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Business Cycle Synchronization of a Small Open EU-Candidate Country's Economy with the EU Economy

Summary: The objectives of this paper are to empirically identify business cycles in a small open EU-candidate country such as the Republic of Macedonia and to assess the degree of synchronization of the country's business cycle with the cycle of the EU economy. Towards the first objective, we apply linear and non-linear methods for delineating the production gap cycle in the Macedonian economy. As for the second objective, we apply autoregressive methods to assess the size and speed of cyclical adjustment of the Macedonian economy to output shocks to the Euro-zone economy. The results of our analysis suggest a high degree of synchronization of the Macedonian business cycles with the cycles of the EU economy. Also, the shocks in economic activity in the Euro-zone economy are transmitted almost instantaneously, and with a large magnitude, to the Macedonian economy. Finally, the impact of the Euro-zone output contraction is less pronounced than the impact of the Euro-zone output expansion, suggesting an impact of the country's autonomous countercyclical economic policies.

Key words: Business cycles, Exogenous shocks, Potential output, Filter methods, Asymmetric adjustment.

JEL: C13, C22, E32, F41, F62.

Republic of Macedonia (RM) is a small, open economy, which has undergone a transition from a socialist-type to a market-based economy. In parallel to the transition process, the process of integration into the EU economy has been taking place, as the EU has been the main trading and investment partner of the Republic of Macedonia. In 2005, the Republic of Macedonia has become an EU-candidate country and since then, it has continuously been receiving positive reports by the European Commission on its efforts to integrate its economy into the EU economic institutional structure. On the economic policy front, one of the features of the Republic of Macedonia is the *de facto* fixed exchange rate regime for quite a long period (starting from 1995), whereby the national currency, the denar, has been pegged first to deutsche mark, and later on to the euro.

This paper deals with the issue of the business cycle synchronization of the RM's economy to the EU. As mentioned above, the importance of the EU economy for the development in the Macedonian economy is quite high due to its trade and

investment orientation towards the EU. Furthermore, Macedonian monetary policy is anchored to the Euro-zone monetary policy due to the currency peg.

The major aim of this paper is twofold: *first*, through application of relevant econometric techniques, to identify the business cycle profile of the Macedonian economy; and *second*, to analyze the impact of the EU business cycles on the fluctuations in the level of activity in the Macedonian economy. The common thread of these two aspects of the analysis is that as the Republic of Macedonia is moving closer to be integrated into the broader EU economy, the issue of the so-called business cycle synchronization between the two economies is very relevant in research and policy question.

The empirical analysis in this paper effectively consists of two broader segments. The first segment is basically related to the identification of the business cycle of the Macedonian economy and its relation with the business cycle of the Euro-zone. In that segment, we apply the two well known filtering techniques, the Hodrick-Prescott filter and the Christiano-Fitzgerald filter, in order to estimate and identify the upturns and downturns in the output gap of the Macedonian economy and their synchronization with the Euro-zone output gap cycle. Additionally, we apply the non-linear Markov-Switching method in order to estimate the probabilities for the Macedonian economy to regime-switch in terms of the phases of the business cycle.

The second segment of our empirical analysis is related to assessing the impact of the output shocks coming from the Euro-zone on the level of activity in the Macedonian economy. For this analysis, we apply the impulse response functions and variance decomposition estimated by vector autoregression (VAR).

This paper is structured as follows: Section 1 surveys the literature related to the business cycle synchronization. Section 2 presents the data used and estimation methods applied. The results and their discussion are provided in Section 3, while the final section of this paper presents the concluding remarks of the research.

1. Literature Review

One of the most important issues in the literature that analyzes business cycles is whether business cycles are synchronized between economies. The economists argued that trade and financial flows, as drivers of the process of globalization, are the main channels of transmission of business cycles. The trade between the economies is considered as a main channel of transmission of the business cycles. Among the first, Jeffrey A. Frankel and Andrew K. Rose (1998) concluded that greater trade exchange as a result of economic integration leads to greater synchronization of the business cycles. Using a panel of annual data for twenty industrialized countries have shown that there is a strong positive correlation between trade integration and business cycles. Therefore, the transmission of business cycles through the foreign trade channel is very important in integrated economies, such as EU. Iulia Siedschlag and Gabriele Tondl (2011) demonstrated that the specialization of production has a significant impact on the trade in the EU15. Foreign trade could indirectly affect the business cycle through its impact on the specialization of production. Ayhan M. Kose, Eswar S. Prasad, and Marco E. Terrones (2003) first examined the correlations between the growth rates of output and consumption in different countries as opposed to the growth rates of the

world output. They claim that globalization has increased the degree of synchronization of business cycles and that the evidence that trade and financial integration enhance global spillovers of macroeconomic fluctuations is stronger for industrial than for the developing countries.

Jonathan Heathcote and Fabrizio Perri (2003) examined the synchronization of the business cycle in the United States with the rest of the world by measuring the synchronization of GDP, investment, consumption, employment in the civilian sector and productivity of labor. They concluded that the US business cycle is not well synchronized with the business cycle for the rest of the world. Stefano Magrini, Gerolimitto Margherita, and Duran Engin Hasan (2013) investigated the business cycle dynamics across the US states. In the paper they analyze one very interesting issue: given a certain level of synchronization, some economies might be systematically ahead of others along the swings of the business cycle, which is closely related to the issue of analysis of synchronization among regional or national business cycles. Based on the data for 48 conterminous US states, for a period 1990-2009, they show that leading (or lagging behind) is a feature that does not occur at random across the economies. They investigate the economic drivers that could explain this behavior in their paper.

There are many papers and studies that examine the synchronization of the business cycles in the European Union, as well as the synchronization of the business cycles of the countries that were not yet EU members when the analyses were made. Michael Artis and Wenda Zhang (1997, 1999) concluded that fixed exchange rate regime, such as ERM, imposes policy discipline that leads to greater synchronization of the business cycles of the participating countries. They found out that since ERM is formed in 1979, the business cycle of ERM member states shifted from the US to Germany. This effect of synchronization of the business cycles is bolstered by the growing links in the trade and finance between the European countries. Antonio Fatas (1997) investigated how the process of integration to the EU affected regional and national fluctuations within the European Union, and the ability of EMU to deal with shocks that are specific to regions and countries in a process of adoption of a single currency among some of the member states. Zsolt Darvas and György Szapáry (2008) analyzed the synchronization of business cycles between new and old EU members. Their results show that some new member states, such as Poland, Hungary and Slovenia, have achieved high degree of synchronization for GDP, industry and exports, but not for consumption and services. According to them, the other CEECs have achieved less or no synchronization.

Cristina-Flavia Tatomir and Cristina O. Popovici (2013) investigated the degree of business cycles synchronization in the European Union, analyzing its evolution during the period 1999-2011. They used the Hodrick-Prescott filter to capture the relevant trends in the business cycles and the Pearson correlation coefficient to measure the degree of synchronization. They found out that Finland and France reached the highest level of business cycle synchronization with the euro area, while a country with the most divergent business cycle is Poland. Iulia Traistaru (2004), using band-pass filters, made a comparison of the degree of business cycle synchronization between member countries of the EMU and Central European countries in the period 1990-

2003. The results of her research show that synchronization of the business cycles between countries of the two groups are lower than the synchronization between the EMU countries. Stavros Degiannakis, David Duffy, and George Filis (2014) were exploring the time variations of the correlations of business cycles between the member states for the period 1980-2009. They prove that changes in synchronization of the business cycles correspond with the institutional changes that are occurring at a European level. Jakub Gazda (2010), in his paper, presented view based on real business cycle approach. The main aim of the article is to present methodological innovations introduced by real business cycles proponents such as: Hodrick-Prescott filter and multistage calibration simulation procedure. According to him, business cycle analysis based on HP filter should be extended with multistage calibration simulation procedures.

The business cycle synchronization issue may be put in a different, long-run perspective by relating it to the economic convergence process within the EU. Mihaela Simionescu (2015) analyzes the overall GDP *per capita* convergence for EU-28 countries as well as the regional convergence for 272 NUTS2 level regions in Europe. Her analysis indicates that the convergence could be much more easily identified at the level of so-called convergence clubs rather than at the level of the whole EU or even at the level of various regions. This supports the assertion that even countries with similar structural characteristics, the new EU member countries from Central and Eastern Europe for instance, can differ in terms of their convergence to steady state equilibria due to differences in the initial conditions.

Similar research is done by Hasan E. Duran and Alexandra Ferreira-Lopes (2015). They investigated the business cycle correlation and its determinants in Eurozone. They explored the relevance of the main determinants of business cycle synchronization such as bilateral trade intensity, dissimilarity of labor market rigidity, financial openness, dissimilarity in industrial structures, net external migration, and FDI relations. The results show that bilateral trade relations present a positive influence on business cycle correlations, the dissimilarity of labor market rigidity presents a negative influence, while the rest of above mentioned variables are non-significant. It must be underlined that according to the results presented in a paper, member states of the Eurozone that usually lead the cycle are the ones that are wealthier, with strict employment legislation, more specialized in construction and finance sectors, and more prone to international capital movements.

In somewhat different perspective, Duran (2013) analyzed business cycle correlations across Turkish provinces and the tendency of these cycles to converge over the period of analysis between 1975-2000 and 2004-2008. He concluded that regional business cycle asymmetries have tended to decrease in recent decades, and results show that the convergence process is rather slow and there still exist asymmetries across the regional business cycles. According to him, dissimilar economic fluctuations and asymmetric shocks across the regions in Turkey might create severe policy distortions that cause aggregate policy interventions to be sub-optimal for at least a fraction of the regions. Hence, the aim of the paper is to provide empirical evidence and policy implications in that context. Two years later, the same author, Duran (2015) examines the synchronization of business cycles across different regions within a

single (Turkish) economy. His analysis indicates that as the entire economy grows through time, the regional business cycles get more synchronized, and that the degree of business cycle synchronization increases with the degree of similarity in industrial structures, market sizes and trade integration, as well as the arbitrary degree of agglomeration and synchronization.

In this context, related to the scope of this research, we provide a brief overview on the structural models already used for the identification of business cycles in the Republic of Macedonia. One model is of Neo-Keynesian's nature, with structural equations, which is used in the process of macroeconomic projections by the National Bank of Macedonia (NBRM)¹. The other output gap is calculated based on Cobb-Douglas production function in the working paper of Biljana Jovanovic and Rilind Kabashi (2011). Both output gaps have certain similarities in the identification of economic cycles, although the output gap calculated according to the Neo-Keynesian model from the NBRM is more volatile. This is perhaps due to the frequency of the data used. Namely, this output gap is calculated according to quarterly data, while the output gap calculated by using production function is based on annual data. Both of the structural output gaps show negative output gap in the period from 2001 to 2004 and negative output gap starting from 2009. In the remaining period, both output gaps indicate a period of economic revival and expansion especially in 2000 and 2008, when the highest values of the output gap are noticed.

2. Data and Methodology

One of the major indicators for determining the stage of the business cycle of the economy is the output gap measure. The output gap measure indicates the deviation of the current actual economic activity in the country (GDP as most comprehensive indication) as a ratio to potential output. Accordingly, the production gap may be considered as an indicator for the existence of balance or imbalance between the aggregate supply and the aggregate demand.

In order to measure the output gap, it is necessary to assess two key elements: the long-term trend component and the cyclical component of the economy, i.e. the potential and actual GDP, respectively. The long-term trend component represents an approximate indicator for the potential output in the country. The cyclical component shows economic fluctuations, i.e. deviations of the current economic activity from its potential output.

Generally, there are two groups of quantitative methods for the assessment of economic cycles through the production gap: statistical and structural. Statistical methods are based on statistical "data generating" approaches, and they can generally be divided into two groups: linear and non-linear. Unlike statistical methods, structural methods are established, i.e. based on the economic theory and they estimate the potential GDP through the interdependence and the dynamics of the various factors that determine economic growth (International Monetary Fund - IMF 2009, p. 5).

¹ This model is not publicly available and more details cannot be exposed.

2.1 Linear Statistical Methods for Evaluation of Economic Cycles

The most commonly used statistical methods are the linear filtering methods, which are based on linear techniques for filtering the data in the process of evaluation of the long-term trend component, and the cyclical component of the production. The most commonly used filter method in the empirical research is the Hodrick-Prescott (HP) (Robert J. Hodrick and Edward C. Prescott 1997).

The basic principle upon which HP filter estimates the output gap is by minimizing the following equation:

$$\min \left\{ \sum_{t=1}^T (y_t - \mu_t)^2 + \lambda \sum_{t=2}^{T-1} ((\mu_{t+1} - \mu_t) - (\mu_t - \mu_{t-1}))^2 \right\}. \quad (1)$$

The left part of the equation above calculates the cyclical component of GDP, while the right part of the equation calculates the potential output, i.e. long-term stochastic trend component. Accordingly, the calculation of the output gap is based on minimizing the variance of the current GDP marked with (y) and the trend component marked with (μ). Minimizing of the variance between cyclical and trend component is limited by the parameter (λ). The values of the parameter (λ) were initially derived for the US economy and later on were confirmed as relevant for several different countries by different authors².

The basic shortcoming of HP filter method is the so-called “end point bias”, wherein HP filter encloses the values of the cyclical and trend component in the final observation of the sample. The result is bringing the output gap close to zero, which indicates that aggregate supply and demand are close to a balanced state. Of course, this may not always correspond to reality. The more recent linear filter methods are the so-called “band-pass” filters, which are divided into two groups: symmetric and asymmetric. The most commonly used “band-pass” filters are Baxter-King (Marriane Baxter and Robert G. King 1999) and Christiano-Fitzgerald (Lawrence J. Christiano and Terry J. Fitzgerald 2003). The basic functioning principle of these filtering methods is the following equation:

$$x_t = \sum_{c=1}^{q+1} w(l,c)y_{t+l-c} + \sum_{c=2}^{q+1} w(l,c)y_{t+c-1}; t = q+1, \dots, n-q, \quad (2)$$

where (y) is the current series of GDP, (x) is the trend-component, and (w) is the factor that makes filtration of the current series of GDP based on the rolling average of lags and leads. Symmetric filters exempt certain observations from the beginning and the end of the sample, whereby, there is a loss of a significant number of observations for the calculation of the output gap. Based on that finding, the appropriate “band-pass” filter method is considered to be the asymmetrical Christiano-Fitzgerald filter method because it does not lose observations at the beginning and end of the sample, which is of particular importance for our research, too.

² According to Hodrick and Prescott (1997), as a pre-defined values of the parameter (λ), depending on the frequency of data used, are as follows: $\lambda = 100$ for data with an annual frequency; $\lambda = 1600$ for data with a quarterly frequency; $\lambda = 14400$ for data with a monthly frequency.

2.2 Non-Linear Statistical Methods for Evaluation of Economic Cycles - Markov-Switching Method and Its Modalities

The non-linear methods are used when it assumed an asymmetric behavior of the economy in the phase of expansion and recession, thus evaluating the various modes through which the economic activity passes.

Non-linear methods assume that the mutual dependencies between economic indicators are not constant, i.e. they change depending on the phase of the economic cycle. The major advantage of these methods is that they control for structural changes in the economy and evaluate different parameters of the model for the separate phases of the business cycle. Accordingly, these methods are very important for the transitional economies because they were subjected to a number of structural and institutional changes during the transition period. The most commonly applied non-linear models are those that are based on the so-called *Markov-Switching method* for assessing the change of regimes.

The essence of Markov-Switching method is that it can determine the stage of the economic cycle of the economy and the time period of the individual phases of the economic cycle. The latter is done through an assessment of the so-called unobservable random state variable (s_t). This variable has a stochastic character and is not directly measurable. It is assessed indirectly through the current observed series (in our case the real GDP) by the assumed distribution, which has the so-called Markov-chain.

Markov chain is defined through transition probabilities, i.e. by determining the probability of the economy to stay in one of the regimes and the probability of the economic activity to shift from one regime to another in the next period. The assessment of the probability of the economy to move from one regime to another can be shown through the following equation:

$$P_{ij} = P[s_{t+1} = i | s_t = j]; i, j = 0, \dots, N-1. \quad (3)$$

In the above equation, (P_{ij}) is the estimated probability that the economy will move from the current state of the economic cycle (j) to state (i) in the next period. The variable (s_t), is unobservable random state variable. The system can have at least two different states ($s_t = 2$), while the maximum number of states is not strictly specified, but depending on the size of the series it is not recommended to be more than 6 (Jurgen A. Doornik and David F. Hendry 2009). As the system must be located in one of the situations (I) or (i), then the sum of the probabilities of the system to be in a state (i) or (i) should equal to 1:

$$\sum_{i=1}^{N-1} p_{ij} = 1. \quad (4)$$

The basic model on which the Markov-Switching is based is "univariate". GDP is modeled as an autoregressive process, which means that it depends on its changes in the previous quarters. Univariate model will be applied in our research because the purpose of our analysis is to evaluate the economic cycles based on the variations of GDP itself, thus obtaining significant recommendations for macroeconomic policies'

makers. The following actions are applied when assessing the autoregressive models with a Markov-Switching method:

- (i) Determining the autoregressive order of the model by assessing the statistical significance of the time lags of the dependent variable;
- (ii) Pre-setting the number of states (regimes) that are expected to be for the series that is the subject of research (GDP). It can be roughly determined intuitively by the economic logic or graphically by the so-called Kernel distribution of the series;
- (iii) Selection of the model that is done by assessing the parameters that are drivers of the change in the system's state. This is done by several indicators: (a) statistical significance of the estimated parameters and (b) diagnostic tests on the residuals of the model such as test for normal distribution of the residuals, test for the non-correlation of the residuals of the model, test for homoscedasticity of the residuals.
- (iv) Conduct of a test for assessment of non-linearity of the model.

3. Methods for Analyzing the Transmission Effects of the Exogenous Changes on Domestic Economic Activity

It is from particular importance for this research to determine how the exogenous factors act on the domestic economic activity. In this context should be used methods that will show to what extent and within what time span the shocks from the international economic environment are transmitted on the domestic. Also, those methods should indicate the persistence of those shocks.

3.1 TAR Method for Assessing the Asymmetric Adjustment of Domestic Economy Conditional to Changes in the Foreign Economic Activity

An important method that enables the evaluation of different adjustment of the domestic economy when the foreign economy is in expansion or recession is the so-called threshold autoregressive method (TAR). The essential difference in the implementation of TAR and Markov-Switching methods is that the former method deterministically defines the turning point in a domestic economic activity, based on the so-called threshold changing of the foreign economic activity. The threshold changing on the foreign economic activity can be determined in one of the two ways:

- (1) By the investigator based on the economic logic and descriptive analysis of the data;
- (2) By using the statistical method called "Grid search" (more details on this method can be found in Kung-Sig Chan 1993).

Once the threshold changing of the foreign GDP is determined, it is fed into the model to assess the domestic GDP as an autoregressive model. The basic form of the model TAR can be shown by the following equation:

$$y_t = I^* [\beta_0 + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \beta_n y_{t-n}] + [I - I]^* [\alpha_0 + \alpha_1 y_{t-1} + \alpha_2 y_{t-2} + \alpha_n y_{t-n}] + u_t, \quad (5)$$

where: $I = 1$ when $y^*_t \geq D$ and $I = 0$ when $y^*_t < D$ and (y) is the domestic economic activity, (y^*) is the foreign economic activity, (D) is the determined threshold for changes in the foreign economic activity and (I) is an indicative function conditional on the defined threshold. (β) and (α) are the parameters that need to be estimated.

The main actions for estimation of the model using the TAR method are as follows:

(i) Determining the number of autoregressive coefficients (the degree of autoregression of the model), by assessing the statistical significance of the included time lags of the dependent variable;

(ii) Determining the threshold through the two ways mentioned previously. In our research, since we have quarterly time series since 1997, we mainly apply the statistical method of determining the threshold changing;

(iii) Based on the determined threshold, the parameters in Equation (5) are estimated in order to obtain the reaction of the domestic economy conditional to the two different regimes of behavior of the foreign economic activity;

(iv) Testing the validity of the model through diagnostic tests of the residuals for: normal distribution, non-correlation and homoscedasticity. The stability of the model is also tested by applying the CUSUM and CUSUM SQ tests;

(v) Evaluation of long-term rates of adjustment of the domestic economy conditional on two different modes of the foreign economic activity is done on the basis of estimated parameters of the model (5) with the following formula:

$$\beta_0 / (1 - \beta_1 + \beta_2 + \dots + \beta_n) \text{ and } \alpha_0 / (1 - \alpha_1 + \alpha_2 + \dots + \alpha_n). \quad (6)$$

3.2 Vector Autoregressive Model (VAR) for Assessing the Impact of the Exogenous Shocks on the Domestic Economy

Although the TAR model is an excellent quantitative tool for the assessment of the impact of the changes in the foreign economic activity on the domestic economic activity, it is necessary to evaluate the time lag according to which the shocks are transmitted on the domestic economic activity. For this purpose, we used the vector autoregressive model (VAR), which can evaluate the so-called cumulative impulse response functions of the domestic economic activity (GDP) to the shocks in the foreign economic activity. Considering the fact that Macedonia is a small and open economy, changes in the foreign economic activity are strictly exogenous compared to the domestic economic activity. This introduces the so-called "block exogeneity" restriction. With this restriction in the VAR model, the transmission of the shocks from the foreign economic activity to the domestic are one directional. The reverse shocks originating from the domestic economy to the foreign one are precluded. As a result of this restriction, the VAR model is estimated in reduced form by the following system of equations:

$$y_t = \beta_{10} + \beta_{11}y_{t-1} + \beta_{12}y_{t-2} + \dots + \beta_{1n}y_{t-n} + \alpha_{11}y^*_{t-1} + \alpha_{12}y^*_{t-2} + \dots + \alpha_{1n}y^*_{t-n} + u_{yt}, \quad (7.1)$$

$$y^*_t = \alpha_{21}y^*_{t-1} + \alpha_{22}y^*_{t-2} + \dots + \alpha_{2n}y^*_{t-n} + u_{y^*_t}, \quad (7.2)$$

where Equation (7.1) refers to the domestic economic activity, while Equation (7.2) refers to the foreign economic activity. In addition, (y) indicates the domestic economic activity (domestic GDP) and (y^*) the foreign GDP. In Equation (7.1), domestic economic activity is expressed as autoregressive function of its time lags and the current foreign economic activity and an appropriate number of its time lags.

When evaluating the VAR model with the “block exogeneity” restriction, the following “standard” steps are applied:

(a) Determining the number of time lags of the variables that are included in the Equations (7.1) and (7.2) through the information criteria: Akaike, Schwartz and Hannan-Quin;

(b) Applying diagnostic tests on the residuals of the model for: normal distribution, non-serial correlation and homoscedasticity. Stability of the estimated coefficients is tested by applying the CUSUM and CUSUM SQ tests;

(c) Estimation of the cumulative impulse response functions and their statistical significance, using two types of confidence intervals such as Efton and Hall by using the “bootstrap” method with 100 replications.

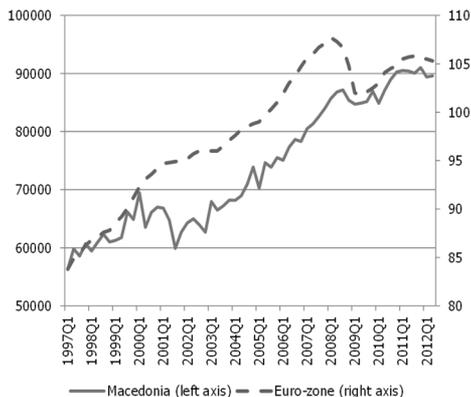
4. Analysis of the Results from the Implementation of Different Methods for Identification of the Economic Cycles in the Republic of Macedonia

This section will present the main findings from the application of the quantitative methods presented in Section 3. Firstly, we start by descriptive analysis of the data, followed by the discussion of the results from the linear and non-linear methods for determining the business cycles in Macedonian economy. In addition, this section discusses the results for transmission of the foreign shocks to the domestic economy based on the methods described in Subsection 3.3.

4.1 Descriptive Analysis of the Data on the Trend of Macedonia’s Real GDP and the Real GDP in the Euro-Zone

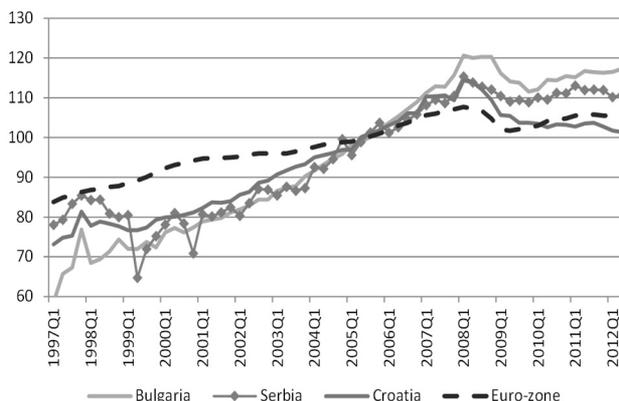
In analyzing and applying the empirical methods for the data on GDP for the Republic of Macedonia and the Euro-zone, we are using seasonally adjusted quarterly data over the period 1997Q1-2012Q2. The seasonal adjustment of the Euro-zone is done by the Eurostat, while for the Republic of Macedonia it is done by the authors applying one of the most commonly used methods “Census X-12 additive”. The series of real GDP of Macedonia and the Euro-zone in levels are presented in the following figure.

From Figure 1 it can be noticed a certain synchronicity in the movement of the GDP of the Republic of Macedonia and the Euro-zone. The synchronization is more pronounced since 2003, a period characterized with economic and political stabilization of the country after the eruption of the armed conflict in 2001. From 2003 to the middle of 2008, it can be noticed a trend of expansion of the foreign and the domestic GDP, while their synchronization becomes more emphasized with the beginning of the global financial crisis. The degree of relatively high synchronization can be also perceived from the correlation rate of 0.9 between the two series, which is statistically significant at 1%, a level of statistical significance. However, the major difference between the two series is the higher volatility of the Macedonian GDP, which is confirmed by the standard deviation of 10.8 despite of 6.8 for the Euro-zone. The relatively higher volatility of Macedonian GDP compared to Euro-zone can also be noticed in other countries of the region, too (Bulgaria, Serbia and Croatia, see Figure 2). The high volatility is most emphasized in the case of Serbia (standard deviation rate of 14.3).



Source: Eurostat (2015)³ and authors' calculations based on data from the State Statistical Office of Macedonia (SSO 2015)⁴.

Figure 1 Seasonally Adjusted Real GDP of Macedonia and the Euro-Zone for the Period of 1997Q1-2012Q2



Source: Authors' calculations based on data from Eurostat (2015) and the Statistical Offices of the member-states.

Figure 2 Seasonally Adjusted Real GDP of Countries from the Region and the Euro-Zone for the Period of 1997Q1-2012Q2

If analyzed dynamically, it can be noticed that the business cycle synchronization between the Macedonian and the Euro-zone economy has been increasing. By dividing the time period on several slots, the correlation has gone up from 0.71 for the initial period of the sample to 0.94 for the period after the beginning of the Global Financial Crisis, during a period characterized with increased economic and financial

³ Eurostat. 2015. Population and Employment.

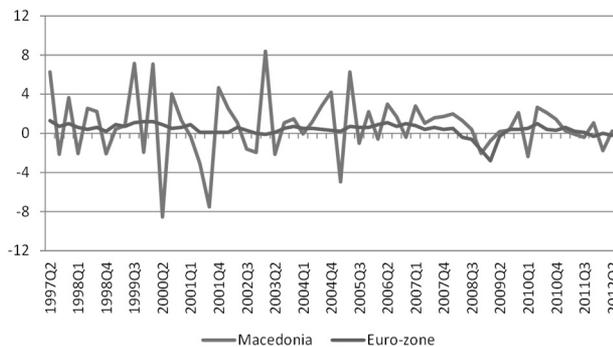
http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=namq_10_pe&lang=en (accessed January 17, 2015).

⁴ Republic of Macedonia State Statistical Office (SSO). 2015. Statistics - Gross Domestic Product. http://www.stat.gov.mk/PrikaziSooptenie_en.aspx?rbtxt=31 (accessed January 17, 2015).

integration with the EU. This result is consistent with the research of Artis and Zhang (1997, 1999), which suggests that the fixed exchange rate regime has a positive impact on business cycle synchronization by imposing economic policy discipline. Also, it is consistent with the research of Duran (2013) and Duran and Ferreira-Lopes (2015), which suggests that trade integration as well as the process of nominal and real convergence are positively associated with business cycle synchronization.

4.2 Analysis of Economic Cycles Based on the Filter Methods

The results obtained by using the HP filter method (shown in Figure 3) show that Macedonian economy has had a positive output gap in the period 1999Q1 till 2001Q1, which was interrupted by the start of the armed conflict in the country.



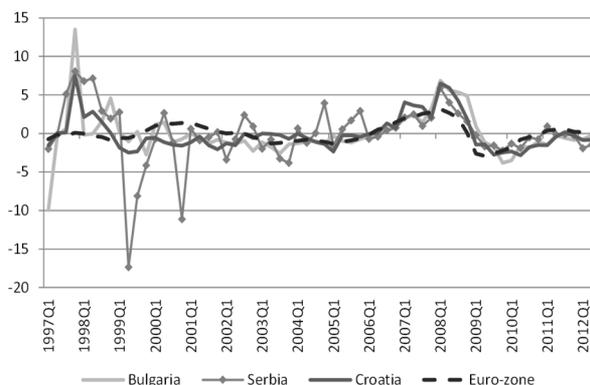
Source: Authors' calculations based on data from Eurostat (2015) and the Statistical Offices of the member-states.

Figure 3 Output Gap of Macedonia and the Euro-Zone for the Period of 1997Q1-2012Q2 Calculated According to the HP Filter Method

With the gradual stabilization of the economic and political situation in the country, the output gap gradually began to close and went into positive territory in 2005, reaching the highest values in 2008. This period indicates economic recovery of the country and a phase of economic expansion. Since the beginning of 2009, as a result of the transmission of the impact of the global economic crisis, the output gap turned to negative again, indicating that the domestic economy re-entered in the phase of recession.

If one compares the calculations of the output gap of the Republic of Macedonia and the Euro-zone, it can be concluded that the period of expansion in the domestic economy (during 2005-2008), corresponds to the period of expansion in the Euro-zone as well. Also, with the realization of a negative output gap in the Euro-zone from the beginning of 2009, a negative output gap appears in the domestic economy, too. This synchronization of the business cycles can be confirmed by the coefficient of correlation of 0.45 between the two series, which is statistically significant at 1% level. However, as shown in Subsection 4.1, it can be seen that there is significantly higher volatility of the domestic output gap compared to the foreign one, which is confirmed by the standard deviations of 2.8 for Macedonia and 1.3 for the Euro-zone. Higher volatility of similar small and open economies, compared to the Euro-zone, can be noticed

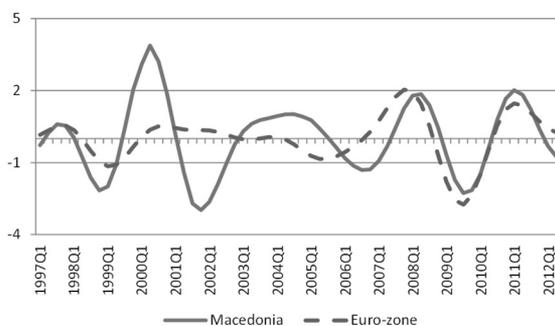
from the calculations of output gaps in the countries from the region (Bulgaria, Serbia and Croatia). Serbia and Bulgaria, with standard deviations of 3.9 and 3.0, respectively, have higher volatility of the output gap compared to Macedonia, while Croatia, with a standard deviation of 2.2 has lower volatility of the output gap.



Source: Authors' calculations based on data from Eurostat (2015) and the Statistical Offices of the member-states.

Figure 4 Output Gap of Countries from the Region and the Euro-Zone for the Period of 1997Q1-2012Q2 Calculated According to the HP Filter Method

In order to verify the consistency of the calculations for the output gap of Macedonia with the HP filter method, a comparison will be done with the asymmetrical Christiano-Fitzgerald filter method.



Source: Authors' calculations based on data from Eurostat (2015) and the Statistical Offices of the member-states.

Figure 5 Output Gap of Macedonia and the Euro-Zone for the Period of 1997Q1-2012Q2 Calculated According to the Asymmetrical Christiano-Fitzgerald Filter Method

The calculations of the output gaps for Macedonia and the Euro-zone showed consistency. The most significant difference is the lower volatility of the output gap of Macedonia calculated by Christiano-Fitzgerald asymmetric filter compared to the same calculation done with the HP filter.

4.3 Identification of Business Cycles Based on the Non-Linear Markov-Switching Method

In accordance with the steps presented in Subsection 3.2 for the assessment of the model with Markov-Switching method, we selected an autoregressive model of order four by changing the state of the constant and the parameters in front of the autoregressive terms of the dependent variable in the model.

In order to determine the regimes of the system, we defined two distinct regimes as follows:

- (1) **Regime 0** that signifies a period of recession;
- (2) **Regime 1** that signifies a period of expansion.

The pre-definition of the two regimes is based on the argument that a time series of fifteen years is considered as relatively short in order to determine more than two regimes of behavior of the system. An additional argument for this is the fact that in the transition period, when different economic-structural, institutional and social changes occurred, it could not be expected to completely clear the identification of the business cycle with more than two phases as it could be the case with the more developed economies. The existence of two regimes of behavior of the Macedonian economy is also graphically confirmed with the so-called Kernel distribution⁵.

As a last step, we have applied the test for non-linearity of the model where the null hypothesis of linearity of the model can be ruled out. This statistically confirms our choice of a non-linear model.

The specified model with the diagnostic tests and the test for non-linearity are shown in Table 1 below.

Table 1 Selected Model Assessed with Markov-Switching Method for the Macedonian GDP

Variable	Regime 0 (recession)		Regime 1 (expansion)	
	The estimated value of the parameter	t-statistic	The estimated value of the parameter	t-statistic
Constant (β_0)	0.23	.43	4.69***	4.35
Autoregressive parameter 1 (β_1)	-.13	-.57	-1.01***	-5.47
Autoregressive parameter 2 (β_2)	-.30**	1.98	-.69***	-3.02
Autoregressive parameter 3 (β_3)	-.31*	1.69	-.64***	-2.60
Autoregressive parameter 4 (β_4)	-.13	-.75	-.36*	-1.82
Diagnostic tests:				
Test for heteroscedasticity:	p-value = .44 OK			
Test for autocorrelation:	p-value = .84 OK			
Test for normal distribution:	p-value = .04 X			
Test for linearity:	Chi ² (7) = 9.82 [0.1990] approximate upper bound: [0.0798] OK			

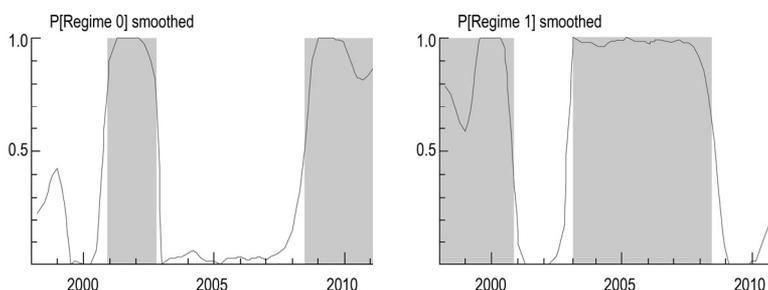
Notes: ***, **, * indicates statistical significance of the estimated parameter to a level of 1%, 5% and 10%, respectively.

Source: Calculations of the authors based on data from SSO (2015).

⁵ The results from the Kernel distribution for the quarterly growth rate of Macedonian real GDP indicate that there are two distinctive groupings of the data, which supports our arguments of existence of two business cycle regimes. These results are available from the authors upon request.

In accordance with the estimated parameters of the model, it can be concluded that most of them are statistically significant at 10% level. The model also rejects the null hypothesis of heteroskedasticity and autocorrelation. The only problem may be related to the test for normal distribution of residuals. However, taking into account the high volatility of growth rates of the real GDP in Macedonia and also in other countries in the region (see Figure 2), the requirement for a normal distribution of residuals cannot be always satisfied, because these economies are subject to the shocks of various natures.

The estimated regimes during the time period of analysis are presented in Figure 6, and the identification of the separate regimes and the estimated probability of being in that regime, is shown in Table 2. Accordingly, the inertia of the duration of the two separate regimes and the probability to switch from one regime to another in the next quarter can be evaluated.



Source: Authors' calculations based on data from Eurostat (2015) and the Statistical Offices of the member-states.

Figure 6 Duration of the Regimes of Changing the Situation in the Macedonian GDP

Table 2 Identification of the Separate Regimes and the Estimated Probability of Being in that Regime for the Macedonian GDP, According to Markov-Switching Method

Regime 0 (recession)		Regime 1 (expansion)	
Time period	Estimated probability of being in the given regime	Time period	Estimated probability of being in the given regime
2001Q1-2002Q2	0.96	1998Q2-2000Q4	0.80
2008Q3-2012Q2*	0.92	2003Q1-2008Q2	0.95

Notes: * 2012Q2 is the last available data that is identified to belong to regime 0, which does not necessarily mean that this is the last time period specified in this regime.

Source: Calculations of the authors based on data from SSO (2015).

As of regime 0 (mode of economic slowdown and possible recession), the model has identified the period from 2001Q1 to 2002Q2, whereas the estimated probability for the system to be in this regime is 0.96. The result is logical by the fact that in the first half of 2001 the armed conflict in the country began, which resulted in a negative growth rate of GDP, whose consequences were felt in 2002, too.

The second period that is identified as a period of economic slowdown is the period from 2008Q3 to 2012Q2, due to the transmission effects of global financial crisis. The estimated probability for the system to belong in this regime is high, i.e.

0.92. The greatest difference compared to the results obtained by the filter methods (Subsection 5.2), is that the Markov-Switching method determined the downturn period from 2008Q3 (two quarters earlier compared to the filter methods). This period coincides with the collapse of one of the largest financial institutions in the US.

As a period of economic expansion, it is defined the interval from 1998Q2 to 2000Q4, whereas the estimated probability of being in this regime is 0.80. Also, from 2003Q1 to 2008Q2, there is a period of economic expansion, which corresponds to the positive growth rates of GDP and the filter methods. The estimated probability for the system to be in this regime is 0.95.

As mentioned in Subsection 3.2, one of the benefits of using the Markov-Switching method is the assessment of the transition probability matrices. In our analysis, the estimated transition matrices by Equations (3) and (4) are as follows:

	$S_t = 0$	$S_t = 1$
$P = s_{t+1} = 0$.91	.08
$P = s_{t+1} = 1$.09	.92
Σ	1	1

(8)

The transition matrix shows a pronounced inertia of the Macedonian economy since the probability to stay in regime 0 (regime of economic slowdown and possible recession) and the probability to stay in regime 1 (regime of economic expansion) from the current to the next period are 0.91 and 0.92, respectively.

4.4 Analysis of the Impact of the Euro-Zone on the Domestic Economy Based on TAR Method

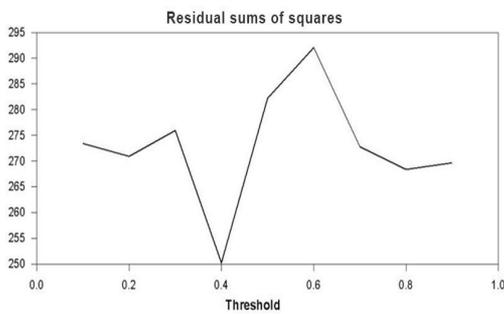
In analyzing the impact of changes in the foreign economic activity on the domestic, the TAR method has been applied on the quarterly growth rates of real GDP of the Macedonian economy and the Euro-zone as an exogenous factor. For assessing the model by a TAR method with the quarterly growth rates of real GDP, we follow the steps presented in Subsection 3.3.1. According to the statistical significance of the autoregressive parameters, we have selected an autoregressive model of order three. The next step is determining the threshold of changes in the growth rate of Euro-zone GDP, for which (as explained in Subsection 3.3.1), we rely on the economic logic and the “grid search” method.

According to the economic logic, it is expected that the threshold to have a value of 0, i.e. if the quarterly growth rate of real GDP in the Euro-zone is higher than 0%, then it would have a positive influence on the domestic economy and *vice versa*. To check this assumption, we have applied the “grid search” method, which has demonstrated a threshold of .4% (shown in Figure 7). This actually means that a higher quarterly growth rate of the Euro-zone of 0.4% will act positively on the domestic economy and *vice versa*.

The next step in the calculation is an estimate of the parameters of the model according to the two different thresholds of 0% and 0.4% for the foreign GDP in order to compare the sensitivity of the results.

The results presented in Table 3 show that selected models meet the diagnostic tests for the residuals and stability of the model. Moreover, the Wald test shows that the estimated model is statistically significant. In such evaluated models, an economic

sense of interpretation has only the evaluated long-term growth rates of the domestic economy (Equation (6)).



Source: Calculations of the authors based on data from Eurostat (2015).

Figure 7 Evaluation of the Threshold Changing of GDP in the Euro-Zone According to “Grid Search” Method

Table 3 Selected Model Evaluated by TAR Method for Macedonian GDP Set at Two Different Threshold Changing of the Foreign GDP of 0% and 0.4%, Respectively

Variable	Threshold changing of the foreign GDP of 0%		Threshold changing of the foreign GDP of 0,4%	
	Period of expansion	Period of recession	The estimated value of the parameter	t-statistic
Constant	2.33***	-.45*	2.56***	-.94*
Autoregressive parameter 1	-.64***	-.22***	-.50**	-.78***
Autoregressive parameter 2	-.32**	.13	-.19	-.35**
Autoregressive parameter 3	-.17	-.32**	-.25*	-.47**
Evaluated long-term changing rates of the domestic economy	1.1	-.3	1.3	-.4
Diagnostic tests				
Test for heteroscedasticity:	<i>p</i> -value = .48 OK	Test for heteroscedasticity:	<i>p</i> -value = .77 OK	
Test for autocorrelation:	<i>p</i> -value = .19 OK	Test for autocorrelation:	<i>p</i> -value = .90 OK	
Test for normal distribution:	<i>p</i> -value = .31 OK	Test for normal distribution:	<i>p</i> -value = .17 OK	
Stability tests of the model CUSUM and CUSUM SQ:	OK	Stability tests of the model CUSUM and CUSUM SQ:	OK	
Wald test for statistical significance of the whole model:	<i>p</i> -value = .00 OK	Wald test for statistical significance of the whole model:	<i>p</i> -value = .00 OK	

Notes: ***, **, * indicates a statistical significance of the estimated parameter to a level of 1%, 5% and 10%, respectively.

Source: Authors' calculations based on data from Eurostat (2015) and the Statistical Offices of the member-states.

When Euro-zone is in a phase of expansion, i.e. when the quarterly rate of real GDP growth of the Euro-zone is higher than 0%, i.e. 0.4% (in the long-term), then the domestic economy will grow with a real quarterly growth rate of 1.1%, i.e. 1.3%, respectively. On an annualized basis, the growth rates of the domestic economy would be 4.4% and 5.3%, respectively. In terms when the Euro-zone is in a phase of recession, i.e. when the quarterly rate of real GDP growth is less than 0% or 0.4% (in the

long-term), then the domestic economy will decline by 0.3% and 0.4% on a quarterly basis. On annual basis, the rates of decline of the domestic economy would be -1.3% and -1.5%, respectively. As can be concluded from the results, there is an asymmetric adjustment the domestic GDP compared to the foreign GDP; and in general, it can be concluded that the adjustment of the Macedonian economy to expansionary foreign economy shock is relatively more pronounced than the adjustment to the recessionary foreign shock. This asymmetry may be traced to at least two factors: (i) the asymmetric nature of trade agreements Macedonia has had with EU as a way of helping the country during the EU accession period to build an economy which can withstand the competitive pressures within the EU economy; and (ii) there has been a pronounced antirecessionary bias in conducting the country's fiscal policy, i.e. a prolonged fiscal expansion during the whole post Great Recession period. In terms of the differences in selected thresholds of the foreign GDP growth (whether it is 0% or 0.4%), there are no significant deviations in calculating the long-term rates of adjustment of the Macedonian economy.

These results also show that changes in the economic activity in the Euro-zone are transmitted with amplification to the Macedonian economy. Such amplification could be explained in the following way. As a small open economy, the Macedonian economy is a shock absorber, and that is particularly relevant when the shocks originate from a very large foreign economy (Euro-zone), which is the main trading and investment partner to the domestic economy. Moreover, as the exchange rate of the Macedonian denar has been pegged to the euro, the adjustment of the domestic economy to the external shocks of the real economic activity in the Euro-zone is done through the adjustment of the real domestic factors (aggregate output) and not through the (nominal) adjustment of the exchange rate of the domestic currency. Put differently, the exchange rate basically cannot function as a partial absorber of the real external shocks.

4.5 Analyzing the Impact of the Shocks in the Euro-Zone on the Domestic Economy through the Application of the VAR Method

The next step in the analysis is the assessment of the intensity and the time lag of transmission of the Euro-zone shocks to the domestic economy. For this purpose, it is applied the VAR method, i.e. the impulse response functions and variance decomposition that can give an adequate answer to the above-mentioned issues. In discussion of the results, we will pay attention only in the case when they are statistically significant, at least by one of the two calculated confidence intervals.

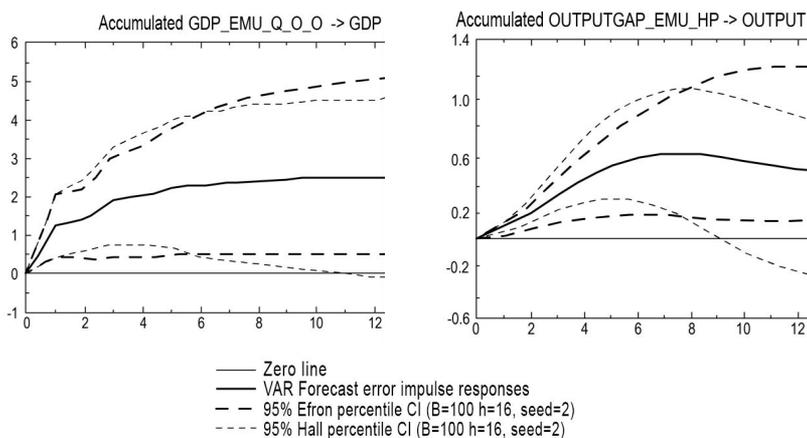
By following the steps presented in Subsection 3.3.2, in assessing the rates of the real GDP growth, we have selected a VAR model with one time lag, while for the analysis of the shocks in the output gap we have selected with two lags.

Furthermore, the selected VAR models fulfill the residual diagnostic tests as well as the tests for stability of the evaluated parameters (CUSUM and CUSUM SQ). An exception is the test for normal distribution of the residuals in the VAR model based on the growth rates of GDP.

Table 4 Criteria for Selection of the VAR Model Quarterly Growth Rates of Real GDP and the Output Gap Calculated with HP Filter between Macedonian GDP and the Euro-Zone

	GDP growth rate	Output gap according to HP filter method
Number of autoregressive terms of the variables selected according to the information criteria	1	2
Test for heteroscedasticity:	OK	OK
Test for autocorrelation:	OK	OK
Test for normal distribution:	X	OK
Stability tests of the model CUSUM and CUSUM SQ:	OK	OK

Source: Calculations of the authors based on data from Eurostat (2015) and SSO (2015).



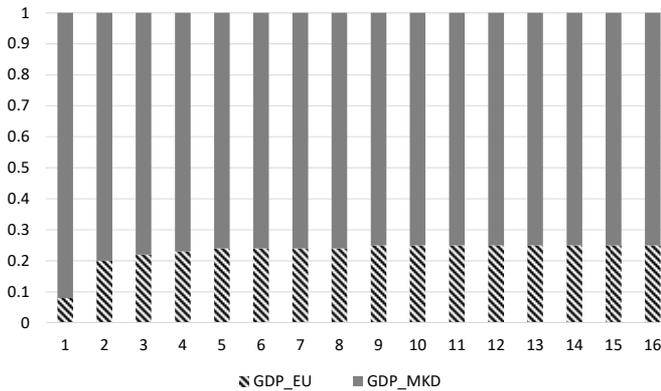
Source: Authors' calculations based on data from Eurostat (2015) and SSO (2015).

Figure 8 Cumulative Impulse Response Functions for Assessing the Transmission of Shocks of the GDP in the Euro-Zone on the Macedonian GDP in Terms of the Real Quarterly Growth Rates (the Left Figure) and the Output Gap (the Right Figure)

According to the results, it can be seen that an increase in the quarterly rate of real GDP growth in the Euro-zone (positive shock of one standard deviation), will increase the quarterly growth rate of the Macedonian GDP. The effect from the shock is transmitted within the current quarter, whereas this impact will persist over the next ten quarters. The magnitude of transmission of the shock in the growth rate of the foreign GDP is above one percentage point, and its cumulative effect increases gradually, reaching the maximum value at approximately two percentage points after the sixth quarter. Similar results are obtained with the transmission of the shocks in the output gap. Increasing the output gap of the Euro-zone (positive shock of one standard deviation), will affect the Macedonian output gap with a delay of one quarter and this effect will persist in the next nine quarters. Again, the intensity of the transmission of these exogenous shocks is above one percentage point, while the maximum intensity of transmission the shock is felt in the sixth quarter.

The variance decomposition method provides consistent results with the impulse responses. As presented in Figure 9, the variations in the Euro-zone economic

activity can explain the significant proportion of the variance in the domestic economy. For example, within a period of one quarter, 8 percent of the variations in the domestic GDP can be explained with the variations in the Euro-zone. The impact of the Euro-zone economic activity gets significantly amplified in the second quarter explaining even 20 percent of the variance. The peak is reached in the 9th quarter where the variations in the Euro-area explain 25 percent of the variance in the Macedonian economy.



Source: Authors' calculations based on data from Eurostat (2015) and the Statistical Offices of the member-states.

Figure 9 Variance Decomposition for Assessing the Transmission of Shocks from the Euro-Zone to Macedonian GDP in Terms of the Real Quarterly Growth Rates

Based on the results obtained by the cumulative impulse response functions and the variance decomposition, it can be concluded that the exogenous shocks have a significant impact on the Macedonian economy. They are transmitted very quickly, in the same direction and their effects are persistent (over two years). Hence, it is important to highlight that the Macedonian economy is quite sensitive to exogenous shocks, in the case of those originating from the Euro-zone, and that their intensity of transmission is also quite high.

5. Conclusion

The major aim of this paper is to empirically identify the business cycles in the small open EU-candidate country like Macedonia and to what extent they are synchronized with the Euro-zone. This is a very relevant question for the policy makers since Macedonia is on the road of joining the EU and for more than a decade, has maintained its fixed exchange rate to the Euro. As such, the investigation of the magnitude and the time period by which the exogenous shocks originating from the Euro-zone economy are transmitted to the domestic one is of utmost relevance for the domestic policy makers.

The identification of the Macedonian business cycles and their synchronization with the EU business cycles was done by using various linear and non-linear quantitative methods that provided consistent results. However, all of the methods have certain

limitations. For example, there is no any single method that can encompass all the aspects of the business cycle synchronization including: the asymmetry and size of adjustment, the magnitude of transmission of the shocks and the time lag of adjustment of the domestic economy.

The major findings of this research suggest that indeed, the Macedonian business cycles are to great extent synchronized with the ones of the Euro-zone. Furthermore, the results also suggest that the shocks in the economic activity originating from the Euro-zone are transmitted almost instantaneously to the domestic one and the magnitude of transmission is quite high. The non-linear TAR method indicates that there is an asymmetry in adjustment of the Macedonian economy depending on the stage of the business cycle in the Euro-zone. Namely, the impact of the economic downturn in the Euro-area economy is less strongly transmitted to the Macedonian economy compared to the period when the Euro-zone economy expands. In other words, a contraction of the Euro-zone economy induces lower contraction of the Macedonian economy compared to the period when the Euro-zone economy expands. This may be a result of the domestic mitigating policy measures when the Euro-zone economic activity contracts such as monetary easing and higher fiscal spending and redirecting the trade to other emerging economies like Turkey etc.

As a recommendation for further investigation, this research can be extended by analyzing to which EU countries Macedonian economy is most sensitive to the shocks. For example, this may depend not only from the volume of trade and financial linkages between the individual EU economies, but also by the type of commodities traded. Moreover, different commodities have different price elasticity of demand. In that direction, it would be interesting to differentiate the type of the traded commodities, i.e. whether they are raw commodities or processed goods and what type of processed goods etc.

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