National Bank of the Republic of Macedonia

Research Department

Working paper

The transmission of external shocks to the Macedonian economic activity

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Abstract

Macroeconomists have been concerned with the structure of business cycle fluctuations and their sources for a long time. In a highly integrated and globalized world, the study of co-movement, or integration, is important because the results of the study on emerging countries could help policy-makers design more appropriate policies for those countries. In this study, we are trying to answer how much of economic volatility in Macedonia can be explained by shocks originating in the Euro area, as main trading partner and world prices and what is the dynamic response of Macedonian GDP to a such shocks. To examine this, we are estimating three variable recursive SVAR models. The results from the basic estimated model, as well as the models in the sensitivity analysis, show that only small portion of domestic GDP variation can be explained by foreign demand, whereas the prices have limited contribution. Impulse response also confirms these findings, as domestic GDP has statistically significant response to foreign demand shock, while world prices shock has no significant effect.

Key words: VAR, international shock transmission, economic activity, Macedonia

JEL classification: C32, E32, F42, F43

2011

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INTRODUCTION

The world economy has become increasingly integrated in recent years, characterized by a rapid increase of trade and higher degree of openness. In that sense, the external shocks are becoming increasingly important. Macedonia, as a small and open economy, may have benefits from the trade and international liberalization process. However, trade and liberalization may contribute to transmission of external shocks.

Macroeconomists have been concerned with the structure of business cycle fluctuations and their sources for a long time. Extensions in business cycle theory to account international co-movement and external shock propagation come from Backus et al (1992) and Zimmermann (1994, 1995). The study of co-movement, or integration, is important because the results of the study on emerging countries could help policy-makers design more appropriate policies for those countries. Consistent with the Mundell-Fleming model, two specific shocks are measured that could be transmitted from one country to another: a world real output shock and a world real interest rate shock. Clearly, different transmission mechanisms may require different actions to stabilize the economy.

In less developed countries (LDC) the questions related to the source (internal vs. external) and the transmission mechanism (common shocks, goods or asset markets interdependencies, contagion) responsible for cyclical fluctuations are of high importance. The literature about small and open economies points out that the developments in their economic activity and domestic prices depend a lot on the dynamics of big economies, which can be seen as center of shocks. If fluctuations in the small and open countries are largely attributable to shocks originating in the center, then there is scope for coordinated reactions to these shocks.

Empirical evidence on the sources of external shocks to domestic economy fluctuations could bring additional perspectives to the issue of regional trade integration and its economic effects. Indeed, with de facto fixed exchange regime, it is more probably Macedonia to be more vulnerable to such shocks than countries that opted for more flexible exchange rate arrangements. Accordingly, there are several questions that we want to answer in this study. How much of Macedonian GDP volatility can be explained by shocks originating in the Euro area (EA)? Do shocks stemming from the Euro area play a key—or even a predominant—role in driving domestic output fluctuations? How significant are external shocks as sources of Macedonian business cycle fluctuations? What is the dynamic response of Macedonian GDP to a shock affecting the country that absorbs most of Macedonian exports?

There is an extensive empirical literature on international transmission shocks. Vector autoregressive (VAR) model is the most commonly used methodology, as a result of its opportunities for policy analysis. VAR impulse response functions can provide empirical evidence on how strongly the domestic economic variables respond to various types of shocks, and variance decompositions provide some measure for assessing the relative importance of those sources of business cycle variation.

The empirical model used to study the sources of macroeconomic fluctuations and to identify the responses of the Macedonian economy to external disturbances is a structural VAR model. We use quarterly data and the model includes Euro area real GDP and world export

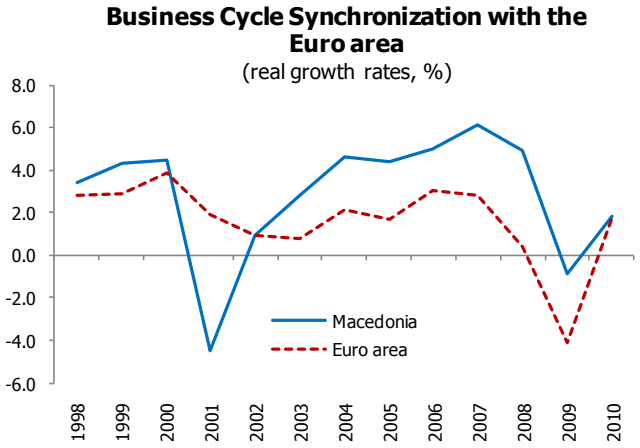
price index (WXPI) as exogenous variables, and Macedonian real GDP as a domestic variable. Additionally to this, we also performed sensitivity analysis for robustness check of the basic results. The results of all estimations are very similar regarding the transmission of foreign demand shocks to domestic output. The results from the estimated model are in line with the common wisdom which suggests that internal conditions play the most significant role (Canova, 2005). Only a small portion of domestic GDP variation can be explained by foreign demand, whereas the price component has a limited contribution. Impulse response also confirm these findings, as domestic GDP has statistically significant response to foreign demand shock, while prices variables have no significant effect.

The rest of this research study is organized as follows: The second part explains the trade and financial linkages between Macedonia and EA. In the third part, the literature review is elaborated, whereas the empirical methodology is explained in the fourth part. The data and the results of our findings are given in the fifth part, including sensitivity analysis and the final remarks and conclusions in the last part.

TRADE AND FINANCIAL LINKAGES WITH THE EURO AREA

The Macedonian economy is a highly open economy, with an average share of external trade of 89.8% of GDP in the period 1998-2010. In 2007 and 2008, the external trade exceeded GDP by 5.8 p.p. and 9.6 p.p., respectively. From 2003 onwards, the openness of the economy had an upward trend (92.9% on average in the period 2003-2008), which halted in 2009, due to the global financial crisis. The openness reached 95.3% of GDP in 2010.

Figure 1

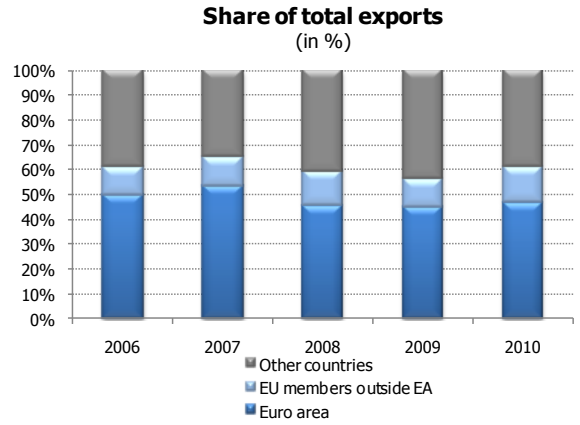


Source: SSO and Eurostat.

The European Union (EU) is the main trading partner of the Republic of Macedonia, according to the analysis of the external trade by regions. It comprises 55% on average of the total foreign trade in the period 2006-2010. At the same time, 40% of the external trade is referring to the Euro area (EA). On the export side, 61% of Macedonian exports are going to EU (48% to the EA). The high correlation between the annual real GDP growth of Macedonia and the Euro area (78% in the period 2002-2010) confirms the significant impact coming from the changes in the foreign demand from EA countries on Macedonian exports. Regarding the fact that the EU members that are the main export partners of our country (such as Germany, Greece and Italy) are also a part of the Euro area, our analysis will have a focus on the shocks coming from the Euro area. The iron, steel and metals and the clothes are the most exported goods to the EA, with an average share in the export to EA of around 70%. Thus, around half of the export of iron, steel and metals (as part of the mostly exported goods) goes to the Euro

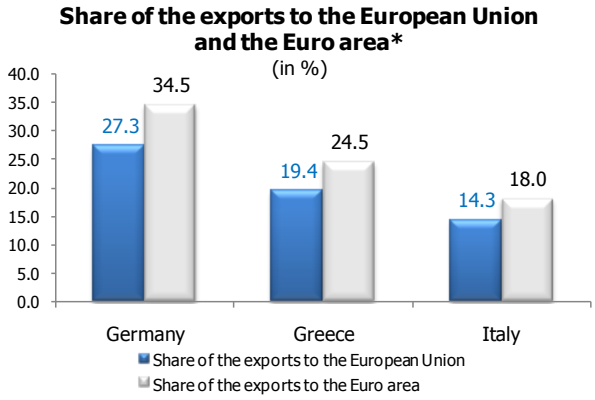
area, of which one third to Italy[1]. Germany and Greece absorb approximately 60% and 16%, respectively, of the Macedonian export of clothes (which is processing-production).

Figure 2



Source: SSO and calculations of NBRM.

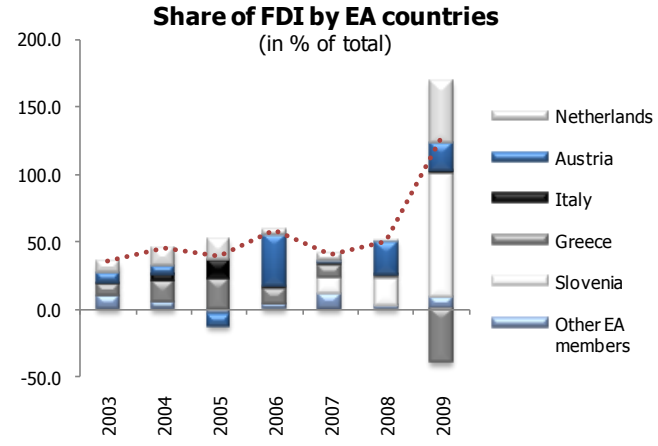
Figure 3



* Average of the shares in the period 2006-2010.
Source: SSO and calculations of NBRM.

The Macedonian economy is highly euroized. The level of euroization measured by the share of foreign currency deposits in M4 is around 45% on average (or 54% as a share in total deposits) and measured by the share of gross private debt to total external debt it is around 62%[2]. The external trade which is realized in Euro represents a significant part of the total trade, or around 73% on average in 2006-2010. The great portion of the payments in Euro is stressing the importance of the exchange rate of the Denar against the Euro and the exchange rate targeting regime in general.

Figure 4



Source: NBRM.

The share of foreign direct investment (FDI) in Macedonia from countries that are members of the Euro area is around 57% on average in 2003-2009. The greatest part of the EA FDI inflows comes from Slovenia, Netherlands and Austria.

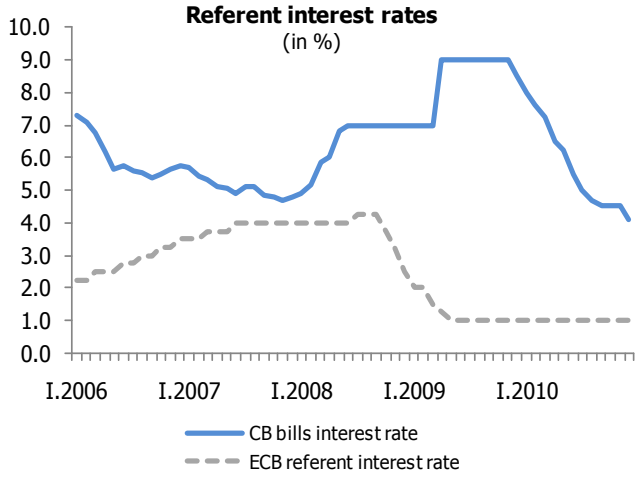
Regarding the ownership structure of the banks, over 70% of the banking system is owned by foreign shareholders, of which a significant share refers to banks from the Euro area. Notwithstanding the sizable part of foreign ownership, recent financial crisis didn't have direct

[1] The data refer to averages for the period 2006-2010.
[2] The data refer to averages for the period 2006-2010.

spillover effects on the banking sector because of its traditional type of banking, minimal reliance on foreign financing and low exposure to world markets' movements.

Although the domestic currency is pegged to Euro, the fixed exchange rate regime is applied under partially liberalized capital account, which suggests that the well known constraints of the so-called "impossible trinity" do not fully hold for the Macedonian case, in the period analyzed in this study. Given that, Macedonian monetary policy to some extent can be treated as independent, i.e. the domestic policy rate (the interest rate of the CB bills) is not exclusively determined by the movements of the ECB policy rate.

Figure 5



Source: NBRM and ECB.

According to this, it is obvious that the trade channel is more important than the financial channel of shocks transmissions from Euro area and our analysis will examine such shocks to Macedonian output.

LITERATURE REVIEW

The impact of the external shocks on the dynamics of certain economies is a subject of numerous and various analyses. The scope of the studies varies from regional to smaller coverage (analysis of the impact of one group of countries on another, the impact of a big economy on one or more small economies, etc). Considering the extensive literature about this topic, we are pointing out the results of some researches applying VAR analysis, made in the wake of last few years, of which the greater part refers to the transmission of shocks on emerging economies.

The shocks stemming from the US have a remarkable impact on Latin America. The research made by Canova (2005) finds that there are significant fluctuations in Latin America countries caused by US monetary shocks, unlike the shocks on real demand and supply. Geiregat (2004) implements a VAR analysis to examine the shock transmission (from the changes of international commodity prices, U.S. monetary policy, the real effective exchange rate and the sovereign risk premium) on Argentinian GDP during the currency board regime. As regards to these factors, only the sovereign risk premium affects output significantly, whereas the appreciation of the US dollar doesn't seem to have an adverse effect on the economy. Despite that the monetary base and money market interest rates react to changes in US monetary policy, these shocks do not affect GDP of Argentina significantly. Sosa (2008) analyzes the relative importance of foreign shocks as sources of business cycle fluctuations in Mexico, and identifies the dynamic responses of domestic output to external disturbances, such as shocks to US demand for Mexican exports, international financial conditions and oil price shocks. Using a VAR model with block-exogeneity restrictions, Sosa concludes that shocks

coming from the US explain a sizable share of Mexico's GDP fluctuations after joining NAFTA; and that the effect from these disturbances is rapidly transmitted.

Many studies examine the effects of external shocks in different European countries. Benczur, Koren and Ratfai (2004), discuss that although external shocks have a significant impact in countries in Central and Eastern Europe (CEE), most of the variation comes from domestic shocks. Thereto, in most of the economies, the financial and goods market channels of transmission are significant, considering that the financial channel of shock transmission is more important in countries with more flexible exchange regime (except for the Baltics). Kanda (2008) examines trade and financial linkages of Ireland with key trading partners by estimation of a VAR. The analysis shows that shocks to US GDP have a greater impact on Irish economic activity than shocks from the Euro area or the UK, as well as the effect from the worsening of competitiveness on Irish GDP rises with the forecast horizon. Obiora (2009) also uses a VAR model to investigate the spillover effects of shocks to the Baltic countries from their main trading partners and from the real effective exchange rate (REER) and concludes that the spillovers from EU partners outweigh the impact of the shocks from Russia. Additionally, the results indicate that an adverse shock to the REER decreases growth in the Baltics (mostly in Estonia). Beņkovskis, Bessonovs and Fadejeva (2010) find that the impulse responses of Latvian macroeconomic indicators to a monetary shock coming from the Euro area have the expected sign: industrial production, investments, exports and imports respond negatively, whereas unemployment reacts with a positive sign to a contractionary Euro area monetary shock. Also, they point out that the real activity variables have a stronger reaction to unexpected changes in the Euro area interest rates, than to a domestic monetary shock. In addition, the effects are twofold: there is a direct effect, via changes in interest rates (that strongly affect the Latvian credit market), and an indirect effect, via changes in foreign demand, which has an impact on Latvian exports, taking into consideration the openness of the economy. Krznar and Kunovac (2010) investigate the spillover effects of external shocks on inflation and GDP in Croatia, using impulse responses and variance decomposition of a VAR model with block-exogeneity restrictions. The results of the VAR show that the external factors are the main determinants of the dynamics of these variables, whereas the impact of the domestic shocks is small. Thus, the effect of the world price shocks on domestic prices (consumer prices, CPI, and producer prices, PPI) is significant; the shocks to GDP of the European Union affect the domestic economic activity and are main source of GDP fluctuations. Using an open economy structural vector autoregressive (SVAR) model, Cuaresma, Eller and Mehrotra (2011) discuss that there is a significant reaction of certain macroeconomic variables in five CEE countries (Czech Republic, Hungary, Poland, Slovakia and Slovenia) to the transmission of foreign fiscal shock coming from Germany.

The role of China in the world economy is a subject of analysis of Arora and Vamvakidis (2010). Using VAR analysis and Error-correction models, they conclude that the impact of China's growth in the short run has increased in last decades. The estimate of the long-run spillover effects by panel-techniques shows that they are significant.

EMPIRICAL FRAMEWORK

In order to account various shocks' transmission and to quantify their effect on economic activity we need to consider an appropriate framework. The most commonly used empirical framework in the literature is a small open-economy version of the structural vector autoregression (SVAR) model proposed by Blanchard and Quah (1989). SVARs are widely used, because they provide an appropriate framework in which researchers can identify the relevant shocks and describe the response of the system to shocks by analyzing impulse responses as well as variance decompositions. Variance decomposition represents the percentage of the variance of the *j*-th variable forecast error in period *t+k* explained by a shock in the *i*-th variable at time *t*, whereas Impulse Response function (IRF) shows the response over time of the *j*-th variable to a shock in period *t* in the *i*-th variable.

The structural form of the model is:

$$A_0 y_t = (B_0 x_t + A_1 y_{t-1} + u_t) \qquad (1)$$

where x_t is a vector of exogenous variables (for example, world real output, world commodity prices and interest rates), y_t is a vector of endogenous variables (for example, domestic real output, real exchange rate, domestic prices), A_0 represents the contemporaneous relations among the variables, A_1 is a matrix finite-order lag polynomial and contains the coefficients on the *i* lag of *y*, and u_t is a vector of structural disturbances with $E[u_t]= 0$ and $E[u_t u_t']=I$. The structural model is not directly estimable, hence, a reduced model is used. The reduced form is obtained by multiplying equation (1) by A_0^{-1}:

$$y_t = A_0^{-1} B_0 x_t + A_0^{-1} A_1 y_{t-1} + A_0^{-1} u_t \qquad (2)$$

$$y_t = C_0 x_t + C_1 y_{t-1} + e_t \qquad (3)$$

where the *e*'s are the reduced-form innovations with zero mean and $E[ee']= \Omega=(A_0)^{-1}[(A_0)^{-1}]'$. The reduced form errors should be orthogonalized, and usually this is done by Cholesky decomposition. Cholesky decomposition assumes that all of the correlations between errors are assigned to the equation that comes earliest in the ordering. The selected Cholesky ordering is characterized by the idea that the external variables of the model precede the domestic economic variables. This ordering implies that foreign variables do not respond instantly to domestic variables, but the domestic variables may be affected by contemporaneous changes in external conditions.

The impulse responses are obtained from vector moving-average - VMA (∞) representation. Equation (3) can be used to obtain the vector moving-average representation:

$$y_t = \sum_{i=0}^{\infty} C_1^i C_0 x_{t-i} + \sum_{i=0}^{\infty} C_1^i e_{t-i} \qquad (4)$$

where $C_1^i = A_0^{-1} A_1$ and $C_0 = (A_0^{-1} B_0)^i$.

The following impulse responses are analyzed:

$$\frac{\partial y_t}{\partial x_t} = C_0 \text{ and } \frac{\partial y_t}{\partial x_{t-i}} = C_0 C_1^i \qquad (5)$$

Impulse responses trace the response of current and future values of each of the domestic variables to a one-unit increase in the current value of the exogenous variables.

Since the VAR(l) includes only lagged endogenous variables, the reduced form of the model can be estimated consistently by OLS (Geiregat, 2004). However, since the estimate for Ω contains only $n(n+1)/2$ distinct elements, this is the maximum number of free parameters that can be used to estimate the coefficients of A_0. The literature has solved this identification problem in different ways, among which imposing short-run and/or long-run restrictions. Since A_0 has been given ones on its diagonal axis, there are $n(n-1)/2$ necessary identification restrictions for the model to be identified. A popular approach has been to constrain A_0 to be lower triangular.

In the case of small and open economies, which by definition cannot contribute to the world output fluctuations and are price takers, most of the literature assumes complete exogeneity of the foreign variables. This is achieved by imposing block exogeneity restrictions. Hence, the model is separated in two blocks of equations: one external block and one domestic economy block. The domestic economic variables are completely absent from equations in the external block, meaning that shocks to domestic variables cannot affect, neither contemporaneously, nor with any lags, the external variables. This type of model is known as "near-VAR" in the literature. The block exogeneity procedure reduces the number of parameters to be estimated, which helps to limit the erosion of degrees of freedom and to improve the efficiency of the estimation.

However, the standard method developed by Sims (1980) has been criticized because results based on IRFs crucially depend on the "orthogonality assumption" and might differ markedly on the ordering of the variables in the VAR (Minea and Rault, 2008, Geiregat, 2004). The VAR methodology, which is considered as the most appropriate for analyzing fluctuations, can work only with a limited number of variables (Lotfi, 2005).

The first econometric question is the identification of Euro area shocks. In our study, we are relying on the advantages of using structurally identified VARs found in the extensive literature in order to examine the aggregate effects of unexpected external variables innovations.

DATA AND RESULTS

Basic estimation

We are estimating a three-variable recursive contemporaneous SVAR model[3]. In the case of a small open economy, SVAR with block exogeneity is mostly used in the literature, and we are implementing it by using JMulti software[4]. According to this, we are not allowing domestic variable to be included in equations of foreign variables. At the same time, the recursive SVAR assumes, as we mentioned before, that all of the correlations between errors are assigned to the equation that is the earliest in the ordering, which means that a shock to domestic variables cannot affect contemporaneously the world variables, only with their lags. As we are interested in short-term spillover effects of external shocks on domestic variables, long-

[3] All calculations are done with EViews 6 and JMulti.

[4] Due to software limitations, block-exogeneity is not applicable in EViews. Source: Centre for Central Banking Studies (CCBS) exercises on VAR (by I.Stevens).

term connections between variables are not in our field of research. Moreover, in terms of short data span, analyzing the long-term relationship between variables is not desirable.

The following variables were included: Euro area (EA) real GDP (2000 constant prices), WXPI- World Export Price Index (2005=100, in Denars) and Macedonian real GDP (1997 constant prices). The source for EA GDP is EUROSTAT, for Macedonian GDP it is Macedonian State Statistical Office (SSO) and WXPI is an index calculated by the Research Department in the NBRM[5]. The first two variables are included as foreign variables and the last one as a domestic variable.

We are using EA real GDP, having in mind that most of EA GDP is consisted of Macedonian biggest exporting countries, such as Germany, Greece, Italy, Spain and Netherlands. On the other hand, EU is a much wider group of countries, and most of them are only marginal trading partners regarding to export. Also, the Macedonian domestic currency - the Denar is pegged to the Euro. Consequently, we think that EA is more appropriate to be considered as a center from where the shocks are coming and affect Macedonian economy. We are using WXPI instead of world commodity price index because the latter includes prices which are not of interest for Macedonia, such as soybeans, sea food, coffee, timber etc. The included variables suggest that the model captures only the trade channel, whereas the financial channel is excluded. As we mention in the second part, we consider trade channel as more important for external shocks transmission to Macedonian output.

The data are quarterly and the model includes 52 observations with period of estimation 1998Q1-2010Q4. Both GDP data were seasonally adjusted. Since the visual inspection and the unit root tests have shown that all data are non stationary in level, but stationary in first difference, the VAR model was estimated with difference in logs of the variables. The ADF test was applied in order to test for unit root test. The results are given in Appendix, Table 3.

According to the suggested ordering that puts foreign variables before the domestic variables, the ordering of the variables is the following:

EA RGDP ⟶ WXPI ⟶ MKD RGDP.

The ordering follows this intuition: The EA is one of the most important global consumers, whose demand for certain product can affect the prices on world markets. At the same time, EA demand for Macedonian products is very important, as EA is one of the major trading partners of the Republic of Macedonia. Macedonia, as a small open economy, is considered as a price taker. Consequently, the model suggests that the increased EA demand causes world prices to rise and increases the demand for Macedonian products i.e. increases Macedonian output. At the same time, the rise in world prices can be considered as a stimulating factor for higher Macedonian export and production.

Before estimation, we are considering the correlation between the variables in first differences of log (see Appendix, Table 4). The correlation between foreign and domestic variables is not very strong, suggesting *a priori* not very strong influence from the foreign

[5] WXPI is constructed as a weighted index of the world prices of several most important export products of our economy: cotton (proxy for clothes and textile), iron ore, lamb, nickel, steel, tobacco, zinc and oil (as proxy for oil derivatives).

variables. Also, we tested the block-exogenous restriction, in order to check the validity of the assumption that the domestic economy cannot influence the world economy. For this purpose, we applied Granger causality test, which confirms that the a priori selection of block-exogenous restrictions is correct (see Appendix, Table 6).

The empirical estimation begins with determining the lag structure. First we are estimating unrestricted VAR with the endogenous variables mentioned above, and then we are applying the Lag length test with 4 lags because the data are quarterly. Most of the lag length criteria indicate lag order 1 (see table Appendix, Table 5). This is also appropriate to our relatively short data span of 52 observations, which means that with this estimation, a smaller number of degrees of freedom will be lost. According to this, we are estimating a VAR with one lag.

After the estimation, we are testing the stability of the unrestricted VAR model, whether the residuals are normal, stationary and not autocorrelated. Jarque-Bera normality test shows that the null hypothesis of normality cannot be rejected. Stability test suggests that no root lies outside the unite circle (the value of AR root module is smaller than 1). For autocorrelation, Autocorrelation LM test was implemented, showing that null hypothesis of no autocorrelation cannot be rejected. The results of the tests are given in the Appendix, Table 7, Table 8 and Table 9.

In order to estimate a three-variable recursive contemporaneous SVAR model, we are imposing a short-term restriction. EViews requires that such restriction schemes must be of the form (CCBS exercises):

$$Ae_t = Bu_t \qquad (6)$$

This is also known as the AB model. By imposing structure on matrices A and B, we impose restrictions on the structural VAR in equation (1). An example of this specification using the Choleski decomposition identification scheme is:

$$A = \begin{pmatrix} 1 & 0 & 0 \\ a_{21} & 1 & 0 \\ a_{31} & a_{32} & 1 \end{pmatrix}, \text{ and } B = \begin{pmatrix} b_{11} & 0 & 0 \\ 0 & b_{22} & 0 \\ 0 & 0 & b_{33} \end{pmatrix} \qquad (7)$$

Estimated matrix A and B with their standard errors, as well as matrix $A^{-1}B$ are given below:

Structural VAR Estimation Results
ML Estimation, Scoring Algorithm (see Amisano & Giannini (1992))
Convergence after 1 iterations
Log Likelihood: 498.4522
Structural VAR is just identified

$$A = \begin{bmatrix} 1 & 0 & 0 \\ -4.5185 & 1 & 0 \\ -0.6933 & -0.0101 & 1 \end{bmatrix} \qquad B = \begin{bmatrix} 0.0072 & 0 & 0 \\ 0 & 0.0805 & 0 \\ 0 & 0 & 0.0179 \end{bmatrix}$$

$$A_{st.dev} = \begin{pmatrix} 0 & 0 & 0 \\ 1.5724 & 0 & 0 \\ 0.3775 & 0.0315 & 0 \end{pmatrix} \qquad B_{st.dev} = \begin{pmatrix} 0.0007 & 0 & 0 \\ 0 & 0.0081 & 0 \\ 0 & 0 & 0.0018 \end{pmatrix}$$

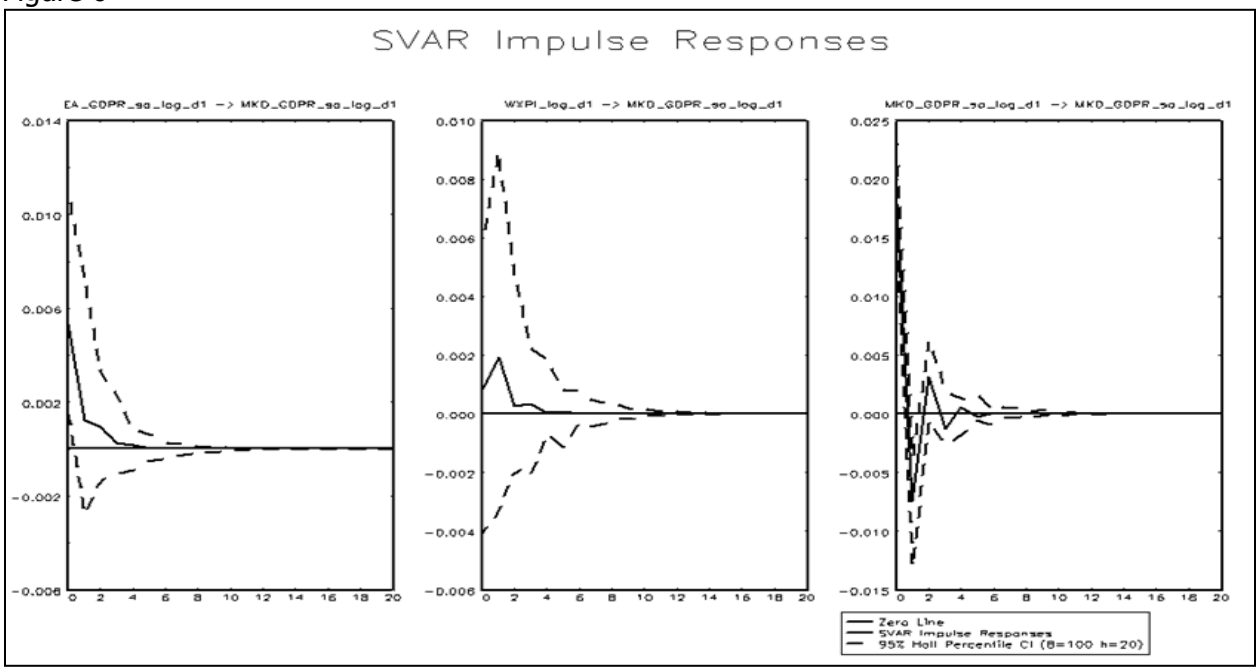
$$A^{-1}B = \begin{bmatrix} 0.0072 & 0 & 0 \\ 0.0327 & 0.0805 & 0 \\ 0.0054 & 0.0008 & 0.0179 \end{bmatrix}$$

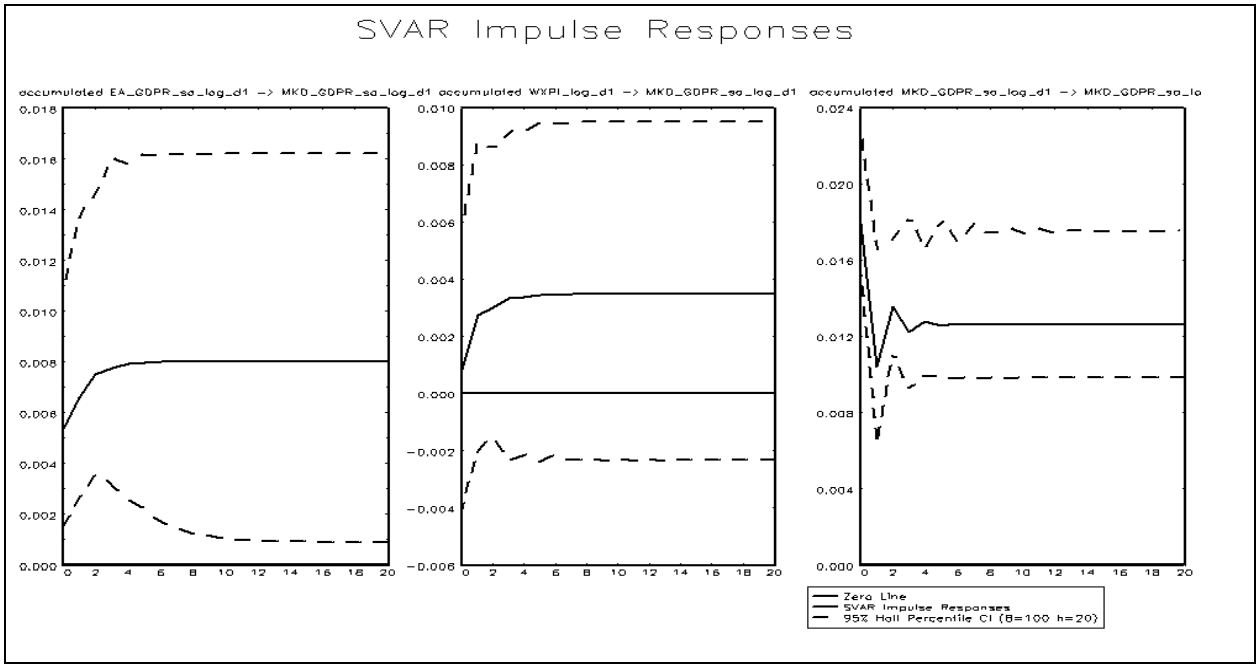
Only one of the three freely estimated coefficients in the *A* matrix (0.0315) is statistically insignificant (therefore we set it equal to zero). Essentially, this means that the relationship between the reduced-form errors, e_t, and the structural errors, u_t, is as follows ($e_t = A^{-1}Bu_t$):
@e1 = 0.0072*@u1
@e2 =-0.0327*@e1+0.0805*@u2
@e3 =-0.0054 *@e1 + 0.0179*@u3
where @e1 represents DLOG(EA_GDPR_SA) residuals, @e2 represents DLOG(WXPI) residuals and @e3 represents DLOG(MKD_GDPR_SA) residuals.

This representation means that the first estimated reduced-form shocks are equal to the first (scaled) structural shocks and that the shocks to DLOG(WXPI) and DLOG(MKD_GDPR_SA) are a weighted linear combination of the DLOG(EA_GDPR_SA) residuals and the structural shocks to DLOG(WXPI) and DLOG(MKD_GDPR_SA) itself.

The *a priori* expectations for not very strong response to foreign variables shock and small contribution in total variance of Macedonian output is confirmed by the results from variance decomposition and IRF.

Figure 6





The cumulative impulse response shows that Macedonian output reacts immediately with an increase to positive shock to EA GDP innovations, then the reaction slows down gradually and diminishes after five periods, i.e. the initial shock is almost fully absorbed. However, the response is not very strong, as we were expecting. A positive shock of 1 p.p. in foreign GDP growth rate (q-o-q) causes about 0.7 p.p. immediate increase in domestic output growth rate (q-o-q) and around 1 p.p. increase within two years. The positive shock to WXPI innovations also affects Macedonian output in same direction, however the effect is insignificant.

IRF results match with the variance decomposition results. The variance decomposition up to 24 periods shows that only a small portion of Macedonian GDP variance is explained by EA output. The results show that only in the first period EA output has a little bit stronger explanatory power, but after that it falls about 1 p.p. and stabilizes around 7%. The shock to world export prices index explains a negligible part of the total variance of Macedonian output.

Table 1
Variance decomposition of Macedonian GDP

Period	DLOG (EA_GDPR_SA)	DLOG (WXPI)	DLOG (MKD_GDPR_SA)
1	0.08	0.00	0.92
2	0.07	0.01	0.92
3	0.07	0.01	0.92
6	0.07	0.01	0.92
12	0.07	0.01	0.92
18	0.07	0.01	0.92
24	0.07	0.01	0.92

Sensitivity analysis

The sensitivity analysis was applied as a robustness check for the stability of the results shown in the basic equation. The sensitivity analysis is done by shortening the period of estimation, but also by introducing other variables instead of those in the basic estimation.

The first robustness check is done by changing the period of estimation. In our case we estimated the SVAR system with a shorter period. The robustness check captures the period Q1.2002-Q4.2010, as a period with higher correlation between domestic and EA real GDP. We would like to check whether this new estimation will show significantly different results in direction of higher effect of EA real GDP and world prices compared to the results in the basic estimation.

The results (see Appendix, Figure 5 and Table 10) show that there is higher impulse response of domestic GDP to positive shock of one standard deviation in EA GDP, while the effect from WXPI shock is insignificant again. The changes in variance decomposition are in the same direction as in the impulse response analysis, in the sense that EA GDP and WXPI explain more of the variations in GDP compared to the basic estimation. However, the conclusion that EA GDP and WXPI explain small part of Macedonian GDP variations still remains, as EA GDP explains 17%, while WXPI 10%.

Next, we estimated a VAR including REER index instead of WXPI. Since the shock to world export price index was insignificant for Macedonian output, we just wanted to investigate whether the result would change substantially if we include the competitiveness in the model, whether the price channel is still insignificant if we take into account another variable. The positive shock to REER means appreciation and decrease of the competitiveness, and it is expectable to contribute negatively to the domestic output.

The impulse response shows almost the same response of domestic GDP to a shock in EA GDP innovations. Regarding the response to a shock in REER, it is insignificant and it is in the opposite direction, domestic GDP is increasing, which is opposite of the expectations. Also, variance decomposition results are similar with the results of the previous VAR model. Foreign demand explains about 9% of the variations in Macedonian GDP (2 p.p. more than in the basic VAR model) and REER index explains even a smaller part compared to WXPI (see Appendix, Figure 6 and Table 11).

As another robustness check, we estimated a VAR including Foreign effective demand[6] instead of EA real GDP, in order to check whether the results will differ if another measure of foreign GDP is used. The results show some differences (see Appendix, Figure 7 and Table 12). The impulse response is higher, which is in line with our expectations. However, the reaction path of the accumulated shock varies from the basic estimation. After the impact in the first period, it decreases in some of the following quarters, unlike the basic estimation. The variance decomposition shows that 20% of variation in domestic GDP can be explained by the fluctuations in foreign effective demand. The greater effect is expectable, since this indicator

[6] This indicator is a sum of weighted GDP indices of the most important countries - importers from the Republic of Macedonia, through the normalized share in the exports of these countries in the 2006-2009 period. The calculation of this indicator includes Germany, Greece, Italy, the Netherlands, Belgium, Spain, Serbia, Croatia and Bulgaria.

includes countries with a high export share but are not part of EA, among which are Serbia, Croatia and Bulgaria, whose joint share is around 23% of total export. Also, the effect of WXPI fluctuation over domestic GDP is higher compared to basic estimation, but it is still small.

Additional estimation was done by replacing Macedonian output with the export, as foreign demand and prices have a more direct impact on export than on total domestic output and according to that to examine whether the reaction will be stronger. The impulse response analysis shows very strong reaction of the export growth rate to the positive shock in EA_GDP growth rate. At the same time, WXPI has a significant effect on the Macedonian export growth rate, in contrast to the previous estimations. However, the variance decomposition analysis shows that only 9% of variation in the export are explained by the variations in EA_GDP, while WXPI variations, unlike all other estimations, have a greater explanatory power, explaining 15% of the export variations (see Appendix, Figure 8 and Table 13).

The results of domestic output response through the trade channel of transmission point to the conclusion that the quantity aspect of trade is more important than price. The insignificant price shock on GDP suggests that the demand side is more important than the supply side. The conclusions were confirmed with all estimated SVAR models. These results are similar with the analysis of Unevska and Kadievska-Vojnovic (2007) for income and price elasticity of export, where the export shows significant income elasticity, but small, i.e. non-elasticity to the relative prices changes (domestic/foreign prices). Despite the high openness of Macedonian economy, our results show that the reaction of Macedonian GDP to foreign income growth is modest, which can be partially explained by the high import dependence of Macedonian production. Indeed, the estimation with export included showed that export reacts very strongly to a shock in foreign demand, unlike in the case with total domestic output. Furthermore, the results that most of the variances of domestic GDP are explained by itself, point to the conclusion that the growth in some periods is driven by the domestic factors. Namely, GDP structure shows that in most of the analyzed years, households' consumption is the main driver of GDP growth.

The modest, but significant response of domestic GDP to foreign GDP suggests that EA GDP is a factor that should be taken into account when Macedonian economic activity is analyzed, with particular importance for export demand. Regarding the quantity aspect of financial channel transmission, which can be captured by foreign capital inflows, FDI and loans from abroad are the most important capital inflows. Given that these inflows are mostly linked with investments and future increase of domestic production, increased capital inflows can be viewed as an additional channel of external shock transmission, which can be examined in future.

CONCLUSION REMARKS

Macedonia, as a small and open economy, in the world of strong globalization and integration may have benefits from the trade and international liberalization process. However, trade and liberalization may contribute to transmission of external shocks. Indeed, with de facto fixed exchange regime, it is more probable for Macedonia to be more vulnerable to such shocks than countries that opted for more flexible exchange rate arrangements. The literature about small and open economies points out that the developments in their economic activity and

domestic prices depend a lot on the dynamic of the big economies, which can be seen as a center of shocks.

In order to account various shocks transmission and to quantify their effect on economic activity, the most commonly used empirical framework in the literature is Vector autoregression (VAR) model. VARs are widely used, because they provide an appropriate framework in which researchers can identify the relevant shocks and describe the response of the system to shocks by analyzing impulse responses, as well as variance decompositions.

The empirical model used for studying the sources of macroeconomic fluctuations and identifying the responses of the Macedonian economy to external disturbances is a structural recursive VAR model. We use quarterly data and the model includes EA real GDP and world export price index as foreign variables, and Macedonian real GDP as a domestic variable. Additionally to this, we also made sensitivity analysis by shortening the period of estimation, including REER instead of WXPI, foreign effective demand instead EA real GDP and Macedonian export instead of domestic GDP. However, the results do not change substantially.

The investigation of the trade channel of transmission to the Macedonian economic activity points to the conclusion that the quantity aspect of trade is more important than price. The results show that only a small portion of domestic GDP variation can be explained by foreign demand, whereas world prices and REER have limited contribution, except in the estimation with exports. Impulse response also confirms these findings, as domestic GDP has statistically significant response to foreign demand shock, while world prices shock has no significant effect. Despite the high openness of the Macedonian economy, still the reaction of Macedonian GDP to foreign income growth is not very high, which can be explained partially by high import dependence of Macedonian production and domestically driven growth in some periods. Consequently, the results point to the conclusions that structural changes are necessary and the macroeconomic policies should be implemented to improve the structure of the economy and to take advantage of the globalized world economy.

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APPENDIX

Figure 1

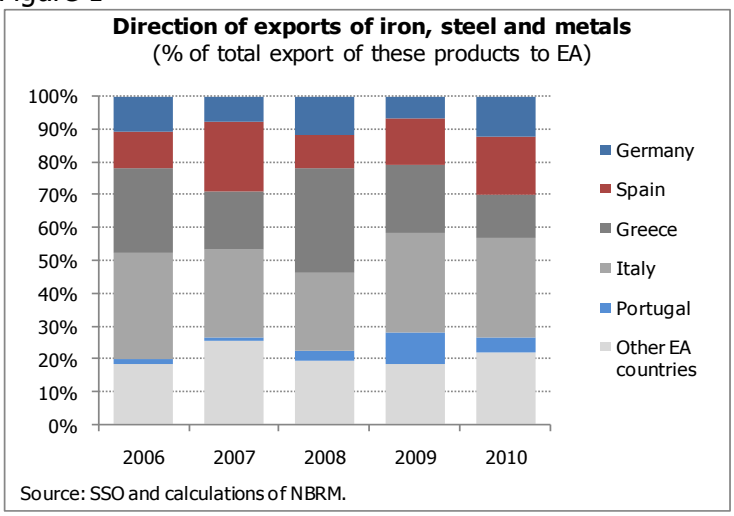


Figure 2

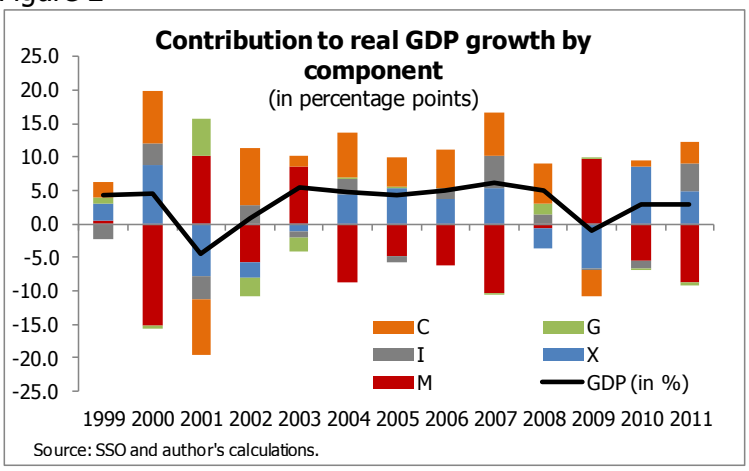


Figure 3

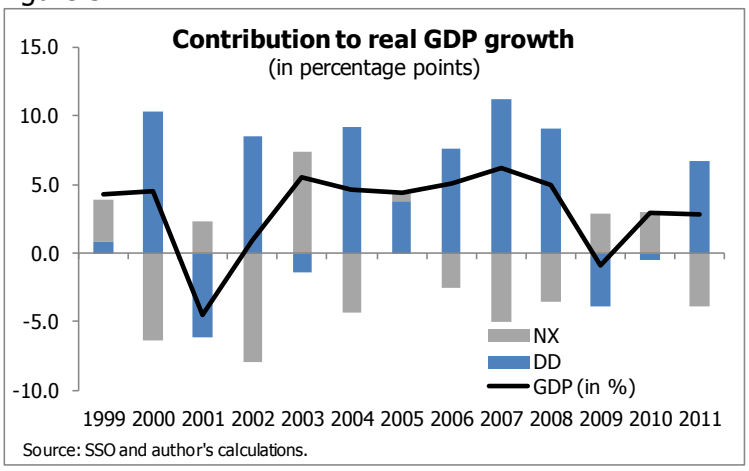


Figure 4
Dynamics of the variables

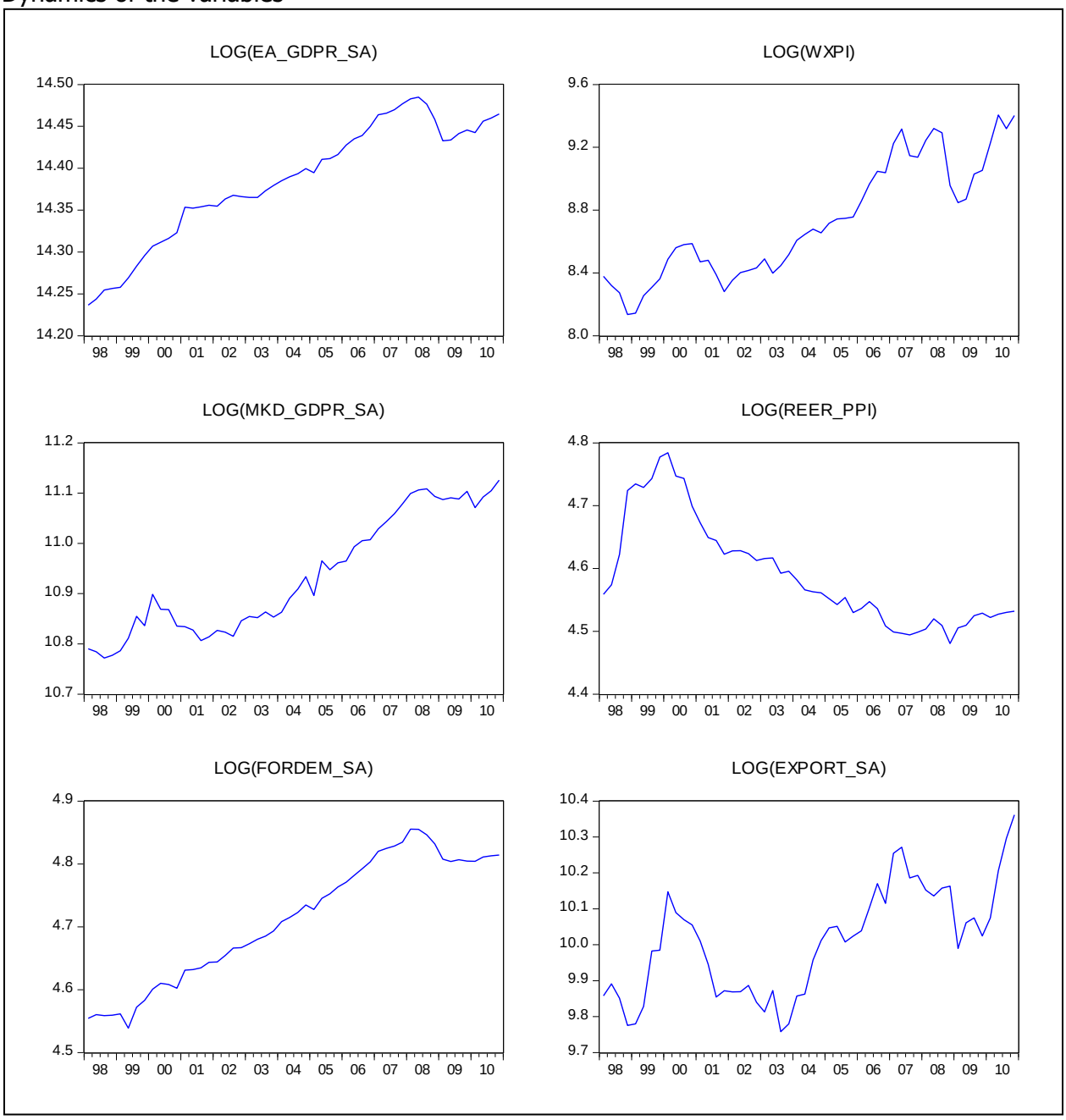


Table 1

	Total exports	Exports to: Euro area	Germany	Greece	Italy	Spain
	EUR million					
2006	1,917.5	956.3	303.1	286.7	189.7	39.4
2007	2,477.1	1,326.5	365.7	309.6	255.3	128.1
2008	2,697.6	1,229.1	382.9	358.4	219.5	51.4
2009	1,937.0	869.7	327.7	209.4	155.7	27.4
2010	2,497.5	1,169.7	522.3	185.8	178.1	56.3
Average 2006-2010	2,305.4	1,110.3	380.3	270.0	199.7	60.5

Table 2

Share of exports to these countries in exports to Euro area (in %):				
	Germany	Greece	Italy	Spain
2006	31.7	30.0	19.8	4.1
2007	27.6	23.3	19.2	9.7
2008	31.2	29.2	17.9	4.2
2009	37.7	24.1	17.9	3.2
2010	44.6	15.9	15.2	4.8
Average 2006-2010	34.5	24.5	18.0	5.2

Table 3
ADF Unit root test for stationarity of the series

	level		first differences	
Variable	ADF statistics	*p*-value	ADF statistics	*p*-value
EA_GDPR_SA	-1.85	0.6641	-4.89	0.0002
WXPI	-2.94	0.1587	-5.74	0.0000
MKD_GDPR_SA	-2.08	0.5460	-9.53	0.0000
additional variables				
REER_PPI	-3.12	0.1131	-4.72	0.0003
FORDEM_SA	-0.50	0.9806	-5.80	0.0000
EXPORT_SA	-1.73	0.7245	-6.55	0.0000

Tests in levels are done with Intercept and trend, while in first differences only with Intercept.
Both testings are done Schwarz Info Criterion, using E-Views software.

Table 4
Correlation matrix

	DLOG(EA_GDPR_SA)	DLOG(WXPI)	DLOG(MKD_GDPR_SA)	DLOG(REER_PPI)	DLOG(FORDEM_SA)	DLOG(EXPORT_SA)
DLOG(EA_GDPR_SA)	1	0.36507	0.32925	-0.03266	0.69150	0.31418
DLOG(WXPI)	0.36507	1	0.21096	-0.03679	0.24872	0.42947
DLOG(MKD_GDPR_SA)	0.32925	0.21096	1	0.08304	0.37979	0.38501
DLOG(REER_PPI)	-0.03266	/	0.08304	1	/	/
DLOG(FORDEM_SA)	/	0.24872	0.37979	/	1	/
DLOG(EXPORT_SA)	0.31418	0.42947	/	/	/	1

Table 5
VAR Lag Order Selection Criteria in the basic estimation

VAR Lag Order Selection Criteria
Endogenous variables: DLOG(EA_GDPR_SA) DLOG(WXPI) DLOG(MKD_GDPR_SA)
Exogenous variables: C D_2001
Sample: 1998Q1 2010Q4
Included observations: 47

Lag	LogL	LR	FPE	AIC	SC	HQ
0	328.4625	NA	2.20e-10	-13.72181	-13.48562*	-13.63293
1	343.4765	26.83339*	1.71e-10*	-13.97772*	-13.38725	-13.75552*
2	352.1326	14.36558	1.75e-10	-13.96309	-13.01833	-13.60757
3	356.0435	5.991120	2.21e-10	-13.74653	-12.44749	-13.25769
4	362.3703	8.884459	2.55e-10	-13.63278	-11.97946	-13.01062

* indicates lag order selected by the criterion

Table 6
Granger causality test

VAR Granger Causality/Block Exogeneity Wald Tests
Sample: 1998Q1 2010Q4
Included observations: 50

Dependent variable: DLOG(MKD_GDPR_SA)

Excluded	Chi-sq	df	Prob.
DLOG(EA_GDPR_SA)	1.114977	1	0.2910
DLOG(WXPI)	0.721048	1	0.3958
All	3.009941	2	0.2220

Table 7
Normality test of the residuals

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
H0: residuals are multivariate normal
Sample: 1998Q1 2010Q4
Included observations: 50

Component	Skewness	Chi-sq	df	Prob.
1	-0.133135	0.147709	1	0.7007
2	-0.657402	3.601482	1	0.0577
3	-0.231094	0.445036	1	0.5047
Joint		4.194227	3	0.2412

Component	Kurtosis	Chi-sq	df	Prob.
1	2.817365	0.069490	1	0.7921
2	3.111680	0.025984	1	0.8719
3	2.301049	1.017776	1	0.3130
Joint		1.113250	3	0.7739

Component	Jarque-Bera	df	Prob.
1	0.217199	2	0.8971
2	3.627466	2	0.1630
3	1.462812	2	0.4812
Joint	5.307477	6	0.5050

Table 8
Test for residuals autocorrelation

VAR Residual Serial Correlation LM Tests
H0: no serial correlation at lag order h
Sample: 1998Q1 2010Q4
Included observations: 50

Lags	LM-Stat	Prob
1	8.369053	0.4974
2	8.476439	0.4869
3	3.188885	0.9563
4	6.083100	0.7316
5	9.327473	0.4076
6	9.182626	0.4206
7	5.937620	0.7461
8	8.444363	0.4901
9	5.173205	0.8190
10	10.68788	0.2977
11	4.903881	0.8426
12	10.74661	0.2935

Probs from chi-square with 9 df.

Table 9
Test for VAR stability

Roots of Characteristic Polynomial

Endogenous variables:
DLOG(EA_GDPR_SA) DLOG(WXPI)
DLOG(MKD_GDPR_SA)

Exogenous variables: C D_2001

Lag specification: 1 1

Root	Modulus
0.453727	0.453727
-0.437452	0.437452
-0.16234	0.162340

No root lies outside the unit circle.
VAR satisfies the stability condition.

Figure 5
SVAR impulse response of the estimation using a shorter period of estimation (Q1.2002-Q4.2010)

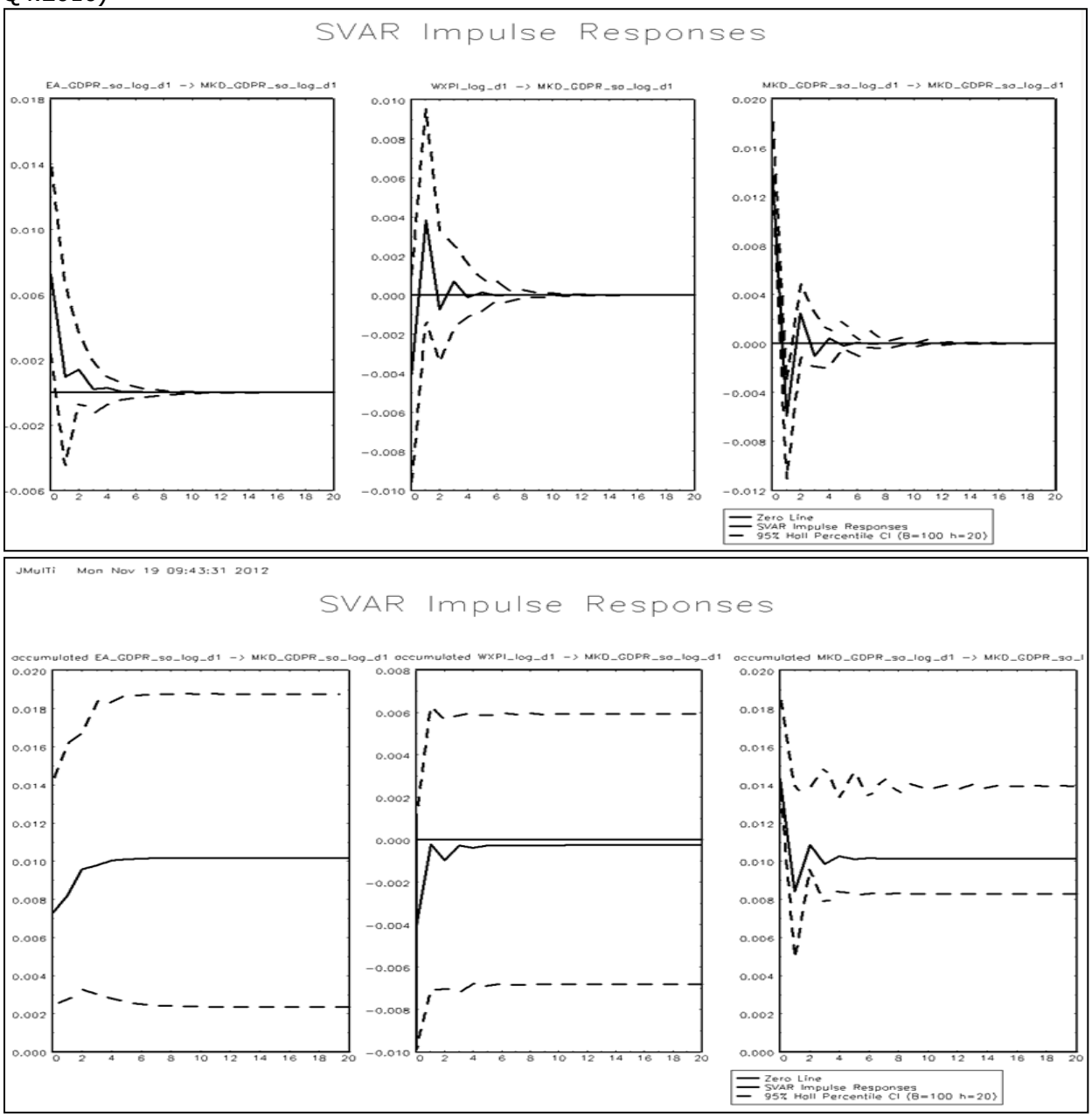
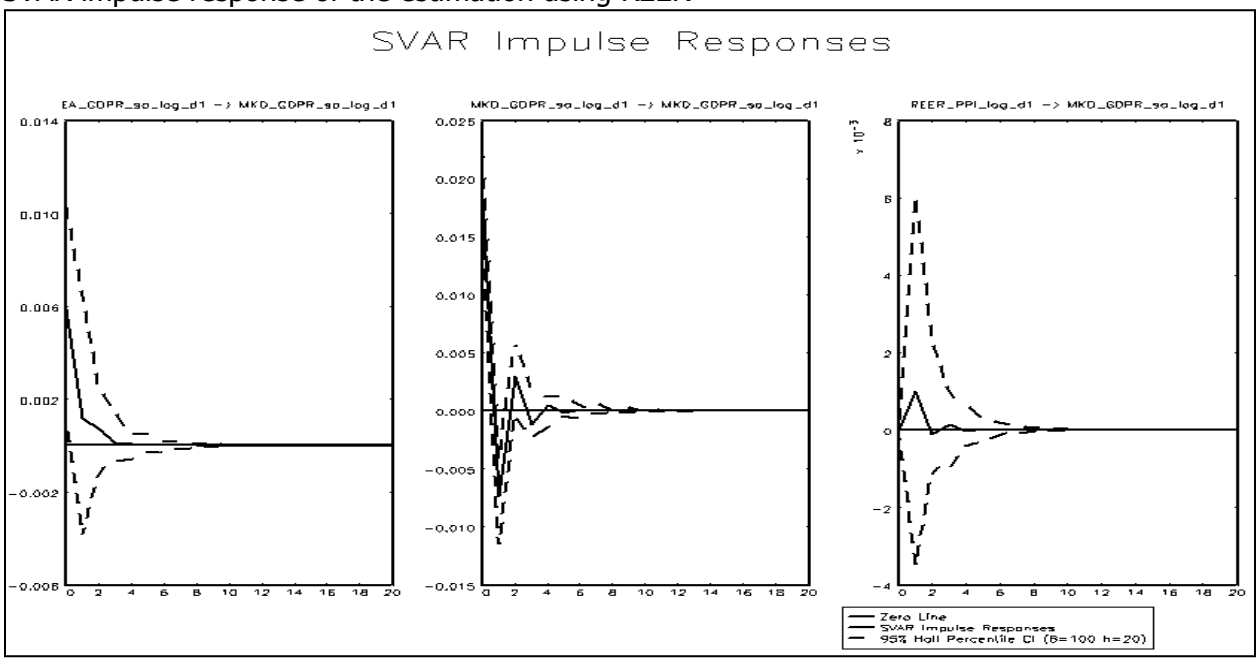


Table 10
Variance decomposition of Macedonian GDP using a shorter period of estimation (Q1.2002-Q4.2010)

Period	DLOG (EA_GDPR_SA)	DLOG (WXPI)	DLOG (MKD_GDPR_SA)
1	0.19	0.06	0.75
2	0.16	0.10	0.74
3	0.17	0.09	0.74
6	0.17	0.10	0.74
12	0.17	0.10	0.74
18	0.17	0.10	0.74
24	0.17	0.10	0.74

Cholesky Ordering: DLOG(EA_GDPR_SA) DLOG(WXPI) DLOG(MKD_GDPR_SA)

Figure 6
SVAR impulse response of the estimation using REER



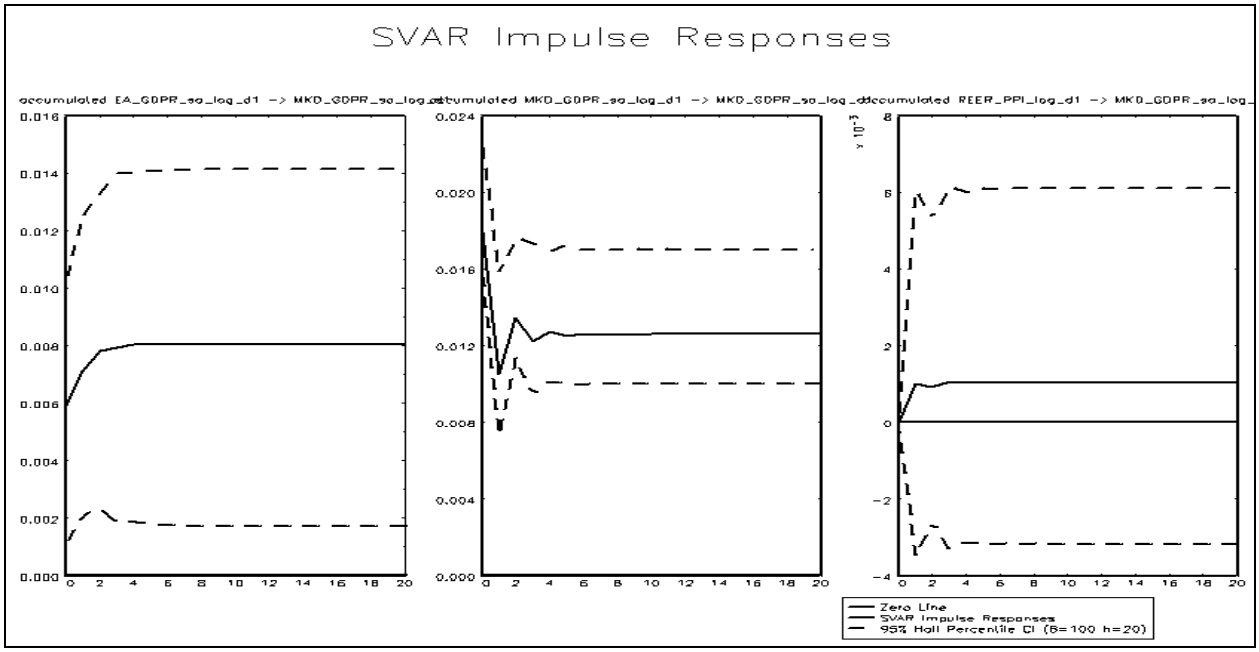


Table 11
Variance decomposition of Macedonian GDP using REER

Period	DLOG (EA_GDPR_SA)	DLOG (MKD_GDPR_SA)	DLOG (REER)
1	0.10	0.90	0.00
2	0.09	0.91	0.00
3	0.09	0.91	0.00
6	0.09	0.91	0.00
12	0.09	0.91	0.00
18	0.09	0.91	0.00
24	0.09	0.91	0.00

Cholesky Ordering: DLOG(EA_GDPR_SA) DLOG(MKD_GDPR_SA) DLOG(REER)

Figure 7
SVAR impulse response of the estimation using FORDEM

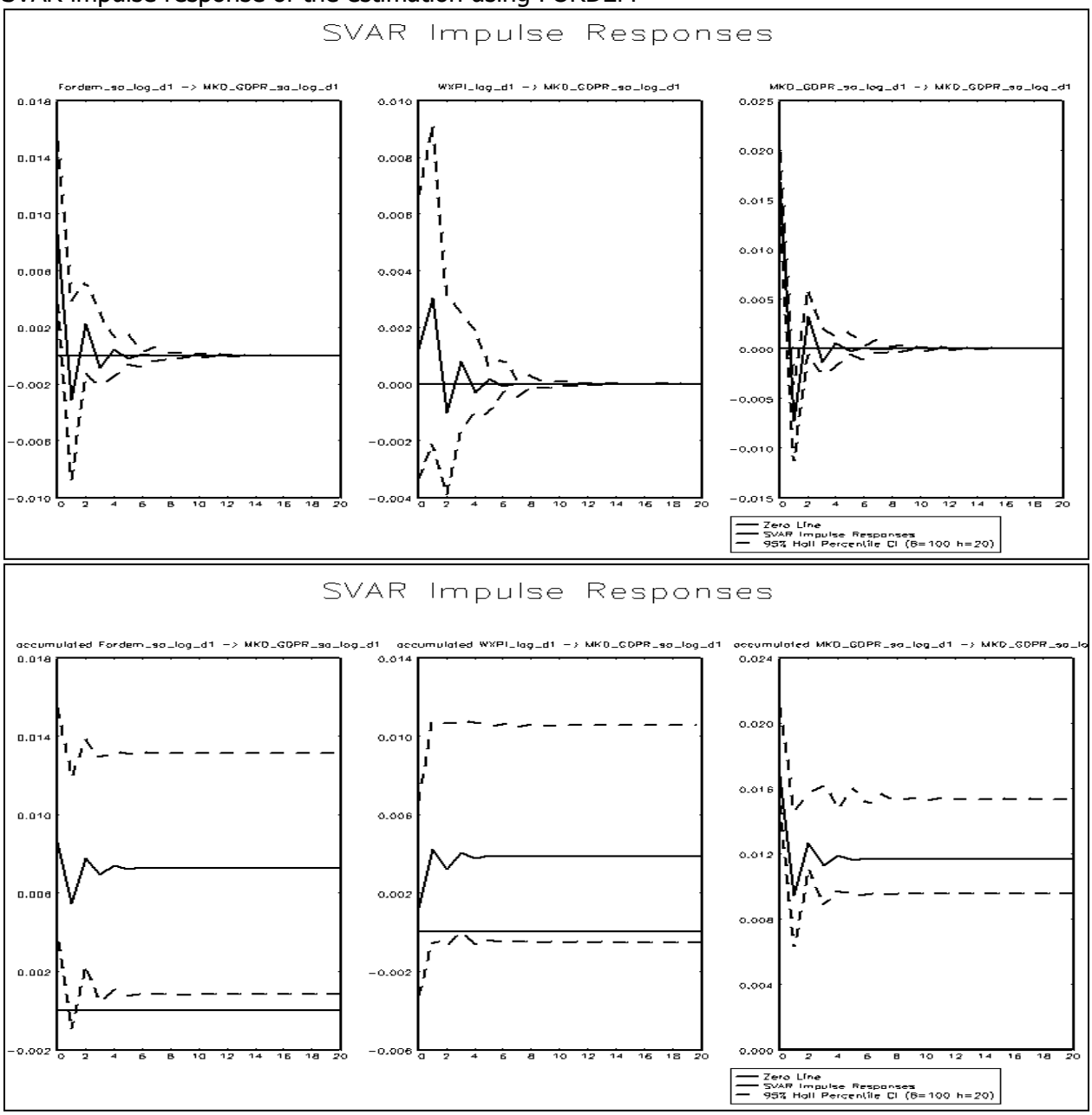
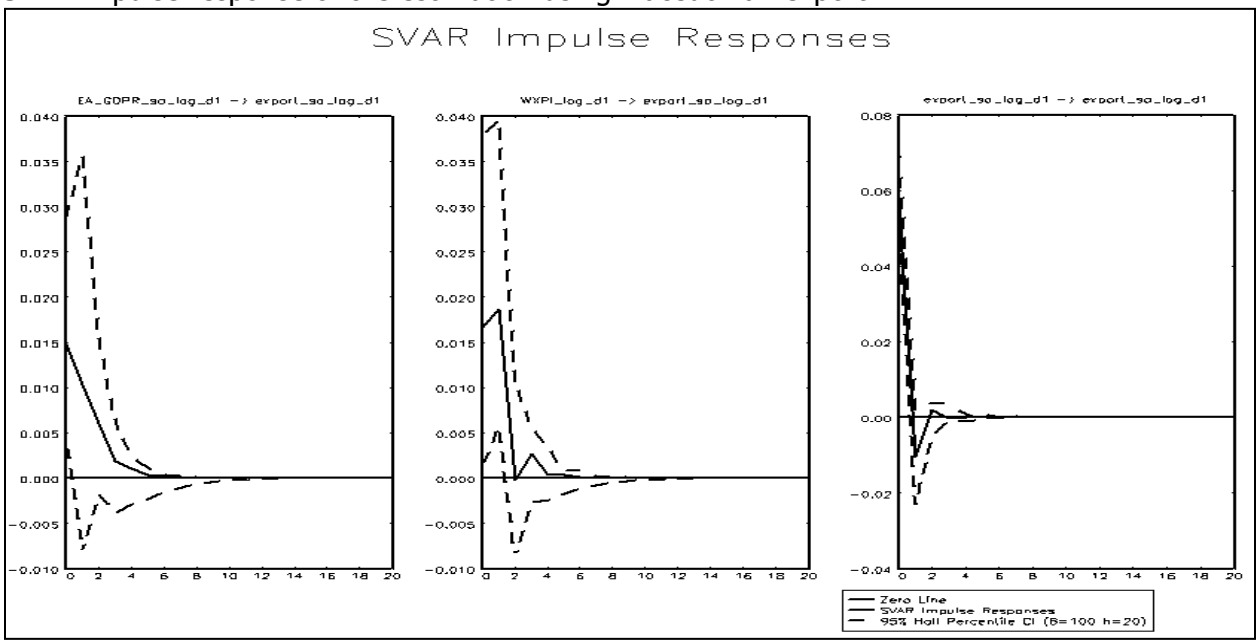


Table 12
Variance decomposition of Macedonian GDP using FORDEM

Period	DLOG (FORDEM_SA)	DLOG (WXPI)	DLOG (MKD_GDPR_SA)
1	0.21	0.00	0.79
2	0.19	0.02	0.78
3	0.20	0.03	0.78
6	0.20	0.03	0.77
12	0.20	0.03	0.77
18	0.20	0.03	0.77
24	0.20	0.03	0.77

Cholesky Ordering: DLOG(FORDEM_SA) DLOG(WXPI) DLOG(MKD_GDPR_SA)

Figure 8
SVAR impulse response of the estimation using Macedonian export



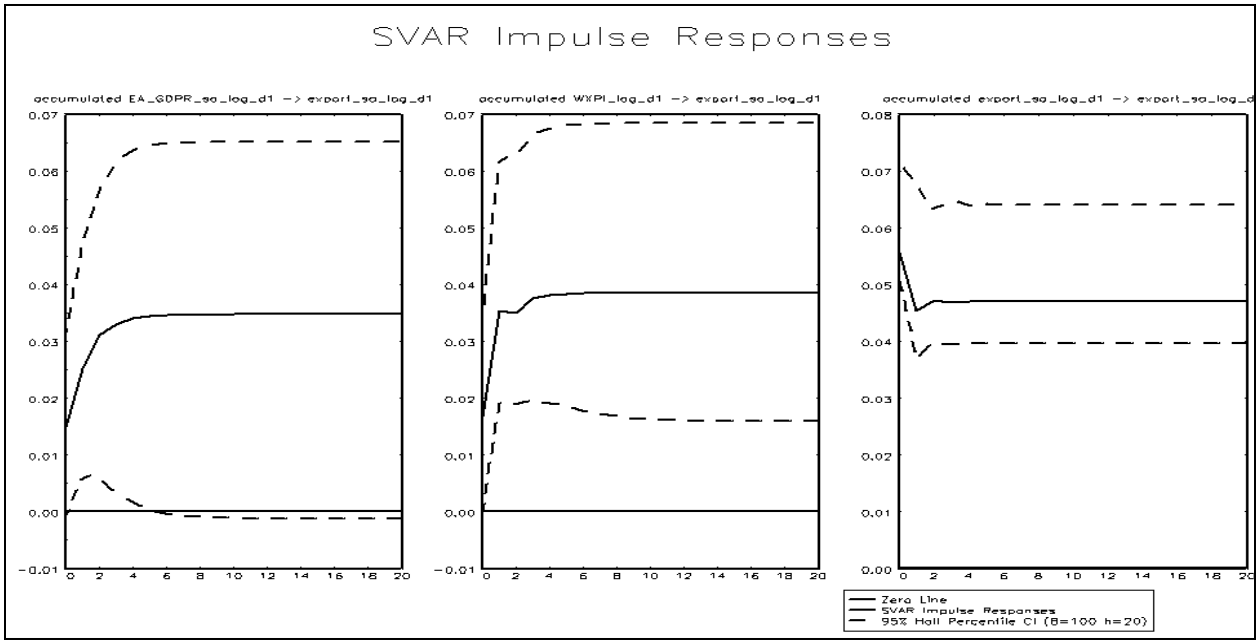


Table 13
Variance decomposition of Macedonian export

Period	DLOG (EA_GDPR_SA)	DLOG (WXPI)	DLOG (EXPORT_SA)
1	0.06	0.08	0.86
2	0.08	0.15	0.77
3	0.09	0.15	0.77
6	0.09	0.15	0.76
12	0.09	0.15	0.76
18	0.09	0.15	0.76
24	0.09	0.15	0.76

Cholesky Ordering: DLOG(EA_GDPR_SA) DLOG(WXPI) DLOG(EXPORT_SA)