Mendel University in Brno
Faculty of Business and Economics

Determinants of Business Cycle Synchronization in the European Union

Diploma thesis

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Abstract
TOUFAROVÁ, MIROSLAVA. *Determinants of Business Cycle Synchronization in the European Union*. Brno, 2016. 89 p. Diploma thesis. Mendel University in Brno.

The main objective of this thesis is to identify and test the synchronization of business cycles within the EU, with accent to those countries that accessed in 2004. The thesis also examines the effects of selected factors such as indiscipline in fiscal policy, trade intensity and industry specialization on the synchronization of economic activities. For the purpose of this thesis, the correlation analysis, the panel data analysis and multivariate regression analysis is used. Results provide the evidence of positive effect of trade intensity; negative effect of industry specialization and fiscal indiscipline on the business cycle convergence in the EU.

Keywords
The OCA theory, business cycle synchronization, correlation analysis, rolling correlation, panel data regression analysis, multivariate regression analysis, intra-industry trade, specialization, fiscal indiscipline

Abstrakt
TOUFAROVÁ, MIROSLAVA. *Determinants of Business Cycle Synchronization in the European Union*. Brno, 2016. 89 p. Diploma thesis. Mendel University in Brno.

Hlavním cílem práce je identifikovat a testovat synchronizaci ekonomických cyklů v EU s akcentem na ty země, které přistoupily v roce 2014. Práce se dále zabývá vlivy vybraných faktorů jako je vnitro-odvětvový obchod, fiskální nedisciplína a odvětvová specializace na synchronizaci ekonomických aktivit. K tomuto účelu je použita korelační analýza, regresní analýza panelových dat a vícerozměrná regresní analýza. Výsledky prokazují pozitivní vliv vnitro-odvětvového obchodu; negativní vliv odvětvové specializace a fiskální nedisciplíny na konvergenci ekonomických cyklů v EU.

Klíčová slova

Teorie optimální měnové oblasti, synchronizace hospodářských cyklů, korelační analýza, klouzavá korelace, regresní analýza panelových dat, vícerozměrná regresní analýza, vnitro-odvětvový obchod, specializace, fiskální nedisciplína

Contents

1 Introduction

The creation of common currency area in Europe was discussed already in 1960´s, and finally realised in 1999, when the Euro came into existence. The political discussion and the process of harmonization and convergence of economies had preceded the scheme. At the same point the interest in theoretical and empirical papers dealing with the common currency area in the EU and the readiness of countries to adopt Euro have significantly increased.

From the political point of view, the criteria for adoption of common currency is determined by Maastricht criteria, which includes deficit, debt, inflation, interest rates and nominal exchange rate. Kohout (2010) stated that the choice of criteria is at least arguable and the ability of permanent sustainability of Euro is not measurable by them. The Euro Area consists of countries which danger existence of all EA. The final choice of criteria was given by the political debates and agreements rather than the criteria created on the basis of empirical studies.

From the theoretical and empirical point of view of recent studies, The Optimum currency area theory has become the main approach in considerations of enlargement of the EA. The theory was able to answer the question why should countries abandon their own currency, loose ability to use the monetary policy and give the power in hands of supra-national institution the ECB. And it explained both the costs (or threats) and benefits, which are connected to being part of the common currency area. From the perspective of development of the OCA theory, it is rather the great amount of studies and researches than the comprehensive theory, but on the strong theoretical basis. This fact also shows that the theory is still needed to be developed further to find out the final comprehensive approach. During the last 50 years, the economists and researches brought up with the several criteria, which should be fulfilled by countries in order to make the common currency beneficial for all members, such as flexibility of labour and wages, economic openness and more. The key role and basis of the OCA theory is the necessity of business cycle synchronization within the countries of the EA, which leads to smooth functioning and decrease of risk of asymmetric shocks (costs) in the the EA. The asymmetric shocks are the highest danger of countries of the common currency, since members lost the ability to use monetary policy with the adoption of Euro. The ECB takes into account all member states of the EA and it would be naive to suppose that it does take actions, which would damage more economies than protect. Therefore, the convergence of business cycles must be fulfilled at a sufficient level by all countries, which form the common currency area or want to join the EA. In the context of the OCA theory the business cycle convergence plays the key role. The question is whether the member states and candidates have synchronous business cycles and which actions should take to support smooth functioning of the EA. Additionally, are the candidates of the EU ready for adoption of the common currency.

The question of access of new countries in the EA was shifted from the main debates in the context of recent issues, mainly the financial and debt crisis. Now, the Europe is again under the pressure caused by migrant crisis, which needs to be solved in advance. Furthermore, it is more obvious that there is a critique of whole project of European integration, will to exclude some countries from the EA or the

EU, especially Greece and contrarily the vote for the fastening of integration processes. In the context of hardly measureable and probably very high costs from the leave of the EA (the EU). The issues of access of candidate countries into the EA and observation of results in the context of members are still actual theme. Therefore, it is very useful to observe the synchronization of business cycles in the EU and to identify the factors, which affect the business cycle synchronization in the EU to ensure the smooth and beneficial functioning of the Euro Area for all members.

2 Objectives of the thesis

Open market with no trade barriers helps to boost international trade of particular countries. Thus the accession to the EU should strengthen economic linkages among the EU countries. Objectives of the thesis are in accordance the "Optimum currency area theory" criteria. The objective of the thesis is to identify and test the synchronization of business cycles within the EU, with accent to those countries that accessed in 2004. The thesis examines the effects of selected factors such as indiscipline in fiscal policy, trade intensity etc. The first partial objective is to test whether European countries' business cycles are synchronized. Than the business cycle synchronization of nowadays members (CEEC) in the pre-accession period will be tested to examine the effect of accession. The second partial objective is to examine the effects of various factors including fiscal policy indiscipline, trade intensity on the synchronization described above. The third partial objective is to evaluate whether those new accessed countries (particularly CEEC's) are more synchronized with each other than with the EU.

Several research questions are examined as:
"Are the business cycles synchronized across the EU?"
"Does the synchronization change within the time in the EU?"
"Are the CEE countries synchronized together rather than to the EU or the EA?"
"What are the factors determining the business cycle synchronization within the EU? Do the trade intensity or fiscal indiscipline affect the business cycle synchronization? "
"Particularly, does the fiscal dissimilarity (measured as dissimilarity in fiscal deficits) lead to business cycle divergence in the EU?"

3 Methodology

The goal of the thesis is to investigate the business cycle synchronization across the EU countries and to test its determinants with the respect of trade intensity and fiscal similarity and discipline measures.

Thesis involves the analysis of the empirical studies dealing with the Optimum currency area theory and the theory of endogeneity. For the purpose of empirical analysis, chosen methodology includes the correlation analysis, panel regression analysis and multivariate regression analysis.

Although the number of papers dealing with the OCA theory and its development has increase significantly last years, there is no consensus about chosen method, identification of business cycle convergences, and neither the interpretation of the results. The methodology for the thesis is chosen based on the most used and known statistical approaches.

3.1 Business cycle similarity

To investigate the level of business cycle similarity it is used the method of traditional approach of the OCA theory based on the pairwise correlation coefficient application. The data were collected from the Eurostat database, which includes the larger extend of data for the EU countries for the purpose of analysis. The OECD uses the same methodology of accounting, but the data availability is not extended for non-member countries of the OECD, which should be involved in the thesis. Gross domestic product was collected as a seasonally adjusted and adjusted by working days in quarterly frequency from the year 1996Q1 to 2015Q4 at the price level of 2005. GDP is transformed into the logarithms with the aim of easier interpretation of results.

To obtain the growth of the GDP, the Hodrick-Prescott filter is applied to dissect the cyclical component out of the GDP series. HP filter is one of the most used instrument of identification of cyclical component. Hodrick-Prescott (1997) identified the time series as:

$$y_t = g_t + c_t$$

where g_t is growth component, the c_t is cyclical component, t stands for the t=1,.., T. Next, HP filter is based on the minimization relationship:

$$Min\left\{\sum_{t=1}^{T} c_t^2 + \lambda \sum_{t=1}^{T} \left[\left(g_t - g_{t-1}\right) - \left(g_{t-1} - g_{t-2}\right)\right]^2\right\}$$

λ stands for smoothing parameter with optional level of value. Hodrick-Prescott suggested the value of 14 400 for monthly data, 1600 for quarterly data, 400 for half-yearly data and 100 for yearly data.

Identified cycles are used in the pairwise correlation analysis from the static and mostly from the dynamic point of view with aim to measure the similarity in business cycles in the EU countries. Correlation of cycles is measured between

chosen states and benchmark (EU15, EU28, EA and for a purpose of regression it was used EU15 as a benchmark). Correlation coefficient ranges in interval <-1;1>. The dynamic correlation coefficient is calculated based on four-year rolling window of Pearson´s correlation. For the purpose of regression analysis, it is used the rolling correlations and GDP is transformed into yearly data, since the deficit criteria is involved.

3.2 Determinants of business cycle synchronization

To identify the determinants of the business cycle synchronization is involved:

- Grubel-Lloyd index of intra-industry trade, Herfindahl-Hirschman index of specialization. The export and import were collected from the Eurostat database in yearly data. For the purpose of Grubel-Lloyd index it was used the SITC classification of the two-digit level.
- Krugman specialization index was collected in yearly data and it is used the NACE lev. 2.
- Fiscal dissimilarity is based on the difference of the deficits over GDP above the Maastricht criteria between country and benchmark. The fiscal dissimilarity criterion is measured as:

$$DEF_{i,t} = \left| \left(\frac{deficit_{i,t}}{GDP_{i,t}} - Maastricht criteria \right) - \left(\frac{deficit_{j,t}}{GDP_{j,t}} - Maastricht criteria \right) \right|$$

where deficit is net lending or borrowing, i and j stands for countries, Maastricht criteria is calculated at the level of 3 %, t stands for time.

3.3 Panel data analysis

The thesis involves the panel data analysis to determine the dependency of chosen variables. Kennedy (2008) stated that panel data can be explain as a combination of the time series and cross sectional series and helps us to create model which examine the relationship of chosen variables.

The model is estimated as a panel dataset, which fulfil statistical criteria. It is assumed, that Fixed Effect Model should be used. Firstly, it is examined the pool regression. The impact of variables varies over time, constant probably starts at the different point and errors might differ, the Pooled model does not show as an appropriate model. This is testified by the Panel diagnostics in Gretl. Statistical test prove the result, which has been assumed. In context of choice of Individual effects models, it is used panel diagnostic to choose between Random Effect Model and Fixed Effect. In respect of Residual variance, Breusch-Pagan test and Hausman test it is used the Fixed Effect Model in the thesis.

The panel dataset has the following structure:

- Dependent variable is the business cycle correlation between the EU 15 and the chosen states measured by the 4 year window rolling correlation (expressed by GDP)

- Independent variables are Grubel-Lloyd index (GLI or GLi), Krugman index (KI) and deficit dissimilarity (Deficit or Def)
- Dummy variable is used for membership in the EA in the first model, further it is omitted due to problem of collinearity in the model.

All variables are examined in the linear form. The logarithm is used to simplify the interpretation of the results. Since some of the variables are also negative, logarithm would cause the loss of data. Therefore, it is used the interpretation based on units.

Pooled regression of following form:

$$corr(y)_{i,t} = \alpha_0 + \alpha_1 GLi + \alpha_2 KI + \alpha_3 Deficit + \alpha_4 D_{EA} + u_{it}$$

where $corr(y)_{i,t}$ denotes the correlation coefficient of business cycles between country i and reference benchmark (EU15) on the basis of rolling correlation over a four year window of quarterly GDP, final time series are at annual frequency. The cyclical component is removed by the Hodrick-Prescott filter.

α_0 is the common intercept,

GLi is Grubel-Lloyd index, Deficit is deficit dissimilarity between chosen states and benchmark over the Maastricht criteria, KI is Krugman index

D_{EA} is dummy variable for membership in EA

Fixed Effects Model has a following form:

- Full model of 21 states:

$$corr(y)_{i,t} = \alpha_n + \beta_1 GLi + \beta_2 KI + \beta_3 Deficit + \beta_4 D_{EA} + u_{it}$$
$$corr(y)_{i,t} = \alpha_n + \beta_1 GLi + u_{it}$$
$$corr(y)_{i,t} = \alpha_n + \beta_1 KI + u_{it}$$
$$corr(y)_{i,t} = \alpha_n + \beta_1 Deficit + u_{it}$$
$$corr(y)_{i,t} = \alpha_n + \beta_1 GLi + \beta_2 KI + \beta_3 D_{EA} + u_{it}$$
$$corr(y)_{i,t} = \alpha_n + \beta_1 GLi + \beta_2 Deficit + \beta_3 D_{EA} + u_{it}$$
$$corr(y)_{i,t} = \alpha_n + \beta_1 KI + \beta_2 Deficit + \beta_3 D_{EA} + u_{it}$$

- Model of CEE countries:

$$corr(y)_{i,t} = \alpha_n + \beta_1 GLi + \beta_2 KI + \beta_3 Deficit + \beta_4 D_{EA} + u_{it}$$
$$corr(y)_{i,t} = \alpha_n + \beta_1 GLi + u_{it}$$
$$corr(y)_{i,t} = \alpha_n + \beta_1 KI + u_{it}$$
$$corr(y)_{i,t} = \alpha_n + \beta_1 Deficit + u_{it}$$
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$$corr(y)_{i,t} = \alpha_n + \beta_1 KI + \beta_2 Deficit + \beta_3 D_{EA} + u_{it}$$

- Model of the EA members:

$$corr(y)_{i,t} = \alpha_n + \beta_1 GLi + \beta_2 KI + \beta_3 Deficit + \beta_4 D_{EA} + u_{it}$$

$$corr(y)_{i,t} = \alpha_n + \beta_1 GLi + u_{it}$$
$$corr(y)_{i,t} = \alpha_n + \beta_1 KI + u_{it}$$
$$corr(y)_{i,t} = \alpha_n + \beta_1 Deficit + u_{it}$$
$$corr(y)_{i,t} = \alpha_n + \beta_1 GLi + \beta_2 KI + \beta_3 D_{EA} + u_{it}$$
$$corr(y)_{i,t} = \alpha_n + \beta_1 GLi + \beta_2 Deficit + \beta_3 D_{EA} + u_{it}$$
$$corr(y)_{i,t} = \alpha_n + \beta_1 KI + \beta_2 Deficit + \beta_3 D_{EA} + u_{it}$$

where dependent variable $corr(y)_{i,t}$ denotes the correlation coefficient of business cycles between country i and reference benchmark (EU15) on the basis of rolling correlation over a four year window of quarterly GDP at time t. Final time series are at annual frequency. The cyclical component is removed by the Hodrick-Prescott filter.

α_n is the unknown intercept for each entity,

independent variables GLi is Grubel-Lloyd index, Deficit is deficit dissimilarity between chosen states and benchmark over the Maastricht criteria, KI is Krugman specialization index,

D_{EA} is dummy variable for membership in EA

u_{it} is the error term.

3.4 Analysed countries and models

Countries are chosen primarily based on data availability and with a purpose to cover states from different parts of Europe, members and non-members of the Euro Area. The model consists of full model 21 countries, the EA members and CEE countries. The observed period is from 1999 to 2014.

In the context of panel analysis of full model and multivariate regression model, it is examined the model of 21 countries, such as: Austria, Belgium, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, the Netherlands, Portugal, Slovakia, Slovenia, Spain, Sweden and the United Kingdom.

Panel analysis also examines the group of countries such as EA members, consist of Austria, Belgium, Estonia, Finland, France, Germany, Ireland, Latvia, Lithuania, the Netherlands, Portugal, Slovakia, Slovenia and Spain.

The model of CEEC includes the Czech Republic, Hungary, Latvia, Lithuania, Slovenia, Slovakia, Estonia and Romania.

3.5 Multivariate regression analysis

Multivariate regression analysis is used as an additional tool to panel data analysis. Due to low history of data, the thesis is focused on panel analysis. Regression model has a following structure:

- Dependent variable is the business cycle correlation between the EU 15 and the chosen state measured by the 4 year window rolling correlation (expressed by GDP and the cyclical component is removed by HP filter)

- Independent variables are Grubel-Lloyd index (GLI or GLi), Krugman index (KI) and deficit dissimilarity (Deficit or Def)
- Dummy variable is used for membership in the EA in the first model, further it was omitted due to problem of collinearity in the model.

$$corr(y)_{i,t} = \alpha_0 + \alpha_1 GLi + \alpha_2 KI + \alpha_3 Deficit + \alpha_4 D_{EA} + \varepsilon_{it}$$

where $corr(y)_{i,t}$ denotes the correlation coefficient of business cycles between country i and reference benchmark (EU15) on the basis of rolling correlation over a four year window of quarterly GDP, final time series are at annual frequency. The cyclical component was removed by the Hodrick-Prescott filter.

α_0 is the common intercept,

GLi is Grubel-Lloyd index, Deficit is deficit dissimilarity between chosen state and benchmark over the Maastricht criteria, KI is Krugman index,

D_{EA} is dummy variable for membership in EA.

For the purpose of the thesis, for the calculation and estimations was used software, the Microsoft Excel and the Gretl.

4 Theory of optimum currency areas (OCA)

Theoretical considerations concerning optimum currency areas had been a goal of many studies a long time before countries decided to set up the Economic and Monetary Union (EMU), as a next step of economic integration. (Maes, 1992)

Pros and cons of system of floating exchange rate regimes were already occupied by Milton Friedman in early fifty´s (Milton Friedman, 1953). Even though there are more authors which were dealing with this issue, the most recognised and widely cited is Robert A. Mundell´s (1961) OCA theory.

The idea of giving up the national currency was unimaginable step at that time; it was the time of fixed exchange rate under the Bretton-wood exchange rate regime. Without a doubt, it was functional regime until 1960. After successful period of fixed exchange rate regime, some distortion has appeared and more and more economists believed in floating exchange rate regime as a tool of a solution of starting problems. Mundell was supporter of a different idea. He claimed that it was not necessary to change overall system, the system needed to be adjusted to different conditions. Although the OCA theory was rather the subject of academicians´ discourse in context of sixty´s and it was not considered as a theoretical concept while establishing EMU, mentioned by Kowalski, Kowalski and Wihlborg (2007), discovery of OCA led to wide exploration of the notion of monetary union and undoubtedly develop economic thoughts of concerning area.

The theory of optimum currency areas explains both the criteria and the costs and benefits of forming a common currency area. (Mundell, 1961)

Rozmahel (2006) interprets the OCA theory as a theoretical basis for discussion about meaning and conditions of successful process of monetary integration.

4.1 Development of OCA Theory

However, there is no standard theory of OCA, but rather several approaches that have been developed under the basis of Mundell´s OCA theory. According to Mongelli (2002) OCA evolved in four phases since its birth in sixty´s, such as the Pioneering Phase from 1960s to early 1970s. Which is connected with the papers published by R. A. Mundell, R. McKinnon and P. B Kenen, in which every author defined his own criteria for defining OCA. The Reconciliation Phase in 1970s, which is connected with a time of switching word´s key economies to the system of floating exchange rate regime and with a will of analysing and examining already known criteria. Some of new criteria was defined but with a lack of empirical examination. Therefore, studies were focused on cost and benefits of monetary union. The Reassessment Phase from 1980s until early 1990s, West Europe was dealing with the idea of deepening of economic integration and later setting up the EMU. From the recent history, it is developed the Empirical Phase, which is important practically.

Other literature divided the OCA theory into Traditional OCA theory and New OCA theory. The traditional theory includes crucial papers of Robert A. Mundell, Ronald I. Mc Kinon and Peter B. Kenen, in which criteria was defined. New OCA theory was created as an attempt to obtain comprehensive approach to analysing costs and benefits of creation of Economic and Monetary Union in terms of the OCA

theory. New OCA theory is focused on criteria of synchronization of business cycles and (a)symmetry of supply and demand shocks.

4.2 Traditional OCA theory

Before forming the well-known basis of OCA theory by Mundell in 1961. In early 1950´s, most papers were dealing with exchange rates. That time regime was fixed regime, known as Bretton Woods's exchange rate regime, characterised by pegged and adjustable exchange rates and capital controls enforced by great amount of countries. The question of a choice of the exchange rate regime has become more important in context of 1960´s when some distortion of fixed exchange rate regime has appeared. The most influential paper that time was "The Case for Flexible Rates", written by Milton Friedman in 1953. More and more economists believed that floating exchange rate regime would be successful solution for problems that economies faced.

Mundell was supporter of a different idea. He claimed that it was not necessary to change overall system, the system needed to be adjusted to different conditions. Although Friedman (1953) noted some cases when the fixed exchange rate regime was more suitable solution, Mundell was the first who used the phrase "optimum currency area" in 1961, which published in his paper entitled "A Theory of Optimum Currency Areas". And he is known as a founder of the OCA theory. According to Mundell, monetary union is an area, which is not necessarily identical with geographical borders, it is rather a region fulfilling specific criteria (it can be found also in Milton´s writings). Mundell tried to answer the question when it is beneficial for countries (regions) share the common currency. It should be noted that at that time; situation, when countries decided to abandoned their nation currencies, was unimaginable step for the most of countries. It was rather theoretical concept recognised by academicians and it took some time since it was taken into account in decision making by policy makers and became a new impulse in economic integration.

Mundell (1961) considered simplified model of two countries (the US and Canada), supposing the Eastern regions of both countries specialized in car making and the Western regions in lumber products. Assumptions came out from Keynesian thoughts. He explained what happened when a shift in demand occurs in the area, which differ from the national borders (asymmetric shock, which does not affect overall economy). He let face economy the problem under the two different regimes, flexible and fixed exchange rate regimes.

According to Mundell, an optimum currency area is a region with high degree of factor mobility, especially labour mobility. It is a crucial criterion of the OCA Theory, which helps facilitate transition into equilibrium in a time of disturbances. Since he did not believe in sufficient level of labour mobility, he advocated the floating exchange rate regime.

Mundell is the most cited author of the OCA Theory. The OCA Theory was also under the pressures of critique that boost the further development.

The OCA theory was developed in 1963 and 1969, by other economists, Ronald I. McKinnon and Peter B. Kenen, who defined other criteria for optimum currency area.

McKinnon (1963) pointed out weak attention to mobility and immobility between industries. He focused on optimum area and defined other criteria. McKinnon´s stated that openness of country is a crucial criterion. The highest openness of economy, the greater amount of arguments for fixed exchange rate. And on the contrary the floating exchange rate regime is more suitable for closed economies.

Kenen´s (1969) criteria for determination of OCA is diversification of production. OCA is area where countries´ production and exports are widely diversified and of similar structure form. According to Kenen the asymmetric shock would be of small concern in such area fulfilling criteria.

Fidrmunc (2001) and Mongelli (2002) depicted additional set of basic criteria, which were formed from discussion of experts, such as

- wage and price flexibility which reduce features of asymmetric shock when one country faces to increasing unemployment and the other one to high inflation. Countries with high level of price and wage flexibility are likely adjusted into the equilibrium rather, stated by Friedman (1953),
- fiscal transfers, which are tool of redistribution from country with higher level of living to country with lower level and distribution of risk and Kenen (1969) described the importance of this tool in the process of adjustments.
- High level of financial market integration and therefore high capital mobility lead to the ability of easier financing of consequences of outside disequilibrium,
- similarity in inflation rate indicates stable mutual trade and the need of floating exchange rate regime is lowered,
- the level of political integration which is necessary for decision making with one accord about unemployment, inflation, economic growth and others key areas,
- similarity of economic cycles and shocks.

All the criteria should be fulfilled by countries considering joining a monetary union. In general, the more criteria are met by countries the higher level of benefits the country can expect from joining the monetary union. On the other hand, some of the criteria are hardly measurable and Tavlas (1994) suitably mentioned that some of them are even incompatible. In some situation it can be recommended to join the monetary union according to some of the criteria and according to others it cannot be recommended to adopt common currency, for example small open economy which is specialized. Therefore, this theory missed the unambiguous conclusion.

The OCA theory has been developed by the summarizing the costs and benefits from joining monetary union. Lacina (2007) determined deep overview of costs and benefits of join monetary union.

4.3 Endogeneity of the OCA

After a failure of Werner´s plan and high inflation in 1970´s, the interest in theory of optimum currency area has been decreased. At the beginning of 1980´s the idea of monetary union was revived with the completion of single market and therefore

the previous OCA theory was examined, revised and developed. The new OCA theory make an effort in formulation of costs and benefits of joining monetary union.

While the traditional OCA theory describes accession criteria for successful join the monetary union. Endogeneity of optimum currency area has a different theoretical approach. The hypothesis of endogeneity assumed that deepening of economic and monetary integration lead to business cycle synchronization and therefore fulfilling of the OCA theory criteria. Rozmahel (2008) stated that adopting common currency represents significant elimination of intensity of mutual trade which lead to economic integration and consequently to business cycle synchronization.

The dispute over endogeneity and exogeneity of monetary area can be defined as a dispute of two streams. One stream stated that country needs to fulfil all the necessary criteria before joining monetary union in a way that revenues from joining exceed the costs (the OCA theory) and the other one stated that criteria can be fulfilled during the process of joining of monetary union and after that (The endogeneity of the OCA theory). Since they are fulfilled after the process of joining, there is no need to fulfil all the criteria before the access. The first empirical study was analysed by Frankel and Rose in 1998. Authors described the relationship between business cycles and economic integration by OCA line in figure 1. Mongelli in 2002 adjusted the graph and added a few developed economies into the graph.

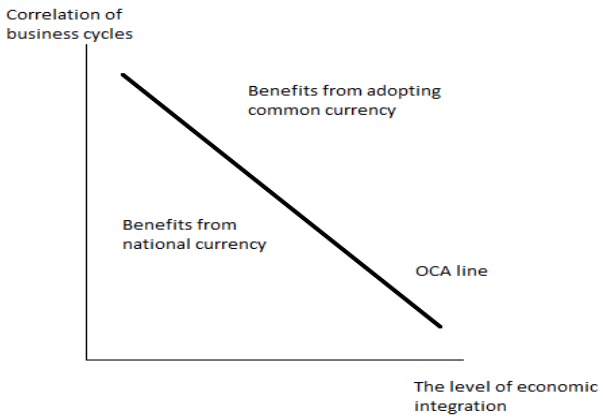

Fig. 1 Relationship between correlation of business cycles and the level of economic integration
Source: Frankel and Rose (1998)

The problem of endogeneity of monetary union was also discussed in dispute between the European Commission and Paul Krugman, in other words dispute connected to specialization versus diversification in production in monetary union.

The European Commission (1990) reported in "One Market, One Money" idea that after joining monetary union the intra-industry trade is increased among the member states. Grauwe (2009) explains the intra-industry trade as a situation when countries forming one market trade the same kind of products. Expansion in mutual trade supported by single market and creation of common currency would lead to higher level of business cycle synchronization. In situation, when negative

demand shock occurs, all the countries forming MU would face the same problem. With the EC view is connected endogeneity of OCA criteria hypothesis created by Frankel and Rose.

Contrarily, American economist Krugman (1993) stated that the expansion in mutual trade would lead to specialization in regions in one industry and therefore the probability of asymmetric shocks would increase as well. That would govern decrease in convergence, in particular divergence. Grauwe (1994, 2009) responded that Krugman´s assumption is that specialized regions would not cross the national borders. Which is not necessarily true if countries decide to integrate politically and economically, all the countries will face the same asymmetric shock collectively as well as Kučerová (2005) stated it by its own words.

Graphical illustration of diverse idea of trade integration and business cycle synchronization is illustrated in Figure 2, where on the vertical axis is business cycle synchronization (the level of output and unemployment) and the horizontal axis stands for the trade intensity between countries that are in monetary union. According to Paul Krugman, the relationship of these two variables are negative, the deeper the intensity in trade, the higher probability of asymmetric shock. The EC adheres to the deeper trade integration, the higher level of symmetry.

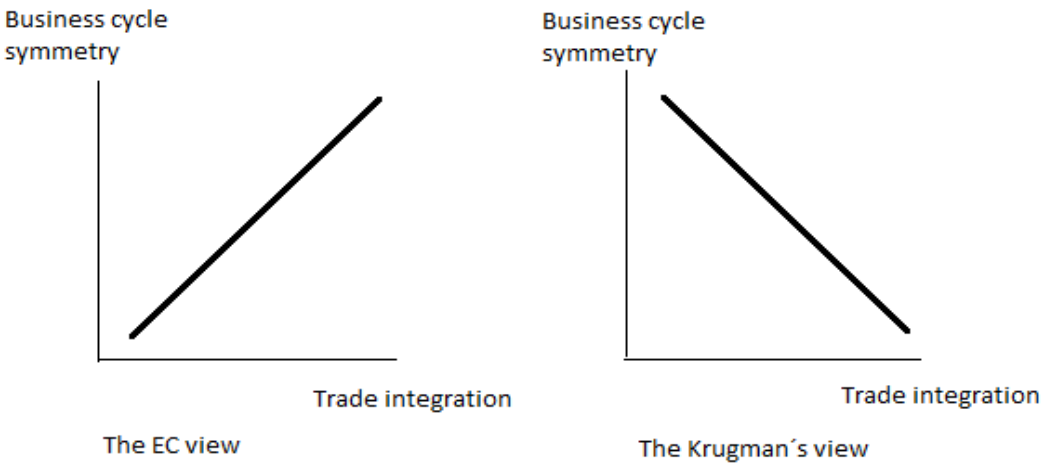

Fig. 2 Paul Krugman and European Commission view.
Source: De Grauwe (2009)

4.4 Further empirical studies

Recent years the studies regarding to the OCA theory are focused on empirical analysis and quantity prove. It is obvious that empirical studies were focused also on answering the question whether the EC view or the Krugman´s view is more probable. Authors tried to verify relationship between creation of monetary union and growth in mutual trade between member states with application of level of economic integration or they measure the relationship between common currency and economic integration and correlation of business cycle of member states. Major papers confirmed the EC view, more precisely the endogeneity of optimum cur-

rency area. Authors also considered the impact of common currency on business cycle synchronization.

In the context of development of the OCA theory of recent years, new factors were examined. Such as harmonization of fiscal politics, integration of financial markets, production specialization, variability of exchange rates, capital flows and last but not least institutional changes.

Bayoumi and Eichengreen (1993, 1997) attempted to detect occurrence of demand and supply shocks in the EU member states and creation of the OCA-index, on the basis of index it would be possible to measure the suitability of countries of candidacy to join MU.

Fidrmuc (2001) described the main stream criteria of the OCA the level of openness of economy, similarity in shocks and cycles, mobility of labour, diversification of production, fiscal transfers and similarity in price level.

Recent studies were focused mainly on criteria such as trade intensity, similarity in shocks, level of labour mobility and mainly business cycle synchronization.

Frankel and Rose (1998) were the first who empirically verified criteria of optimum currency area in an article "The endogeneity of the optimum currency area criteria" which were fulfilled after joining the monetary union. Authors used quarterly data from years 1959-1993 of 21 countries of OECD, they examined the mutual trade and correlation of business cycles. They deduced the strong positive interdependence between a degree of bilateral trade intensification and correlation of cross-country business cycles. They concluded that country can fulfil the criteria of the OCA theory after adopting the common currency, which is consequence of expansion in mutual trade between new accession country and the rest of countries of monetary union as a result of common currency, lowering the transaction costs with subsequent synchronization of business cycles. Therefore, empirical studies endorse the EC view rather than Krugman´s view on the endogeneity of monetary union. Kapounek and Lacina (2007) stated the fact that many economists criticised the methodology, since Frankel and Rose included overall trade in the analysis instead of bilateral trade.

4.4.1 Relationship between monetary union and mutual trade of member states

Rose (2000) used a gravidity model. The author analysed 186 countries from five years spanning 1970-1990. He found a large positive relationship between common currency area and international trade and small impact of exchange rate volatility. He concluded that currency unions may lead to growth in mutual trade.

Frankel and Rose (2002) used a gravidity model. They used economic data for over 200 countries to measure the impact of common currency on trade and income. They concluded that every increase in trade positively affect income per capita by more than 30 per-cent.

Rose and Wincoop (2001) used a gravidity model. They analysed data from 200 countries from years 1970-1995. Adopting a common currency lead to decrease in barriers in trade and therefore increase in mutual trade of member states and the level of national wealth.

Mélitz (2001) used a gravidity equation. He used 284 observations with countries within and outside of Free Trade Area. He concluded the positive relationship between creation of monetary union and trade.

Persson (2001) also confirmed positive relationship between creation of monetary union and trade.

Glick and Rose (2002) used annual panel data of 217 countries between years 1948 and 1997. They examined statistically significant decrease in bilateral trade of countries, which left the monetary union and increase in bilateral trade of countries which join the monetary union by double.

Juvenal and Monteiro (2010) Authors used a IRBC model and observed 21 OECD countries between 1988-2007. Authors stated that higher bilateral trade intensity lead to higher correlation between country´s ratio of expenditure on domestic goods.

4.4.2 Relationship between monetary union and trade and business cycles of member states

Rose and Engel (2000) used a gravidity model for 150 countries. They examined that countries in monetary union have experienced the higher level of mutual trade, lower volatility of exchange rates and their business cycle are more synchronous compared to countries which used own currency.

Alesina, Barro and Tenreyro (2002) stated that monetary union has positive effect on bilateral trade.

Weimann (2002) used a VAR model. Author examined 11 countries of the Euro Area in years 1999-2001 and 9 countries of CEE in years 1995-2001. The higher level of correlation was examined in the core of the Euro Area (Germany, Belgium, France, the Netherlands, Austria). Rest of the countries are described as periphery states. In the second period, he found out the better results of countries of Euro Area and the extension of the states, which were classified as a core.

Tenreyro and Barro (2003) used the regression model and verified Krugman´s view rather than the EC view.

4.4.3 Relationship between monetary union and business cycle of member states

Bayoumi and Eichengreen (1993) used a VAR model for a data from years 1960-1988 of the EC members to identify demand and supply shocks. They focused on the size of shocks, correlation and speed of recovery from the shocks. They concluded that Europe is divided in two: the core of EC (German, France, Belgium, the Netherlands and Denmark) where the shocks are highly correlated and therefore, states are the great adepts for one currency union. Other states (Ireland, the UK, Spain, Greece, Italy and Portugal) do not examine that high correlation and therefore it could be recommended not to join MU. The shocks are at a higher level and less correlated at peripheries of the EC compared to the US regions. Additionally, Verhoef (2003) stated that symmetry of shocks has increased in last two decades within members of EMU.

Frankel et al. (1999) used a VAR model for 26 countries (members of EMU and 3 group of states, non-members of EMU, EFTA countries and CEE candidate's

countries) between years 1992-1998. They concluded that correlation of demand and supply shocks are high between countries of forming the Euro Area and as well as countries in the European Union. The lowest correlation was examined between France, Germany and entering countries of CEE. The worst result was for the Czech Republic and Poland. On the other hand, the interpretation is quite hard due to the length of chosen data.

Frankel and Nickel (2002) used a SVAR model. They analysed data from years 1993-2001 of 21 countries. The most development CEE countries examined similar correlation as the members of Euro Area.

Fidrmuc and Korhonen (2003) focused on difference between structural shocks of the Euro Area and the CEE countries. The Euro Area is considered as an optimum currency area. They used SVAR model. Correlation differ between the CEE countries in years 1991-2000. From countries which enter the MU, the most correlated with Euro Area are Hungary and Estonia. Latvia and Lithuania have negative correlated shocks. The size of shocks are relatively small for all non-members countries of the EA (except for Poland and Slovakia) and in the Czech Republic and Estonia the size of shocks were at lower level than in many member states. It is possible to find similar results in papers Boone and Maurel (1999), Korhonen (2001) or Fidrmuc (2003).

4.4.4 Other criteria

In the context of development of the OCA theory authors examined other criteria which would lead to synchronization of business cycles such as integration of financial markets, production specialization, variability in exchange rates, flows of capital, institutional changes and last but not least fiscal policy harmonisation.

Artis, Zhang (1997, 1999) examined the relationship between correlation of business cycle and variability of exchange rates. Authors (1999) used monthly data of 19 OECD countries from year 1979. Data was adjusted by HP filter. They stated that after joining the ERM in 1979, countries experienced higher level of synchronization towards Germany. Authors empirically proved relationship between decrease in variability in exchange rates and increase in correlation of business cycles.

Contrarily, Inklaar, de Haan (2000) stated that there is no empirical relationship between variability of exchange rates and convergence of business cycles.

Otto, Voss and Willard (2001) studied cross-country variation in bilateral output growth for 17 OECD countries, 5 countries out of the EU. Authors used paired correlation coefficients for years of 1960-2000 in twenty years´ periods. Average convergence in English speaking countries are higher compared to other observed countries. According to Otto and others, the mutual trade has not significant effect in business cycle synchronization, which was proved by Australia. Australia is highly correlated with the USA, which is not the main trade partner, but on the other hand, Australia has higher level of mutual trade with Japan and low level of business cycle synchronization. Authors concluded that positive trade intensity, positive FDI, negative spread, negative volatility of interest rate and exchange rates and negative structure deference are significant. In more general, trade intensity and industry structure are not significant according to authors.

Brada and Kutan (2001) focused on monetary policy in Germany and CEE countries, Finland, Austria and Austria in years 1993-2000. They used a VAR model. In case of the Czech Republic, Slovak, Slovenia and Estonia there is long-term relationship with monetary policy of Germany. In case of Poland, Latvia, Hungary, Bulgaria and Romania there is a weak relationship.

Kalemli-Oscan et al. (2001) examined data from US states and 11 OECD countries to find out the relationship between asymmetry and specialization. They stated that the more specialized production structure is connect to less symmetric fluctuations.

Bordo and Helbling (2003) used data of 59 countries in years 1880-2001 split into two periods. Authors examined strong relationship between trade intensity and business cycles and not significant effect of capital restrictions and variability in exchange rate.

Kose et al. (2003) found out significant effect of trade openness, negative capital account restrictions, and negative terms of trade variability.

Imbs (2004) examined effects of financial integration and trade intensity on the sample of 24 countries in years 1980-1990.

Garnier (2004) used monthly data of 16 OECD countries from years 1967-2001 and examined weak linkage between intra-industry trade and business cycle synchronization.

Bergman (2004) used a Pairwise correlation on quarterly data from 1961-2001 of 14 EU members. Author examined positive correlation of trade intensity, standard deviation of money market rates and exchange rates volatility related to synchronization.

Inklaar, Pin, Haan (2005) examined the relationship between trade intensity and business cycle synchronization. Authors used multivariate model and data of 21 OECD countries from years 1970-2003 covering specialization, financial integration, similarity of economic policies. Inklaar et al. proved that trade intensity and other criteria affects similarity in business cycles at low level.

Bebetskii (2005) stated that higher level of trade intensity is connected with more demand shock similarity and found out that exchange rate volatility is negatively related to demand shock similarity.

Camacho et al. (2006) examined EU countries, Canada, Japan, Norway and US countries in years 1965-2003 by pairwise difference in business cycle in specialization. Authors examined significant variables: savings, labour productivity, trade intensity, specialization and fiscal policy.

Specialization can be connected with a successful business activities and high level of productivity in a specified line. It is more evident in small open economies rather in big ones which are more closed. Recent literature examined the fact that the higher level of integration is connected with the growth in specialization.

Imbs (2006) stated that financial integration positively effects trade and specialization.

Calderon et al. (2007) examined 33676 pair states in years 1960-1999. Authors stated that bilateral trade has positive impact on business cycle synchronization.

Haan, Inklar, Pin (2008) stated that there is no consensus on the significant determinants of business cycle co-movement. The problem is that there are many

potential explanations. The authors focused on examination of business cycle synchronization since there are very different conclusions. Authors used a quarterly data of GDP, monthly data of IP

Rozmahel (2013) stated that recent studies are focused on correlation and synchronization at regional level due to deepening integration and regional specialization. The author presents clear overview of recent literature dealing with the OCA theory at regional level.

4.4.5 Fiscal similarity and indiscipline

European Union has significantly changed since it has been established. The EU has been enlarged gradually and has deepen the integration. Recent years the EU, as well as the Euro Area, faced to the consequences of financial crisis. It has been shown that economic integration and common currency need deeper coordination in fiscal policy. At the beginning of 1990´s, the integration process took into account one central economic and fiscal policy. Since it was a big step to adopt common currency and abundant national currency, the next step of common fiscal policy was rather theoretical point that time. While the European Central Bank is responsible for whole common monetary policy for the Euro area member states, fiscal policy is still in hands of national governances. Fiscal policies differ across the EU states at the time of signing Maastricht Treaty (Belgium with the deficit to GDP at 8 %, Greece 12.2 %, Italy 10.7 %, UK 6.5 % in 1992; while Austria 1.9 %, Denmark 2.2 %, Germany 2.6 %, Luxembourg 0.3 %). The Treaty encouraged fiscal similarity among the states. At least countries agreed on common rules, which were not overly satisfied by many member states. The Stability and Growth Pact determined the maximum deficit (3 % of GDP) and debt under the level of 60 % of GDP. Although enforcement was under the control of member states. The rules were broken by many states and many times, even by Germans or French. Since the EU is the organisation which rather react with delay on daily issues than in advance, it was necessary to tight the rules after crisis and change the way of enforcement. This tightness should be reflected by the Six pack and next Two pack valid for MU members and fiscal compact which was accepted by 25 from 27 member states of the EU. The difference in fiscal policy has become a crucial problem for the Euro area and the European Union as a whole.

In the context of development of the optimum currency area, new criteria were observed to find out, whether harmonisation of fiscal politics effect the synchronization of business cycle. Academicians and economists focused on question whether there are any consequences of fiscal divergence.

Darvas, Rose, Szapáry (2005) used an annual panel data of 21 OECD states in years 1964-2003 split into four periods. The authors used a difference of deficits between partner countries and examined that countries with similarity in fiscal budget position experience business cycle synchronization. Furthermore, they found out that reduction in fiscal deficits lead to increase in business cycle synchronization and stated that increase in business cycle correlation along with fiscal similarity makes state better candidate for a monetary union. Darvas et al. suggested to let the EU be more responsible for fiscal policy and therefore reduce possibility of creation of idiosyncratic fiscal shocks by national government with aim to move the EU to the OCA.

Kocenda, Kutan, Yigit (2008) examined the fiscal convergence of 10 states of EU based on fulfilling the Maastricht criteria, authors used quarterly data of years 1995-2004. They used data for convergence of the 8 states of CEE, Cyprus and Malta with respect to the distance from deficit-to GDP and debt to GDP given by Maastricht criteria. Authors also examined convergence of these countries with respect to the deficit and debt ratios experienced by Austria, Belgium, France, Germany and the Netherlands and the average values achieved by Greece, Portugal and Spain. Authors stated that new EU members have worsen fiscal position compared to the old EU members. New members have higher levels of deficit without the significant reason. Old members of the EU are in conjunction with each other. Convergence of the deficit to GDP ratio of new members towards the core of the EU or periphery is not examined. Authors suggested to design further policies to improve fiscal performance of EU members and adopt fiscal policy rules.

Camacho et al (2006) found out that fiscal policy is significant variable with respect of business cycle synchronization. The authors used data from the EU countries, Canada, Japan, Norway and US from years 1965-2003.

4.4.6 Contradictory studies

Recent studies are focused on empirical examination and applicability. In the context of economic integration many studies focused on examination of synchronization of business cycles were published. Although similar studies brought different results and different interpretation. There is a dispute over methodology between the academicians and economists. Fidrmuc and Korhonen (2006) stated that there is different interpretation of the same results given by different group of people.

There is an evidence of studies which empirically reject the hypothesis of endogeneity and authors considered the criteria of OCA as an exogenous factor as well. Also many authors were not able to make a clear prove of hypothesis.

Darvas, Szapáry (2004) analysed the correlation of business cycles between old EU states and the new ones. Authors used a quarterly data of 26 OECD countries and variables such as GDP, IIP, investments, private consumption, services, export and import in years 1983-2002 split into two periods. The authors divided countries in group of

- EMU 1 – the core of the Euro Area, which are considered countries with the higher level of correlation with the EA. There is an evidence of growth in the level of correlation between first and second observed period. EMU is represented by Belgium, France, Italy, Germany, the Netherlands and Austria.
- EMU 2 –Countries with a significantly lower level of correlation of cycles with the EA with no difference between first a second observed period.
- CEE 1 – Countries of CEE with the highest level of correlation with the EA from all CEE countries such as Hungary, Poland and Slovenia. The correlation was similar to EMU 1, this fact rejects the hypothesis of endogeneity.
- CEE2 – Slovakia and the Czech Republic with low level of correlation with the EA in both periods.

- CEE 3 – Latvia, Lithuania and Estonia which were not synchronous with the EA. Authors stated that these countries are connect to Russia rather than to the EA.
- Countries out of the EA, such as Denmark, Sweden, the UK, Switzerland.

The authors stated that the hypothesis of endogeneity cannot be proved by results observed in group of EMU 1 even if the results were significantly higher in context of other observed groups.

Miles, Vijverberg (2011) stated that the Euro Area does not fulfil criteria of OCA at sufficient level, such as mobility of labour, share of risk, insufficient correlation of periphery states with the core of the EA. The EA is not optimum currency area from author´s point of view. Authors criticised the chosen methodology, especially in case of Frankel and Rose from 1998. Miles and Vijverberg used a quarterly data of IPP from years 1983-2009 of Germany, France, Greece, Ireland, Portugal, Spain, Denmark, Switzerland and Sweden. They examined no correlation between Portugal, Spain, Greece, Ireland and the EA. Contrarily, Sweden experienced correlation of cycle with the EA.

Vieira, Vieira (2011) rejected the hypothesis of endogeneity. Authors examined 21 OECD countries in years 1988-2008 and calculated OCA line.

They stated that from the ten years´ perspective some states such as Portugal still experienced costs over benefits from joining monetary union. There is an evidence of correlation between the core of the EA, but not at the same level for all countries. And correlation of periphery states still differs from the core at significant level.

Romana (2013) observed 8 countries, 5 from the EA, 3 out of the EA, to find out whether countries adopting Euro are more synchronous after the year of 1999. Author used data from years 1999-2012 split into two periods. Synchronization was measured for instance by correlation coefficients or standard deviation. Authors stated that the level of synchronization was not changed within the observed period and was not at significant level.

5 Synchronization of business cycles in the EU

Business cycle synchronization is one of the method how to measure whether the candidate country is prepared to join the monetary union and adopt common currency and it is a basic criteria of smooth functioning of monetary union. With aim to analyse synchronization of business cycle in the EU, data must be de-trended. There are several methods how to do it, one of the most adopted method is Hodrick-Prescott filter (HP) which is used to de-trend data in this thesis.

The empirical research is focused on existence of business cycle synchronization in the EU and the change within the observed period.

Cycles in the EA countries and the non-EA countries are quite similar in observed period (Figure 3), quarterly data of 1996-2015. While almost all EA countries experienced more similar evolution. Belgium, Germany, France, Italy, Netherlands, Austria and Finland´s cycle growth around year 1999 after adopting Euro as a common currency. Later they experienced little decrease, big growth in year 2006 until the world wide financial crisis occurred in Europe in 2008, when all economies were dealing with the issues of disequilibrium in the markets. Finland experienced higher level of growth and consequently decrease before and in crisis compared to the observed EA countries. The Czech Republic, Denmark, the UK and Sweden have similar cycle, while Romania experienced higher deviations many times. Cycles are different last two years, economies are still recovering from the crisis and economies experienced growths and decreases at a different time.

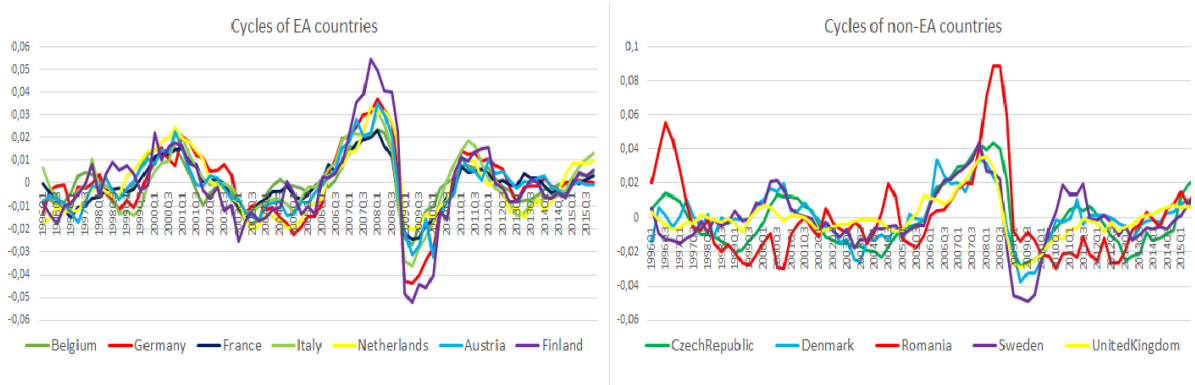

Fig. 3 Cycles of the EA countries and the non-EA in years 1996–2015
Source: Eurostat, Author´s calculations

5.1 Synchronization of business cycles of states with the EA and the EU

Correlation analysis is one of the most common and used analysis to detect the similarity of business cycles. Germany, France and Netherlands have high level of correlation with the EU 28 and the EA 12, which is evident from Figure 4, from year 1996 until year 2010. Correlation coefficient is in the range of <0.7-0.95>. In the time of crisis, all the economies were dealing with the huge decrease and there-

fore the correlation coefficient is nearly equal 1. After crisis, countries are less correlated with the rest of the the EU and the EA. Belgium differed around year 2000 and experienced divergence from the EU28 and the EA12. Business cycle synchronization (convergence) is obvious primarily from year 1996 until 2010. On the other hand, economies are dealing differently with the consequences of world financial crisis, which started in 2008. Some of the economies experienced changes in little growth and then decreased. Since that, changes held at different time, economies do not converge like in the time of symmetric shock. Since the figure summarizes the development of correlation of cycles with a four-years´ window, there is significant influence of crisis and also the dealing with the crisis afterwards by all economies.

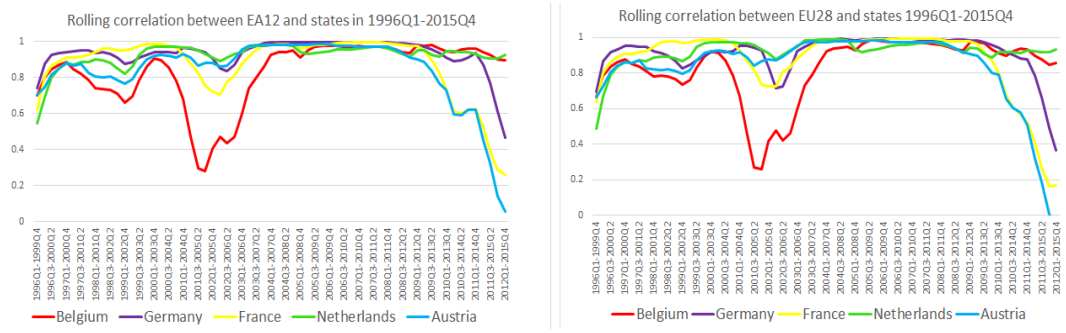

Fig. 4 Rolling correlation of the EU28 (the EA12) and the core of the Euro Area
Source: Eurostat, Author´s calculations

Correlation of the states of the Euro Area of 12 and periphery states differ during the observed period (Figure 5). While Italy has a high level of correlation with the EA 12 during whole observed period and convergence is evident, Spain experienced high level of correlation except the years around period 2008-2014. Slovenia´s correlation increased after the year 2000 at the level around 0.8 and other increase experienced again around the year of 2007, which is the year after adopting the common currency. This fact is in common in respect of the hypothesis of endogeneity. Countries after join monetary union experience higher level of business cycle synchronization. The problematic country of the Euro Area is Greece, which does not converge or even diverge with the EA12 almost for whole period. Since the low level of synchronization, there is risk of asymmetric shock. The highest correlation is evident for almost all countries between 2000 and 2010.

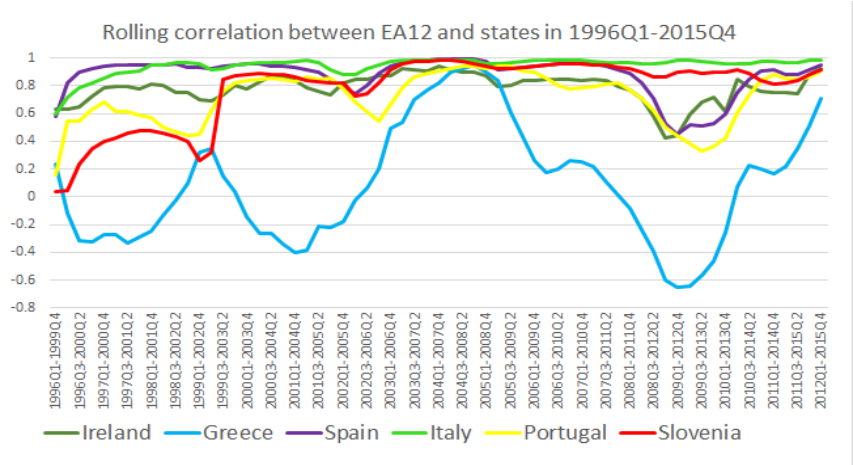

Fig. 5 Rolling correlation of the EA12 and periphery states of the EA
Source: Eurostat, Author´s calculations

Correlation of CEE countries and the EA12 is low very until year 2004 or even negative for the most of the states, which is obvious from Figure 6. Since the year 2004 is a year of accession of the EU and countries open the markets and start to trade more, economies went more dependent and therefore the business cycles went more synchronous. After the year 2010 countries experienced lower level of synchronization, which is improved last two years. From the correlation analysis almost all countries are not a good candidate for common currency with the rest of the EA12 countries with a few exception. There is also an evidence of higher deviation of correlation compared to the core of the EA or periphery states with the EA. Slovenia improved correlation coefficient after the year 2000 and again after 2007 as it was mentioned above, Estonia experienced quite high level of correlation with two exceptions around year 1999 and 2004. Other observed economies of CEE are still dealing with many periods of low level of synchronization with the EA12.

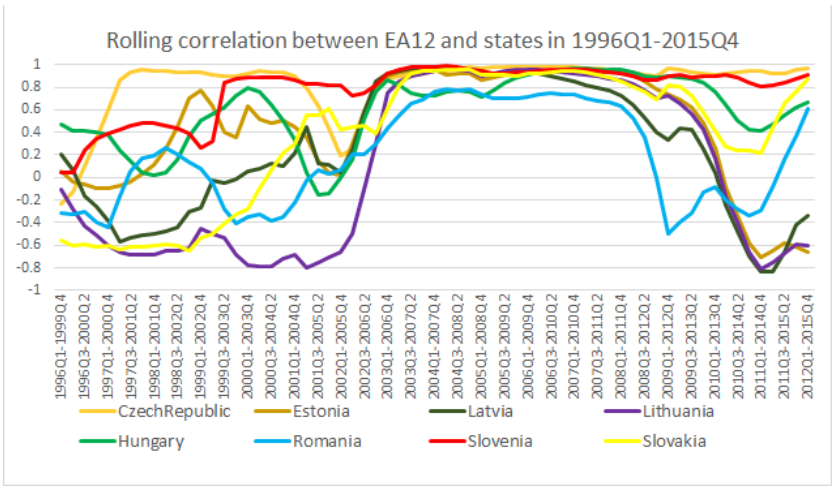

Fig. 6 Rolling correlation of the EA12 and CEEC
Source: Eurostat, Author´s calculations

Figure 7 illustrate the comparison of correlation coefficients of all states in two period before the crisis (1996–2006) with the period which involves crisis (2007–

2015) for chosen states and the EA19, respectively the EU28. Correlation coefficients of the EU28 and the EA19 with chosen states are very similar. Countries can be divided in three groups. First group are countries which experienced very high and relatively stable correlation, traditionally Germany, the Netherlands and Austria. Countries experienced little growth in second period. Second group in which countries improved the correlation coefficient in second period. Such as Belgium, the Czech Republic, Denmark, France, Italy, Latvia, Slovenia, Finland, Sweden. Greece also improved the correlation coefficient in second period but it is still very low. High improvement of correlation was made by some CEEC, Estonia, Lithuania, Latvia, Hungary, Romania, Slovakia; and the UK. Third group consists of the countries which correlation coefficient has been decreased in second observed period, such as Spain, Cyprus and Portugal.

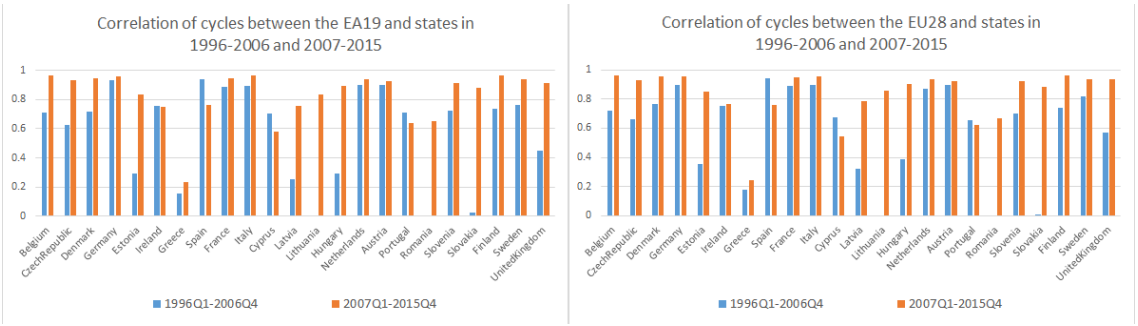

Fig. 7 Comparison of correlation of cycles between the EA19 (the EU28) and states in two periods 1996-2006 and 2007-2015
Source: Eurostat, author´s calculations

In Figure 8 we can compare correlation coefficient between the EA19 and chosen states in three periods 1996-2002, 2003-2009 after large enlargement of the EU, the beginning of the crisis and period after 2010. The highest level of correlation is obvious in second period. Belgium, the Czech Republic, Denmark, Estonia, Latvia, Lithuania, Greece, Italy, Hungary, Romania, Slovakia, Slovenia Finland and Sweden have higher business synchronization with the EA19 after crisis period compared to the situation before the year 2002. Germany, Ireland, Spain, France, Cyprus, Austria, Portugal and the UK experienced higher level of synchronization of cycles with the EA19 before the crisis.

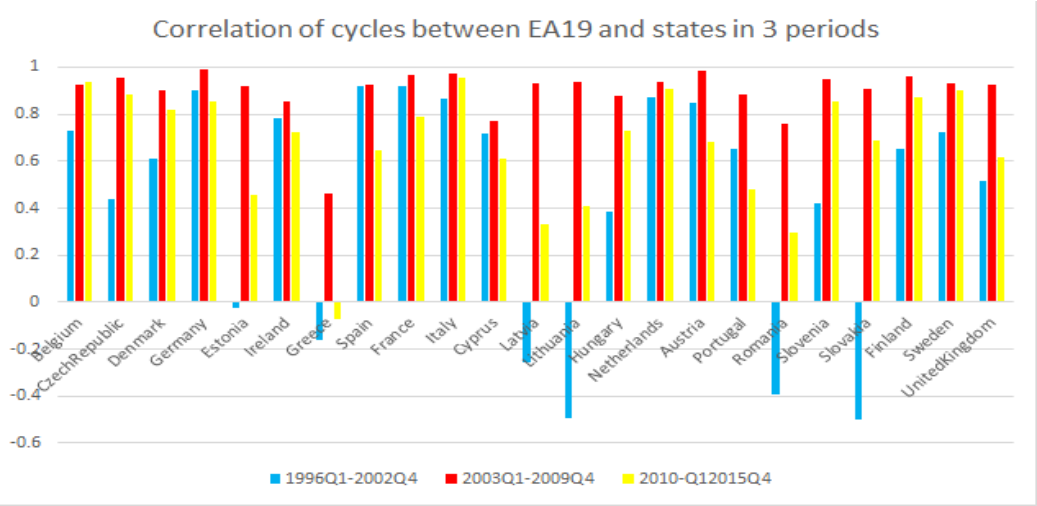

Fig. 8 Comparison of correlation of cycles between the EA19 and states before, during great enlargement of the EU in 2004 and after financial crisis in 2008.
Source: Eurostat, author´s calculations

5.2 Business cycle synchronization of CEE countries with other states

This chapter deal with the question whether the CEE countries are correlated with each other rather than with the rest of the EU (the EA) countries. From an evidence, the Czech Republic is correlated with the west countries rather than with other CEE countries and also with Slovakia after accession of the EU. Slovakia examined significant and negative correlation before accession in the EU, the highest level of synchronization examined also with the west countries rather than with the CEE countries after accession. Importantly Slovakia´s business cycle is more synchronous with the EA states compared to the EU states. Baltic countries are highly correlated with each other for both observed period. Additionally, Romania´s business cycle is more correlated with the other CEE countries rather than the EA or the EU average.

5.2.1 The Czech Republic

Evolution of correlation of the Czech Republic and the chosen CEE countries illustrated in Figure 9, is similar to evolution of synchronization of the EU or the EA analysed in previous chapter. The highest business cycle synchronization experienced the Czech Republic after the accession in the EU experienced with Slovenia, Slovakia and Hungary.

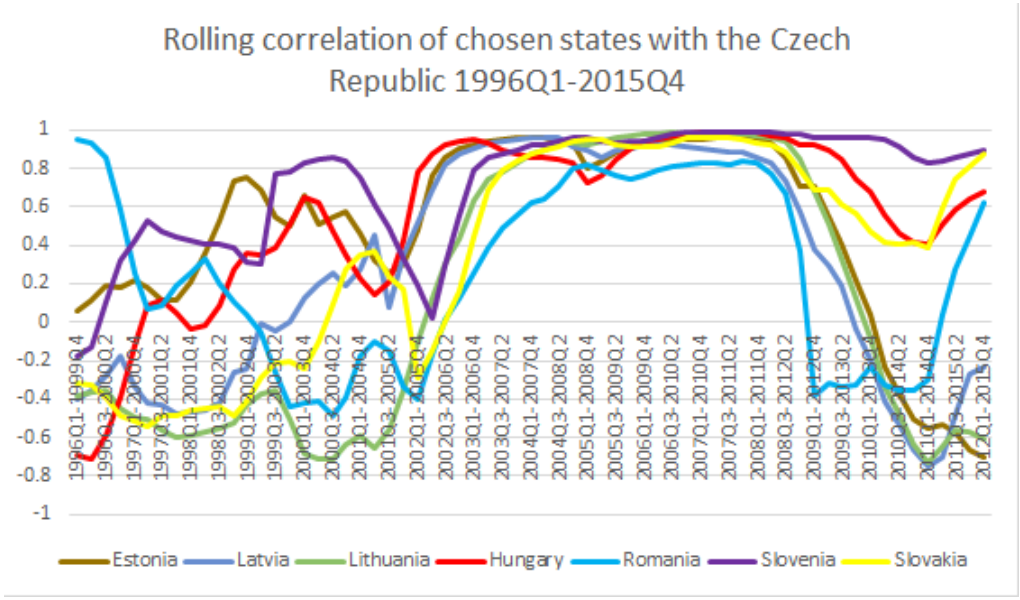

Fig. 9 Rolling correlation of the Czech Republic and chosen CEEC in year 1996Q1-2015Q4
Source: Eurostat, author´s calculations

From a comparison of business cycle synchronization in period before accession and after accession of the EU, it is clear that the Czech Republic improved the situation and its business cycle became more synchronized with all EU countries after accession, which is illustrated in Figure 10. Additionally, the Czech Republic´s business cycle is more synchronized with the western countries rather than with the other CEE countries. Before accession, the business cycle was similar more to Denmark, Italy, the EU28, Spain, the EA19 or Germany. The lowest level of synchronization occurs with Baltic countries. After accession, the business cycle was similar to Slovenia, the EU28, Netherlands, the EA19, Italy, Ireland or Denmark. The higher correlation experienced with the EU28 rather than with the EA19. The Czech Republic for both observed periods do not experience highest level of business cycle synchronization with the other CEE countries with exception of Slovakia in second period, which became a member of the EA and therefore there is an evidence of higher level of synchronization with the EA and therefore also with the SK. Convergence between the Czech Republic and the EU or the EA has increased in the second observed period significantly and the position of correlation has improved by 1 position.

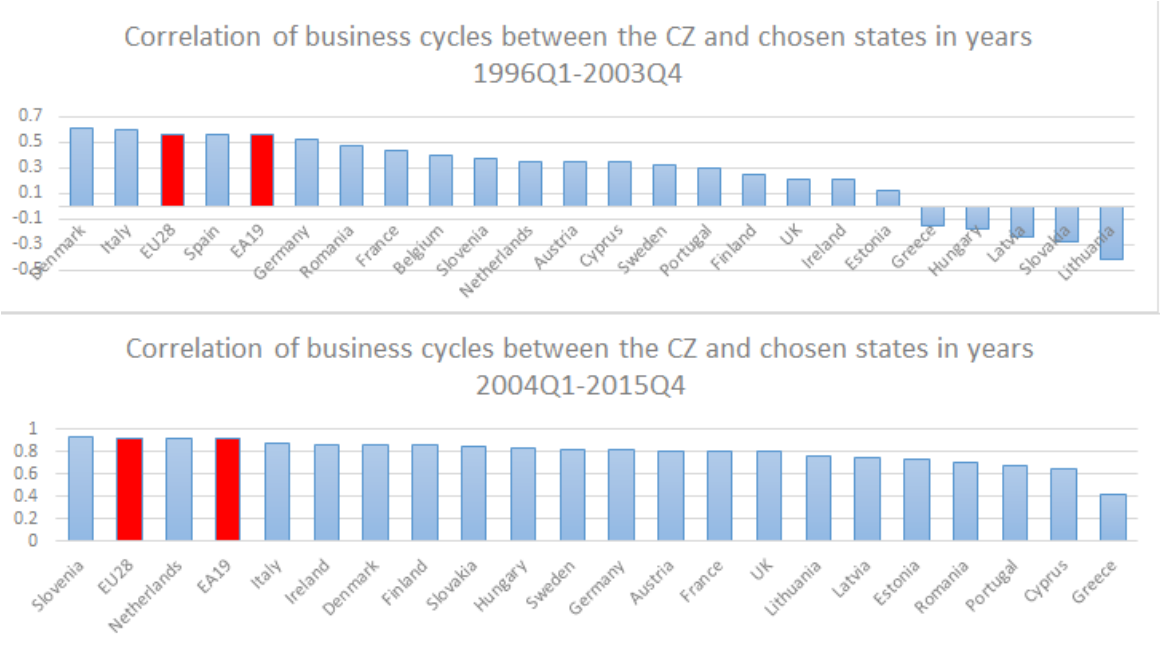

Fig. 10 Correlation of business cycles between CZ and chosen states in period 1996Q1-2003Q4 and 2004Q1-2015Q4 in descending order
Source: Eurostat, author´s calculations

5.2.2 Slovakia

New accession countries undertook to join the monetary union and adopt common currency. Slovakia made it on the 1st January 2009. Business cycle of Slovakia in first observed period (1996-2004) was determined rather by domestic factors which can be seen as an asymmetric compared to the rest of the EU states, since the correlation coefficients are mostly significant but negative at the same time. After accession, Slovakia improved the situation and business cycle became more synchronous with the all the EU countries. From Figure 11 it can be observed that the highest business correlation has Slovakia with the Netherlands, Slovenia, the EA19, Finland, the EU28, the Czech Republic or Germany. Slovakia experienced higher level of synchronization with the EA19 rather with the EU28, which is very important in the context of asymmetric shock. The lowest correlation is examined with Ireland, Hungary, Portugal, Cyprus or Greece during the observed period. High level of convergence with the EA in the second period is very important in the context of asymmetric shock.

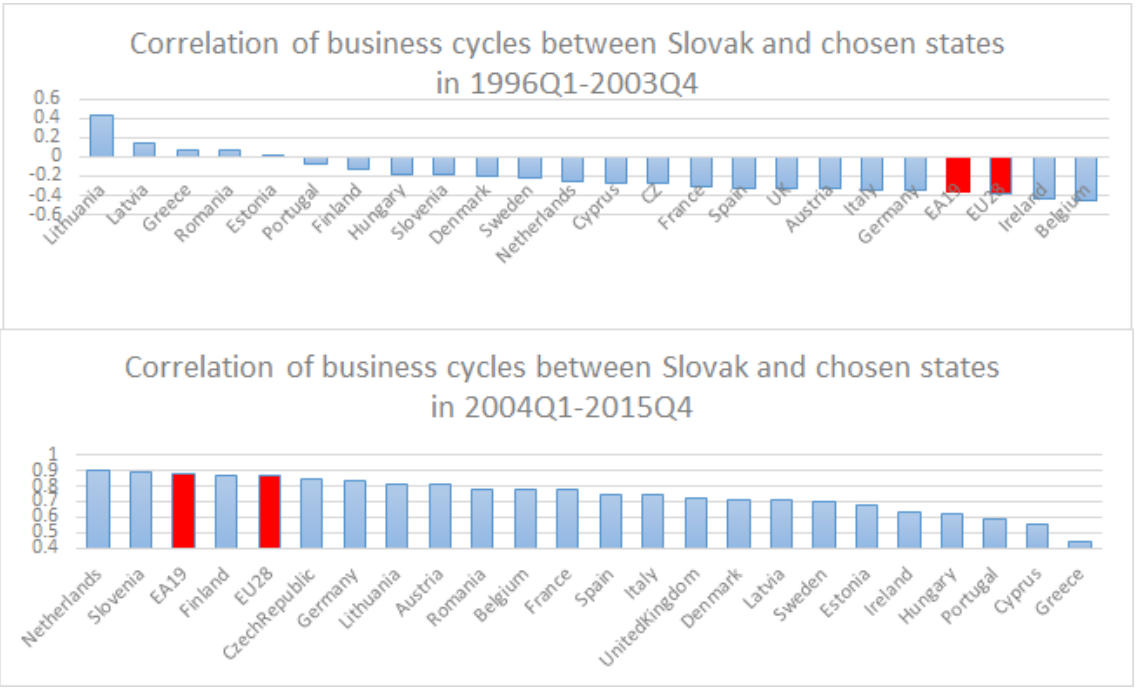

Fig. 11 Correlation of business cycles between Slovak and chosen states in periods 1996Q1-2003Q4 and 2004Q1-2015Q4 in descending order
Source: Eurostat, author´s calculations

5.2.3 Hungary

Hungary experience relatively high level of correlation with the EU and the EA in both periods compared to the level of correlation of the rest observed CEEC with them. From this point of view, it could be a good adept for join the monetary union. Before accession Hungary in the EU, its business cycle is less synchronized with the CEEC. After accession Hungary business cycle is most synchronized with the UK, Denmark, CZ, the EU28, the EA19, Italy or Slovenia. There is an evidence of improvement in the level of convergence between Hungary and the EU28 or the EA19, since the EU28 was at 7th position before accession and at 4th position after, the EA19 was at 9th position in first period and 5th positon in second period.

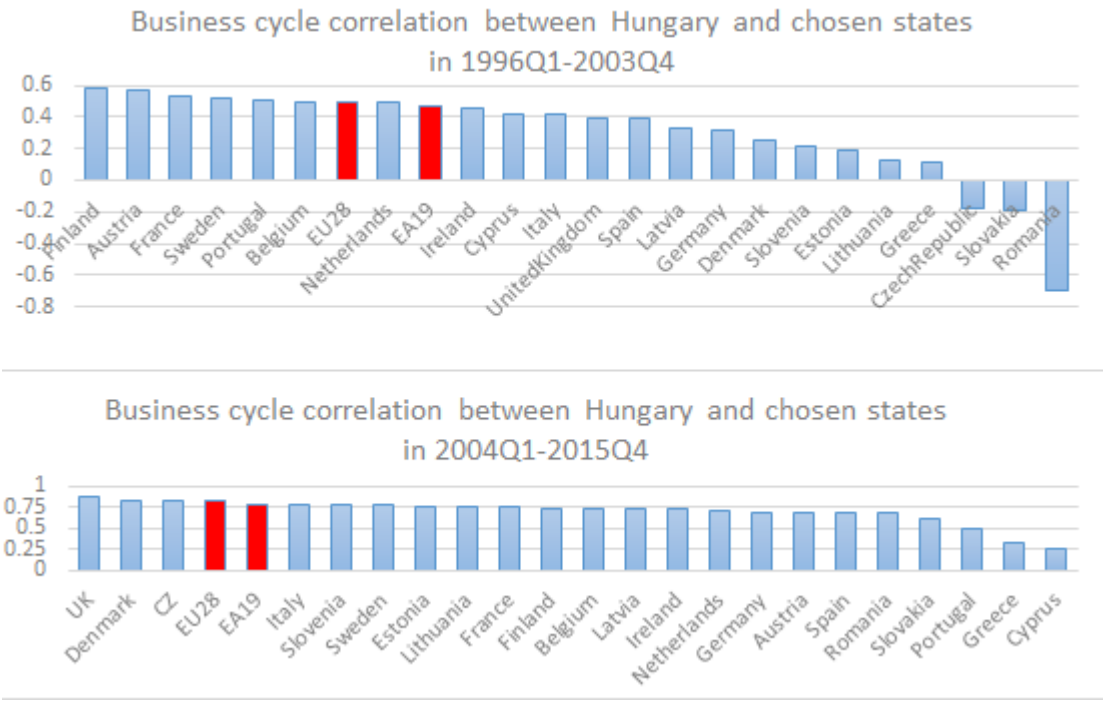

Fig. 12 Correlation of business cycles between Hungary and chosen states in periods 1996Q1-2003Q4 and 2004Q1-2015Q4 in descending order
Source: Eurostat, Author´s calculation

5.2.4 Romania

From an examination of correlation of business cycles between Romania and other states in Figure 13. Romania business cycle is the most synchronized with the Czech Republic, Estonia and Lithuania in first period, Romania is negatively correlated with other states. After accession in the EU, Romania is still the most correlated with some of the CEE countries, such as Slovenia at level 0.78, Slovakia 0.78, Lithuania 0.74 and the Czech Republic at level 0.74. Romania shows one of the lowest correlation of business cycles with the rest of the EU countries from all observed countries. Convergence of the EU28 and the EA19 have improved in second observed period, but it is not still at the same level compared to other states of the EU which signed the obligation to adopt Euro in the future. In respect of correlation analysis, Romania is still not a good adept for monetary union. On the other hand, Romania is more correlated with the EA states than the EU28 which is positive in the context of potential join the monetary union in first period, oppositely it is in the second observed period.

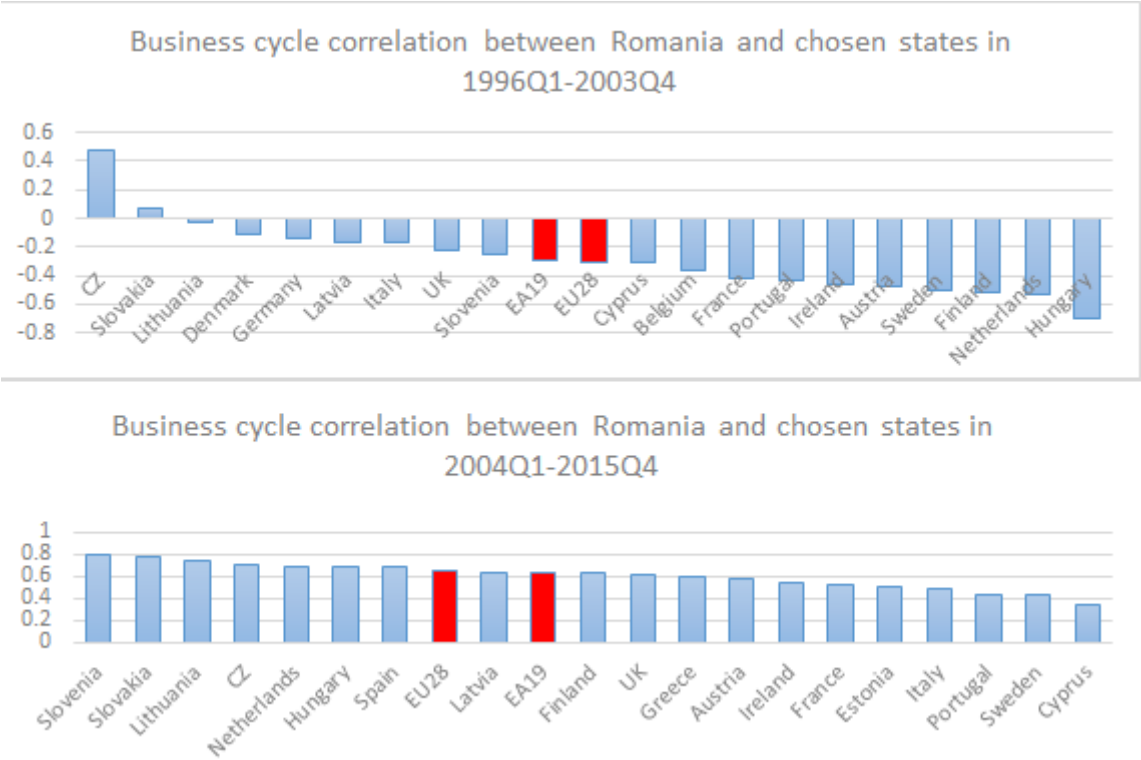

Fig. 13 Correlation of business cycles between Romania and chosen states in periods 1996Q1-2003Q4 and 2004Q1-2015Q4 in descending order
Source: Eurostat, Author´s calculation

5.2.5 Baltic countries

The examination of business cycle synchronization of Estonia is very similar to Lithuania and Latvia in both periods and it shows that there is a high level of dependence of economies of Baltic countries. Correlation of business cycles between Baltic countries and chosen states are illustrated in Figure 14, 15 and 16.
Estonia examined in both observed periods high level of correlation with Latvia and Lithuania. As it was mentioned in last chapter, all countries improved the business cycle synchronization after accession and especially in crisis. After accession in the EU, Estonia experienced business cycle synchronization also with western countries. Estonia improved the convergence with the EU and the EA in the second period.

Latvia between years 1996-2003 has correlation of business cycle with Estonia at the level of 0.69 and with Lithuania at 0.68 and in next period 0.92 with Estonia and 0.915 with Lithuania. In second period Latvia experience high correlation also with the UK, Austria, Denmark, France. Also it is more synchronised with the states of the EU rather with the EA states.

Lithuania experienced the highest business synchronization in first observed period with Greece at level 0.74, Latvia 0.68 and Estonia 0.65, next Slovakia 0.43, with other states examined negative correlation. After accession the business cycle of Lithuania is the most synchronous again with Latvia at level 0.92, Estonia 0.89, next also with Finland, the UK, Austria, as well with the EU states rather with EA states.

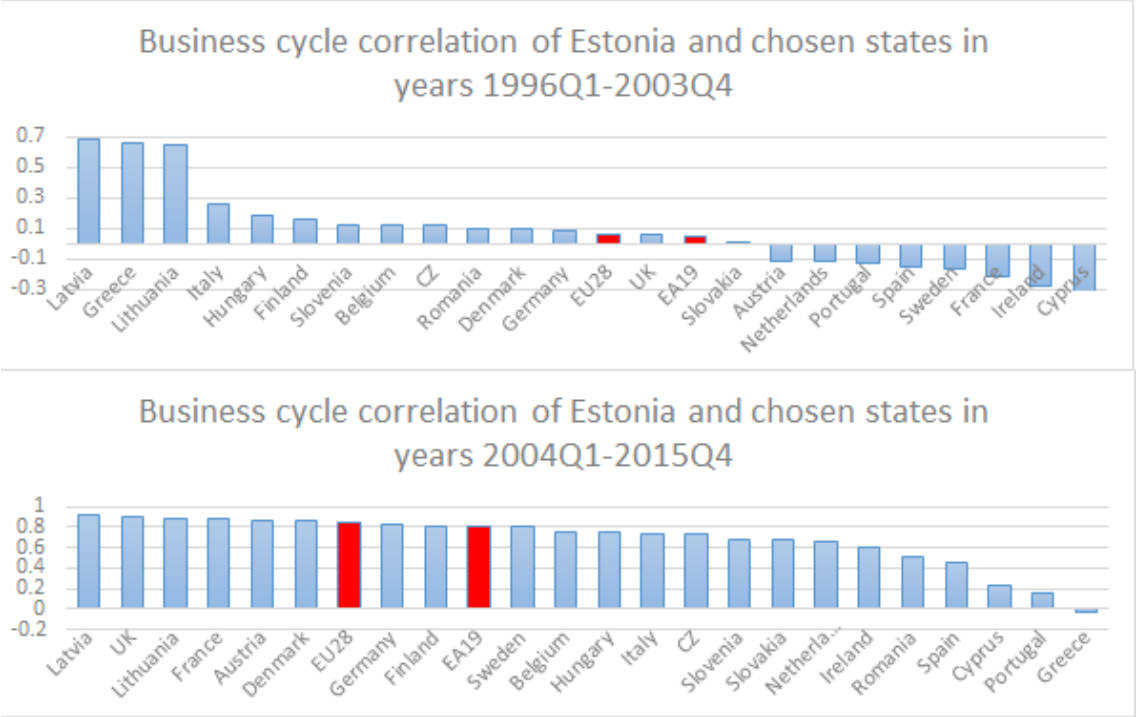

Fig. 14 Business cycle correlation of Estonia and chosen states in periods 1996-2003 and 2004-2015 in desceding order
Source: Eurostat, author´s calculations

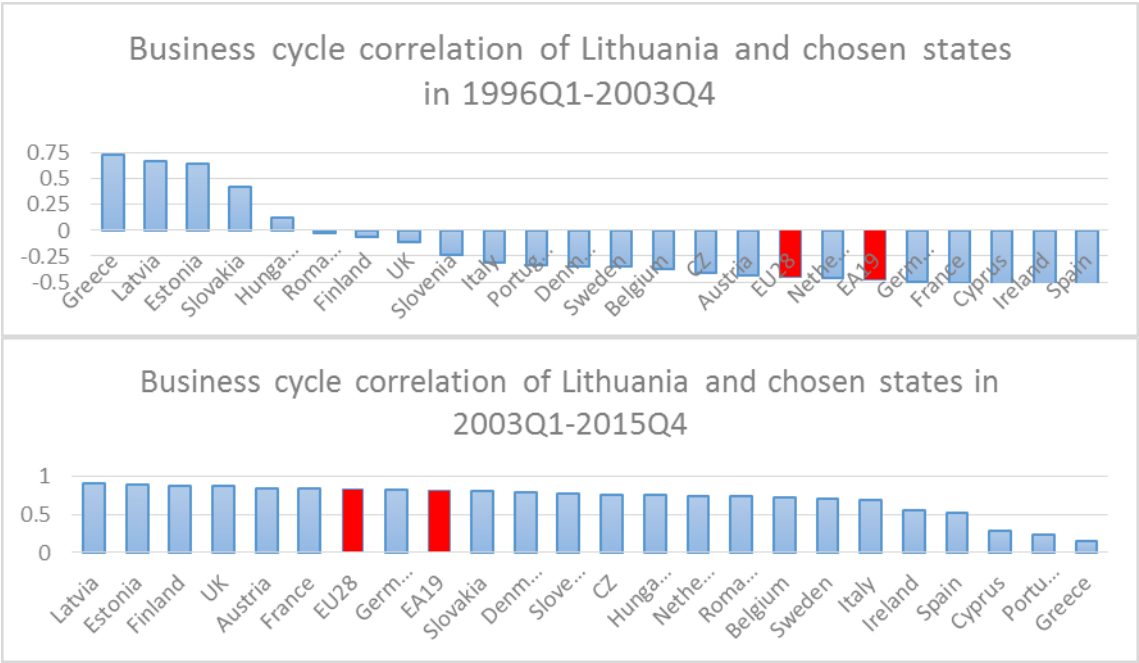

Fig. 15 Business cycle correlation of Lithuania and chosen states in periods 1996-2003 and 2004-2015 in desceding order
Source: Eurostat, author´s calculations

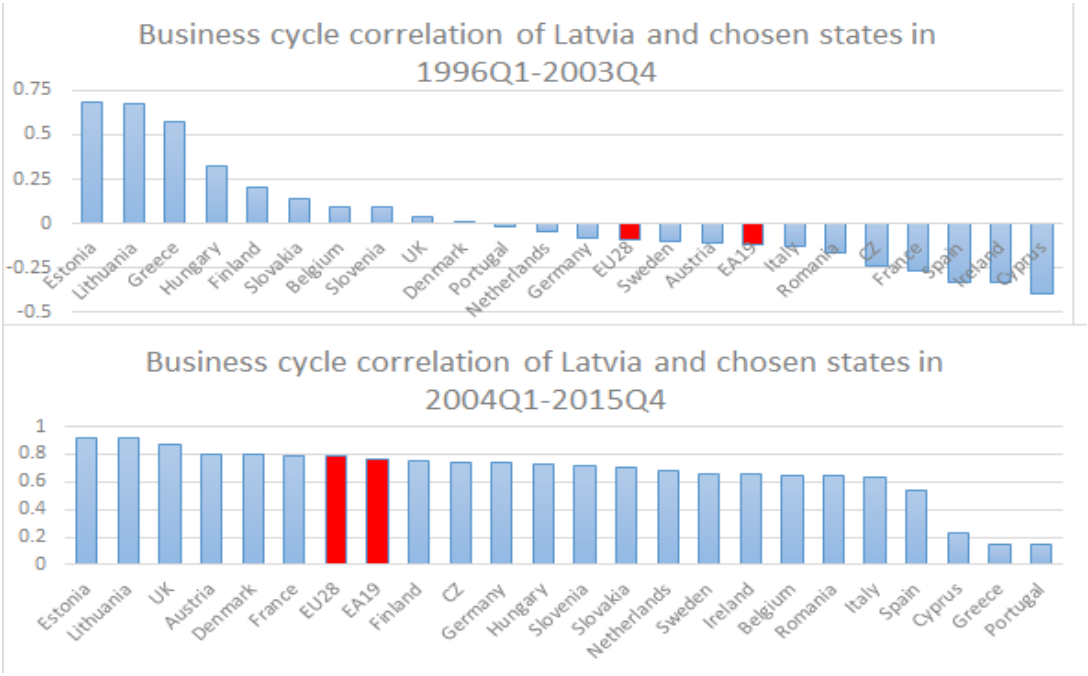

Fig. 16 Business cycle correlation of Latvia and chosen states in periods 1996-2003 and 2004-2015 in descending order
Source: Eurostat, author´s calculations

Although all Baltic countries´ economies are more synchronous with each other at a high and significant level in both observed periods. Latvia, Estonia and Lithuania have improved the convergence with the EU28 and the EA19 in the second observed period, which is positive in the context of potential join of monetary union.

6 Indices of structural convergence in the EU

The similarity in production structure and trade was defined by Mundell´s traditional OCA theory and next to business cycle synchronization, the similarity in structure minimizes the occurrence of asymmetric shocks in monetary union. The recent literature used export specialization calculated by Herfindahl-Hirschman index, intra-industry trade by Grubel-Lloyd index and Krugman specialization index.

6.1 Herfindahl-Hirschman index

In history, Herfindahl-Hirschman (HI) was used as a measurement of market shares and market concentrations with aim to detect monopoly, oligopoly and cartel market structure, Scherer and Ross (1990). Recent years HI is used for macroeconomic analyses in context of deepening integration and creation of monetary union.

Herfindahl-Hirschman index is used to analyse the degree of specialization and concentration.

HI formula is based on La (2011) study:

$$HI = \sum \left(\frac{x_{k,t}}{x_t} \right)^2$$

Where HI is Herfindahl-Hirschman index of each observed country, $x_{k,t}$ is value of exports of commodity k in time t, x_t denotes total export value of all commodities exported from each observed country. The index has been normalised to obtain results within the range of <0,1>. The higher HI index, the higher level of specialization, value of 1 indicates the maximum specialization and country exports one kind of commodity in the EU. Data are used of commodity groups of SITC of double digit levels.

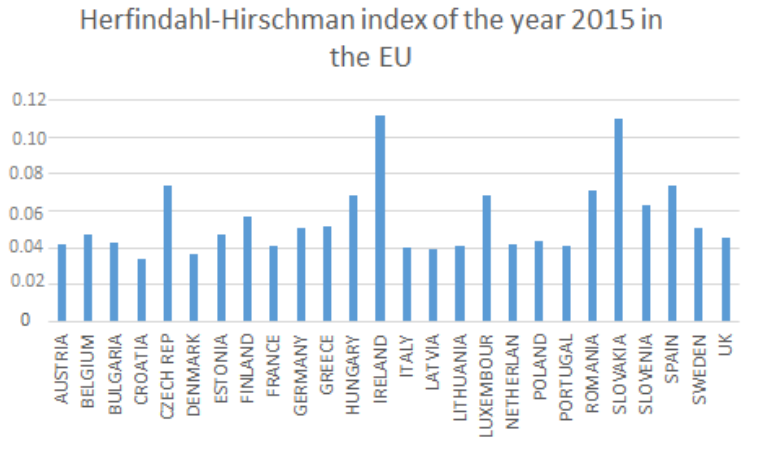

Fig. 17 Herfindahl-Hirschman index of the year 2015 in the EU
Source: Eurostat, author´s calculation

From the Figure 17 the HI of the given EU states in 2015, the HI is between the level of 0,04-0,11. The lower level of HI is given by the fact that HI was calculated with higher grade of division of industries. The most specialized countries are Ireland, Slovakia, the Czech Republic, Spain, Romania and Hungary. Since the Ireland, Slovakia and Spain are the members of monetary union there is a risk of asymmetric shock. On the other hand, the Czech Republic, Romania and Hungary are the worst candidates for adopting common currency in the context of HI.

Let us now see how the HI indices have developed over time The evolution of specialization in the years of 2002-2015 differs within the EU, which can be observed in Figure 18, where countries have been split into three graphs by the membership in monetary union.

- observed countries making up the monetary union such as Austria, Belgium, Finland, France, Germany, Italy and Portugal have the lowest level of specialization within the EU, the HI is between <0.03 and 0.1.>. This low level is very important for such countries forming the Euro Area in context of potential asymmetric shock in some of the industry. Finland has the highest level of HI, but it is important mentioned that the trend is negatively sloped since the decline in export of mobile industry. The negative slope is also evident in Portugal. The constant trend of trade specialization can be observed in Belgium, Italy and Austria. Last year Germany has increased the index, but it is still at low level. First group has lower and relatively constant trend. (left part of Fig. 18)
- Observed countries which joined monetary union after the creation of MU (in years 2001-2015), such as Estonia, Greece, Latvia, Lithuania, Slovakia and Slovenia differ in trend compared to first group of states and there is an evidence of higher deviations. Latvia has significantly improved the position within the observed period. Lithuania joined the monetary union in 2015, since it has lowered the specialization last three years, it has decreased the impact of potential asymmetric shock. One the other hand Slovakia is more and more specialized within the time period and it dangers itself by the asymmetric shock when there is a decline in demand of certain product. (right part of Fig. 18)

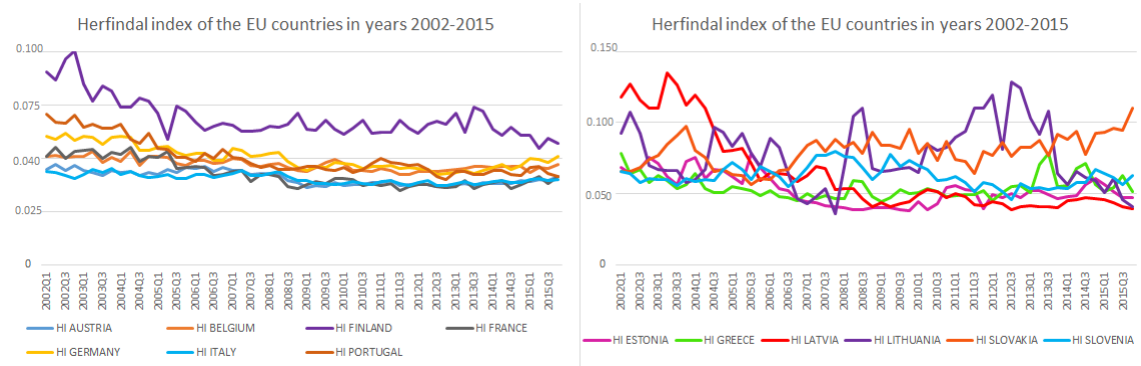

Fig. 18 The evolution of HI of observed countries in years 2002-2015
Source: Eurostat, author´s calculations

- Observed countries which are not MU members has the HI at the similar level compared to the new members of MU. At the beginning of observed period the highest level of HI was connected with Romania, once it improved the posi-

tion, it experienced the positively sloped trend again last years. Only the Czech Republic has positively sloping trend during the whole observed period, which makes the CZ the worst candidate for monetary union. (Figure 19)

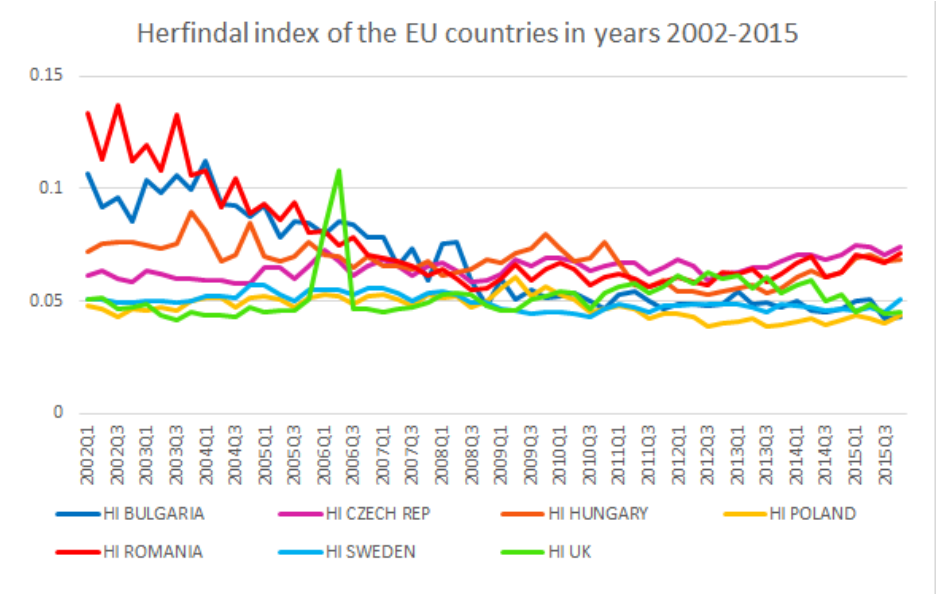

Fig. 19 The evolution of HI of observed countries in years 2002-2015
Source: Eurostat, author´s calculations

6.2 Krugman specialization index

Krugman specialization index (KI) measures the level of industry specialization between two countries. Rozmahel (2013) stated that Krugman specialization index measures the share of employment which would have to be relocated to reach an industry tantamount to the average structure of the reference group. Krugman specialization index is named after the author, Paul Krugman (1993).

Krugman specialization index is based on the study of Rozmahel (2013) and transform in following form:

$$KI = \sum \left| \frac{L_{iA}^t}{L_A^t} - \frac{L_{iB}^t}{L_B^t} \right|$$

Where L_{iA}^t denotes the employment of L in industry i and country A (member state of the EU), in time t and L_{iB}^t is the employment of L in industry i and country B, in time t. Benchmark used for this calculation is the Euro Area of 19. L_A^t is employment in country A and time t, L_B^t is total employment in country B and time t.

Industrial classification is based on NACE Rev.2. Value of KI is within the range of <0,2> and the lower KI, the similar share of industry between observed countries and therefore equilibrated structure, the level of 2 is interpreted as highest deviates of the economic structure of country from the reference group.

Figure 20 illustrates the evolution of KI between chosen EA countries (non EA countries) with benchmark of the EA 19. The most equilibrated industry structure is evident in case of Germany, Finland, and Austria where the value is around 0.05 which means that only 2.5 % of labour force would have to be relocated to achieve the equivalent structure of the EA. From the evolution, the specialization has increased in last 3 years of observed period at very low level. France experienced decrease of KI and in year 2014 it is more similar to Finland, Austria and Germany. Slovakia and Slovenia have higher level of labour force which should be relocated, Slovakia is around the level of necessary relocation of 10 % labour force. Slovenia at the beginning of the year 2000 would have to relocate app. 17.5 % and improved the level to 12.5 % by the year of 2014.

From the non EA countries the best specialization structure is evident for Sweden, Denmark. Sweden even lowered the level at the level of the best EA countries. The Czech Republic experienced the higher level of KI compared to all observed countries and it has worsen the situation by 3 % of labour force within the last 14 years.

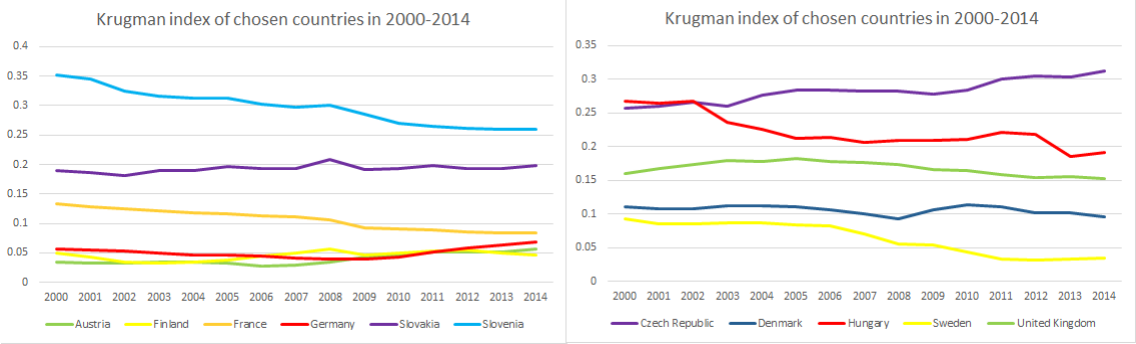

Fig. 20 Figure Evolution of Krugman index in chosen countries (the EA and the non-EA) and the EA19
Source: Eurostat, author´s calculations

Figure 21 illustrates evolution of KI between the EA and chosen CEEC, where all the observed countries are at higher level than the core of the Euro Area. The highest level of labour force which should be relocated is in Poland and it is around of 17,5 % of labour force. Slovenia has negatively sloped trend, the industry structure converges towards the structure of the EA, oppositely to the Czech Republic, which experienced positively sloped trend. Hungary and Lithuania significantly improved the KI index last years and converged towards the EA.

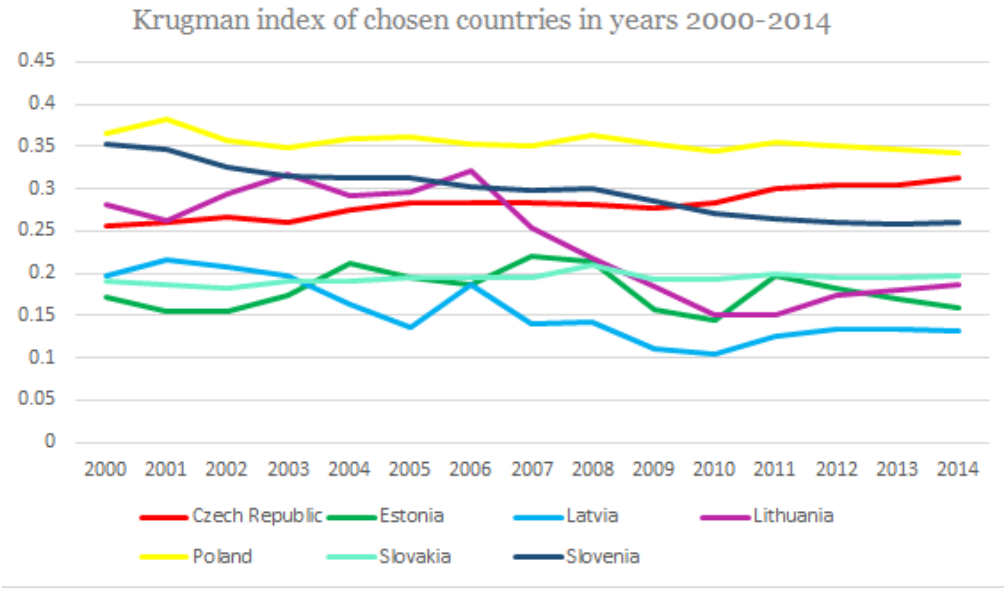

Fig. 21 The evolution of Krugman index in CEEC and EA
Source: Eurostat, author´s calculations

6.3 Grubel-Lloyd Index

Grubel-Lloyd index (GLi, GLI) is used to measure the intra-industry trade intensity between two countries. It is a share of import and export between two countries of a given commodity within the industry over the total export and import between these two countries. High level of intra-industry trade means high level of bilateral trade and therefore the higher level of dependence and business cycle synchronization. Formula of GLi is based on Rozmahel, Grochová, Litzman (2014) in decimal formulation

Rozmahel, Grochová, Litzman (2014): $$GLI = \left|1 - \frac{\sum_k \left|X_{k,i,j,t} - M_{k,i,j,t}\right|}{\sum_k \left|X_{k,i,j,t} + M_{k,i,j,t}\right|}\right| x100$$

Decimal formulation: $$GLi = \left|1 - \frac{\sum_k \left|X_{k,i,j,t} - M_{k,i,j,t}\right|}{\sum_k \left|X_{k,i,j,t} + M_{k,i,j,t}\right|}\right|$$

Where $X_{k,i,j,t}$ is export of commodity k from the country i to country j in time t, $M_{k,i,j,t}$ stands for import of commodity of k from the country j to country i in time t. GLi index is in the range of <0,1>, where the GLi equals 0 means that there is no intra-industry trade between countries and the value of 1 means deep trade integration. Commodity distribution is used according to SITC at two-digit level.

In Figure 22 is GLi between the European Union of 15 countries and chosen states in year 2015, in the range of <0.17 and 0.75>, where the lowest trade intensity is between Malta and the EU15 and highest trade intensity is between the EU 15 and Germany, Belgium and Spain.

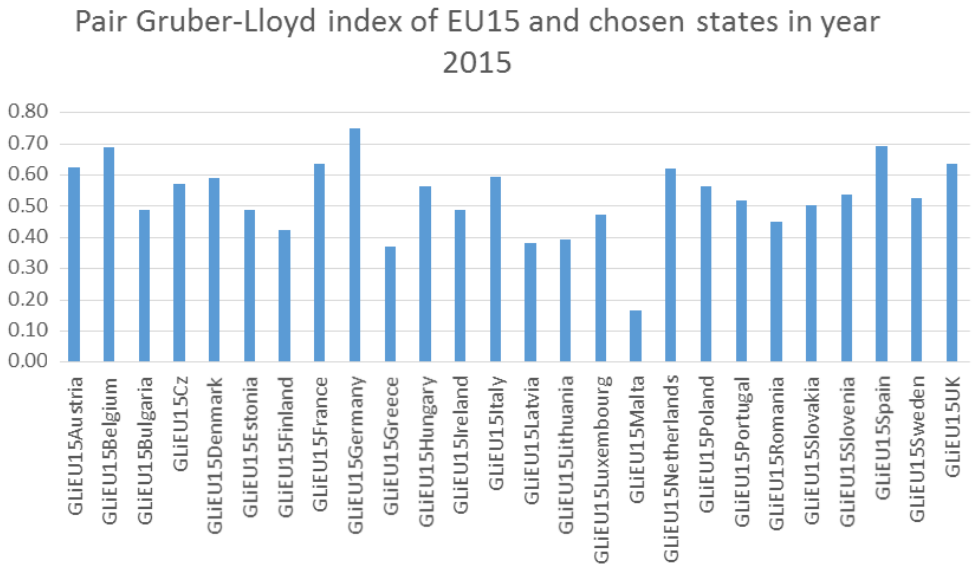

Fig. 22 Gruber-Lloyd index of the EU 15 and chosen states in 2015
Source: Eurostat, Author´s calculations

Figure 23 illustrates the evolution of GLi index between EU15 and chosen states from year 1999 to 2015. Germany has the highest level of intra-industry trade with countries of the EU15 within the whole period, it reaches the level from 0.68 to 0.75. Belgium has quite stable evolution of intra-industry trade. The lowest level from the EA countries is between Italy and the EU15. The result is quite similar if we use the GLi index between the EA and chosen states. Since these states form the Euro Area the high level of trade intensity lowers the risk of asymmetric shock. CEEC experienced lower level of GLi compared to western states in the first figure. From year 1999 to year 2015 all countries improved the trade intensity. Steeper growth is evident from year 2004, where countries joined the EU and therefore the markets got open for them. Poland and Hungary are the best candidates for adopting common currency for last years from observed CEE countries. There is no significant growth of GLi for Slovenia after adopting a common currency compared to whole period evolution.

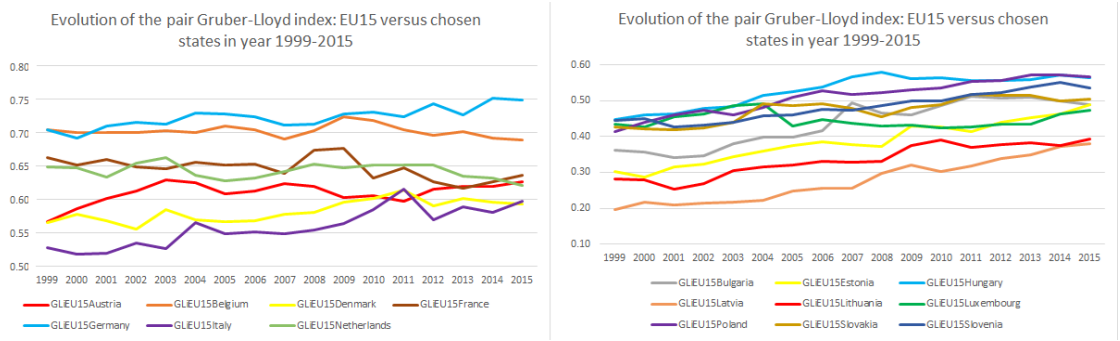

Fig. 23 The evolution of Gruber-Lloyd index between the EU15 and chosen states between years 1999-2015
Source: Eurostat, Author´s calculations.

7 Regression analysis: Determinants of business cycle synchronization in the EU

7.1 Panel regression analysis

According to Kennedy (2008) panel data, longitudinal data or in different words cross-sectional time-series help us to create model and observe the same units in different time periods. Panel data can be seen as combination of time series and cross sectional series, where the cross sectional data is a random sample of one or more variables at the same point of time and time series involves the variables in process and therefore the time development is essential.

Following panel multivariate regression model is examined as dataset for 21 countries, such as Austria, Belgium, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, the Netherlands, Portugal, Slovakia, Slovenia, Spain, Sweden and the United Kingdom. Countries were chosen primarily on the basis of data availability and with a purpose to cover states from different parts of Europe, members and non-members of the Euro Area. It is used the panel dataset in the analysis. The observed period is from 1999 to 2014. In order to estimate the determinants of business cycle synchronization. Panel dataset is in following form:

- Dependent variable is business cycle synchronization between the EU 15 and countries calculated on the basis of four years´ window rolling correlation of business cycles. Cycles were adjusted from GDP by Hodrick-Prescott filter. (In the model GDP)
- Independent variables include trade intensity, dissimilarity in industrial specialization and fiscal deficit dissimilarity, measured by Grubel-Lloyd index (GLi), Krugman specialization index (KI) and deficit difference between countries above the Maastricht criteria(Deficit)
- Dummy variable stands for the membership of the EA 19 (0 – non-member, 1 member)

Before the model is specified and estimated, stationarity of all variables and classical assumptions must be fulfilled.

Stationarity was testified by Dickey-Fuller test in the Gretl. Null hypothesis means unit root, which was rejected for all variables (Tab. 1). Since the variables do not cause any other obstacles in further estimating of model, the theoretical assumption can be determined.

Tab. 1 Unit root test of all variables

Dickey-Fuller test for GDP, test with constant model: (1-L)y = b0 + (a-1)*y(-1) + ... + e H_0: all groups have unit root N = 21, Tmin = 11, Tmax = 15
GDP Inverse chi-square(42) = 106.057 [0.0000]
GLi Inverse chi-square(42) = 88.9284 [0.0000]
Deficit Inverse chi-square(42) = 155.889 [0.0000]
KI Inverse chi-square(42) = 59.9419 [0.0357]

Source: author´s calculations, Gretl

Theoretical assumptions tested in analysis are:

- Increase in industry specialization has negative impact on the business cycle synchronization. It is assumed the negative value of coefficient of KI
- Increase in intra-industry trade positively effects the business cycle synchronization, the GLi coefficient is expected to be positive
- Increase in deficit differential has negative impact on business cycle synchronization, the sign of Def is negative
- The sign of dummy variable of membership of EA is expected to be positive, the membership lead to business cycle synchronization

7.1.1 Pooled ordinary least square model

First model, which was examined in the thesis was pooled ordinary least squares model of 21 countries in years 1999-2014, all variables were significant, the GLi was significant and positive, KI was significant and negative, Deficit dissimilarity was negative, but not significant. When the lag is testified, the dissimilarity in deficits occurs as a significant with a two years lag, which is illustrated in the Tab. 2. The dummy variable of membership/non-membership of the EMU is omitted due to fact that it caused collinearity in the model.

Tab. 2 Results for panel data set of 21 EU countries

POOLED OLS, USING 294 OBSERVATIONS					
Included 21 cross-sectional units Time-series length = 14 Dependent variable: GDP					
	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	0.336439	0.123805	2.7175	0.0070	***
GLI	1.03918	0.186836	5.5620	<0.0001	***
Deficit_2	−2.10458	0.86185	−2.4419	0.0152	**
KI	−0.659667	0.144104	−4.5777	<0.0001	***
Mean dependent var	0.716937	S.D. dependent var		0.387882	
Sum squared resid	31.22440	S.E. of regression		0.328132	
R-squared	0.291683	Adjusted R-squared		0.284356	

F(3, 290)	39.80711	P-value(F)	1.42e-21
Log-likelihood	−87.53806	Akaike criterion	183.0761
Schwarz criterion	197.8104	Hannan-Quinn	188.9768
rho	0.698820	Durbin-Watson	0.571247

Source: Author´s calculations, Gretl

The pooled OLS model occurs as inappropriate, constants are not the same for all the observed countries and therefore the model with fixed or random effects would be more appropriate. Tab. 3 shows that in Residual variance test, the p-value is under the level of 0.05 and therefore the model with fixed effects are more suitable, the same results show Breusch-Pegan tests. Hausman test rejects the null hypothesis and therefore the most appropriate model is model with fixed effects.

Tab. 3 Diagnostics of panel dataset

Diagnostics: assuming a balanced panel with 21 cross-sectional units
observed over 14 periods

Fixed effects estimator
allows for differing intercepts by cross-sectional unit
slope standard errors in parenthesis, p-values in brackets

const: 0.2244 (0.49577) [0.65119]
GLI: 1.6698 (0.75481) [0.02779]
Deficit_2: -3.7337 (0.92783) [0.00007]
KI: -1.6683 (0.78234) [0.03387]

21 group means were subtracted from the data

Residual variance: 24.6233/(294 - 24) = 0.0911975
Joint significance of differing group means:
F(20, 270) = 3.61912 with p-value 7.48256e-007
(A low p-value counts against the null hypothesis that the pooled OLS model
is adequate, in favor of the fixed effects alternative.)

Breusch-Pagan test statistic:
LM = 30.2641 with p-value = prob(chi-square(1) > 30.2641) = 3.77032e-008
(A low p-value counts against the null hypothesis that the pooled OLS model
is adequate, in favor of the random effects alternative.)

Variance estimators:
between = 0.0153692
within = 0.0911975
theta used for quasi-demeaning = 0.454404

Random effects estimator
allows for a unit-specific component to the error term
(standard errors in parenthesis, p-values in brackets)

const:	0.34627	(0.18962)	[0.06887]
GLI:	1.0917	(0.29471)	[0.00025]
Deficit_2:	-3.0601	(0.88829)	[0.00066]
KI:	-0.73975	(0.23441)	[0.00177]

Hausman test statistic:
H = 8.82972 with p-value = prob(chi-square(3) > 8.82972) = 0.0316427
(A low p-value counts against the null hypothesis that the random effects model is consistent, in favor of the fixed effects model.)

Source: Author´s calculations, Gretl

7.1.2 Model with fixed effects

When testing the pooled OLS model, the model with fixed effects occurs as the most suitable for observed dataset. The model with fixed effects was used for 21 countries, years 1999-2014.
Firstly, all variables (intra-industry trade, industry specialization and dissimilarity in deficits) were examined separately. It was used the model with robust standard errors. It was testified whether the variables influence the business cycle correlation with the time lag. All variables were significant in respect of the EU average.
Secondly, the panel dataset was examined for all variables in one model. It occurred that all variables in one model are not significant. But with some adjustments there are significant level of more than one variable in the same model at the same time.

a) Relationship between business cycles and intra-industry trade for 21 countries

Tab. 4 illustrates model of the dependence of intra industry trade measured by Grubel-Lloyd index and correlation coefficient of business cycles between EU15 and 21 countries.
Intra-industry showed as a significant variable at the level of significance 10 %. It has positive effect on business cycle correlation. Since the range of correlation coefficient is between <-1; +1>, the interpretation is following, when the intra-industry trade increased by 0.1 unit, the business cycle correlation increased by 0.360177 unit. It was not used the logarithm due to fact, that correlation coefficient is also negative in some observed periods and it would cause the loss of data, which is undesirable when the observed period covers only 16 years. Model is explained by 11 %, which is not high number, but the result is very common in all empirical studies. The result with time lag did not examine significance.

Tab. 4 Model with fixed effects, panel regression analysis

Model: Fixed-effects, using 336 observations Included 21 cross-sectional units Time-series length = 16 Dependent variable: GDP Robust (HAC) standard errors					
	coefficient	std. error	t-ratio	p-value	
const	−1.21980	0.555157	−2.197	0.0400	**
GLi	3.60177	1.05482	3.415	0.0027	***
Mean dependent var		0.675829	S.D. dependent var		0.414120
Sum squared resid		31.91123	S.E. of regression		0.318792
LSDV R-squared		0.444548	Within R-squared		0.112382
Log-likelihood		−81.26559	Akaike criterion		206.5312
Schwarz criterion		290.5076	Hannan-Quinn		240.0066
rho		0.622898	Durbin-Watson		0.699505

Source: Author´s calculations

b) Relationship between business cycles and dissimilarity in industry specialization for 21 countries

Tab. 5 illustrates panel dataset model of the dependence of Krugman specialization index and correlation coefficient of business cycles between the EU15 and 21 countries of the EU.

Krugman specialization index showed as a significant variable at the significance level of 5 %. It has negative effect on the business cycle correlation. Since the higher number of KI shows the higher level of dissimilarity in employment within the industries, the negative impact is desirable result. When the KI decrease by 0.1 unit, the correlation coefficient increases by 0.289963 unit. Model is explained by 6 %, which is lower than model with Grubel-Lloyd index. The model with time lag examined also significant KI when the time lag was equal to 1 year. But the R^2 slightly decreased.

Tab. 5 Model with fixed effects, panel regression analysis of KI

Model: Fixed-effects, using 336 observations Included 21 cross-sectional units Time-series length = 16 Dependent variable: GDP Robust (HAC) standard errors					
	coefficient	std. error	t-ratio	p-value	
const	1.20854	0.209412	5.771	1.20e-05	***
KI	−2.89363	1.13750	−2.544	0.0193	**
Mean dependent var		0.675829	S.D. dependent var		0.414120
Sum squared resid		33.67232	S.E. of regression		0.327470
LSDV R-squared		0.413894	Within R-squared		0.063397
Log-likelihood		−90.29028	Akaike criterion		224.5806
Schwarz criterion		308.5570	Hannan-Quinn		258.0559
rho		0.625791	Durbin-Watson		0.666228

Source: Author´s calculations, Gretl

c) Relationship between business cycles and deficit dissimilarity for 21 countries

Tab. 7 illustrates panel dataset model of the dependence of dissimilarity in deficits and correlation coefficient of business cycles between the EU15 and 21 countries. The first model that does not take into account time lag of variables, do not show significance of deficit dissimilarity on the business cycle correlation. It was examined the relationship between correlation of business cycles and deficit dissimilarity with the time lag of deficit variable. From the Tab. 6 it is obvious, that dissimilarity in deficits effects the correlation of business cycle with 3 years lag.

Tab. 6 Examination of time lag for Deficit

MODEL: FIXED-EFFECTS, USING 336 OBSERVATIONS			
Included 21 cross-sectional units			
Dependent variable: GDP			
	coefficient	p-value	
Time lag= 0			
Const	0.710198	<0.0001	***
Deficit dissimilarity	−1.45804	0.1220	
Time lag = -1			
Const	0.750216	<0.0001	***
Deficit dissimilarity_1	−2.05688	0.2821	
Time lag= -2			
Const	0.803558	<0.0001	***
Deficit dissimilarity_2	−3.57719	0.0521	*
Time lag = -3			
Const	0.823016	<0.0001	***
Deficit dissimilarity_3	−3.60087	0.0486	**

Time lag = -4			
Const	0.809766	<0.0001	***
Deficit dissimilarity_4	−2.39562	0.1277	

Source: Author´s calculations, Gretl

Tab. 7 shows the panel dataset model with fixed effects of relationship between correlation of business cycles and deficit dissimilarity with three year´s lag. Deficit dissimilarity is significant at the 5 % significance level. With the increase in dissimilarity in deficits between EU average and observed states by 0.1, the correlation coefficient decreases by 0.360087 unit.

Tab. 7 Model with fixed effects of business cycle correlation and deficit dissimilarity

Model: Fixed-effects, using 273 observations Included 21 cross-sectional units Time-series length = 13 Dependent variable: GDP Robust (HAC) standard errors					
	coefficient	std. error	t-ratio	p-value	
const	0.823016	0.0420635	19.5660	<0.0001	***
Deficit_3	−3.60087	1.71491	2.0997	0.0486	**
Mean dependent var		0.734694	S.D. dependent var		0.370136
Sum squared resid		23.02266	S.E. of regression		0.302859
LSDV R-squared		0.382178	Within R-squared		0.053273
Log-likelihood		−49.80668	Akaike criterion		143.6134
Schwarz criterion		223.0217	Hannan-Quinn		175.4894
rho		0.582904	Durbin-Watson		0.767619

Source: Author´s calculations, Gretl

d) Relationship between business cycle correlation and intra-industry trade, industrial specialization dissimilarity and deficit dissimilarity for 21 countries

When the relationship between business cycle correlation and intra-industry trade, industry specialization and deficit dissimilarity is observed individually in panel data analysis, all variables are significant by at least 5 % significance level. Intra-industry trade effects positively correlation of business cycles, industry specialization effects negatively business cycle correlation and dissimilarity in deficits effects negatively business cycle correlation with three years´ lag.

It was examined the relationship between business cycle correlation and all variables in model with fixed effects and robust standard errors of 21 countries between years 1999-2014. It is obvious from Figure 8 that only intra-industry trade measured by GLi effects the business cycle correlation of observed states by a positive direction. If the intra-industry increases by 0.1 unit of GLi, the correlation of business cycles will increase by 0.287868 unit. Model fulfil statistical assumptions and it is explained by 12 %.

Tab. 8 Model with fixed effects, all variables

Model: Fixed-effects, using 336 observations Included 21 cross-sectional units Time-series length = 16 Dependent variable: GDP Robust (HAC) standard errors					
	coefficient	std. error	t-ratio	p-value	
const	−0.545771	0.663932	−0.8220	0.4208	
GLI	2.87868	1.05379	2.73177	0.0129	**
Deficit	−1.60647	1.53276	−1.0481	0.3071	
KI	−1.38838	1.17783	−1.1788	0.2523	
Mean dependent var		0.675829	S.D. dependent var		0.414120
Sum squared resid		31.32782	S.E. of regression		0.316875
LSDV R-squared		0.454703	Within R-squared		0.128610
Log-likelihood		−78.16576	Akaike criterion		204.3315
Schwarz criterion		295.9422	Hannan-Quinn		240.8501
rho		0.600392	Durbin-Watson		0.733299

Source: Author´s calculations, Gretl

Further adjustments were examined. If the time lag is analysed, the deficit dissimilarity occurred as significant with a time lag of three years. Other variables did not prove any impact with the time lag. From the Tab. 9 the dissimilarity in deficits is significant at the significance level of 5 %. If the dissimilarity in deficits increases by 0.1 unit, the correlation of business cycles will decrease by 0.38 unit.

Tab. 9 Model with fixed effects, all variables, time lag taken into account

Model: Fixed-effects, using 336 observations Included 21 cross-sectional units Time-series length = 13 Dependent variable: GDP, Robust (HAC) standard errors					
	coefficient	std. error	t-ratio	p-value	
const	1.14463	0.763668	I.89	0.1495	
GLI	0.191924	1.12905	0.1700	0.8667	
Deficit_3	−3.80023	1.62968	−2.3319	0.0303	**
KI	−2.33063	1.37758	−1.6918	0.1062	
Mean dependent var		0.734694	S.D. dependent var		0.370136
Sum squared resid		21.94178	S.E. of regression		0.296849
LSDV R-squared		0.411183	Within R-squared		0.097720
Log-likelihood		−43.24292	Akaike criterion		134.4858
Schwarz criterion		221.1132	Hannan-Quinn		169.2598
rho		0.560283	Durbin-Watson		0.829798

Source: Author´s calculations, Gretl

It was also examined more combinations to find what determinants influence the business cycle correlation. It illustrates Tab. 10.

- The first two models were already mentioned in a case of full model without elimination. If the time lag is not taken into account, the only significant variable is GLi. In the opposite case, the deficit dissimilarity is significant with a negative impact. (Tab. 8 and 9)
- If we examine the case of model3, where the variables such as GLi and KI were used, the intra-industry trade measured by Grubel-Lloyd index is significant at the significance level of 5 %. Krugman industry specialization is negative, but it is not significant. The increase in GLI by 0.1 unit would cause the increase in business cycle correlation by 0.301927 unit.
- The model4 where the GLI and deficit dissimilarity was used, the only significant variable is dissimilarity in deficits. If the dissimilarity in deficits above the Maastricht criteria increases by 0.1 unit, the correlation of business cycles will decrease by 0.363545 unit.
- The last model takes into account the industry specialization and the dissimilarity in deficits. Both variables are significant with the respect of business cycle correlation at the 5 % significance level. The model can be interpreted as if the dissimilarity in deficits increases by 0.1 unit, the business cycle correlation will decrease by 0.380512 and if the industry specialization increases by 0.1 unit, the business cycle correlation will decrease by 0.244202 unit.

Tab. 10 Models of fixed effects, combinations of variables

Model: Fixed-effects, 21 cross-sectional units Dependent variable: GDP Robust (HAC) standard errors				
Model1	Coefficient	p-value		
const	−0.545771	0.4208		R2=0.128610
GLi	2.87868	0.0129	**	AIC=204.3315
Deficit	−1.60647	0.3071		
KI	−1.38838	0.2523		HQC=240.8501
d_mem	-	-		

Model2	Coefficient	p-value		
const	1.14463	0.1495		R2=0.097720
Gli	0.191924	0.8667		AIC=134.4858
Deficit_3	−3.80023	0.0303	**	
KI	−2.33063	0.1062		HQC=169.2598
d_mem	-	-		

Model3	Coefficient	p-value		
const	−0.699273	0.3834		R2=0.119669
Gli	3.01927	0.0220	**	AIC=205.7614
Deficit	-	-		
KI	−1.16217	0.3623		HQC=240.7584
d_mem	-	-		

Model4	Coefficient	p-value		
const	0.0251245	0.9654		R2=0.070533
GLi	1.49926	0.1870		AIC=140.5903
Deficit_3	−3.63545	0.0334	**	
KI	-	-		HQC=173.9153
d_mem	-	-		

Model5	Coefficient	p-value		
const	1.26703	<0.0001	***	R2=0.097529
GLi	-	-		AIC=132.5436
Deficit_3	−3.80512	0.0314	**	
KI	−2.44202	0.0478	**	
d_mem	-	-		HQC=165.8686

Source: Author´s calculations, Gretl

7.1.3 Partial conclusion

There is a lack of consensus about the interpretation and used methodology in the OCA theory. From the panel analysis it is obvious, that it really depends on the used methodology and even more on the final choice of model. In many cases the other options are not shown and therefore the interpretation can significantly differ.

In first part it was examined the relationship between intra-industry trade, dissimilarity in industry specialization and dissimilarity in deficits above the Maastricht criteria and the business cycle correlation in the panel data analysis individually. All variables have occurred as a significant and have positive or negative impact on the convergence of economies with the respect of assumptions.

Second part was focused on the examination of all variables in one dataset or in the combinations of more than one variable at the same time. It was not examined the significance of all variables in one model, but all variables occurred as significant in the model of combinations of variables. Since all models are explained in the low level and the difference between them is not significant, the author suppose that all variables effect the business cycle correlation for the observed states and for the observed period. If we compare the AIC or HQC criteria, then it could be

assumed that only intra-industry trade effects the correlation of business cycles. But the model is still explained at relatively low level.

7.2 Multivariate regression model for 21 countries

Following multivariate regression model is examined for 21 countries, such as Austria, Belgium, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, the Netherlands, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom. Countries were chosen primarily on the basis of data availability and with a purpose to cover states from different parts of Europe, members and non-members of the Euro Area. It is used the generalized least squares estimator (OLS) in the analysis. In order to estimate the determinants of business cycle synchronization. Dataset is in following form:

- Dependent variable is business cycle synchronization between the EU 15 and given country calculated on the basis of four year window rolling correlation. Cycles are adjusted from GDP by Hodrick-Prescott filter.
- Independent variables include trade intensity, dissimilarity in specialization and fiscal deficit dissimilarity measured by Grubel-Lloyd index (GLi), Krugman specialization index (KI) and deficit difference.

Since the history of the EA is not long enough, data for most of the states is available since the year 1999. It was examined the determinants in multivariate regression model for period 1999-2014 between the EU15 and 21 states. The results are summarized in Tab. 11, where the significance of variables are examined individually for all 21 countries.

Tab. 11 Multivariate regression models, significance of determinants of chosen states

Determinants/ States	Belgium	Czech Republic	Denmark	Germany	Estonia
Deficit dissimilarity	-	-	-	**	-
Grubel-Lloyd index of intra industry trade	-	-	-	-	-
Krugman specialization index	**	-	-	**	-

Determinants/ States	Ireland	Spain	France	Italy	Latvia
Deficit dissimilarity	-	-	-	-	-
Grubel-Lloyd index of intra industry trade	**/***	-	-	-/*	-
Krugman specialization index	-	-	-	-	**

Determinants/ States	Lithuania	Hungary	Netherlands	Austria	Portugal
Deficit dissimilarity	-	-	-	-	*
Grubel-Lloyd index of intra industry trade	-/**	-/**	-	-	***
Krugman specialization index	-	-	-	-	***

Determinants/ States	Romania	Slovenia	Slovakia	Finland	Sweden	United Kingdom
Deficit dissimilarity	-	-	-	-	-	*
Grubel-Lloyd index of intra industry trade	-	-	**/***	-	*/**	-
Krugman speciali-zation index	*/**	**/***	-	-	-	-

Source: Author´s calculations, Gretl
Note: * 1 % significance, ** 5 % significance, *** 10 % significance.
The improvement in model after adjustments are noted with a /

The significance of variables are lower compared to Panel data analysis, which is caused by the short history of data and therefore low observations in every model, while Panel analysis is able to testify whole dataset at the same time and therefore extend the number of observation. Due to this fact, the thesis is focused on the panel data analysis. From the result of multivariate regression model, there is evidence of significance of Krugman specialization index in Belgium, Germany, Latvia, Portugal, Romania and Slovenia. Deficit dissimilarity is significant in respect of business cycle correlation in Germany, Portugal and the United Kingdom. The effect of intra-industry trade on business cycle convergence are examined in case of Ireland, Italy, Lithuania, Hungary, Portugal, Slovakia and Sweden.

7.3 Comparison of panel regression analysis of the groups of states: the CEEC, the EA members

It is also examined the relationship between trade-intensity, dissimilarity in industry employment and dissimilarity in deficits on the group of states to determine whether all variables are more or less significant for a different groups of states in the EU, such as 21 countries of the EU, CEE countries or the EA members. The significance of variables differs between the groups, but all variables are significant when the models are assumed as a combination of variables more than all variables in one model.

The model of 21 countries represents Austria, Belgium, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, the Netherlands, Portugal, Slovakia, Slovenia, Spain, Sweden, Romania and

the United Kingdom. The model of the EA members represents the EA members chosen from the 21 countries. The CEEC is represented by the Czech Republic, Hungary, Latvia, Lithuania, Slovenia, Slovakia, Estonia and Romania.

Tab. 12 illustrates the comparison of the model with all variables of 21 countries, the CEEC countries and the EA members. The time lag is taken into account. While the model of 21 countries shows the positive effect of time lag of dissimilarity in deficits of 3 years. It is the only significant variable. If the deficit dissimilarity increase by 0.1 unit, the correlation coefficient will decrease by 0.380023 unit. The level of significance of variable is 5 %. The EA members do not reflect the time lag of variables, the only positive variable is intra-industry trade measured by Grubel-Lloyd index and it can be interpreted as following, if the GLi increases by 0.1 unit, then the correlation of business cycles will increase by 0.300015 unit. The model of CEE countries takes into account time lag of 3 years for deficit dissimilarity variable. The significant variables are deficit dissimilarity at the 10 % significance level and industry specialization at the 5 % significance level. If the deficit dissimilarity increases by 0.1 unit, the correlation of business cycle will decrease by 0.850497 unit and if the dissimilarity in industry specialization increases by 0.1 unit (measured by KI), the correlation of business cycles will decrease by 0.43978 unit.

Tab. 12 Panel regression analysis of 21 EU countries, CEEC and EA members of full model

	Panel regression analysis Fixed effects, Robust standard errors Dependent variable: GDP											
	21 countries				CEEC (8)				EA members(13)			
	Coef	Lags	p-value		Coef	Lags	p-value		Coef	Lags	p-value	
const	1.1446		0.1495		2.6660		0.0350	**	−0.6209		0.4704	
GLi	0.19192	0	0.8667		1.2173	0	0.4110		3.0002	0	0.0529	*
Def	−3.8002	-3	0.0303	**	−8.5050	-3	0.0058	***	−2.2420	0	0.2986	
KI	−2.3306	0	0.1062		−4.3798	0	0.0199	**	−1.342	0	0.4093	
R^2	0.097720				0.214301				0.132564			
AIC	134.4858				119.7075				165.5722			
HQC	169.2598				131.4920				188.9830			

Source: Author´s calculations, Gretl
Note: * 1 % significance, ** 5 % significance, *** 10 % significance.

Tab. 13 illustrates the models of 21 countries, CEEC and EA members after elimination of variables. While the model of EA members shows that GLi is significant at the 5 % significance level, other combinations do not prove better results. If the Grubel-Lloyd index increases by 0.1 unit, the correlation coefficient will increase by 0.3687 unit. The model of 21 EU countries after elimination and CEE countries examined significant Krugman specialization index and deficit dissimilarity.

If the deficit dissimilarity increases by 0.1 unit, the correlation coefficient of business cycle will increase by 0.83089 unit and if the dissimilarity in specialization in industry employment measured by Krugman specialization index by 0.1, the correlation coefficient will increase by 0.35167 unit. The significance level of variables are examined at the level of 10 % in the context of model for CEEC.

Tab. 13 Panel regression analysis of 21 EU countries, CEEC and EA members after elimination

	Panel regression analysis after elimination Fixed effects and Robust standard errors Dependent variable: GDP											
	21 countries				CEEC (8)				EA members(13)			
	Coef	Lags	p-value		Coef	Lags	p-value		Coef	Lags	p-value	
const	1.2670		<0.0001	***	1.8566		0.0009	***	−1.2217		0.1337	
GLi	-	-	-	-	-	-	-	-	3.6487	0	0.0277	**
Def	−3.8051	-3	0.0314	**	−8.3089	-3	0.0041	***	-	-		
KI	−2.4420	0	0.0478	**	−3.5167	0	0.0099	***	-	-		
R2	0.097529				0.208503				0.109538			
AIC	132.5436				118.4722				167.4405			
HQC	165.8686				129.1854				188.0971			

Source: Author´s calculations, Gretl
Note: * 1 % significance, ** 5 % significance, *** 10 % significance.

7.4 Summary of results, thoughts and recommendations

There is a lack of consensus about the interpretation and used methodology in the OCA theory. From the panel analysis it is obvious, that it really depends on the used methodology and even more on the final choice of model. In many studies the other options are not shown and therefore the interpretation can significantly differ. Since all variables (dissimilarity in deficits, industry specialization and intra-industry trade) occurred as a significant in empirical part, it can be interpreted that all three variables have impact on the business cycle correlation in the EU between years 1999-2014. The same results were examined by researchers in empirical part of thesis. All models were explained at the low level, which is quite common in the OCA theory analysis, in case of the model fulfil all the statistical assumptions. Due to the fact that models are explained at very similar level, it is hard to choose final model and say what determinants at the end influence the business cycle convergence within the EU. It is accepted that all variables are significant at some point and therefore all effect business cycle synchronization.

- The intra-industry trade positively effects the business cycle synchronization in the EU,
- The industry specialization leads to business cycle divergence.
- And the difference in deficits above Maastricht criteria from average of the EU lead to business cycle divergence.

If the results from the point of groups of states are taken into account. The EA members examine positive relationship between intra-industry trade and business cycle correlation. In the CEEC the negative relationship was examined between deficit dissimilarity above the Maastricht criteria; the specialization in industry specialization and the business cycle correlation. As it has been already mentioned in the thesis, in some of the models (eliminated), it is examined the relationship between all variables described above and the business cycle correlation with a different significance level.

Bilateral trade between the EU countries lead to business cycle synchronization and therefore to smooth functioning of the Euro Area. The core of the Euro Area experienced the higher level of bilateral-trade compared to the rest of the EU. It is positive that all CEE countries convergate together, the level significantly increased last years. However, the level is still lower compared to the core, but the slope is positive. The European Union supports bilateral trade by the free movement of goods and services which lead to the convergence and smoothly functioning of the EA. The EU also supports bilateral trade by many new issued rules with the aim of harmonisation of tax and law system generally. The results of these actions are very desirable, on the other hand the EU every year issues new rules which are need to be implemented or followed, it increases the costs of companies, which need to educate their employment or change the overall process. The process of harmonization is hard, costly and takes time. But it causes that business across the borders are easily negotiated and employees are able to work in the EU without the shock of very different conditions and therefore they are less afraid of working in a different state. In the context of harmonisation of taxes, the process of bilateral trade is easier and faster than the years before the accession to the EU, at least if we compare the situation in the Czech Republic. Since the companies statements are accounted by the similar (sometimes with a little difference) rules, the numbers are easily interpreted and therefore the new business are set, many services and goods are changed across the national borders, companies are selling or buying across the EU, prices and strategies are more easily to understand. It all leads to higher level of bilateral trade between the states, the companies can easily make a decision about the prices and costs if they are able to compared it to the whole EU.

In the context of level of bilateral trade, there are a few states, which experienced the low level compared to the average, for example Malta, Greece, Lithuania and Latvia. It would be desirable to support the bilateral trade with the EU members to avoid the risk of asymmetric shock for all countries, which differ from the average. The negative slope is evident in the case of Belgium and the Netherlands for last years, which is not positive.

Higher level of industry specialization increases the risk of asymmetric shock in the monetary union and it decreases the level of readiness to adopt common currency and became the part of monetary union for the states, which are still in the process. The specialization is significantly lower between the states of the core of the Euro Area. The higher level of specialization is evident in all CEE countries and new accessed countries of the EA compared to the average. Slovenia and Slovakia experienced higher level of industry specialization compared to the core of the EA, since they are the members of the EA, there is a risk of asymmetric shock in some of the industry, which would lead to the situation, at which the states would be able to handle with it only by fiscal policy. The problem is, that behaviour in the fiscal policy also effects the business cycle synchronization and therefore it can lead to further problems. For all states of the EA it is highly recommend to support employment in the industry which negatively differ from the average in the EA (since the EA members are great economies, the result of average in the EU is very similar to the EA results). Positive fact is that almost all economies lead to convergence of the similar employment in all industries for last years. On the other hand,

there are some exceptions such as f.e. the Czech Republic, Slovakia or Romania that experienced the negative slope and relatively high level of industry specialization. The EU should also support the situation and influence the EU economies to be more similar, dependent on each other and more flexible in the context of move of employment from one industry to the desirable one.

The European Union issued the rules, which covered the fiscal policy behaviour before the great accession of CEEC in 2004 by Maastricht criteria. Since fiscal policy is in the hands of national governances, the different financing, debt and deficits issues are obviously a significant problem of the European Union and the Euro Area. The thesis examined the relationship between the business cycle correlation and the dissimilarity in deficits over the Maastricht´s criteria. If the states experience the difference compared to the average of the EU, it will lead to lower level of business cycle correlation and therefore there is a higher risk of asymmetric shock for EA member and it postpones the adopting of Euro for countries, which signed the adoption. The potential problem is evident from the Fig. 24, which illustrates the evolution of difference between deficit and Maastricht criteria compared to the average of the EA. While the west economies, such as Belgium, Germany, France, Italy, Netherlands or Austria experienced the difference between 0 – 3,5 %, mostly under the level of 2 %. CEE countries or periphery states of the EA experienced the level between 0 – 12 % in some cases, mostly under the level of 4 %, which is 2 % of difference compared to the west economies.

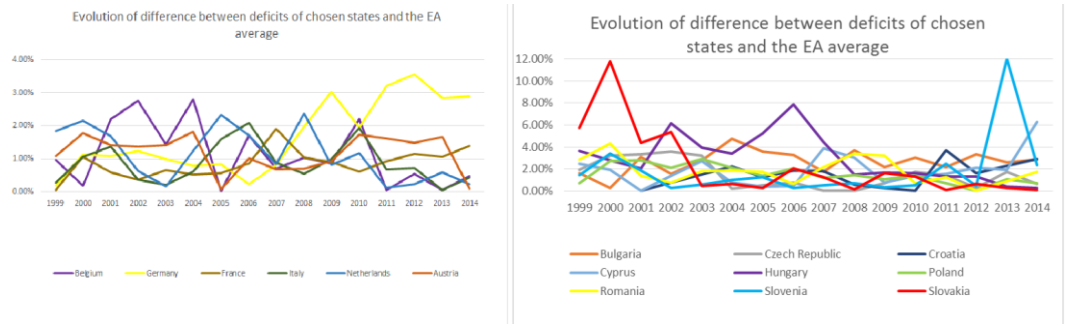

Fig. 24 The evolution of difference between deficits of choses states and the EA average

The fiscal indiscipline postpone the readiness of the CEE countries to adopt the Euro.

Nowadays the EU as a project is under the critique and there are disputes, which attack the nature of the project. Many problems and distortions occurred last years. The question whether the states should leave the European union, whether states should get rid of Euro and adopt back the national currencies and many other questions have occurred. And it became highly important to find out which determinants influence the business cycle correlation and therefore find the way of smooth functioning of whole European Union and more precisely the EA.

As many authors mentioned, for example Lacina (2007), there is still problem with inefficient harmonization in many fields and therefore the risk of asymmetric shock and lower convergence of the EU economies. Different rules for financing of companies or different functioning of mortgage markets are evident. Moreover, author added that many empirical studies examined the negative impact in the context of asymmetric shock.

From the author of the thesis's point of view, the European Union very often react on the situation with the significant time lag or after the point when the solution is already "urge". The process of harmonization and deepening of the cooperation in the EU are slow and at the end, all economies face to problems, which are caused by the situation "in the middle of process", where some of the steps cannot be taken. Since the states gave the power to the hands of the EU. On the other hand, the final rules are not already set. The EU very often does not take the initiative and let many people have doubts about the whole project and more than fifty years of history, spent energy, time and money. Therefore, people forgot about the benefits we got from the functioning of the EU (no wars, freedom, free movement of goods, services and people and further more). It might suppose that the EU do not react on the problematic situation in advance, even though many researchers or empirical studies have already determined the problematic issues and recommendations. In addition, since the EU do not have initiative and loud united presentation of the ideas, the states such as Germany is the voice of the EU when the problem occurs. Since Germany is the most powerful economy, there is no doubt about the power, which it holds in the context of decision-making, representation and leadership of the EU. On the other hand, the project of the EU (and the later phase the EMU) was considered as a democratic projects with the power in hands of institutions of the EU rather than in one or other states. From the perspective of history, it might be a dangerous step to let Germany "create the rules" and speak for the whole Europe. The only advantage is that Germany do not have high level of army, which would be able to use. On the other hand, from the author´s perspective, the EU missed the load voice for its own presentation.

It was obvious that the members of the European Union differed from each other and the process would be costly and take some time. On the other hand, only by systematic process and initiative can be achieved the desirable goal signed many years ago by all members.

The last but not least recent literature and discussions are dealing with the question of potential survive of Euro and the Euro Area and the question of whether some states should get rid of common currency, namely the Greece is great adept. The still ongoing differences between the EU and the EA states are obvious (also in this thesis). The transition process back to national currencies would be costly and there is still problem of how would economies deal with the transition process and how long would it take. The fact is that integration would stop for some time if not for ever. And changes in the field of the EA would definitely effect the whole EU. And let just think about the employment which is covered by the institutions of the EU and further more.

Since the federalization is not a solution for all problems, there are differences between the states from the nature. Less costly and more effective is seen the study of determinants of the business cycle synchronization deeply, to determine the effects and then create the rules which would help the European Union make the project of European integration successful for the recent and last phase. Additionally, enforce the states to respect the common rules, the new ones and also the old ones at the sufficient level. In case of higher business cycle correlation the policy is easier to implement.

8 Discussion

The empirical part of the diploma thesis is primarily focused on the correlation of business cycles and determination of variables, which affect the business cycles in the European Union. The empirical studies usually used the Hodrick-Prescott filter or the Baxter King filter. Rozmahel (2006) stated that both filters examined similar results in the context of business cycles. And since the HP filter is commonly used to remove the cycle from the GDP, it is applied for the purpose of the thesis.

In case of determination of variables, the panel data analysis and the multivariate regression analysis is used as an additional tool to determine the influences on the individual states. The panel analysis is examined for all variables in the models, individual variables and combination of variables. The results showed at some point that all variables are significant and influence the business cycle synchronization, such as intra-industry trade, Krugman specialization, and fiscal indiscipline measured by deficit. The panel data analysis become the main tool of analysis. The multivariate regression as a tool do not bring the valuable results, since the data history is low and the observations do not cover enough observations to find out much dependence.

Kocenda, Kutan, Yigit (2008) examined the fiscal convergence of new members of the EU (10 states). The authors also used the difference from the Maastricht criteria and observed the period from years 1995-2004, while the thesis observes the period of 1999-2014. The method of dependent variables differ, while authors used the calculation of deficit over government budget yields and involved also the inflation, initial yield and others. In the thesis, the deficit over GPD is used. The thesis examines the worst fiscal position of the CEE countries and periphery states which is in common with the paper of Kocenda, Kutan and Yigit. The model of paper was explained at very high level, since the government budget yields and inflation was involved in the calculation of variables (deficit over government budget yields on one size and on the other, the inflation and yields, which are highly correlated). The variables of countries to benchmark examined the significant level in context of the Czech Republic, Estonia, Latvia, Lithuania, Malta, Poland, Slovak and Slovenia. The used programme for the purpose of this thesis do not support the panel data analysis with the individual results for the observed states. If it is compared to multivariate regression, which is also used as an additional tool, the thesis do not examine the significant dependent of fiscal indiscipline for the same states. The reason might by firstly using different calculation of fiscal indiscipline variables. Secondly, by the methodology, which differ in comparison of individual states´ results, panel regression analysis includes the extended observations and the results are therefore more accurate. Thirdly, different time period is examined.

Inklaar, Haan, Pin (2005) used the Panel data analysis for 21 OECD countries, authors concluded that trade intensity affects the business cycle synchronization. Authors also used additionally the monetary and fiscal policies, financial integration and specialization, which was determined as the significant variables. The similar methodology brings the same results in the context of trade. The thesis is

focused on the period of 1999-2014, while authors observed the period from 1970-2003. Other variables were not examined in the paper of the authors.

Rozmahel, Grochova, Litzman (2014) also used the Panel data analysis for 27 EU countries from the observed period 1996-2012. The authors were focused primarily on the effect of fiscal indiscipline, but the intra industry trade in the formula was used. They concluded that fiscal dissimilarity strongly and negatively affects the business cycle synchronization. In the context of intra-industry trade, the strong positive relationship was examined. The results are similar to the diploma thesis for pooled regression analysis and fixed effects model of panel regression for individual variable. The difference is that the lags are involved in the formula in this thesis. In the thesis, all variables including the Krugman specialization index is involved in pool regression and the variables are significant. After the usage of individual effects (namely fixed effects model) and time lags in variables in the model, only one deficit has occurred as a significant variable compared to the model of the authors. When the intra-industry trade and deficit dissimilarity with lags are examined in the individual models, the only significant variable is deficit at the level of 10% significance level. Since the used methodology is very similar, the difference in results might be caused by different time observation and little difference in the primary data. From the options of analysis and given results, the authors probably used more sophisticated statistical programme, which might also have caused some of the difference. The Krugman specialization index was not examined in the paper of the authors.

Weimann (2002) used a VAR model. Author examined 11 countries of Euro Area in years 1999-2001and 9 countries of CEE in years 1995-2001. The higher level of correlation was examined in the core of Euro Area (Germany, Belgium, France, the Netherlands, Austria). The thesis provides the same evidence for the core of the EA although the methodology differs.

Although Otto, Voss and Willard (2001) studied cross-country variation in bilateral output growth for 17 OECD countries, 5 countries out of the EU. Authors used paired correlation coefficients for years of 1960-2000 in twenty years´ periods. In more general, trade intensity and industry structure are not significant according to authors. The thesis and other empirical studies prove the significant impact of trade intensity in the EU between years 1999-2014. Although the authors observed the period before, other empirical studies prove the significance with a use of similar methodology.

From the general point of view, the thesis examined similar results, namely the significant variables such as fiscal indiscipline and intra-industry trade. Which is in common with the results of many empirical studies. The thesis also examined the week position of the CEE countries or the periphery states compared to the core, which is also in common with the results of empirical studies. The individual results for given states are relatively different, since the compared methodology differ by the calculations of variables, the different time period or the lack of tools provided by used programme for the purpose of the thesis. The interesting results

are in the context of time lags, which was not examined or did not prove as significant in the context of recent empirical studies. While it is examined the 3 years lag in effect of fiscal indiscipline on the business cycle synchronization in the thesis. For the purpose of thesis, Gretl was used, while many empirical studies used more sophisticated programmes, which provides authors with more accurate and deep results in the context of panel data analysis. Therefore, the precise comparisons of individual results for the states are not possible.

9 Conclusion

The question of entry of candidates into the Euro Area has often shifted from the main point of debates in the context of recent events, such as financial crisis and nowadays the whole of Europe is again under the pressure of a real migrant crisis, which needs to be solved in advance. Furthermore, there is an evidence of critique of separate project of European integration and will of some states to leave the EU (the EA) or exclude some of the members. On the other hand, with a few exceptions (such as the UK or Denmark), the EU members agreed with the adoption of common currency sometime in the future without any doubt. The study of costs and benefits of common currency, business cycle convergence, determinants of smooth functioning of common currency area and more, are still a needed and actual topic, due to condition which states agreed on, hardly measurable and probably very high cost from transition back to national currencies, very low idea about the transition process and the fear of total stop of integration in the Europe.

Since the business cycle synchronization helps to smooth the functioning of the common currency area, the goal of the thesis is to identify and test the synchronization of business cycle within the EU and examine various factors which affect the convergence of business cycles in the context of the OCA theory criteria.

Results provide the evidence of business cycle synchronization of member states with the EA and the EU average. The convergence differ in the context of time and observed states. The highest correlation is examined particularly between the years 1996-2010. The core of Euro Area is more correlated compared to the periphery or CEE states. The CEE countries significantly improved the position after access in the EU. CEE countries are more correlated with the rest of members than with other CEE countries with an exception of Baltic countries, which are highly correlated with each other. Additionally, Romania experienced the higher level of business correlation with the other CEE countries rather than with the EA or the EU average.

The business cycle synchronization was tested for the period of 1996 -2015. The economies in the EU are synchronized but similarity of business cycles in the EU differ in context of observed time period and further the level differs between the states of the EU.

From the point of time, the synchronization of business cycles were higher until the financial crisis. In the time of crisis, all economies were dealing with the huge decrease, the symmetry shock occurred and therefore, the convergence of all economies was at a high level. The convergence is obvious primarily from the year 1996 until 2010. After crisis, the convergence is lower, since all economies were able to deal with the crisis and recovery at a different level. While some of the economies experienced a little growth, some of them were still experiencing decrease and therefore, the business cycle synchronization has been lower recent years.

The highest level of synchronization is obvious between the EA and Belgium, Germany, France, the Netherlands or Austria and with the lowest deviation in the evolution for all observed states. The synchronization of periphery states differ during the observed period and states are less correlated than the "core" of the EA. Greece is the problematic member of the EA. The business cycle of Greece do not converge with the EA nearly for all period. Therefore, the risk of asymmetric shock is increased. The correlation of business cycles between the EA and the CEEC is lower before the year 2004. The position has been significantly improved after the accession of the countries in the EU with open markets and higher level of trade. Slovenia experienced the growth in the synchronization after the accession in the EA, which is in common with the hypothesis of endogeneity. The level of synchronization between the EA and the EU and the CEEC is lower compared to the core of EU.

It was examined whether the states of CEE are synchronized with the EU (the EA) or with the other CEE states in periods of 1996-2003 and 2004-2015. All states improved the position and experienced higher level of correlation in the second observed period, even the Baltic countries in the respect of the EA and the EU members. The only similar convergence was evident in the Czech Republic before and after accession, while Slovak, Hungary, Estonia, Lithuania and Latvia improved the position significantly in the second period. The correlation with the EU (the EA) is at the very high level compared to the rest of states (CEE and EU members) and states are correlated rather with the EU or the EA members. The exceptions are Baltic countries, which are more synchronised with each other in both observed periods rather than with the EU. Additionally, Romania´s business cycle is more correlated with the other CEE countries rather than with the EU or the EA average.

For the purpose of thesis, the evolution of specialization (Herfindahl-Hirschman index and Krugman specialization index), the intra-industry and fiscal indiscipline was examined. The results provide similar results compared to business cycle analysis. The core of the EU observed better results compared to the CEE countries or periphery states.

From the context of specialization the Czech Republic, Romania or Hungary are the worst candidates for adopting the common currency. For instance, the Czech Republic has worsen the position by 3 % of labour force within the observed period. The situation is similar in the context of intra-industry trade or the fiscal indiscipline as CEE states recorded the worst results compared to the core of the EU.

The results provide evidence of positive affect of trade intensity on the business cycle synchronization. In particular, the higher level of intra-industry trade measure by Grubel-Lloyd index, the higher level of correlation of business cycles. Negative effect of industry specialization measured by Krugman specialization index, therefore the higher specialization of country, the lower level of business cycle

synchronization. Additionally, the negative effect of fiscal indiscipline with three years lag. The higher difference between the average deficit in the EA (the EU) and observed states, the higher business cycle divergence with a time lag of three years.

The panel data analysis and multivariate regression are used to examine the significance of determinants on the business cycle synchronization, namely the intra-industry trade measured by Grubel-Lloyd index, industry specialization calculated by Krugman specialization index and fiscal indiscipline measured by deficit over the Maastricht´s criteria. Due to low data availability for all variables, the observed period covers the years from 1999 until 2014.

In the context of the panel data analysis, all variables show significance at least at the level of 5 % and even of 10 % if they are examined individually or in combination of 2 factors in the model. The intra-industry trade positively affects the convergence, whereas the fiscal indiscipline and difference in the industry specialization has a negative impact. The deficit is examined as significant with time lag of 3 years, which means that today fiscal indiscipline would affect the business cycles by 3 years. In the model of all three variables at the same time, the deficit with 3 years lag is examined as a significant variable at the level of 10% significance level.

The panel regression was also used for the model of groups of states, EA members, and also for the CEE countries. The model for 13 EA members examines the significant variable intra-industry trade, while the model for 8 CEE countries examines significant variables deficit dissimilarity with 3 years lag and also industry specialization at the same point.

The multivariate regression was used as an additional tool as was already mentioned. This kind of tool provides us with the less accurate results, since the low observation in one model is evident compared to the panel data analysis. There is an evidence of significance of Krugman specialization index for Belgium, German, Latvia, Portugal, Romania and Slovenia. The deficit dissimilarity is observed to be significant for Germany, Portugal and the UK. The intra-industry trade was significant for Ireland, Italy, Lithuania, Hungary, Portugal, Slovakia and Sweden.

The thesis is in accordance to the recent studies that proved that business cycles are more synchronized within the EU and the intra-industry trade, industrial specialization and fiscal dissimilarity affect the business cycle synchronization.

10 Literature

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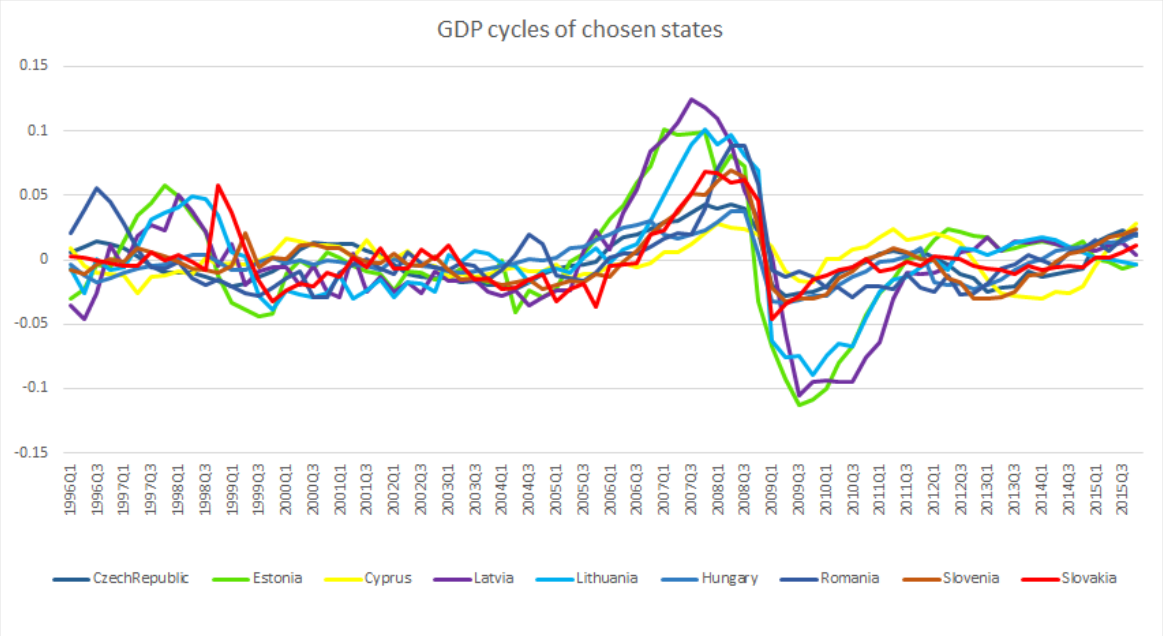
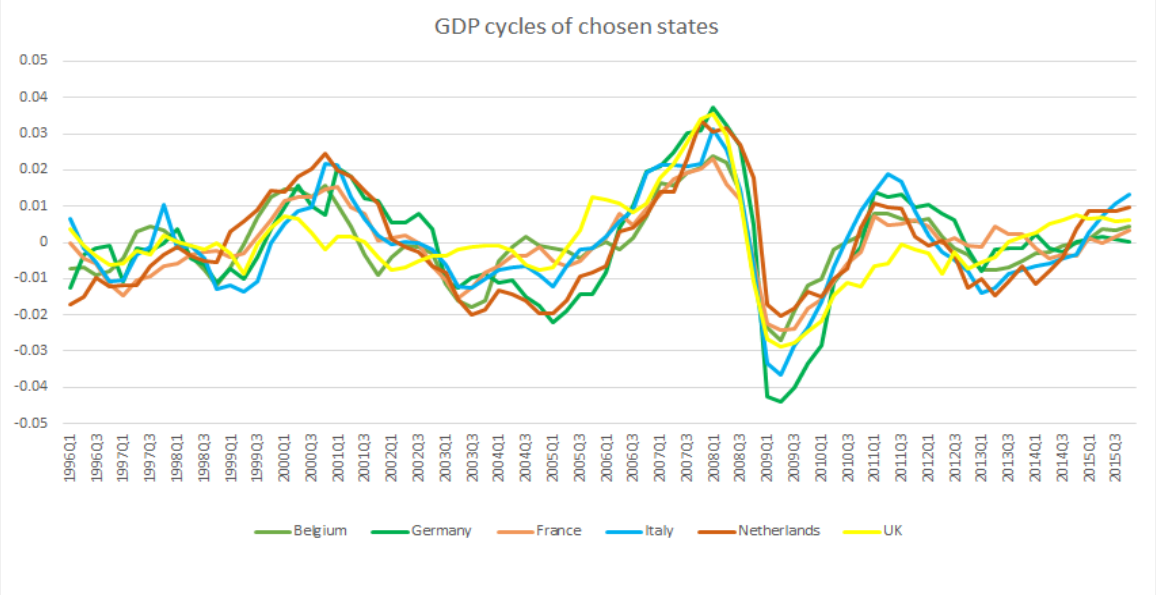
Appendix

A Business cycles between years 1996Q1-2015Q4

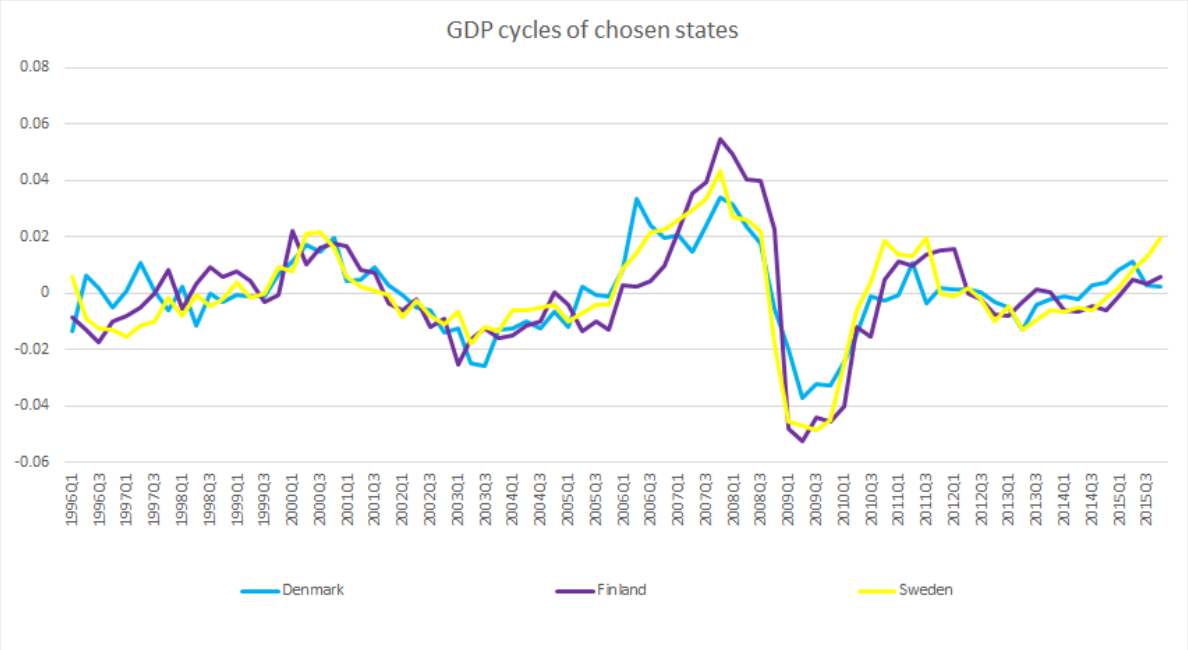
GDP cycles of CEE countries



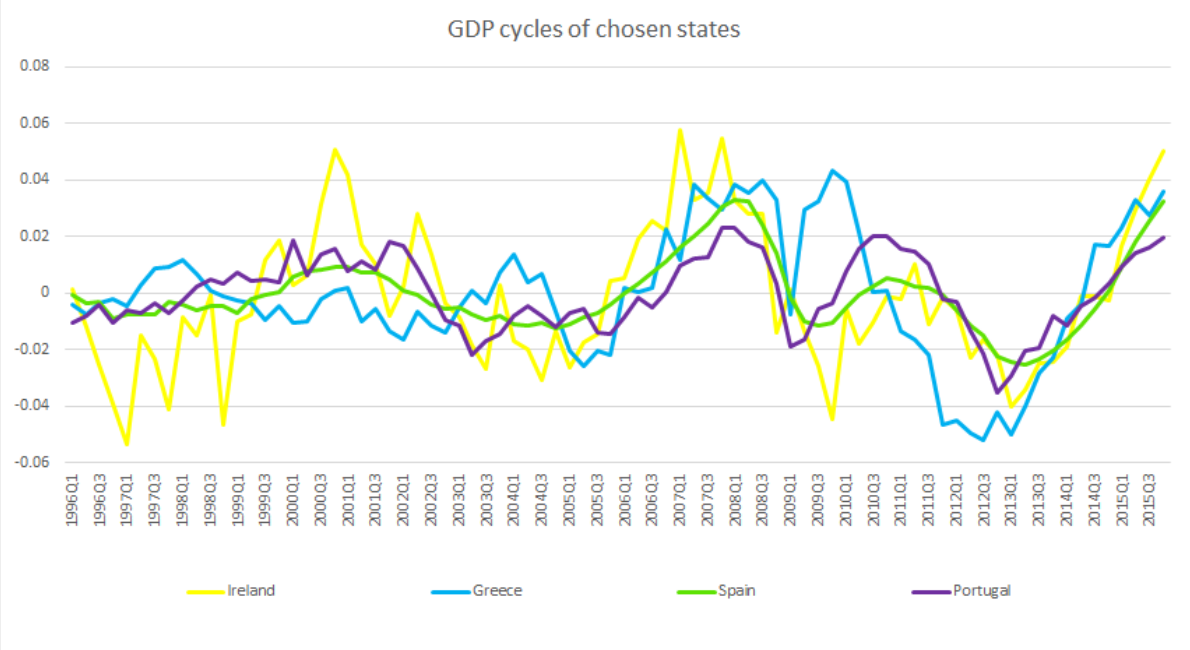
GDP cycles of the core



GDP cycles of chosen north states



GDP cycles of PIGS



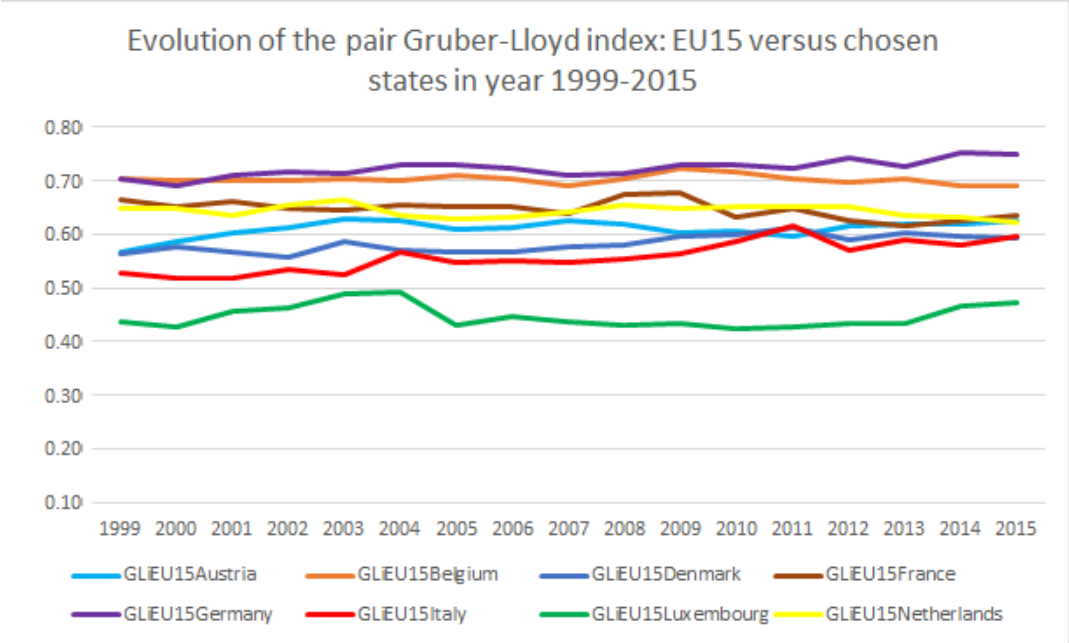
B Correlation matrix of business cycles for period 1996Q1-2015Q4

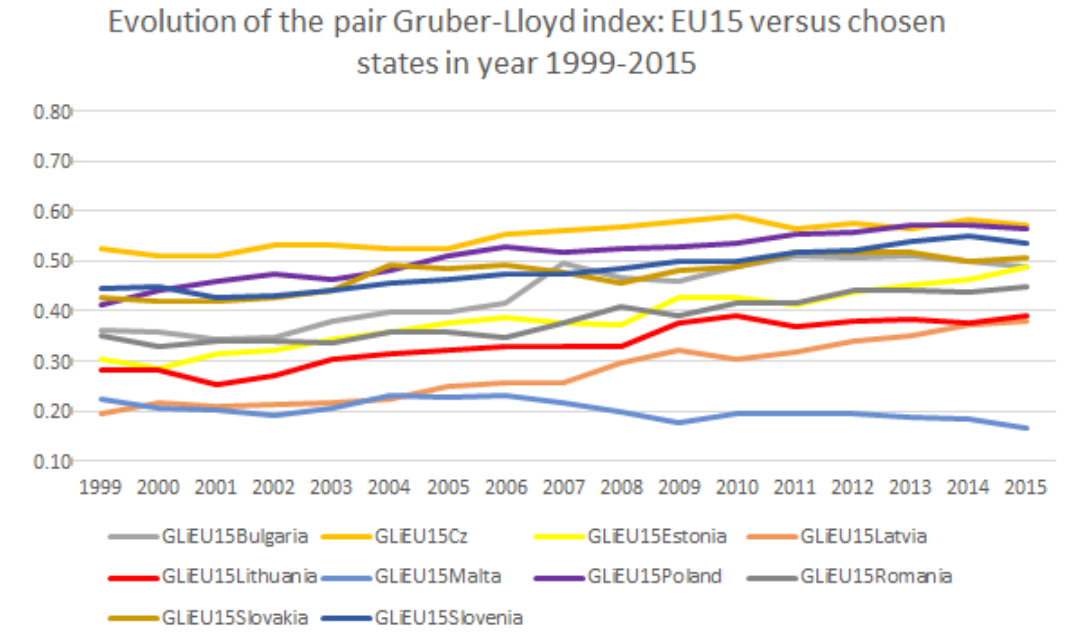
EU28	EU15	EA19	EA18	EA12	Belgium	CZ	Denmark	Germany	Estonia	Ireland	Greece	Spain	France	Italy	
1	-	-	-	-	0.8825	0.8623	0.8726	0.9395	0.74	0.7345	0.247	0.792	0.919	0.937	EU28
	1	-	-	-	0.885	0.8522	0.8736	0.9434	0.7347	0.7364	0.227	0.782	0.927	0.942	EU15
		1	-	-	0.8842	0.8521	0.8531	0.9533	0.6964	0.7401	0.231	0.793	0.923	0.944	EA19
			1	-	0.8848	0.8517	0.8526	0.9529	0.6931	0.7415	0.231	0.794	0.923	0.945	EA18
				1	0.8858	0.8489	0.8511	0.9526	0.6868	0.7436	0.228	0.792	0.924	0.947	EA12
					1	0.7066	0.7987	0.8115	0.6013	0.6367	0.153	0.649	0.859	0.862	Belgium
						1	0.8028	0.7523	0.6386	0.6727	0.372	0.848	0.707	0.814	CZ
							1	0.8052	0.7331	0.6391	0.096	0.634	0.827	0.794	Denmark
								1	0.7252	0.5912	0.046	0.62	0.884	0.882	Germany
									1	0.393	0.034	0.392	0.644	0.659	Estonia
										1	0.372	0.799	0.687	0.706	Ireland
											1	0.607	0.002	0.181	Greece
												1	0.607	0.743	Spain
													1	0.863	France
														1	Italy

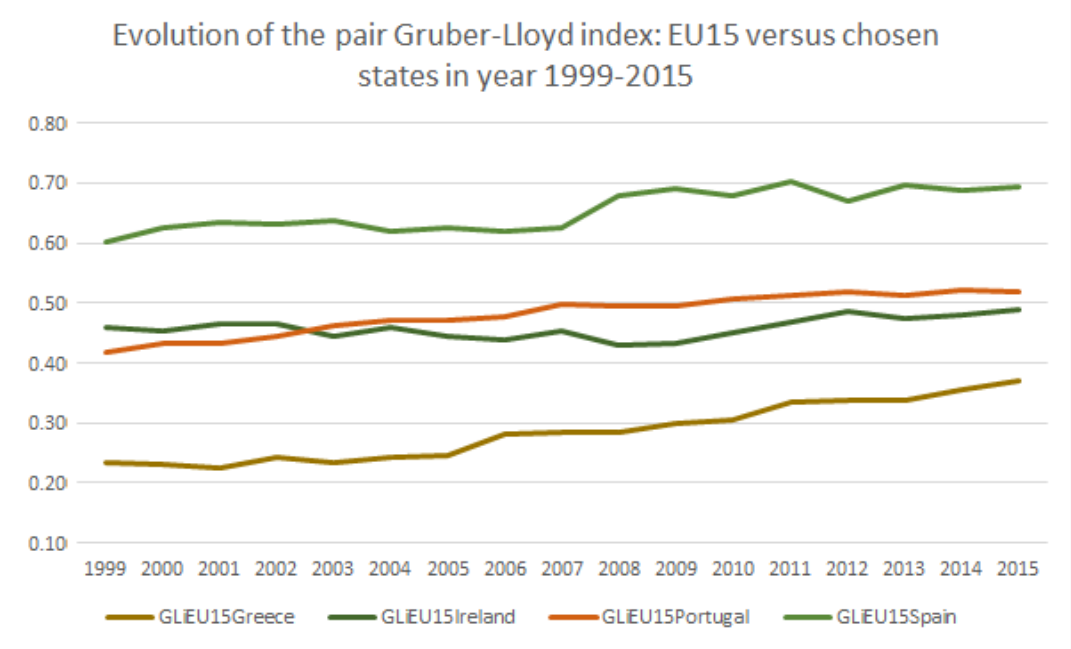
Cyprus	Latvia	Lithuania	Hungary	Netherl.	Austria	Portugal	Romania	Slovenia	
0.58	0.694	0.6534	0.7827	0.8825	0.9128	0.6325	0.4629	0.88	EU28
0.575	0.6816	0.6378	0.7766	0.8803	0.915	0.6326	0.4384	0.8662	EU15
0.618	0.6434	0.6024	0.7346	0.9057	0.917	0.6653	0.4297	0.8719	EA19
0.62	0.6394	0.5973	0.7327	0.9064	0.9164	0.668	0.4267	0.8707	EA18
0.622	0.6307	0.5875	0.7293	0.9065	0.916	0.6711	0.4191	0.8661	EA12
0.542	0.5158	0.4546	0.647	0.8001	0.8548	0.6125	0.259	0.7551	Belgium
0.595	0.6175	0.5598	0.7314	0.7552	0.7096	0.5736	0.6553	0.8572	CZ
0.426	0.6722	0.5672	0.7402	0.7597	0.8003	0.5014	0.3653	0.734	Denmark
0.517	0.6322	0.6138	0.6317	0.8249	0.8971	0.529	0.3858	0.783	Germany
0.134	0.8942	0.8562	0.7045	0.4777	0.6965	0.0987	0.429	0.6249	Estonia
0.585	0.4362	0.2727	0.6178	0.7351	0.6267	0.6128	0.2235	0.6743	Ireland
0.139	0.1838	0.1971	0.3433	0.2914	0.0434	0.4893	0.4933	0.4912	Greece
0.725	0.4639	0.3994	0.6705	0.8139	0.607	0.7833	0.5133	0.8728	Spain
0.545	0.5839	0.5252	0.667	0.821	0.9287	0.5258	0.2555	0.6825	France
0.594	0.5225	0.5043	0.719	0.7943	0.8353	0.6322	0.3294	0.7734	Italy
1	0.154	0.1415	0.2855	0.6827	0.5214	0.6083	0.1988	0.5682	Cyprus
	1	0.8814	0.7007	0.5138	0.657	0.1111	0.5005	0.6689	Latvia
		1	0.686	0.4399	0.5998	0.1143	0.5749	0.6641	Lithuania
			1	0.5973	0.6485	0.4423	0.5072	0.7438	Hungary
				1	0.8433	0.7452	0.3178	0.8375	Netherlands
					1	0.4902	0.3164	0.7534	Austria
						1	0.1971	0.6726	Portugal
							1	0.6274	Romania
								1	Slovenia

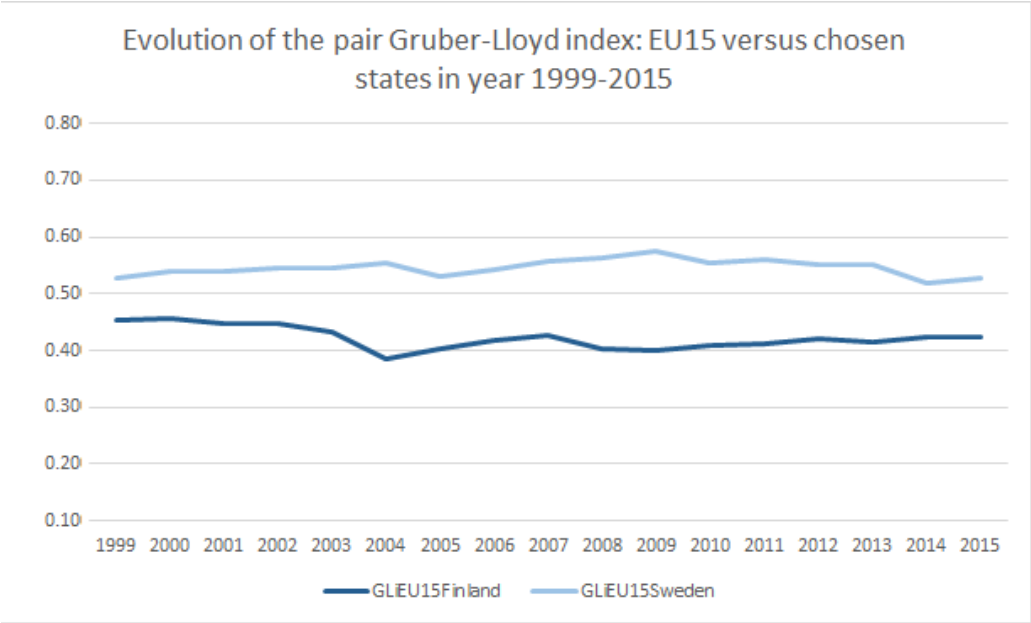
Slovakia	Finland	Sweden	UK	
0.6601	0.919	0.9086	0.8682	EU28
0.6458	0.915	0.9151	0.8659	EU15
0.6474	0.912	0.8943	0.8101	EA19
0.6446	0.911	0.8944	0.8077	EA18
0.6367	0.908	0.8947	0.8037	EA12
0.4434	0.834	0.8456	0.7232	Belgium
0.6287	0.754	0.7436	0.7273	CZ
0.5162	0.797	0.8361	0.7941	Denmark
0.6312	0.882	0.8304	0.7573	Germany
0.5647	0.727	0.6762	0.8264	Estonia
0.3271	0.554	0.6737	0.5808	Ireland
0.391	0.119	0.1125	0.2219	Greece
0.598	0.65	0.6798	0.6133	Spain
0.4992	0.883	0.8805	0.7796	France
0.5246	0.831	0.8947	0.756	Italy
0.391	0.554	0.5451	0.2683	Cyprus
0.6221	0.689	0.5797	0.8119	Latvia
0.745	0.737	0.5489	0.7763	Lithuania
0.5257	0.711	0.7494	0.8431	Hungary
0.5846	0.816	0.7626	0.6275	Netherlands
0.5692	0.876	0.8292	0.7654	Austria
0.4275	0.551	0.5873	0.3475	Portugal
0.6116	0.403	0.2549	0.4968	Romania
0.7527	0.812	0.7332	0.7407	Slovenia
1	0.699	0.5497	0.6021	Slovakia
	1	0.8595	0.7944	Finland
		1	0.8078	Sweden
			1	UK

C Grubel-Lloyd index for chosen countries

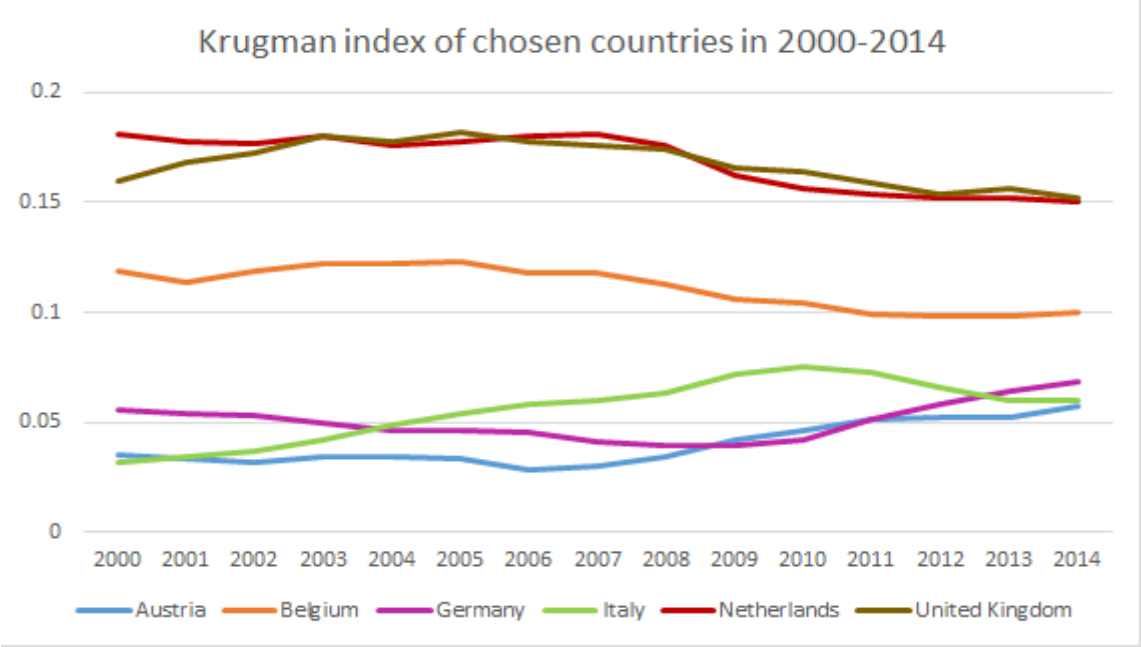


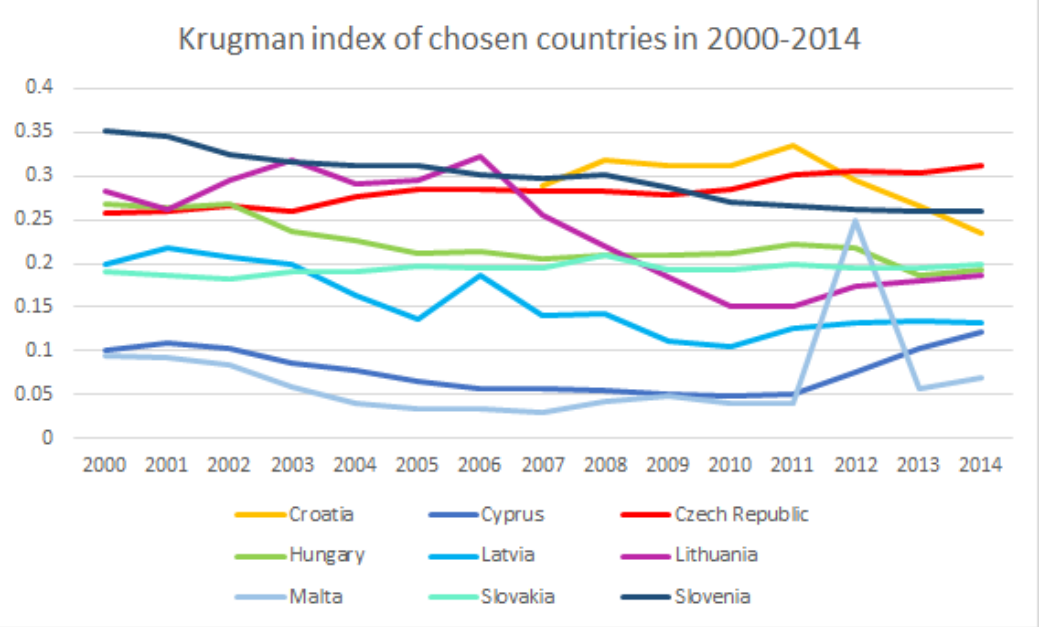


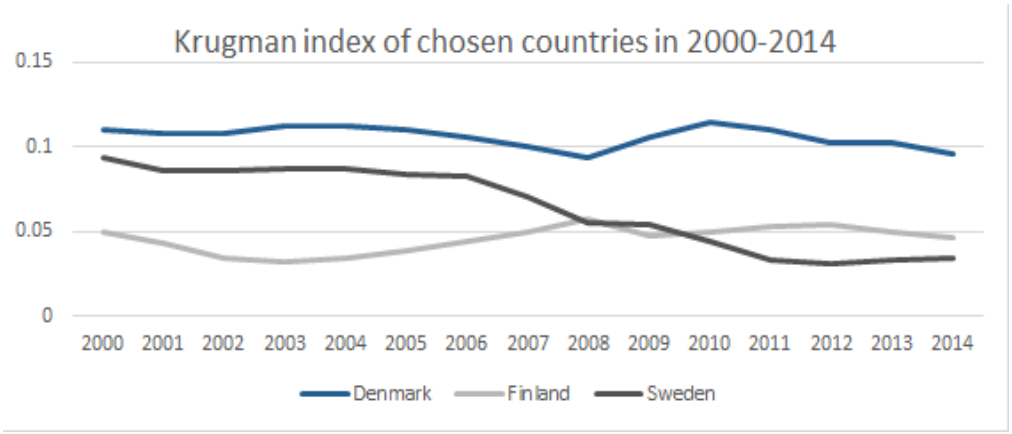

Evolution of the pair Gruber-Lloyd index: EU15 versus chosen states in year 1999-2015
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
GLIEU15Greece
GLIEU15Ireland
GLIEU15Portugal
GLIEU15Spain

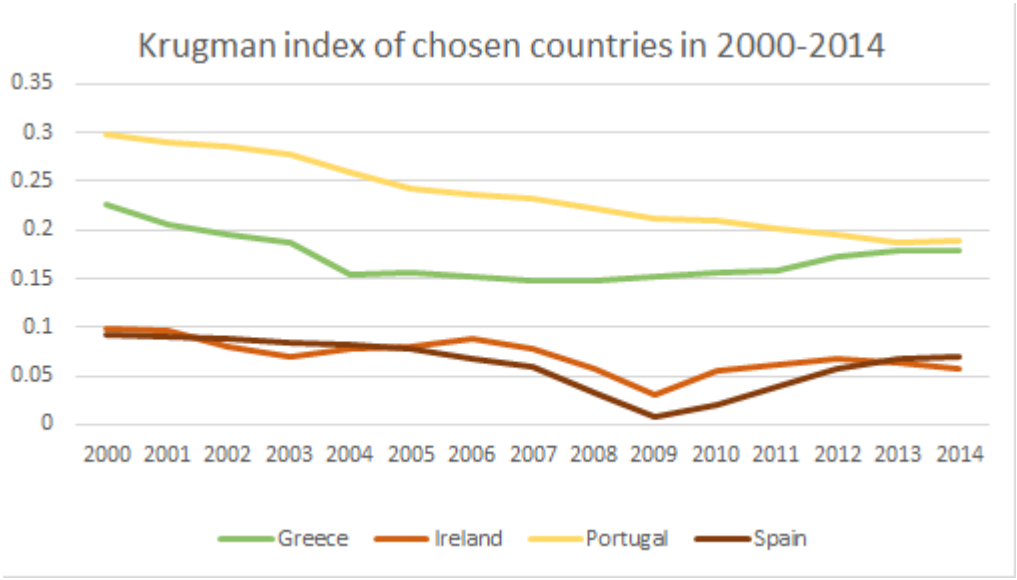

Evolution of the pair Gruber-Lloyd index: EU15 versus chosen states in year 1999-2015
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
GLIEU15Finland
GLIEU15Sweden

D Krugman specialization index for chosen countries

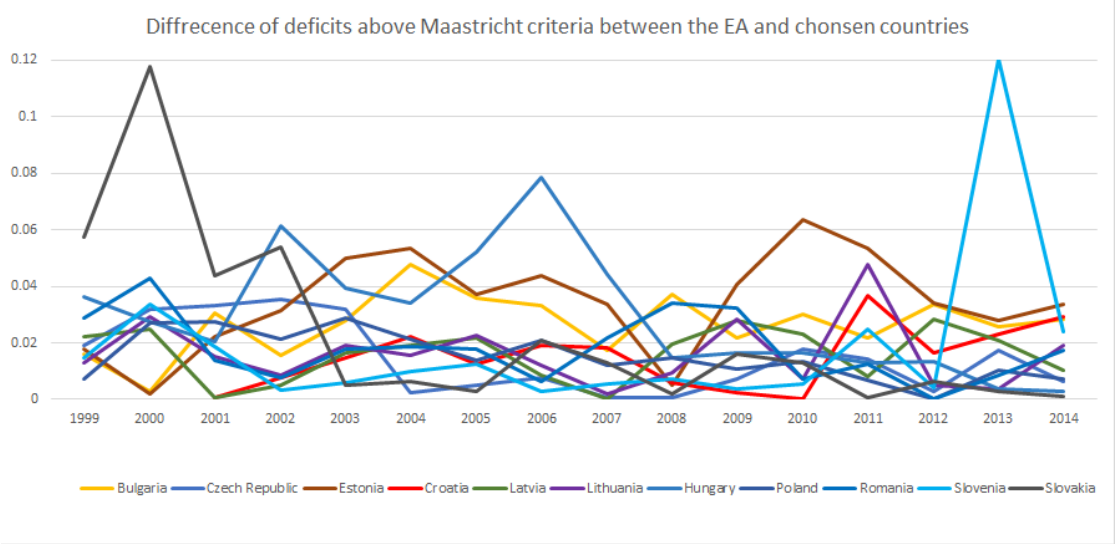


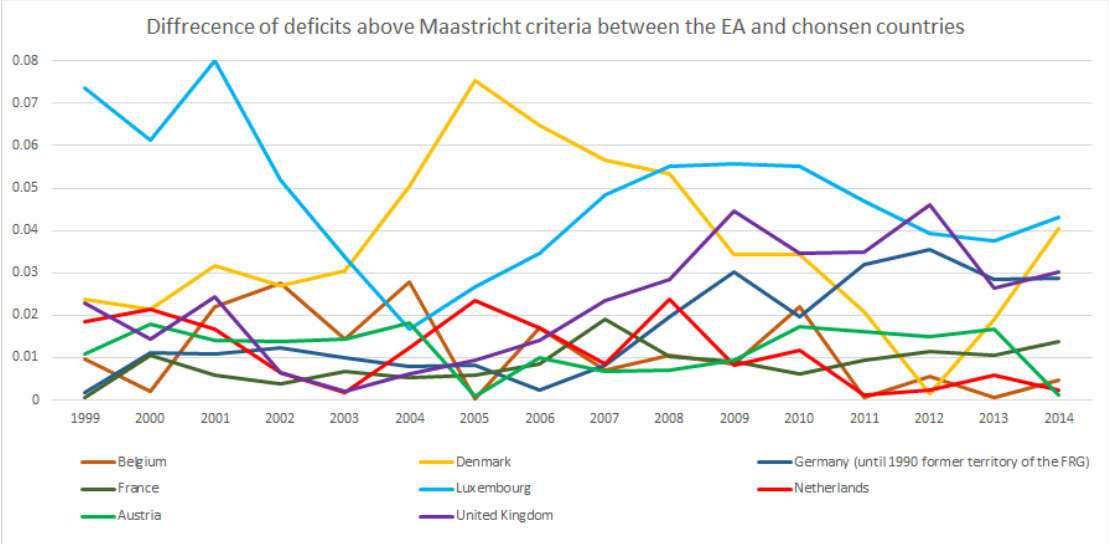


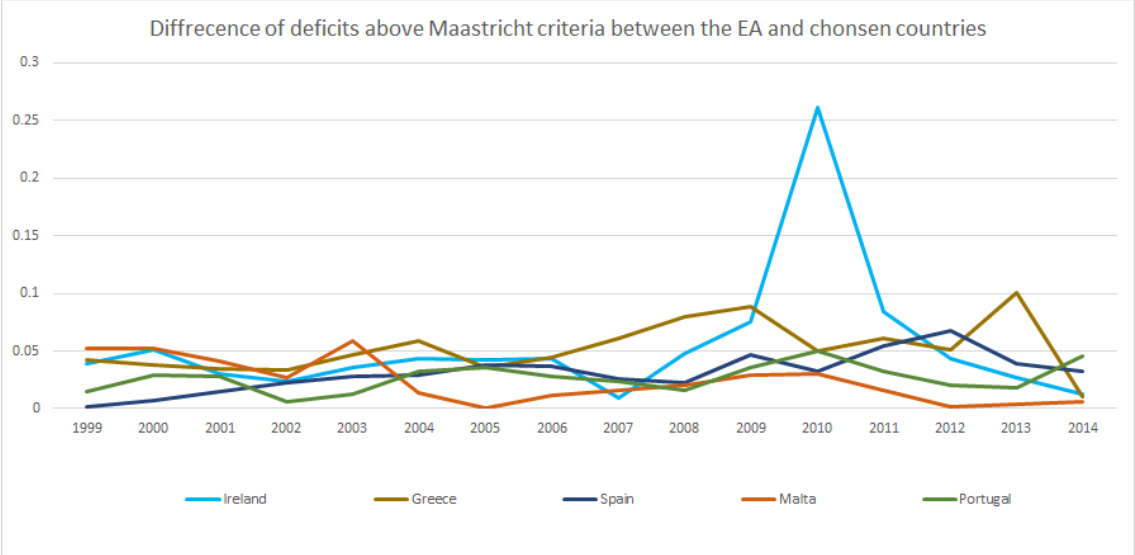

Krugman index of chosen countries in 2000-2014
0.15
0.1
0.05
0
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Denmark
Finland
Sweden

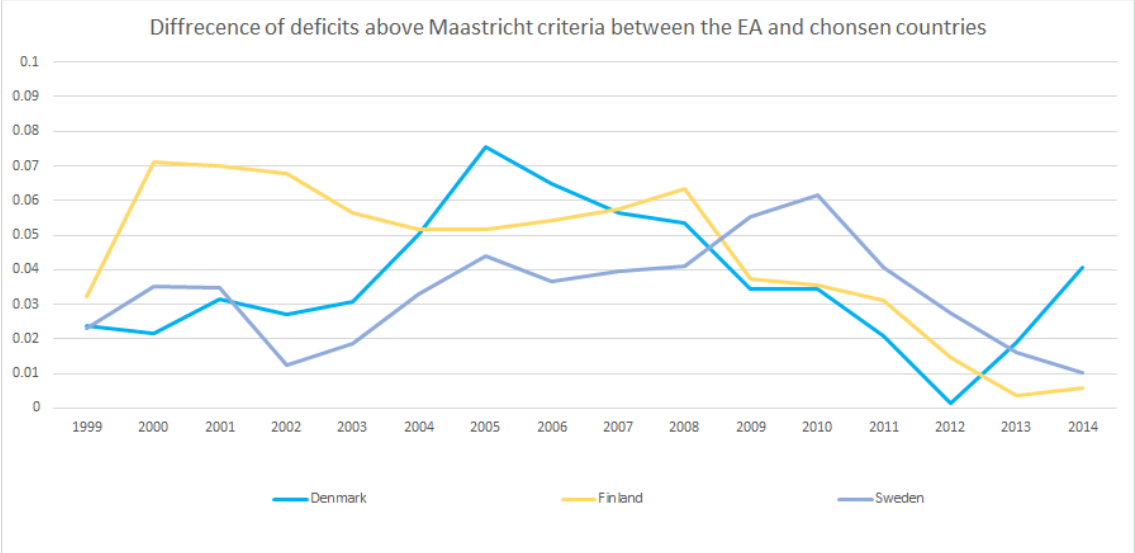

Krugman index of chosen countries in 2000-2014
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Greece
Ireland
Portugal
Spain

E Difference of deficits above Maastricht criteria between the EA and chosen countries






Diffrecence of deficits above Maastricht criteria between the EA and chonsen countries
0.3
0.25
0.2
0.15
0.1
0.05
0
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Ireland
Greece
Spain
Malta
Portugal


Diffrecence of deficits above Maastricht criteria between the EA and chonsen countries
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Denmark
Finland
Sweden