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THE ROLE OF EXTERNAL SHOCKS IN CROATIA: BLOCK EXOGENEITY SVAR APPROACH

Abstract

The aim of this paper is to analyze the impact of foreign shocks on the Croatian economy in the last decade. The Croatian small open economy (SOE) does not affect prices nor other macroeconomic variables of the foreign sector, but its economic activity depends on foreign economic trends. The crucial characteristic of the small open economy is the exogeneity of foreign variables for the domestic economy, whereat foreign variables impact the domestic economy while the restriction of the model is that domestic variables do not impact foreign variables. Therefore, the structural vector autoregressive (SVAR) model is estimated in order to assess the impact of foreign shocks on the Croatian economy. The impact of the euro area and income and price shocks is analyzed, with the emphasis on the relative importance of domestic versus foreign shocks. The impulse response functions and the variance decomposition analysis have confirmed that the foreign variables have a substantial impact on domestic variables and that the inclusion of the euro area variables is necessary for macroeconomic modelling of the Croatian economy.

Keywords

Block exogeneity restrictions, Foreign shocks, Small open economy (SOE), Structural vector autoregressive (SVAR) model

Acknowledgment: This work has been fully supported by Croatian Science Foundation under the project STRENGTHS (project no. 9402).

1. Introduction

The concept of small open economy has been a subject of research for decades (de Vries, 1973; Kuznets, 1960; Scitovsky, 1960), but a consensus on what characterises the small open economy still has not been reached. Therefore, Davenport (2001) suggested defining the small economy based on its share in the world economy and not based on demographic indicators. Based on the named criterion, a country is to be considered a small economy if its share in the total world trade amounts to less than 0.03%. Namely, small economies, despite their significant trade openness, usually have a very small share in the world trade.

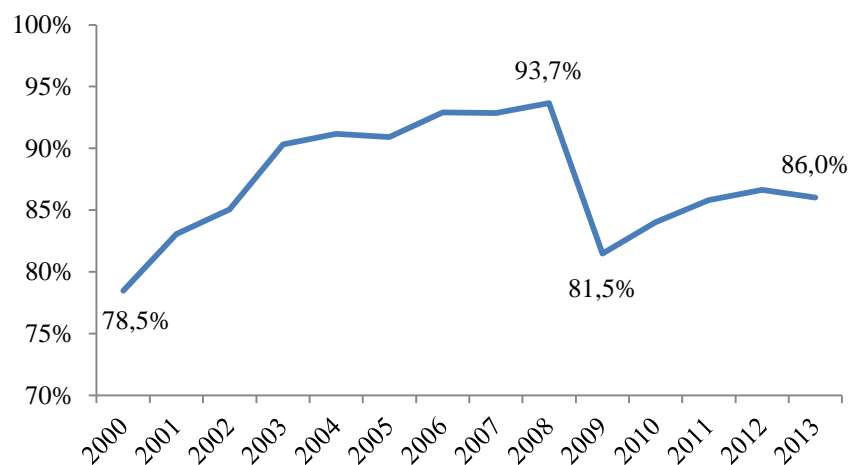
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For many years, empirical research has focused on the effects of macroeconomic shocks and channels of their transmission, especially small and open economies. However, the recent global economic crisis in the period 2008-2009 has additionally emphasised the importance of understanding the source of shocks on key macroeconomic variables.

Defining the variable openness presents a prerequisite for understanding the openness of the Croatian economy. Based on empirical research, openness of an economy is defined as the share of the sum of export and import in the gross domestic product (Kovačević and Tomić, 2012). The openness of the Croatian economy has been shown in Graph 1 using annual data on export, import and GDP. In the period from 2000 to 2008, Croatia was characterised by relatively high coverage of import by export, resulting in a higher openness of the economy, i.e. the average share of foreign trade in GDP amounted to 88.7%. The Republic of Croatia was least open to the international market in 2000, when the share of foreign trade in GDP amounted to 78.5%, while, on the other hand, it was most open to it in 2008 with the named share amounting to 93.7%. However, the beginning of the global crisis changed this trend, i.e. there was a significant decrease in export and even more drastic decrease in import, which consequently resulted in the reduced openness. Consequently, the share of foreign trade in GDP decreased as well and amounted to 81.5% in 2009.



Graph 1 Openness of the Republic of Croatia in the period from 2000 to 2013
Source: Authors' calculations based on the data of the Croatian Bureau of Statistics

The decrease in openness of the Croatian economy, i.e. the decrease of the share of foreign trade in GDP in 2009 is a result of the decrease of economic activity in the euro area member states. As it has been explained in Section 3, the decrease of income in the euro area has resulted in the decrease of the total demand for goods, and consequently the demand for Croatian goods as well.

The Croatian small open economy is characterised by a pronounced openness of the economy, whereby the share of foreign trade in GDP in certain years, for instance in 2008, exceeded 90%. Furthermore, in addition to unfavourable international trade, i.e. strong dependence on export and very weak competitiveness of domestic products, more than half of foreign trade is conducted with the euro area countries. Moreover, the Croatian economy is significantly indebted with the foreign debt amounting to more than 100% of GDP. In addition to a passive monetary policy, resulting from the focus on the currency control

aimed at maintaining price stability, there is also the inability to influence real movements, i.e. insufficient possibilities for using the monetary policy in dealing with shocks. The Republic of Croatia is also characterised by the dependence of its financial sector on the euro area. In other words, due to the unfavourable structure of the national economy, as it has been explained above, all adjustments of the monetary policy by the European Central Bank or changes in the economic activity in the euro area would significantly reflect on economic fluctuations in Croatia (Dumičić and Krznar, 2013).

In line with the empirical facts stated above regarding the SOE of Croatia, the aim of this research is to identify and examine the reaction of the domestic economy to foreign shocks whereat foreign shocks refer to euro area shocks. In other words, the aim of this study is to quantify the domestic and the euro area shocks by assessment of the relative importance of each shock for macroeconomic developments in Croatia.

After the literature overview, the structural vector autoregressive (SVAR) model with block exogeneity restrictions is described and the empirical analysis of the impact of domestic and foreign shocks on the Croatian economy is conducted. Finally, the conclusions of the research are stated as well as limitations of the study and a future research perspective.

2. The overview of the research of domestic and external shocks in Croatia

Authors	Model	Sample	Variables
Broz (2008)	SVAR model with Blanchard- Quah long-run restrictions	1995Q1 - 2006Q4	the domestic and the euro area variables: real GDP, inflation approximated by GDP deflator
Dumitru and Dumitru (2011)	SVAR model with Blanchard- Quah long-run restrictions	1997Q1 - 2009Q2	the domestic and the euro area variables: GDP growth rate, GDP deflator (inflation indicator)
Erjavec, Cota and Jakšić (2012)	SVAR model with Blanchard- Quah long-run restrictions	1998M1 - 2011M9	real relative income expressed as the difference of the real industrial production index in the Republic of Croatia and EU-27), kuna real exchange rate against the euro, relative price level (difference between CPI in the Republic of Croatia and HCPI in EU-27)
Fidrmuc and Korhonen (2001)	SVAR model with Blanchard- Quah long-run restrictions	1995Q1 - 2001Q2	real GDP and inflation
Jovančević, Arčabić and Globan (2012)	VAR model	1997Q1 - 2010Q4; subperiod 2000Q1 - 2010Q4	real GDP cyclical components obtained by HP filter for Austria, France, Germany, Italy, UK and EU-15

Koukouritakis, Papadopoulos and Yannopoulos (2013)	Global VAR (GVAR) model	2000M1 - 2011M12	the domestic and the euro area variables: real effective exchange rate, harmonised consumer price index, industrial production index and money market interest rate; global variable: euro nominal exchange rate against the dollar
Nabil (2009)	SVAR model with Blanchard- Quah long-run restrictions	1997Q1 - 2005Q3	real GDP, CPI (inflation indicator)
Krznar and Kunovac (2010)	VAR model with block exogeneity restrictions	2000Q2 - 2010Q1	real GDP EU, global raw material prices in kuna; GDP EU, production price index and consumer price index
Petrevski, Bogoev and Tevdovski (2013)	SVAR model with block exogeneity restrictions	2000Q2 - 2011Q4	the euro area variables: GDP gap, Euribor, HCPI (inflation indicator); domestic variables: GDP gap, inflation, money market interest rate, the share of public debt in GDP

Table 1 The summary of empirical research of the impact of foreign shocks on the Croatian economy

The most relevant studies which examine the impact of foreign shocks on the Croatian economy are given in Table 1. The detailed analysis of existing literature in Croatia is conducted (for the explanation of methods, see, for example, Žugaj, Dumičić and Dušak, 2006). Fidrmuc and Korhonen (2003), Broz (2008) and Dumitru and Dumitru (2011) did not find that there is a relationship between foreign and domestic economic fluctuations. There could be several reasons for such results. First of all, GDP data for the period before 2000 differ substantially in the way of measurement compared to data for the period after the year 2000, and such data are not consistent and comparable to each other. Secondly, Broz (2008) and Dumitru and Dumitru (2011) use the GDP deflator as an indicator of inflation. However, the GDP deflator measures the prices of all products that are produced in a particular country, whether or not these products are aimed for export. On the other hand, the Consumer Price Index (CPI) measures the prices of goods produced and consumed in a particular country as well as the prices of imported goods. Thus, unlike the GDP deflator, CPI includes import, but excludes export. Since a significant portion of goods in Croatia is imported, it would be more appropriate to use CPI rather than the GDP deflator as an indicator of the price level. Finally, aforementioned authors use data in the period before 2000 in which the Croatian economy was not dependent on external economic developments to a large extent. However, the effect was intensified primarily by the entry of foreign banks to the Croatian banking market. The results of other studies (see Nabil, 2009; Krznar and Kunovac, 2010; Erjavec, Cota and Jakšić, 2012; Jovančević, Arčabić and Globan, 2012; Koukouritakis, Papadopoulos and Yannopoulos, 2013; Petrevski, Bogoev and Tevdovski, 2013) indicate that the Croatian economy is highly vulnerable to the foreign shock, in particular to shocks coming from the euro area.

3. The preparation of data for the empirical analysis

Time series data used for the purpose of the empirical analysis refer to the quarterly data for the period from the first quarter 2000 to the fourth quarter 2013 for Croatia, supplied by the

Croatian National Bank (CNB) as the official source. In order to prepare data for the empirical analysis, certain transformations of variables are conducted, such as the logarithmic transformation and the seasonal adjustment. Moreover, the stationarity of the time series is tested using the augmented Dickey–Fuller test (ADF) as a unit root test (for more details on the ADF test see, for example, Enders (2010)). The results of the ADF test are not presented in the paper due to its conciseness, but are available on request. ADF stationarity testing shows that time series in levels are not stationary, while the first differences of variables are stationary, suggesting that the variables in the model are integrated of order one.

The selected variables are divided into two blocks:

- The first is the foreign block which represents the economy of the euro area. It consists of the growth rate of seasonally adjusted real GDP (DSLBDP_EZ) with the base year 2005=100 and the growth rate of CPI (DLCPI_EZ). The foreign block does not include the referent interest rate in the European interbank market (Euribor) because its inclusion would not contribute to the interpretation of results. The Euribor stems from the Taylor (1993) rule of the European Central Bank, meaning that GDP is taken into account when defining the level of interest rate and therefore the results of the estimated impulse response functions have the same interpretation regardless of whether the model includes only GDP or both the Euribor and GDP (Krznar and Kunovac, 2010).
- The second block refers to the domestic economy, in this case the SOE of Croatia, and consists of the growth rate of seasonally adjusted real GDP (DSLBDP_RH) with the base year 2005 =100, the growth rate of CPI (DLCPI_RH) and the growth rate of seasonally adjusted real exchange rate against the euro (DSLRRER). The domestic block does not include the money market interest rate because the Croatian National Bank does not conduct monetary policy that relies on the interest rate channel and therefore the interest rate does not have a significant role in the financial system, nor the impact on the real sector (Krznar, 2004).

4. The estimation of svar model with block exogeneity restrictions

Despite numerous advantages of the VAR model and its common application in empirical research, Colley and LeRoy (1985) criticised its use. The most common critique of the VAR model refers to the fact that economic theory is not taken into account while defining the model, and variables are not classified as endogenous and exogenous in advance. Sims (1986) and Bernanke (1986) therefore suggested a new model form, the so-called structural vector autoregression model or identified VAR model, overcoming the named flaws. When the SVAR model is used, the analysis is not based on the estimation of autoregression parameters as when the VAR model is used, but the model identification is based on error terms (innovation process) which are interpreted as a linear combination of exogenous shocks.

The reduced form of the VAR model is given by (Lütkepohl and Kratzig, 2004):

$$\Delta y_t = \Pi y_{t-1} + \Gamma_1 \Delta y_{t-1} + \dots + \Gamma_{p-1} \Delta y_{t-p+1} + v_t \quad , \quad (1)$$

whereat $\Pi = A^{-1}\Pi^*$, $\Gamma_j = A^{-1}\Gamma_j^*$, $j=1, \dots, p-1$, $A_j = A^{-1}A_j^*$, $j=1, \dots, p$ and $v_t = A^{-1}B\varepsilon_t$, what relates error terms v_t with the corresponding structural shocks ε_t . For the purpose of the empirical research, vector y_t , which consists of five endogenous variables, is given by:

$$y_t = [DSLBDP_EZ, DLCPI_EZ, DSLBDP_RH, DLCPI_RH, DSLRER].$$

It consists of the growth rate of seasonally adjusted real GDP in the euro area, the growth rate of the price level in the euro area, the growth rate of seasonally adjusted real GDP in Croatia, the growth rate of the price level in the Republic of Croatia and the growth rate of the seasonally adjusted real exchange rate against the euro at the end of period.

In order to estimate the SVAR model, it is necessary to introduce a certain number of constraints on the parameters of the matrix to identify the parameters in the structural form. The Cholesky orthogonalization is used in the formation of accurately identified model. In this case, the order of variables can have a significant effect on the result obtained and the variables are ordered with regard to the economic theory. As it is previously mentioned, Croatia is a SOE which does not have a significant impact on economic developments in the euro area. Therefore, the euro area variables are determined to be the first in the model, followed by the variables which refer to Croatia.

Specifically, the variables introduced into the model are:

- The first variable is the GDP of the euro area, which is considered to have a direct impact on all the other variables in the model.
- The next variable is the price level in the euro area, which is considered not to have an immediate impact on the GDP of the euro area, but it impacts other variables in the model. Therefore, GDP is put prior to the price level.
- The intuition is that it is considered that the euro area is one of the most important world economies, whose demand for certain products may affect the price level in the world market. After the foreign variables, using the same intuition, domestic variables are placed in the model. So, the third variable is the domestic GDP. As it has previously been mentioned, changes in economic activity or price changes in the euro area may be transmitted to the Croatian economy through a trade channel, due to the fact that the euro area is one of the biggest trading partners for Croatia. An increased demand in the euro area leads to the increase in foreign prices, and thus to an increase in demand for Croatian goods, which ultimately increases the GDP of Croatia (Andonova and Petkovska, 2011).
- The last variable in the order is the real exchange rate because it is considered that it responds to changes in the aforementioned variables (Kim and Roubini, 2000).

The following matrix representation describes the abovementioned economic relations:

$$\begin{bmatrix} \varepsilon_t^{DSLBDP_EZ} \\ \varepsilon_t^{DLCPI_EZ} \\ \varepsilon_t^{DSLBDP_RH} \\ \varepsilon_t^{DLCPI_RH} \\ \varepsilon_t^{DSLRER} \end{bmatrix} = \begin{bmatrix} b_{11} & 0 & 0 & 0 & 0 \\ b_{21} & b_{22} & 0 & 0 & 0 \\ b_{31} & b_{32} & b_{33} & 0 & 0 \\ b_{41} & b_{42} & b_{43} & b_{44} & 0 \\ b_{51} & b_{52} & b_{53} & b_{54} & b_{55} \end{bmatrix} \begin{bmatrix} v_t^{DSLBDP_EZ} \\ v_t^{DLCPI_EZ} \\ v_t^{DSLBDP_RH} \\ v_t^{DLCPI_RH} \\ v_t^{DSLRER} \end{bmatrix}$$

Since it is necessary to introduce at least $K(K-1)/2$ restrictions for the identification of the matrix, and thus the structural shocks, using Cholesky decomposition 10 restrictions is

introduced, what allows accurate identification of the model. For the explanation of Cholesky orthogonalization see, for example, Lutkepohl and Kratzig (2004).

It is well known that the shocks in SOEs have very little impact on major foreign countries and therefore it is proper to treat the foreign variables as exogenous to domestic economy. As a result, the model is divided in two blocks: the euro area block and the domestic (Croatian variables) block.

Therefore, the first block represents the foreign euro area economy while the second block to represents the Croatian economy. Thus the vector y_t , which represents the vector of endogenous variables, is to be divided into two blocks what can be written in the following form:

$$y_t = [y_{1t}, y_{2t}]'$$

Vector y_{1t} is comprised of the variables representing euro area economy and it is given by $y_{1t} = [DSLBDP_EU, DSLCPI_EU]$, while y_{2t} represents Croatian economy and is given $y_{2t} = [DSLBDP_RH, DSLCPI_RH, DSLNER]$.

Accordingly, the VAR model may be presented in the following way:

$$y_t = \begin{bmatrix} y_{1t} \\ y_{2t} \end{bmatrix}, \Gamma_j = \begin{bmatrix} \Gamma_{j,11} & \Gamma_{j,12} \\ \Gamma_{j,21} & \Gamma_{j,22} \end{bmatrix}, v_t = \begin{bmatrix} v_{1t} \\ v_{2t} \end{bmatrix},$$

where $\Gamma_{j,11}$ i $\Gamma_{j,12}$ are coefficients related to the euro area economy, while $\Gamma_{j,21}$ i $\Gamma_{j,22}$ refer to coefficients of domestic economy. Since Croatia is a SOE, domestic shocks do not have a significant impact on the economy of the euro area and therefore the block-exogeneity restriction is introduced in the form $\Gamma_{j,12} = 0$, what fits the assumption that domestic (Croatian) shocks have no impact on the foreign (euro area) block, while foreign shocks may impact the domestic economy.

5. Results of the empirical analysis

The results of the empirical analysis are based on impulse response functions and variance decomposition. The main objective of the vector autoregression methodology is the analysis of the relationship among variables, for which innovation analysis is used. Innovation analysis includes analysis of the impulse response function and variance decomposition. The advantage of conducting innovation analysis is suitable interpretation of parameters and simplicity of drawing conclusions about the dynamics of group of economic variables (Dumičić and Čibarić, 2010). Figure 1 reports the impulse response functions of domestic variables to one standard deviation shock in the variables from the euro area.

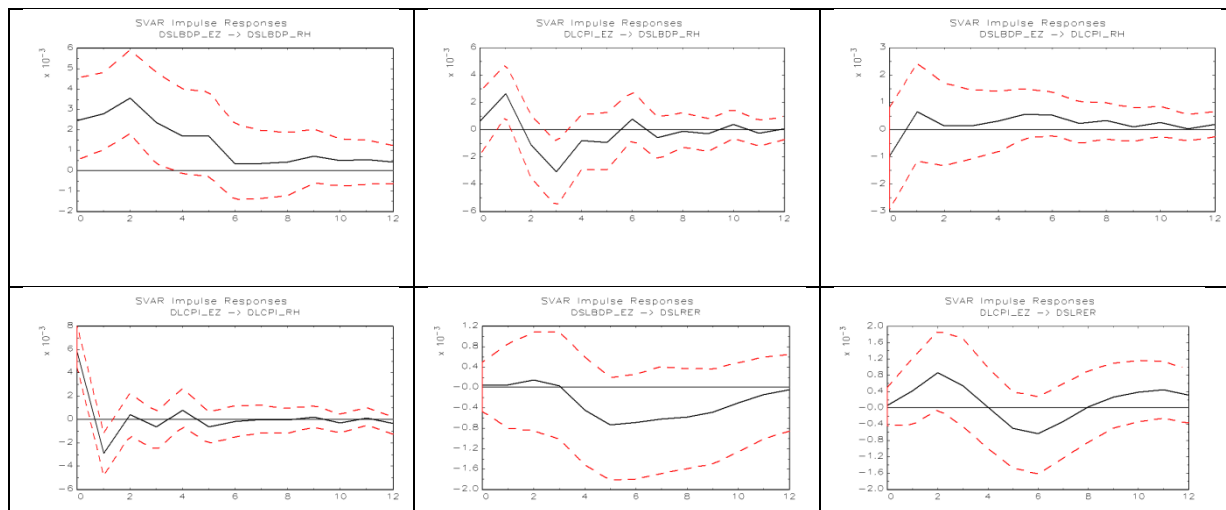


Figure 1: The impact of one-unit shock in the euro area variables on the domestic economy
(Authors' calculation using JMulti software)

The results suggest that economic developments in the euro area have a significant effect on domestic economic fluctuations. The positive shock of one standard deviation in the growth rate of GDP in the euro area has a positive effect on the domestic GDP. This effect is the strongest in the first year after the shock. However, it weakens with time and three years after the shock, the domestic GDP is around its initial level. The result is in line with the economic theory and empirical research referring to SOEs. Taking into account the empirical fact that the Croatian economy is largely dependent on the trade with the euro area countries, an increase of economic activity in the euro area stimulates demand for Croatian products, thus increasing Croatian export, which consequently increases the domestic GDP. Furthermore, an increase of the foreign GDP leads to inflationary pressures, although after that the growth rate of the CPI decreases and then fades out a year and a half after the shock. The effect of the foreign GDP on the real exchange rate is not significant.

Variable	Period	Shock				
		DSLBDP_EZ	DLCPI_EZ	DSLBDP_RH	DLCPI_RH	DSLRER
DSLBDP_RH	1	0,15	0,01	0,84	0,00	0,00
	4	0,32	0,18	0,46	0,01	0,02
	8	0,34	0,19	0,43	0,01	0,03
	12	0,34	0,18	0,43	0,01	0,04
DLCPI_RH	1	0,02	0,71	0,11	0,17	0,00
	4	0,02	0,7	0,09	0,14	0,05
	8	0,03	0,68	0,09	0,14	0,06
	12	0,04	0,68	0,09	0,14	0,06
DSLRER	1	0,00	0,00	0,06	0,03	0,91
	4	0,00	0,08	0,05	0,07	0,8
	8	0,08	0,09	0,08	0,11	0,64
	12	0,10	0,10	0,10	0,11	0,59

Table 1: Variance decomposition of domestic variables (Authors' calculation)

Moreover, the results of variance decomposition of domestic variables are given in Table 1. Presented variance decomposition shows the extent to which the domestic shocks and the euro area shocks account for fluctuations in domestic variables. On the basis of variance decomposition, it can be concluded that one third of variation of economic activity in Croatia

can be explained by the euro area income shock, i.e. the demand side shock in the euro area. Moreover, when the foreign prices shock is included, more than half of the domestic GDP fluctuations are explained by euro area shocks. Accordingly, more than 70% of the forecasting errors variation in the domestic price level is explained by the price shock and the demand shock in the euro area.

6. Conclusion

In order to establish the appropriate economic model, economic policy makers should be acquainted with the source of fluctuations in the domestic economy. Since Croatia is a SOE, it is considered that external shocks have a significant effect on its economic development. Therefore, the aim of this paper is to develop an econometric model which would be able to comprise the most important macroeconomic shocks which affected the Croatian economy in the period from 2000 to 2013. Thus, the reaction of the domestic economy to foreign economic fluctuations, i.e. economic shocks in the euro area, was analysed. The fluctuations in the domestic economy primarily arise from a significant dependence of the Republic of Croatia on the euro area in respect of foreign trade and a high dependence of its financial system on the euro. Such an unfavourable economic structure makes the domestic economy highly vulnerable to negative economic fluctuations in the euro area. In other words, the aim of this paper is to establish the reaction of the domestic economy to the fluctuations in the euro area and determine the relative importance of each individual domestic and foreign shock on the economic fluctuations in the Republic of Croatia.

The application of the structural vector autoregression model with block exogeneity restrictions resulted in impulse response functions showing that economic fluctuations in the euro area have a significant impact on the domestic economic fluctuations. The increase of economic activity in the euro area results in the increase of the domestic economic activity, the price level increase and the real exchange appreciation. On the other hand, an increase of prices in the euro area influences the fluctuations in the Republic of Croatia, but this influence is short term and inconsistent. The results of the estimated impulse response functions indicate that the economic fluctuations in the euro area have a significant influence on the domestic economic fluctuations.

Variance decomposition has shown that one third of the variability in economic activity in the Republic of Croatia can be explained by shocks on the demand side in the euro area, i.e. the income shock in the euro area. Similarly, more than a half of GDP fluctuations, including foreign price shocks, can be explained by the euro area shocks. On the other hand, more than 70% of the forecasting error variation in the domestic price level can also be explained by supply and demand shocks in the euro area. As far as Croatian kuna real exchange rate against the euro variations are concerned, external shocks have the least relevant influence on the variability of the named variable, and after three years most variations are explained by the variable itself. This confirms that the relative contribution of the euro area variables to the domestic fluctuations is higher than the contribution of domestic variables.

Although the estimated SVAR model with block exogeneity restrictions resulted in satisfactory results, its use still remains limited. First of all, due to a limited time period the

research could include only key macroeconomic variables, since the inclusion of additional variables would reduce the number of degrees of freedom and would render obtained results questionable. Therefore, multidimensional models such as the factor VAR model or the DSGE model are recommended for future economic research. In addition, the influence of external shocks is not to be limited to observing the influence of the euro area and it is necessary to estimate the influence of oil price fluctuations on the global market as well. To conclude, despite the named research limitations and given guidelines for research improvement, the obtained results can be significant to economic policy makers because they clearly indicate that the variability of foreign economic fundamentals needs to be taken into account in all future research of domestic economic fluctuations.

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