = 1$ and $w_{ii} = 0$ for every i. Weights w_{ij} reflect importance of country j for the economy of country i. In case of trade weights, w_{ij} is share of country j in the international trade of country i.

After estimating $N+1$ VARX* individual country models (1), individual models are stacked together and the GVAR model is then solved for the world as a whole. Domestic and foreign specific variables are grouped as a $(k_i \times k_i^{*}) \times 1$ vector

$$\boldsymbol{z}_{it} = \begin{pmatrix} \boldsymbol{x}_{it} \\ \boldsymbol{x}_{it}^{*} \end{pmatrix} \tag{5}$$

In order to write each VARX* model (1) as

$$\boldsymbol{A}_{i0}\boldsymbol{z}_{it} = \boldsymbol{a}_{i0} + \boldsymbol{a}_{i1}t + \boldsymbol{A}_{i1}\boldsymbol{z}_{it-1} + \boldsymbol{A}_{i2}\boldsymbol{z}_{it-2} + \boldsymbol{u}_{it} \tag{6}$$

where $\boldsymbol{A}_{i0} = (\mathbf{I}_{k_i}, -\boldsymbol{\Lambda}_{i0}), \ \boldsymbol{A}_{i1} = (\boldsymbol{\Phi}_{i1}, \boldsymbol{\Lambda}_{i1}), \ \boldsymbol{A}_{i2} = (\boldsymbol{\Phi}_{i2}, \boldsymbol{\Lambda}_{i2})$ are $k_i \times (k_i + k_i^{*})$ matrices and are of full rank. Namely, rank $(\boldsymbol{A}_{i0}) = k_i$. After that all domestic variables are collected to form a $k \times 1$ global vector,

$$\boldsymbol{x}_t = (\boldsymbol{x}_{0t}, \boldsymbol{x}_{1t}, \dots, \boldsymbol{x}_{Nt})' \tag{7}$$

$k = \sum_{i=0}^{N} k_i$, containing all endogenous variables. Individual countries are connected to a global model through $(k_i + k_i^{*}) \times k$ country-specific link matrix $\boldsymbol{W}_i$, defined by using trade weights w_{ij},

$$\boldsymbol{z}_{it} = \boldsymbol{W}_i\boldsymbol{x}_t, \qquad i = 0,1,2,\dots,N \tag{8}$$

By substituting (8) into (6) follows $\boldsymbol{A}_{i0}\boldsymbol{W}_i\boldsymbol{x}_t = \boldsymbol{a}_{i0} + \boldsymbol{a}_{i1}t + \boldsymbol{A}_{i1}\boldsymbol{W}_i\boldsymbol{x}_{it-1} + \boldsymbol{A}_{i2}\boldsymbol{W}_i\boldsymbol{x}_{it-2} + \boldsymbol{u}_{it}$, for $i = 0,1,2,\dots,N$.

$N+1$ individual country models are stacked into GVAR(2) model

$$\boldsymbol{G}_0\boldsymbol{x}_t = \boldsymbol{a}_0 + \boldsymbol{a}_1 t + \boldsymbol{G}_1\boldsymbol{x}_{t-1} + \boldsymbol{G}_2\boldsymbol{x}_{t-2} + \boldsymbol{u}_t \tag{9}$$

where $G_0 = \begin{pmatrix} A_{00}W_0 \\ A_{10}W_1 \\ \vdots \\ A_{N0}W_N \end{pmatrix}, G_1 = \begin{pmatrix} A_{01}W_0 \\ A_{11}W_1 \\ \vdots \\ A_{N1}W_N \end{pmatrix}, G_0 = \begin{pmatrix} A_{02}W_0 \\ A_{12}W_1 \\ \vdots \\ A_{N2}W_N \end{pmatrix},$

$$a_0 = \begin{pmatrix} a_{00} \\ a_{10} \\ \vdots \\ a_{N0} \end{pmatrix}, a_{01} = \begin{pmatrix} a_{01} \\ a_{11} \\ \vdots \\ a_{N1} \end{pmatrix}, u_t = \begin{pmatrix} u_{0t} \\ u_{1t} \\ \vdots \\ u_{Nt} \end{pmatrix}.$$

If matrix $\boldsymbol{G}_0$ is non-singular then (9) can be inverted to obtain reduced form GVAR (2) model

$$\boldsymbol{x}_t = \boldsymbol{b}_0 + \boldsymbol{b}_1 t + \boldsymbol{F}_1\boldsymbol{x}_{t-1} + \boldsymbol{F}_2\boldsymbol{x}_{t-2} + \boldsymbol{\varepsilon}_t \tag{10}$$

where $\boldsymbol{F}_1 = \boldsymbol{G}_0^{-1}\boldsymbol{G}_1, \ \boldsymbol{F}_2 = \boldsymbol{G}_0^{-1}\boldsymbol{G}_2, \ \boldsymbol{b}_0 = \boldsymbol{G}_0^{-1}\boldsymbol{a}_0, \ \boldsymbol{b}_1 = \boldsymbol{G}_0^{-1}\boldsymbol{a}_1, \ \boldsymbol{\varepsilon}_t = \boldsymbol{G}_0^{-1}\boldsymbol{u}_t$.

IV. The GVAR Trade Model for the CSEE Countries

Trade model used in the empirical analysis consists of eleven countries, including nine CSEE countries (data availability restricted the analysis to nine CSEE countries: Czech Republic, Hungary, Poland, Slovak Republic, Slovenia, Bulgaria, Romania, Croatia, and Former Yugoslavia Republic Macedonia). Additionally, two advanced economies are included in the model: USA, to emphasise the context of the study (global economic and financial crisis), and Germany, as the main trading partner in most of the analysed countries, and the country through which the crisis was transmitted to the CSEE countries. Naturally, the trade model includes real exports and imports as the key variables. Also, to proxy for relative prices and foreign demand, the real effective exchange rate and real output are added to the model. Apart from that, oil prices and foreign specific variables are included in the model in order to capture possible unobserved common factors influencing the CSEE countries export dynamics. Although GDP is a common measure of output, it is available only on quarterly basis. So as a proxy for output the industrial production index was used because it is available on monthly basis and thus reacts earlier to external shocks. Monthly data for the period from January 1995 to December 2012 are employed in the study, which makes a total of 216 observations. Data on exports, imports, real effective exchange rates and industrial production indices are obtained from the IFS and OECD databases. Oil prices are obtained from U.S. Department of Energy. All series are seasonally adjusted using the TRAMO/SEATS method within DEMETRA statistical program.

Vector of domestic variables $\boldsymbol{x}_{it}$ contains real output (y_{it}), real effective exchange rate (e_{it}), export (ex_{it}), and import (im_{it}), for $i = 0(US), 1,2,\dots,10$. All variables are in logs. Therefore, vector of domestic variables for country i is $\boldsymbol{x}_{it} = (y_{it}, e_{it}, ex_{it}, im_{it})'$ for $i = 1,\dots,N$. US economy is modelled differently to account for its importance in the world economy. US model also includes the price of oil (p_t^{0}), as an additional endogenous variable $\boldsymbol{x}_{0t} = (y_{0t}, e_{0t}, ex_{0t}, im_{0t}, p_t^{0})'$.

Weights play an important role in a GVAR model as they are used in defining foreign-specific variables and in linking country-specific models. Similar to [1], [20], [21], this paper employs fixed trade weights calculated as average trade flows for the period from 2008 to 2010 (Table I). Although weights can also be time varying and they can be defined on the basis of data other than international trade (capital flows), they

should not introduce additional randomness in the analysis. In defining trade weights IMF Direction of Trade Statistics (DOTS) data on international trade were used. Weights add up to one by column, but not by row. Such inconsistency is due to different ways the countries report their trade. For instance, in some countries certain costs and taxes are included in the trade value, while in other countries they are not included. That is why the exports from country *i* to country *j* are not always equal to imports from country *j* to country *i*.

TABLE I
TRADE WEIGHTS

Country	bug	cze	cro	hun	mac	ger	pol	rum	us	svk	svn
bug	0	0.0055	0.0161	0.0126	0.2137	0.0130	0.0066	0.0845	0.0040	0.0068	0.0153
cze	0.0588	0	0.0557	0.0808	0.0225	0.1908	0.1225	0.0578	0.0239	0.3100	0.0662
cro	0.0140	0.0047	0	0.0201	0.0973	0.0109	0.0047	0.0054	0.0040	0.0050	0.1530
hun	0.0783	0.0500	0.0930	0	0.0473	0.1147	0.0567	0.1871	0.0260	0.1346	0.0964
mac	0.0526	0.0005	0.0301	0.0022	0	0.0031	0.0009	0.0042	0.0006	0.0010	0.0124
ger	0.3898	0.6052	0.4126	0.5457	0.3839	0	0.6782	0.4823	0.8779	0.3681	0.4614
pol	0.0689	0.1262	0.0547	0.0885	0.0424	0.2244	0	0.0842	0.0379	0.1173	0.0677
rum	0.2416	0.0166	0.0236	0.0857	0.0527	0.0458	0.0231	0	0.0119	0.0239	0.0387
us	0.0386	0.0284	0.0685	0.0420	0.0281	0.3130	0.0366	0.0382	0	0.0165	0.0362
svk	0.0308	0.1517	0.0327	0.0987	0.0251	0.0588	0.0594	0.0382	0.0090	0	0.0526
svn	0.0265	0.0112	0.2129	0.0237	0.0870	0.0255	0.0111	0.0181	0.0049	0.0167	0

For all of the CSEE countries, Germany is the most important trading partner, its share ranging from 36.8% in Slovak Republic to 67.8% in Poland. Table I also shows the importance of the inclusion of US economy in the model. Although US trade share with CSEE countries is relatively small (ranging from 1.65% to 6.85%), it takes up 31.3% of trade with Germany. Therefore, shock in the US economy will indirectly, through its impact on German economy, have impact on the CSEE countries.

Using (4), $k_i^* \times 1$ vector of foreign-specific variables (all variables are in logs.) is $\boldsymbol{x}_{it}^* = (y_{it}^*, e_{it}^*, p_t^0)'$ for $i = 1, \dots, N$, and for US economy $\boldsymbol{x}_{0t}^* = (y_{0t}^*, e_{0t}^*)'$.

Foreign export and import are not included in the model. In addition to defining a more parsimonious model, the main reason for their omission is of theoretical nature. Namely, including imports and exports as domestic variables and then foreign imports and exports as foreign-specific variables would lead to theoretical in consistency [8].

Unit root tests indicate that all of the studied variables are *I*(1). Both ADF (Augmented Dickey Fuller) and WS (weighted symmetric) test statistics indicate that all variables (domestic, foreign-specific and global variable) are *I*(1). Out of 87 variables, the results are ambiguous for only one variable (Macedonia's output). Therefore, the empirical analysis is performed under the assumption that all of the variables are *I*(1). Furthermore, weak exogeneity tests indicate that all foreign specific variables are weakly exogenous. Results of the unit root and weak exogeneity tests as well as descriptive statistics for domestic, foreign-specific and global variable are available upon request.

V. Empirical Results

Reference [22] recommend persistence profiles for investigating the speed at which long-run relations converge to their equilibrium values following the shock. Estimated persistence profiles (Fig. 2) indicate that the model is well defined. Empirical results are obtained using GVAR Toolbox 1.1 [14] and are not reported to save space but are available upon request.

To assess the relative importance of various factors of export dynamics generalised forecast error variance decomposition (GFEVD) for CSEE countries exports is estimated. GFEVD estimates the proportion of the variance of the *h*-step ahead forecast errors of each variable that is explained by conditioning on contemporaneous and future values of the non-orthogonalised (generalised) shocks of the system. GFEVD is not sensitive to ordering of the variables in the country specific models which is very useful in the multi-country models like the one applied in this paper. Due to non-zero correlation between errors, the individual shock contributions to the GFEVD need not sum to unity. GFEVD results for CSEE exports are shown in Tables A-I to A-IX in terms of the ten most important determinants at the five-year horizon (60 months). The importance of the variables is ranked according to their contributions in explaining the forecast variance after two years following the shock. Tables also include the sum of the contributions of the ten most important determinants (row Sum 10 in Tables A-I to A-IX) as well as the sum of all contributions (row Total in Tables A-I to A-IX).

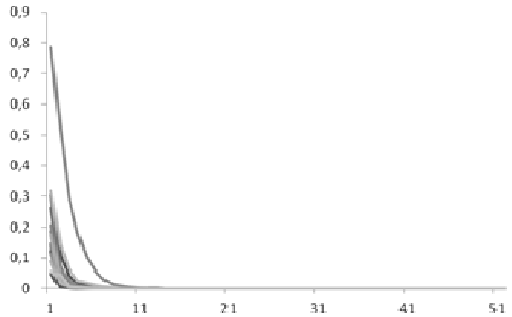

Fig. 2 Persistence profiles of the effect of system wide shocks to the cointegrating relations

Domestic variables explain the most of the forecast variance, both in the short and in the long run, in Slovenia, Slovak Republic, Romania, Poland, Macedonia, Hungary and Bulgaria. It turns out that countries in which domestic variables are the main determinant of export dynamics (both in the short and in the long run) and that are not highly exposed to only one or two countries, managed to increase their exports above the pre-crisis peak (Slovak Republic, Romania and Bulgaria). Countries in which German economy is one of the key factors of export dynamics did not manage to raise their exports above the pre-crisis value (Hungary, Czech Republic, Poland, Slovenia, Croatia).

In Croatia and Czech Republic domestic variables explain the most of the forecast variance, in the short but not in the long run. Furthermore, while Czech Republic has three domestic variables in the top ten determinants, Croatia is the only CSEE country (besides Romania) with only one domestic variable in the top ten determinants. In the long run, the main determinants of Croatian export are the US and German real exchange rates. Croatia is one of few CSEE countries with lower exports compared to the pre-crisis level so all of these findings provide evidence in favour of low competitiveness of Croatian export.

Another interesting finding is that oil prices are among the top ten determinants only in Croatia. Furthermore, the results of the study reveal that the real exchange rate is not the key factor of export dynamics (with the exception of Croatia).

VI. Conclusion

GVAR model applied in this paper differs from previous GVAR applications in few important aspects, but the most important are the country selection and the selection of monthly data. This paper is the first analysis of the exports dynamics for a set of CSEE (ex-transition) countries in a global macroeconometric model. Furthermore, most of the GVAR applications are based on quarterly data. However, as the world economy is becoming more and more globalised and integrated, the transmission of shocks is faster and lower frequency data enable better description of the dynamics.

As guidance for further research, a theoretical refinement of the model, that is basically a theoretical, could provide better interpretations of shocks. Namely, imposing over identifying long-run restrictions as well as structural generalised impulse response analysis could provide better understanding of the main determinants of export dynamics.

Appendix

TABLE A-I
GFEVD of Bulgarian Exports

	0	6	12	24	36	48	60
bug_ex	0.9714	0.9351	0.9211	0.9119	0.9086	0.9070	0.9060
bug_im	0.4452	0.3578	0.3068	0.2760	0.2652	0.2597	0.2564
bug_y	0.0078	0.0478	0.0640	0.0740	0.0775	0.0793	0.0804
svn_ex	0.0462	0.0480	0.0478	0.0478	0.0478	0.0478	0.0478
hun_im	0.0313	0.0340	0.0343	0.0345	0.0347	0.0347	0.0347
cro_y	0.0461	0.0385	0.0347	0.0324	0.0316	0.0312	0.0309
ger_ep	0.0242	0.0273	0.0280	0.0281	0.0282	0.0282	0.0282
ger_im	0.0155	0.0236	0.0262	0.0277	0.0282	0.0284	0.0286
rom_ep	0.0295	0.0264	0.0253	0.0246	0.0244	0.0242	0.0242
mac_im	0.0272	0.0253	0.0247	0.0244	0.0243	0.0243	0.0242
Sum 10	1.65	1.56	1.51	1.48	1.47	1.47	1.46
Total	1.92	1.84	1.79	1.76	1.75	1.75	1.74

TABLE A-II
GFEVD of Croatian Exports

	0	6	12	24	36	48	60
ger_ep	0.0149	0.1578	0.2144	0.2560	0.2734	0.2831	0.2893
us_ep	0.0070	0.0604	0.1413	0.2273	0.2652	0.2863	0.2997
cro_ex	0.9057	0.4642	0.3149	0.1896	0.1357	0.1056	0.0865
ger_im	0.0517	0.0740	0.0877	0.0974	0.1013	0.1035	0.1049
hun_ep	0.0030	0.0290	0.0495	0.0693	0.0779	0.0828	0.0859
ger_ex	0.0299	0.0383	0.0477	0.0579	0.0625	0.0651	0.0668
pol_ep	0.0042	0.0274	0.0430	0.0575	0.0639	0.0675	0.0698
poil	0.0225	0.0834	0.0704	0.0460	0.0348	0.0286	0.0246
ger_y	0.0036	0.0231	0.0253	0.0258	0.0258	0.0259	0.0259
us_im	0.0158	0.0106	0.0142	0.0211	0.0246	0.0265	0.0277
Sum 10	1.06	0.97	1.01	1.05	1.07	1.08	1.08
Total	1.47	1.27	1.26	1.26	1.27	1.27	1.27

TABLE A-III
GFEVD OF CZECH REPUBLIC EXPORTS

	0	6	12	24	36	48	60
ger_ep	0.1087	0.2654	0.2967	0.3144	0.3209	0.3243	0.3264
ger_im	0.1243	0.1380	0.1403	0.1414	0.1418	0.1421	0.1422
cze_y	0.0452	0.0963	0.1065	0.1128	0.1152	0.1165	0.1173
cze_ex	0.7673	0.2749	0.1659	0.0975	0.0721	0.0588	0.0506
ger_ex	0.1970	0.1247	0.1034	0.0903	0.0854	0.0829	0.0814
pol_ep	0.0217	0.0675	0.0790	0.0869	0.0898	0.0914	0.0923
us_ep	0.0264	0.0376	0.0536	0.0657	0.0701	0.0724	0.0738
ger_y	0.0050	0.0356	0.0431	0.0477	0.0494	0.0503	0.0509
cze_im	0.3380	0.1124	0.0696	0.0432	0.0334	0.0283	0.0251
hun_ep	0.0020	0.0245	0.0336	0.0400	0.0425	0.0437	0.0445
Sum 10	1.64	1.18	1.09	1.04	1.02	1.01	1.00
Total	3.14	1.82	1.55	1.38	1.32	1.28	1.26

TABLE A-IV
GFEVD OF HUNGARIAN EXPORTS

	0	6	12	24	36	48	60
hun_y	0.0337	0.1745	0.2293	0.2702	0.2869	0.2959	0.3016
hun_ex	0.8546	0.4952	0.3436	0.2311	0.1852	0.1603	0.1447
hun_im	0.3551	0.2774	0.2230	0.1827	0.1663	0.1574	0.1518
ger_ep	0.0134	0.0923	0.1246	0.1478	0.1572	0.1623	0.1655
ger_im	0.0898	0.1333	0.1382	0.1414	0.1427	0.1434	0.1438
ger_ex	0.1030	0.0963	0.0841	0.0750	0.0713	0.0693	0.0681
ger_y	0.0123	0.0351	0.0442	0.0509	0.0536	0.0551	0.0560
cze_ex	0.1275	0.0840	0.0630	0.0476	0.0414	0.0380	0.0359
cze_im	0.1270	0.0819	0.0607	0.0452	0.0389	0.0355	0.0334
pol_ep	0.0138	0.0315	0.0380	0.0430	0.0451	0.0462	0.0469
Sum 10	1.73	1.50	1.35	1.24	1.19	1.16	1.15
Total	2.88	2.28	1.97	1.73	1.64	1.58	1.55

TABLE A-V
GFEVD OF MACEDONIAN EXPORTS

	0	6	12	24	36	48	60
mac_ex	0.9369	0.9069	0.9013	0.8981	0.8970	0.8964	0.8961
mac_im	0.1294	0.2506	0.2631	0.2700	0.2725	0.2737	0.2745
mac_y	0.0688	0.0995	0.1023	0.1036	0.1041	0.1043	0.1044
hun_ex	0.0477	0.0674	0.0706	0.0727	0.0734	0.0738	0.0740
ger_im	0.0420	0.0625	0.0663	0.0683	0.0690	0.0694	0.0696
hun_im	0.0287	0.0469	0.0496	0.0513	0.0519	0.0522	0.0524
rom_ex	0.0408	0.0488	0.0495	0.0499	0.0501	0.0502	0.0502
svk_ex	0.0375	0.0457	0.0467	0.0473	0.0475	0.0476	0.0476
rom_im	0.0304	0.0390	0.0398	0.0402	0.0404	0.0404	0.0405
ger_ex	0.0241	0.0309	0.0317	0.0322	0.0324	0.0325	0.0325
Sum 10	1.39	1.60	1.62	1.63	1.64	1.64	1.64
Total	1.66	1.92	1.96	1.97	1.98	1.99	1.99

TABLE A-VI
GFEVD OF POLISH EXPORTS

	0	6	12	24	36	48	60
pol_ex	0.9358	0.4316	0.3259	0.2684	0.2492	0.2395	0.2336
pol_y	0.1368	0.1965	0.2047	0.2101	0.2121	0.2131	0.2138
ger_ep	0.0114	0.1602	0.1882	0.2007	0.2047	0.2067	0.2079
ger_im	0.0843	0.1093	0.1185	0.1232	0.1248	0.1256	0.1261
us_ep	0.0009	0.0317	0.0667	0.0925	0.1012	0.1056	0.1083
ger_ex	0.1358	0.0928	0.0826	0.0778	0.0762	0.0755	0.0750
cze_ex	0.1188	0.0486	0.0383	0.0342	0.0329	0.0322	0.0318
svk_ex	0.0691	0.0412	0.0358	0.0332	0.0323	0.0319	0.0316
rom_ex	0.1081	0.0482	0.0368	0.0311	0.0292	0.0283	0.0277
rom_im	0.0863	0.0440	0.0355	0.0310	0.0295	0.0287	0.0283
Sum 10	1.69	1.20	1.13	1.10	1.09	1.09	1.08
Total	2.66	1.67	1.50	1.42	1.39	1.38	1.37

TABLE A-VII
GFEVD OF ROMANIAN EXPORTS

	0	6	12	24	36	48	60
rom_ex	0.8240	0.6871	0.6486	0.6260	0.6187	0.6150	0.6128
us_ep	0.0179	0.0520	0.0709	0.0834	0.0875	0.0895	0.0907
hun_ex	0.0760	0.0713	0.0703	0.0703	0.0704	0.0704	0.0704
ger_im	0.0389	0.0596	0.0627	0.0641	0.0645	0.0647	0.0648
svk_ex	0.0841	0.0686	0.0646	0.0624	0.0617	0.0613	0.0611
svn_im	0.1029	0.0682	0.0598	0.0556	0.0543	0.0536	0.0532
ger_ex	0.0620	0.0589	0.0551	0.0531	0.0525	0.0521	0.0519
hun_ep	0.0152	0.0375	0.0459	0.0512	0.0530	0.0538	0.0544
hun_im	0.0663	0.0551	0.0516	0.0503	0.0499	0.0497	0.0496
ger_ep	0.0153	0.0416	0.0473	0.0496	0.0503	0.0507	0.0509
Sum 10	1.30	1.20	1.18	1.17	1.16	1.16	1.16
Total	2.29	1.89	1.77	1.72	1.70	1.69	1.69

TABLE A-VIII
GFEVD OF SLOVAK REPUBLIC EXPORTS

	0	6	12	24	36	48	60
svk_ex	0.7775	0.7600	0.7527	0.7483	0.7468	0.7460	0.7455
svk_im	0.1579	0.1567	0.1544	0.1529	0.1524	0.1521	0.1519
cze_ex	0.1118	0.1128	0.1152	0.1171	0.1178	0.1181	0.1184
hun_im	0.0830	0.0955	0.0981	0.1000	0.1006	0.1010	0.1012
hun_ex	0.0724	0.0859	0.0894	0.0916	0.0924	0.0928	0.0931
rom_ex	0.0893	0.0901	0.0901	0.0901	0.0902	0.0902	0.0902
ger_im	0.0427	0.0724	0.0781	0.0812	0.0822	0.0828	0.0831
cze_im	0.0969	0.0814	0.0807	0.0808	0.0809	0.0809	0.0810
svn_im	0.0788	0.0793	0.0800	0.0807	0.0810	0.0811	0.0812
ger_ex	0.0661	0.0711	0.0712	0.0714	0.0715	0.0716	0.0716
Sum 10	1.58	1.61	1.61	1.61	1.62	1.62	1.62
Total	2.32	2.35	2.36	2.37	2.37	2.37	2.37

TABLE A-IX
GFEVD OF SLOVENIAN EXPORTS

	0	6	12	24	36	48	60
svn_ex	0.7232	0.4932	0.4424	0.4115	0.4005	0.3948	0.3913
ger_im	0.0995	0.1848	0.2073	0.2207	0.2255	0.2280	0.2295
ger_ex	0.1902	0.1952	0.1921	0.1899	0.1891	0.1887	0.1885
ger_ep	0.0765	0.1315	0.1416	0.1466	0.1483	0.1492	0.1497
svn_im	0.1753	0.1393	0.1373	0.1368	0.1367	0.1367	0.1367
hun_im	0.1043	0.1174	0.1199	0.1215	0.1220	0.1223	0.1225
cze_ex	0.1349	0.1202	0.1196	0.1197	0.1198	0.1198	0.1199
hun_ex	0.0970	0.1099	0.1139	0.1164	0.1172	0.1177	0.1180
rom_im	0.1598	0.1263	0.1184	0.1132	0.1113	0.1103	0.1097
us_im	0.1097	0.1040	0.1025	0.1028	0.1029	0.1030	0.1031
Sum 10	1.87	1.72	1.70	1.68	1.67	1.67	1.67
Total	3.11	2.80	2.73	2.69	2.68	2.67	2.67

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