CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Economics and Management

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Diploma Thesis

European Monetary Union: Optimum Currency Area Index

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CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

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DIPLOMA THESIS ASSIGNMENT

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Economics and Management

Thesis title

European Monetary Union: Optimum Currency Area Index

Objectives of thesis

The aim of this diploma thesis is to evaluate whether the European Monetary Union is the Optimum Currency Area (OCA). This thesis examines essential conditions that are given by the OCA theory, as it has developed since. This paper seeks to evaluate key parameters of OCA after a thorough examination of economic data and political evidence. At the end of this thesis I will state wheter the European Monetary Union is currently operating as an Optimum Currency Area.

Methodology

The research depends on available theoretical and empirical sources supplemented by the author's analyses. It attempts to reach accurate knowledge of the components of the researched problem by scientific method and analysis of the data and facts related on this research.

The proposed extent of the thesis

60 – 80 pages

Keywords

european monetary union, single currency, optimum currency area, european union, market integration

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Recommended information sources

De Grauwe, P. (1997): The Economics of Monetary Integration, Oxford University Press, 3rd edition
McKinnon, R. I. (1963): Optimum Currency Areas, The American Economic Review, Vol. 53.
Mundell, R. A. (1961): A Theory of Optimum Currency Areas, The American Economic Review, Vol. 51

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Prague on 29. 03. 2016

Declaration

I declare that I have worked on my diploma thesis titled "European Monetary Union: Optimum Currency Area Index" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the diploma thesis, I declare that the thesis does not break copyrights of any their person.

In Prague on March 2016 _____

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Evropská Měnová Unie: Index Optimální Měnové Oblasti

Souhrn

Hlavním cílem této diplomové práce je porovnat a vyhodnotit vybrané států Eurzóny pomocí indexu optimální měnové oblasti (OCA index). Teorie optimálních měnových zón (OCA) slouží jako vodítko při analýze vybraných zemí Eurozóny. Práce se pokouší o výpočet indexu OCA a alternativní výpočet OCA pro Rakousko, Belgii, Kypr, Německo, Estonsko, Španělsko, Finsko, Francii, Řecko, Irsko, Itálii, Lucembursko, Maltu, Nizozemsko, Portugalsko, Slovinsko, a Slovensko. Výsledky ukazují, že OCA index do jisté míry vysvětluje variabilitu směnných kurzů. V závěru této diplomové docházím k závěru, žepráce konstrukce indexu OCA vhodným pro současné ekonomické prostředí, tudíř ho nepovažuji za vhodné měřítko (v jeho původní formě), aby posoudil, zda je země je vhodným kandidátem pro měnovou unii.

Klíčová slova: Evropská monetární unie, Teorie optimální měnové oblasti, Index OCA, Kritéria OCA, Eurozóna

European Monetary Union: Optimum Currency Area Index

Summary

The goal of this diploma thesis is to compare and evaluate Euro area member states using the optimum currency area index (OCA index). Optimum currency area (OCA) theory serves as a guideline when analysing the selected Euro area countries. The thesis attempts to calculate the OCA index and the alternative OCA calculation for Austria, Belgium, Cyprus, Germany, Estonia, Spain, Finland, France, Greece, Ireland, Italy, Luxembourg, Malta, the Netherlands, Portugal, Slovenia, and Slovakia. The results indicate that the traditional OCA index to a certain extent explains exchange rate variability. It concludes that the design of the OCA index is not considered adequate for the current economic environment, and we do not consider it an appropriate benchmark (in its original form) to determine if the country is suitable to become a member of the monetary union.

Keywords: European Monetary Union, Optimal Currency Area Theory, OCA Index, OCA Criteria, Euro area

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List of abbreviations

ECB	European Central Bank
EMU	European and Monetary Union
ERM	European Exchange Rate Mechanism
EU	European Union
GDP	Gross Domestic Product
GL	Grubell Loyd Index
IMF	International Monetary Fund
OCA	Optimum Currency Are
SITC	Standard International Trade Classification
SL	Landesmann structural coefficient

1 Introduction

Criteria set by the European Union (EU) for assessing a country's readiness to become a fully-fledged member of the European monetary union (EMU) are known as the Maastricht convergence criteria. Membership in the EMU implies the commitment to the future adoption of Euro as a single currency. The main benefits from the single currency adoption result in the elimination of transaction costs, exchange rate risks, intensification of competition, and production pressure. The loss of national monetary policy and the associated potential losses in economic performance are considered possible costs of the membership. The economic profitability from the monetary union membership can be assessed as costs and benefits analysis. Quantification and comparison of costs and benefits associated with the adoption of the single currency is a very complex task. The optimum currency area theory is used to assess the appropriateness of single currency adoption, and according to its conclusions, the more individual OCA criteria fulfilled, the more the countries profit from their membership. Contemporary literature addresses a number of the OCA criteria that attempt to examine economic integration. The three main OCA criteria are: Mundell's (1961) labour mobility criterion, McKinnon's (1963) criterion of economic openness, and Kenen's (1969) production diversification criterion. Previously mentioned criteria are often accompanied by business cycle synchronisation. The common monetary policy is a suitable instrument for the stabilization of all monetary union member countries, and thus, the membership does not impose specific requirements for national fiscal policy. Bayoumi and Eichengreen (1997) constructed the optimal currency area index (hereafter referred to as the OCA index), which according to them is able to assess if a country is suitable to access the monetary union.

2 Objectives and Methodology

The main goal of this diploma thesis is to evaluate the level of selected countries that have already adopted Euro as a common currency using the OCA index. The results will explore if the original division into groups (core, converging, or diverging economies) and assumptions regarding them were actually correct (Bayoumi & Eichengreen, 1997). This thesis will assess the applicability of the original equation on the selected period of 2005 to 2014. This study will use the originally designed equation with previously estimated regression coefficients (Bayoumi & Eichengreen, 1997) to construct the OCA index with application on current data. The use of these estimated regression coefficients may be subject to criticism because of the period of 1983 to 1992 in which were the coefficients estimated. As a result, the second goal of this thesis is to work with calculations of the OCA index through an alternative methodology (hereafter referred to only as the alternative OCA calculation). The OCA index and the alternative OCA calculation will be both calculated in relation to the Euro area. In this respect, the study employs the OCA index criteria such as business cycle synchronisation, dissimilarity of export commodity structure, trade intensity, and economic size. The alternative OCA calculation investigates economic openness, intensity of intra-industrial trade, business cycle synchronisation, and similarity of export commodity structure.

The countries that are the subject to the analysis are Euro area member states that have been using the Euro as a currency for more than four years. These are Austria, Belgium, Cyprus, Germany, Estonia, Spain, Finland, France, Greece, Ireland, Italy, Luxembourg, Malta, the Netherlands, Portugal, Slovenia, and Slovakia. In addition to assessing the development of the indicators in terms of time, both the OCA index and OCA alternative calculation are processed by a linear time trend. The method for this index estimation is a regression analysis which is estimated with the usage of panel data. Some of the gathered data had to be seasonally adjusted with the statistical programme NumXL that uses a Hodrick-Prescott filter. The linear time trends and panel data were analysed in GRETL at the 5% level of significance, and the dynamic cluster analysis was processed in SPSS statistical software and edited using MS Office Excel. The data necessary to estimate the regression equation are obtained from the databases of Eurostat, Comext, and National Accounts Main Aggregates Database.

3 Literature review

The first part of the literature review will focus on the very foundation of the OCA theory, which greatly contributed to the determination of next steps towards deeper European integration. This was the basic idea of countries functioning in the monetary union, as defined in the article of Professor Robert Mundell (2011). Following focal points of the literature review will be the development of the OCA theory, and the OCA criteria (properties/characteristics) that a country should fulfil to ensure greater benefits from the integration.

3.1 Optimum currency area theory

It would be useful to recall some important concepts such as the regime of floating and fixed exchange rates before describing the actual OCA theory. Convertible currencies can operate in two basic exchange rates, and those are floating rate (floating, clean / independent / free floating) and fixed rate (fixed) (Neumann, Žamberský, Jiránková, 2010). There are various modifications (e.g., managed floating exchange rate regime (managed floating), crawling peg (De Grauwe, 2012), and currency board (Jones, 2001)) which belong among the fixed exchange rate regimes. A common regime of floating exchange rates does not distinguish between central parity or oscillation bands. The central bank relinquishes the right to intervene in the case of pure floating exchange rates. Therefore, the exchange rate is purely a result of a collision between supply and demand in the foreign exchange market. The central bank does not intervene in the foreign exchange market at all, and usually, it does not even hold foreign reserves. Managed floating allows the central bank to intervene if considered necessary. When the domestic currency appreciates too fast, the central bank might weaken it with the purchase of foreign currency for domestic currency and vice versa. The domestic currency is linked to another currency, basket of currencies, or supranational currency in the case of the fixed exchange rate regime. These courses are characterized by the existence of the central parity and oscillation bands within which the currency can move. If there is deviation from the fixed currency band, the central bank must intervene to keep the currency within the band. Flexible rates based on the exchange rate changes (appreciation, depreciation, revaluation, devaluation) allow changes in real exchange rates

between countries. The exchange rate channel is one of the major compensatory mechanisms in case of shock or external imbalances. Fixed rates do not allow these changes. Mongelli (2002) discusses the OCA as a single currency area, or several currencies, whose exchange rate is irrevocably fixed and can be conflated. This unified currency or fixed rate can only move uniformly against other countries outside the European Union. Optimum monetary area is a given number of countries that have chosen to take over the single currency and irrevocably fix its currency. The author understands the optimality of the territory in sharing some of the OCA criteria, whose origins can be attributed to the authors Mundell (1961), McKinnon (1963), and Kenen (1969, in Dellas, Tavlas, 2004). Sharing these OCA properties reduces the utility of the nominal exchange rate between the members of the currency area. Therefore, the OCA properties maintain internal and external balance and help insulate countries from some types of shocks. The OCA criteria include mobility of production factors, flexibility of wages and prices, economic openness, diversification of production and consumption, inflation, fiscal and political integration, and others. The following section will focus on the development of the OCA theory, which will be divided according to Rozmahel (2006).

3.1.1 "Early phase": from the early 1960s to the early 1970s

The beginnings of monetary integration date back to the early 1960s of the twentieth century. This period was characterized by the collapse of the Bretton Woods system (Jones, 2001). Many economists drew from a negative experience and did not examine the conditions under which a fixed exchange rate could be advantageous (Kučerová, 2005). This issue was indicated by Mundell (1961) when he addressed the issue of fixing the exchange rate as well as progress towards deeper economic and monetary integration. The issue discussed what a country should fulfil in order to become a member in the monetary union with fixed exchange rates. Mongelli (2002) adds that the OCA theory originated precisely from disputes between advocates of fixed and floating exchange rates and from a comparison between the US economy and then members of the European Community (EC). As mentioned by Cesarano (Dellas, Tavlas, 2001), Mundell with his OCA theory sought to refute Friedman's strong case for floating exchange rates (1953 in Mongelli, 2002). Mundell's original OCA theory (1961) was based on Keynesian assumptions with the ability of fiscal and monetary policy that effectively influence aggregate demand. From this perspective, the author and

many others reasoned that floating exchange rates can automatically ensure stabilization of the domestic economy. As Paul De Grauwe (2012) mentions, Mundell's original approach to the monetary unification was rather pessimistic due to loss of the effective tools. Moreover, he mentions that Mundell in the 1970s modified his approach and his views towards the entry to the monetary union (De Grauwe, 2012). At that time, the typical Keynesian intervention was slowly abandoned in favour of a liberal neoclassical approach. According to Mundell (1961), the entrance to the monetary union might be costly if the country does not have automatic compensation mechanisms in the form of mobility factor, wages, and price flexibility. The original OCA theory has raised several questions and was followed by a number of authors. The original OCA theory has been enriched with new criteria. McKinnon (1963) addresses the degree of economic openness and the impact of currency depreciation on the change in prices within the economy. McKinnon (1963) emphasized the fact that the more open the economy is, the more changes in international tradable goods prices are transferred to the domestic economy (McKinnon, 1963).

Therefore, devaluation of the currency over time leads to a growth in domestic price levels and mitigates the devaluation effect. The domestic central bank responds to the imminent increase in the price level with restrictive monetary policy, which will have a negative impact on output and employment. According to the author, it causes a spill over of exchange rate movements on the domestic price level. The devaluation effect on output and employment is eliminated because of the restrictive monetary policy intervention. Therefore, the exchange rate is less effective in addressing the imbalance of payments. Its use in open economies results in greater variability in prices, but the effects on output are ambiguous. According to Kennen (Dellas, Tavlas, 2001), a highly diversified country is a more suitable candidate for joining the monetary union than a less diversified country. High diversification of export and import reduces the impacts of dangerous negative shocks that are specific to a particular sector. Thus, diversification of production reduces the need for changes in the terms of trade in the exchange rate. Ingram (Rozmahel, 2006) mentions another criterion that can reduce the need for exchange rates. According to Ingram, sufficient financial integration and capital flows act as a protective mechanism in front of temporary shocks. Protection can be achieved through lending capital from countries that have a surplus (i.e., outflow of net foreign assets, which can be returned to their original levels after the shock fades away). The above mentioned criteria are among the first that arose in the context of

strengthening the position of OCA theory. An overview of the OCA theory's characteristics from the early period are mentioned by Mongelli (2002). The "Early phase" of the OCA theory was the first step to open deeper discussions about European monetary integration.

Figure 1: An overview of the OCA theory characteristics from the early period

OCA criteria	Criteria description
Integration of the financial markets	As mentioned by Ingram (1962 in Mongelli, 2002), the financial integration may reduce the need for changes of the nominal exchange rate to compensate the failures in the economy. As a consequence of the high degree of financial markets integration coupled with high capital mobility, that even slight changes in interest rates lead to a significant capital flows, that compensate for the resulting instability. These assumptions reduce the differences in long-term interest rates and increase the availability of financing of external imbalances which contributes to the efficient allocation of resources
Similarity of inflation rates	Fleming (1971 in Mongelli, 2002) draws attention to possible external imbalances that may come from persistent differences of national inflation rates. Inflation differences may be due to various structural development of the economies of different labour market institutions economic policies, and others. If the inflation rates are similar and low among the countries, it results in stable trading conditions. This leads to more balanced development of the current account (balance of payments), so there is no need for balancing through rate mechanisms
Fiscal integration	Sharing a supranational fiscal transfer system according to Kenen (1969 in Mongelli, 2002) permits redistribution of funds to a country that is hit by an asymmetric shock. These transfers help affected countries cope with the impact shock without having to use a tool exchange rate policy
Political union	Without the political will there is no ability to create a fully functioning monetary union. The success of monetary integration is based on the willingness of the participating countries to agree on preferences regarding economic growth, unemployment, inflation, and the ability of policy-makers in implementing transnational macroeconomic policies
Economic openness	McKinnon (1963) criteria of openness talks about lower costs associated with entering the monetary union in relatively open economies. Conversely, the systematic use of macroeconomic policies in the form of a nominal devaluation leads to variability in price levels and ambiguous effects of these tools on the output of the economy

Product diversification	High diversification of production and consumption, according to Kenen (1969 in Mongelli, 2002) reduces the effects of possible shocks affecting specific sectors of the economy. Highly diversified countries are likely to face a much lower cost associated with forgoing the possibility of changes in nominal exchange rates
Mobility of production factors	Mundell (1961) advocates a high factor mobility, which reduces the need for change in the real prices of factors and nominal exchange rate changes in response to the disturbances in the form of the impact of asymmetric shocks. The countries hit by the recession with high unemployment, experience a shift of workers to a country where there is excess demand for labour, and thus leading to a settlement failures and return the economy to its original balance
Wages and prices flexibility	According to Friedman (1953 in Mongelli, 2002) price and wage flexibility among countries that have a common currency, such flexibilities dampen the effects of asymmetric shock in the form of unemployment and inflation one country in the other country

Source: Own processing, Mongelli (2002)

3.1.2 "Reconciliation phase": from the late 1970s

Early phase was enriching regarding the establishment of the OCA criteria that countries should fulfil in order to achieve greater benefits from the membership in the EMU. After mapping all possible criteria, attention has turned to the criticism of some of them (diversification criteria and economic openness). On the other hand, certain criteria appeared to be correct at the time of the formation but later on became disputable. The "Reconciliation phase" is associated with the correction of original ideas and deals with ambiguity of some traditional OCA characteristics. According to Robson (1987 in Mongelli, 2002), the uniformity of the measurement as well as the evaluation and complexity of the comparison criteria are commonly subject to criticism. There are no evaluation scales, and some countries may meet certain criteria more and some of them less. It is difficult to decide on the appropriateness of the monetary unification. Tavlas (1994 in Mongelli, 2002) discusses the problem of ambiguity (problem of inconclusiveness). A country may be open to trade with a certain group of partner countries, and therefore, it might be interested in fixing the exchange rate and entering the monetary union. On the other hand, these countries suffer from low mobility of labour and production factors, which stand against the monetary unification. He highlights the inconclusiveness of certain criteria that might contradict each

other. It is generally more prosperous to adopt a common currency and fixed exchange rate in the case of a small and highly open country. On the contrary, these small economies more likely lack the diversification in production in comparison to the major economies. Rozmahel (2006) mentions that the OCA theory forefront was still very much focused on the criteria of wages and price flexibility. The interest shifted towards analysis of variability of the real exchange rate during the phase of reconciliation. Corden (1972 in Rozmahel, 2006) mentions the reduction of the national implementation of activist economic policy in favour of efforts to establish external balance through changes in the real exchange rate. Countries in the monetary union would lose control over their own monetary policy and exchange rates. Rigid wages and downward shifted prices would be necessary costs to the member states. The real exchange rate is crucial for the monetary union member states. It can moderate the impacts of shocks when the country cannot manipulate the exchange rate. These nominal price and wage flexibility can cause changes in the real exchange rate upon the occurrence of shock. The discussion about the variability of the real exchange rate criterion started in connection to the wages and prices flexibility. We cannot forget the emergence of new criteria such as the similarity of shocks or the business cycle synchronisation. Mongelli (2002) calls this criterion "meta characteristic," which includes the effects of other sub-criteria defined in the early period. Moreover, Rozmahel and Najman (2010) add that in case of long-term business cycle synchronisation, members of the monetary union decrease the risk of asymmetric shocks. If there is a low risk of asymmetric shocks, the need to have its own monetary and exchange rate policy decreases as well. Thus, membership in the monetary union may seem more attractive in terms of lower costs associated with integration. According to De Grauwe (2012), the most important part in this period is the contribution of Professor Mundell (1973). Mundell (1973) admits that his new conclusions differ from his initial approach which was based on Keynesian assumptions. Under these assumptions, the autonomous monetary policy seemed very effective but costly. Thus, the author defended maintaining the flexible exchange rate. He places great importance on the effectiveness of macroeconomic policies in the fight against asymmetric shocks. The author was convinced of the increased risk of asymmetric shocks in the monetary union because of low labour mobility in the Europe. Later, the author changed the assumptions and included the influence of expectations and uncertainty of future foreign

currency fluctuations. In his later article, Mundell (1973) admits that sharing a common currency can help to diversify production and reduce the risk of asymmetric shocks.

McKinnon (2000) points to Mundell's contributions to OCA theory, particularly, international risk-sharing with a high degree of financial integration. Mutual ownership of assets between countries can reduce the impact of asymmetric shocks through sourcing of other countries in the form of income diversification. This leads to a smaller significance of the shock similarities criteria between the member countries because the high financial integration reduces the need to meet this criterion. In a later article, Mundell finally abandons his pessimism on monetary integration. He concludes that the common currency is the most effective way to combat temporary damaging waves of currency speculation. Despite the occurrence of asymmetric shocks, European countries gain more from the common currency than they lose. The common currency could dampen fluctuations caused by shock due to movements of capital.

3.1.3 "Reassessment phase": from the 1980s to the early 1990s

Mongelli (2002) characterized the phase of reconciliation as a period with low interest in the OCA theory and no willingness to move towards the deeper monetary integration. The situation changed in the 1980s of the twentieth century mainly due to economic conditions. Economists and politicians revisited OCA theory. Rozmahel (2006) describes this period as one of monetary instability. The European Monetary System[1] (EMS) was created on the basis of the European exchange rate mechanism (ERM) with the ± 2.5% oscillating band. The ERM system was supposed to contribute to the creation of the monetary stability zone in an unstable currency rate. From the beginning, EMS was subjected to considerable instabilities associated with frequent realignments. However, EMS relatively endured these instabilities. This is derived from the oil crisis (1979-1980)[2] and from the divergent evolution of the main economic variables of the participating economies. There was a convergence towards stabilizing the exchange rate and inflation after compensating the instability in the economies. The strong speculation about the oscillation band of the ERM (1992-1993)

[1] European Monetary System (European Commission, 2010).

[2] The members of the Organization of Arab Petroleum Exporting Countries proclaimed an oil embargo. (Black, Hashizmade, Myles, 2009)

emerged and subsequently caused crisis of the whole system. The outcomes were multiple devaluations of the participating currencies and considerable loss of central banks, which at this time, extensively intervened due to efforts to keep the currency within the oscillating band. These interventions failed to avert the crisis and led to the collapse of the original ERM. This resulted in ± 15% fluctuation band widening and in the emergence of ERM II. The period of monetary uncertainty led to a revisit of the European monetary integration, specifically the OCA. It is necessary to revise some initial views of OCA theory, mainly due to developments in macroeconomic theory. Mongelli (2002) suggests a new perspective on the effectiveness of long-term monetary policy, the question of the credibility of the national authorities, efficiency, exchange rate policy, and institutional differences existing in the labour market.

3.1.3.1 The long term effectiveness of monetary policy

One of the most perceived costs of monetary integration is loss of direct control over national monetary policy (Mongelli, 2002). This loss prevents countries in stabilizing their economic cycles. This cost began to be criticized in compliance with the monetarist expansion of short-run Phillips curve of the natural rate of unemployment and the vertical long-run Phillips curve (i.e., Friedman - Phelps extension) (De Grauwe, 2012). This view rejects the possibility of long-term stabilization of economic cycles through monetary policy. If economic policy-makers continuously reduced unemployment below its natural level, it would only lead to a rise of inflationary expectations, and long-term employment would return to its natural level. The price for irresponsible monetary policy would increase the price level without any impact on output. The Phillips curve was replaced with the natural rate of unemployment (NRU). The policy-makers have to choose the rate of inflation rather than the required unemployment rate and economic activity. Based on the argument above, the costs associated with the loss of direct control of national monetary policies seem low.
Rozmahel (2006) points to the development of market economies in accordance with deflection from the activist monetary policy. Criticism of the "Stop-go policy" began with the arrival of the monetarists led by Milton Friedman. The priority of the developed countries was to focus on the stability of monetary policy with price stability as a main goal. In addition to the above mentioned, inefficiency of monetary policy output associated with variability in price levels and the negative impact of high inflation on halting or slowing economic

growth is emphasized. According to Mongelli (2002), a number of authors demonstrate that the relatively high inflation does not lead to any macroeconomic benefits in terms of unemployment or economic growth in the long-term perspective. On the contrary, high inflation is associated with higher unemployment and lower real per capita income. Previously mentioned conclusions on the, and the long term employment would return to its natural level. The price for irresponsible monetary policy would increase the price level without any impact on output. Phillips curve was replaced with the natural rate of unemployment (NRU). The policy-makers have to choose the rate of inflation rather than the required unemployment rate and economic activity. Based on the argument above, the costs associated with the loss of direct control of national monetary policies seem low.

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3.1.3.2 Credibility of national authorities

The ability of countries or groups of countries to achieve and maintain a low inflation rate is important for evaluation of the costs of monetary integration (De Grauwe, 2012). Some governments tend to violate the commitment to low inflation, which was adopted by the private sector in order to reduce unemployment along the short-run Phillips curve. This policy is effective in the short-term. Respectively, it causes a drop in the unemployment rate

at the price of unexpected increase of inflation. However, economic subjects quickly see through these policy activities. It results in expected growth of inflation. Shifts in the short-run Phillips curve are caused due to increases in inflationary expectations, and the country is trapped in high inflation at the same natural rate of unemployment. Mongelli (2002) states that countries with typical high inflation obtain low inflation credibility and abandon national monetary policies as well as ties to low-inflation countries. To conclude, a similar rate of inflation can be easily achieved within the monetary union; therefore, it is not a criterion for joining the monetary union. This OCA criterion becomes redundant.

3.1.3.3 Effectiveness of exchange rate policy

Mongelli (2002) discusses if the nominal exchange rate is an effective change. If not, costs associated with entry to the monetary union would be considerably reduced. There are two major views on this issue. The first of these views argues that changes in the nominal exchange rate do not support the adjustment process in the case of external imbalances as was assumed in the initial OCA theory. Instead, changes in the exchange rate operate with considerable delay. Rozmahel (2006) further adds that although there are certain changes regarding the foreign exchange rate, they are only temporary. Devaluation will initially support competitiveness of domestic goods because domestic goods will be cheaper in foreign markets. On the contrary, the price of imported goods will increase, and increased nominal wages will be demanded due to a decline in their real income. In the end, this will result in the growth of the aggregate price level which would eliminate the initial support from the country's competitiveness through devaluation. Therefore, effectiveness of monetary policy is strongly influenced by the economic openness. The costs associated with the loss of exchange rate policy in small and open economies seems to be low for a relatively open economy. On the other hand, systematic use of the tools of the exchange rate will lead to greater variability of prices in a small open economy compared to a closed one.

Before it is possible to make definitive conclusions on the effectiveness of the exchange rate policy, the author De Grauwe (2012) draws attention to the phenomenon of cash illusion.[3] A decline in nominal wages would be a result of negative impacts of permanent shock in one country (within the monetary union). This causes a decrease in production costs and an

[3] Collective agreements are clauses under which nominal wages are automatically increased by the consumer price index according Lacina (2007).

increase in production and aggregate supply. Due to higher prices of imported goods, real wages of the affected country decline. Considering existence of money illusion, residents will rather prevent the decrease in nominal wages than decrease in real wages due to higher prices of imported goods. This phenomenon results in the support of devaluation policy due to residents' unfamiliarity with the reality. The negative permanent shock would be less expensive for non-members of the monetary union. There is also the opposite view on the effectiveness of exchange rate policy (Mongelli, 2002). History shows that this policy may even be very effective if it is accompanied by proper fiscal and monetary policy, or more precisely, if it is accompanied by restrictions that restrain the growth of price levels after the devaluation. Devaluation was used as a very effective tool to restore competitiveness in 1980s of the twentieth century in France and Belgium (Lacina, 2007). It should be noted that such a policy will only be effective if it is used only once, and it should not be repeated at regular intervals. If the national authorities succeed in not spinning the inflation spiral due to the devaluation, the exchange rate policy will be a very effective tool for establishing a balance. The costs of application of this policy will be lower than if the country could not use the exchange rate mechanism. All of the above applies given the existence of permanent demand shock (Lacina, 2007). It is more profitable to retain independent monetary and exchange rate policy assuming that the temporary shock hits the countries' monetary union. A joint central bank would fail to effectively respond to different economic cycles of EMU countries. Likewise, it would result in definite paralysation. Not even automatic balancing mechanisms in the form of factor mobility as well as and wage and price flexibility would help in this case.

3.1.3.4 The single currency and labour markets

Disparities in labour market institutions may lead to differences in the development of wages and prices even in the presence of similar shocks (Mongelli, 2002).

Bruno and Sachs (Mongelli, 2002) warned that supply shocks may cause very different macroeconomic impacts in terms of different degrees of centralization of wage negotiations. When the wage negotiations are highly centralized, labour unions are able to account for the inflationary effect of wage growth. The unions are aware that excessive demands on nominal wage growth will exert upward pressure on the price level, which in turn affects the value of real wages. If the nominal wage growth does not occur, the supply shock will be shorter, and

the economic activity will be less influenced. Conversely, countries with highly decentralized wage negotiations tend to result in wage negotiations at the company level. Each labour union advocates the interests of individual companies and believes that nominal wage growth of their industry cannot affect the aggregate price level. This results in the growth of nominal wages.

Regarding countries with a decentralized system of wage negotiations, it is very difficult to achieve wage moderation after impact demand shock (De Grauwe, 2012). This issue can be illustrated with the so-called "stadium effect" analogy. The problem occurs if an individual stands up in order to see better when all the other spectators sit. The dynamic causes all spectators to gradually stand up as well because they cannot see over the standing people. It is easier to get everyone to stand up; however, it is more difficult to get all of them to sit down. When one spectator sits, there is no certainty that others will follow, so the spectator will prefer to stand. Countries that are highly decentralized will suffer from the high cost that is a result of the monetary union integration. The companies will lose competitiveness and will reduce unemployment due to high demands for wage assessment. The “new” OCA theory is particularly critical to the “original” OCA theory from the 1960s. Criticism focused mainly on the new economic views. It included the revision of the short-term Phillips curve, the certain criteria before joining the monetary union, and the trust in authorities abiding by their promises. The development of “new” OCA theory attempts to empirically analyse which country is suitable to become a member of the monetary union. Widely used methods are different econometric analyses that are called “operationalization” of OCA theory.

3.1.4 The “Operationalization phase”: from the 1980s to the current day

Development of various empirical studies concerning multiple OCA criteria were a side effect of the regained interest in the deeper European monetary integration (Mongelli, 2012). Series of econometric analyses were used to answer why a particular group of countries should form the OCA. These analyses led to a deeper understanding of the economic structure of a country as well as its institutions and preferences of economic agents. As Mongelli (2012) states, Europe was a focal point of this investigation. The main reason for this choice was the European integration process, which began in the 1950s of the twentieth century. The author emphasizes the findings of very low price and wage flexibility in Europe (more precisely, about two to three times lower than the mobility of factors of production in

the United States of America (US)). When it comes to the financial integration in Europe, it is lower than in the US, but over time, it leads to its growth. The criterion of the economic openness is relatively good in the majority of European countries. Examining the criterion of economic openness led to one of the most important findings of this phase, which concerns endogeneity criteria of OCA theory. It also showed relatively high diversification of production compared to the evidence of specialization in the US market. Rozmahel (2006) states that in the context of operationalization of OCA theory, two major theoretical approaches have been created. The first dealt with the aforementioned endogeneity characteristics of the OCA theory (Frankel & Rose, 1996). The second approach is concerned with empiric quantification of the results on the subject of the single currency area, particularly the OCA index (Bayoumi & Eichengreen, 1997).

3.2 Construction of OCA index

Bayoumi and Eichengreen (1997) boosted the possibility to evaluate the suitability of the candidate countries to form a monetary union and developed a procedure for applying the outputs of the OCA theory. The authors found that the relationship between the criteria of the OCA and the observed behaviour of exchange rates helps the decision of whether or not to be a member of the EMU. The key to operationalize OCA theory is to analyse the determinants of the nominal exchange rate variability. Variability of real and nominal exchange rates should lead to the choice of exchange rate regime. Therefore, it should contain information based on when it is possible to choose the regime to adopt. The real exchange rate behaviour can inform us about fundamental economic factors. Countries are not obliged to decide only about accepting a specific currency regime, but they should be able to maintain it as well. Bayoumi and Eichegreen (1997) analysed bilateral exchange rates with annual data of 21 industrialized countries. The OCA focuses on the characteristics that give base to a stable exchange rate and subsequently to the monetary unification. According to the authors, the most important criteria are business cycle synchronisation, the trade intensity, financial transaction, labour mobility, and range of compensating mechanisms. The last two criteria are crucial for a regional behaviour within a country. However, in the selected sample above, the mentioned criteria do not play a significant role in terms of how individual countries respond to asymmetric shocks. Therefore, empirical work has focused on capturing the first three factors. Costs and benefits of membership in monetary unions are

according to the OCA and dependent on the fulfilment of the OCA. Bayoumi and Eichengreen (1997) estimated the OCA index for 15 European countries for the selected period of 1987-1995. They divided the countries into groups based on the results: the core, converging economies, and diverging economies.[4] At that time, countries used national currencies and were part of the ERM.[5] Because the Monetary Union did not exist at that time, they calculated the OCA index in relation to Germany

The equation for calculating the OCA index has the following form:

$$SD(eij) = -0.09 + 1.46SD(\Delta yi - \Delta yj) + 0.022DISSIMij + -0.054TRADEij + 0.012SIZEij$$

Where *SD* (e_{ij}) stands for standard deviation of change in the logarithm of the nominal exchange rate of countries *i* and j at the end of the year.
SD (Δy_i-Δy_j) is the standard deviation of the difference in the logarithm of a relative change in output in the country *i* and *j* and indicates the degree of alignment of economic cycles of assessed economies. Countries with low values have a symmetrical economic cycles; thus, their national outputs move together. $DISSIM_{ij}$ is the sum of absolute differences in the share of agriculture, mining, and industry of countries *i* and *j* in the total reciprocal exports and affects the structural similarity of the economies. Shocks are more symmetrical in countries that have a comparative advantage in the same industry exports. According to Rozmahel (2006), absolute values of this indicator have no importance. It is important to follow this indicator in time; it may provide clues about convergence between the two countries. The weakness of these indicators is that there is no possible differentiation between intra and inter-industry trade. Growth of inter-industry trade may draw attention to the undesirable specialization in the area of tradable goods. On the contrary, the growth of intra-industry trade represents an increased convergence between the examined countries or region. $TRADE_{ij}$ is the average share of trade between countries *i* and *j* in the GDP and represents

[4] They identified Belgium, Austria, the Netherlands, Switzerland, and Norway as the core countries; the converging countries as Sweden, Italy, Greece, Portugal, and Spain; and the diverging countries as France, Finland, Great Britain, Denmark, and Norway (Bayoumi, Eichengreen, 1997).

[5] The European exchange rate mechanism (ERM) was a system introduced by the European Community in 1979. (Actionforex.com, n.d.)

the benefits and costs of adopting the single currency resulting from the trade interconnection between economies. Rozmahel (2006) states that the different orientation EMU member states' foreign trade may result in rising risk of asymmetric shocks. $SIZE_j$ is the arithmetic average of the GDP logarithms of a country $_i$ and $_j$ expressed in US dollars and represents the benefits of adopting the single currency in terms of the size of the economy. The transaction benefits from the use of the single currency are greater in small economies, and the revenues can thus exceed the cost of membership in the monetary union. The lower the absolute value of the OCA index becomes, the more that economy is structurally similar to the compared region and the more suitable is the creation of the monetary union. Rozmahel (2006) states that the investigated OCA index expresses the dependent variable of the estimated regression equation. Estimation of parameters for the equation was created on the sample of data from the selected period of 1983 to 1992. Another disadvantage is that this particular sample data includes data from non-European countries such as the US, Australia, Japan, Canada, and New Zealand, which may appear misleading when using the OCA index for the assessment of European monetary integration.

3.2.1 Bilateral exchange rate volatility

The variable $SD(e_{ij})$ is the label for the result of the OCA index. Its value will correspond to the input variables, which are part of the OCA index. Results can range from 0-1. The lower the value, the more the country fulfils the OCA criteria included in the equation. Therefore, a country's membership yields more benefits over costs. EUROSTAT and COMEXT are used as sources of data for calculating this indicator. The Bilateral exchange rate volatility is computed as follows:

$$SD(eij) = SD\,\Delta(log\ eij)$$

3.2.2 Business cycle synchronisation

Variable $SD\ (\Delta y_i - \Delta y_j)$ stands for the standard deviation of differences in the logarithm of the relative change in output of the selected countries or region. This indicator attempts to capture the business cycle synchronisation. The growth of the business cycle synchronisation between the countries and region decreases the risk of asymmetric shocks. The EMU central authority has little room for dealing with the presence of asymmetric shocks. The percentage

change in real output can be expressed as the natural logarithm of the share of GDP in this period to GDP in the previous period. The standard deviation expresses the degree of variability of these changes in the GDP. Differences in natural logarithms reflect changes in the GDP variation between countries. The more a country aligns its economic cycle, the more the value of this indicator approaches 0.

$$SD\ (\Delta yi - \Delta yj)$$

3.2.3 Dissimilarity of export commodity structure

Variable $DISSIM_{ij}$ measures similar economic structure in the country depending on the country's share of total exports of commodities. It is calculated as the sum of the absolute values of differences in the proportion of bilateral exports of the agriculture, mining, and industry areas of countries *i* and *j* of the total exports. If the differences in traded commodities vary, the structural similarity of the country differs too. Contrarily, there is smaller probability of the impact of asymmetric shocks if the commodity structure is similar. The variable is calculated as follows:

$$DISSIMij\ =\ [(\left|\ Ait - Ajt\ \right|) + (\left|\ Bit - Bjt\ \right|) + (\left|\ Cit - Cjt\ \right|)]$$

Where variables A_{it} and A_{jt} represent the share of agricultural trade in total merchandise trade of countries *i* and *j* at time *t*. B_{it} and B_{jt} represent the share of mining trade in total merchandise trade of countries *i* and *j* at time *t*, and variables C_{it} and C_{jt} are the shares of industrial trade in total merchandise of countries *i* and *j* at time *t*. Bayoumi and Eichengreen (1997) include categories such as food, live animals, beverages and tobacco, and animal and vegetable fats to the agricultural sector. The mining sector is represented by raw materials and minerals with the exception of fuels. The basic industries, chemicals, machinery, transport equipment, manufactured goods, and other goods are included in the industrial trade. The absolute value of the variable does not have large significance; it is only important to its development in time. With the decline in the value of this variable, structural similarity of the economies increases.

3.2.4 Trade intensity

TRADE measures bilateral trade interdependence between selected countries or groups of countries. Higher values are a greater indicator of trade connections between both samples. The higher the level of trade interdependence, the lower the benefits of an autonomous monetary policy. In general, it is recommended that the countries with high openness become members of the monetary union. Expected growth in business orientation after joining the monetary union can contribute to significant business cycle synchronisation. The important observation will be the development of this indicator over time, which may show an emerging trend that suggests an ongoing convergence of countries in the monetary union. It is important to account for the size of the country when it comes to the bilateral exports. Therefore, $TRADE_{ij}$ is measured as the mean of the ratio of the bilateral exports to the domestic GDP for two countries. $TRADE_{ij}$ variables are used in the formula:

$$TRADEij = ((exij/GDPi + exji/GDPj) / 2)$$

3.2.5 Economic size

The SIZE variable represents the benefits of the single currency. The smaller the country, the greater the benefits of monetary union membership because the national currency in comparison to the single currency loses its significance. According to Bayoumi and Eichengreen (1997), it is appropriate to measure this variable as the arithmetical average of the logarithm of the GDPs of each country, expressed in dollars. It is more suitable to measure the index in euros for our purpose. The greater the average size of GDP, the larger the relative size of the economy and the greater is the importance of the national currency in contrast to a common currency. Conversely, the lower the value obtained, the smaller the economy and the greater the benefits of the common currency.

$$SIZEij = (ln\ GDPi + ln\ GDPj) /2$$

The development of this variable cannot be evaluated in the convergence process of monetary integration in Europe. This variable testifies to the convenience of using a single currency in contrast to the national currency.

Table 1 represents the number of concrete results from the study of Bayoumi and Eichengreen (1997). The OCA index is computed in relation to Germany as the strongest European economy, towards which should the other members of the monetary union converge. According to the results, the authors divide the country into several groups according to whether or not it is to their advantage to create a monetary union with Germany.

Table 1: The OCA index in relation to Germany

Country/Year	1987	1991	1995
France	0.068	0.067	0.074
Italy	0.070	0.065	0.059
Great Britain	0.099	0.094	0.089
Austria	0.008	-0.004	0.008
Belgium	0.003	-0.008	0.013
Denmark	0.063	0.060	0.074
Finland	0.098	0.095	0.087
Greece	0.053	0.054	0.054
Ireland	0.043	0.036	0.021
Netherlands	0.003	-0.008	0.007
Norway	0.078	0.078	0.077
Portugal	0.068	0.066	0.062
Spain	0.088	0.082	0.073
Sweden	0.068	0.063	0.056
Switzerland	0.038	0.030	0.023

Source: Bayoumi and Eichengreen (1997)

The results from Table 1 (Bayoumi & Eichengreen, 1997) indicate prognosis of the dependent variable in comparison to Germany for the selected period of 1987 to 1995. The year 1995 reflects the current state of the OCA index, while 1991 indicates a trend direction over time. Countries are divided into three groups: the major candidates forming the core of EMU with very good index values, the countries whose index shows little convergence and does not drop that much during the selected period, and the countries converging to the EMU with decreasing index values.

The core group of countries include Austria, Belgium, and the Netherlands that are later joined by Ireland and Switzerland. All of these countries have indices below 0.025 in 1995. The United Kingdom, Denmark, Finland, Norway, and France belong to the second group that is characterized by the slow pace of convergence. The standard deviation forecast of the exchange rate for the second group in 1995 reaches high values (higher than 0.07) and then shows little tendency to decrease. These results suggest structural reasons for the decision made by Great Britain and Denmark to apply for permanent exemption, so-called "Opt - out"[6] from the EMU membership. According to the authors, the most significant result is France's position in the group of countries for which there is little evidence of convergence. This probably reflects the nature of the political will over macroeconomic arguments for the EMU integration. The last group of countries is gradually converging Sweden and the southern EU countries: Italy, Greece, Portugal, and Spain. The OCA indices for the third group are decreasing over time. Their values are averaged at around 0.06 in 1995. Spain has the highest value of 0.072. which is not so different from the other countries that did not converge towards the EMU. More important than the results of the individual OCA indices are variables entering the regression equation due to the instability of the regression equation with respect to the input data (Rozmahel, 2006). Variables represent structural similarity and suitability of economies to form a monetary union with regard to the probability of asymmetric shocks. The possibility to measure the suitability of introducing a common currency through the OCA index became very popular. For example, the authors Cincibuch and Vavra (2001) calculated the OCA index for the Czech Republic in relation to Germany in the time periods of 1991-1994, 1995-1998, and 1993-1998. The mentioned authors show that the Czech Republic achieved a high degree of structural convergence with Germany compared to Portugal and Greece during the 1990s according to Bayoumi and Eichengreen (1997). As mentioned above, the problem with this analysis is that equation assumes stability over time. Another problem arises from the fact that there are several non-industrial economies in the original sample data of 1999 to 2009 and is divided into several time slots. The OCA index results in relation to the Euro area can be seen in Table 2. According to Hedija (2011), the Czech Republic has the lowest results of the OCA index in relation to the

[6] The request for a permanent derogation from the EU law. Specifically, the introduction of the euro in Denmark and the UK will not proceed according to the Maastricht criteria, but on the basis of their requirement (CNB, 2003-2015*)*

Euro area. Values of the above mentioned countries are comparable with Austria and the Netherlands. The least suitable candidates for joining the monetary union are the Baltic countries: Lithuania, Latvia, and Estonia.[7]

Table 2: The OCA Index for EU 10 and selected European Union countries in the Euro area

Country/Year	1999-2001	2002-2005	2006-2009	1999-2009
Czech Republic	-0.011	-0.003	-0.004	0.009
Slovakia	-0.007	-0.008	0.027	0.028
Hungary	-0.006	-0.007	0.005	0.013
Poland	0.027	0.014	0.009	0.029
Latvia	0.025	0.010	0.098	0.071
Lithuania	0.012	0.009	0.137	0.093
Estonia	0.034	-0.007	0.086	0.065
Romania	0.023	0.015	0.050	0.041
Bulgaria	0.004	-0.003	0.024	0.022
Slovenia	0.002	-0.014	0.028	0.013
Austria	0.019	-0.001	0.005	0.013
Netherlands	0.021	0.006	0.006	0.012
Portugal	0.018	0.006	0.013	0.013
Spain	0.021	0.014	0.017	0.021

Source: Hedija (2011)

3.3 Alternative OCA calculation

The problem with the original construction of the OCA index may be the inaccurate measurement due to substitution of actual data in the regression equation. Bayoumi and Eichengreen (1997) estimated the regression equation coefficients for the years 1983-1992. Coefficients can be biased and therefore may not accurately reflect the current situation. Since the variables in the equation represent the OCA characteristics, we will try to construct similar criteria to calculate an alternative method. The study of the CNB (2013) will be used for this purpose. Among the selected criteria are similarity of economic structure, the

[7] Estonia and Lithuania became EMU members in 2014.

intensity of intra-industry trade, and economic openness. The business cycle synchronisation as for the OCA index uses the method of Bayoumi and Eichengreen (1997).

3.3.1 Business cycle synchronisation

To achieve the resemblance between the OCA index and the alternative OCA calculation, the method developed by Bayoumi and Eichengreen (1997) is used for the calculation of *(SD EA)*.

3.3.2 Similarity of economic structure

CNB (2013) analysed business cycle synchronisation of the Czech Republic in relation to the Euro area with so-called Landesmann structural coefficient *(SL).* This coefficient is among the most used indicators to measure the similarity of economies. The higher the structural similarity of the GDP, the lower the impact of asymmetric shock on the EMU countries. The calculation is based on the difference between the shares of the basic sectors of the economy in total value added, of country *A* compared to the country or area *B.* The difference is weighted by the proportion of selected industries in the country and divided by 100. The index has values between the interval (0.1); it is understood that the smaller the value is, the higher the structural similarity of compared economies. *SL* coefficient formula is as follows:

$$SL = \sum \sqrt{(shiA - shiB)^2} \times \frac{shiA}{100}$$

Where sh^i_A is the percentage of the *i-th* sector in value added as a whole in country *A* and sh^i_B is the percentage of the *i-th* sector in value added as a whole in comparison to country or region *B*. Country *A* stands for a country whose economic structure similarity is examined; country *B* stands for a country or region with which we compare structural similarity. The closer the value of the coefficient is to 0. the more the economic structures are alike.

3.3.3 Intensity of intra-industry trade

The Grübel-Loyd index *(GL)* is used of the computation of trade intensity, according to CNB methodology (2013).

$$GL = 1 - (\Sigma X^{k}_{it} - M^{k}_{it} \, | \, / \, \Sigma \, | \, X^{k}_{jt} + M^{k}_{jt} \, | \,)$$

The Grübel-Lloyd index measures the ratio of absolute values of net intra-industry trade to foreign trade turnover of the selected country. The variable *X* denotes exports of *i-th* commodity at time *t* in the country. Variable *M* indicates the import of *i-th* commodity at time *t* of the country. Index gains values ranging from 0 to 1. A value of 0 indicates inter-industry trade and specialization in different commodities. Conversely, value of 1 indicates that all trade is intra-industrial. For this purpose, the *GL* index calculates with exports and imports data to the Euro area countries. The aim of the calculation is to observe if there was growth in intra-industry trade with the Euro area. Euro as a common currency, together with the criterion of economic openness, may result in the growth of intra-industrial trade and the gradual business cycle synchronisation in the monetary union. Development of the *GL* index may indicate a gradual economic convergence. Thus, shocks in a monetary union may become more symmetrical, and costs associated with common currency in the form of exchange rate mechanism loss will not be so high

3.3.4 Economic openness

As mentioned by Frankel and Rose (1996), the intensity of bilateral trade *(OPEN)* can have a positive impact on the business cycle synchronisation. Therefore, we will be interested in how the openness of the economy criterion evolved with the adoption of a common currency. As Lacina (2001) states, openness of the economy can be measured in several ways. Criterion can be measured as the turnover of foreign trade/GDP, export/GDP, import/GDP, (export + import)/GDP), export or import/domestic aggregate demand, and as aggregate overall demand. For our purpose, the sum of exports and imports to GDP seems to be the most adequate because of our interest in the overall development of trade relations within the selected countries.

$$OPEN = EX + IM \, / \, GDP$$

3.4 Dynamic analysis: the OCA index and the alternative OCA calculation

The dynamic analysis is tested by linear time trend, panel analysis, and dynamic cluster analysis. The objective of these analyses is to evaluate the OCA criteria development of chosen countries over the selected period. The input values are the values of incremental variables which are included in the calculation of the OCA index and the alternative OCA calculation that were described in the previous chapters.

3.4.1 Linear regression analysis

The goal of the regression analysis is a simple description of the time series trend. As reported by Arlt, Arltová, and Rublíková (2002), it can be used to describe the linear trend analysis, which reflects the long-term trend of the examined phenomenon. An estimated time trend regression coefficient will show us the trend in time series (i.e., whether the direction is positive or negative). The next step will be to test the statistical hypothesis of whether the regression coefficient is different from zero over the selected period. The hypothesis will be tested at the 5% significance level. As reported by Arlt, Arltová, and Rublíková (2002), time series y_t for $t = 1. 2. \ldots, T$ can be written as:

$$yt = Yt + at$$

Where y_t is researched time series of economic indicators Y, and Y_T is a model for the systematic component of economic development of indicator Y and is a function of time t. A is the unsystematic component with the properties of white noise. Since we only analyse the trend component, we can write:

$$Yt = Tt$$

Where T_t is a trend model. The model then has the form:

$$y_t = Y_t + a_t = T_t + a_t$$

Furthermore, the authors Arlt, Arltová, and Rublíková (2002) state that if the trend values are in relation to the time constant variable, the trend may be estimated based on a linear trend function which is then written as:

$$Tt = \beta 0 + \beta 1t$$

Where β_0 and β_1 are parameters of a linear trend, which we estimated using the least squares method (OLS). The goal of regression analysis is to estimate the parameter β1's time trend and its interpretation in the form of increase or decrease as well as to evaluate the overall significance of the model at the 5% significance level. In the model, we tested whether there was a change in the selected criterion over time.

The null hypothesis will represent the condition, where there is no change in the selected indicator (i.e., value of time trend remains unchanged).

$$H0: \beta 1 = 0$$

An alternative hypothesis will represent a state where the selected criteria during the period undergo a change. Interpretation of whether there was a decrease or increase in value indicates improvement or deterioration criteria.

$$H1: \beta 1 \neq 0$$

3.4.2 Panel analysis

According to Novák (2007), panel data analysis can be characterized as a monitoring of individual subjects (in our case countries) and their mutual relations, in which we conduct periodic surveys of characters and their deeper meanings. The advantage is to obtain a large number of observations which are not commonly available in conventional time series. Within the panel data we can test the interdependent behaviour of the entire group entering into the analysis. The analysis of panel data works with a model in the form (Baltagi, 2005):

$$yit = \alpha + xit\beta + uit$$

Where time series y_{it} is dependent on a set of explanatory variables $x_{it} = (x1_{it}, \ldots xK_{it})$ and represents i^{th} unit (selected countries) at time t (each year). The parameter β is a vector of constants 1xK dimension, and α is a constant, which represents the effects of the variables which are characteristic of the i^{th} observation. Variable u_{it} represents the error component model with effects of the insignificant variables in the i^{th} observation and can be written as:

$$uit = \mu i + vit$$

Where μ_i denotes the unobservable individual-specific disorders and v_{it} denotes the remainder of observable specific disorders. The model can be written as:

$$yit = (\alpha it + vit) + xit\beta + \mu i$$

Thus, the constant α represents the character of the whole observation, and constant v_{it} characterizes specific behaviour of observed individual units (country). Therefore, the *i-th* observation can be specified constant ($\alpha_{it} + v_i$) for each country. The fixed effects model can assess the homogeneity of the evolution of variables through a selected time series. According to Baltagi (2005), a fixed effects model assumes that the sum of all individual constants v_i for all the countries is equal to 0. The output from a statistical program is then estimated constant of the model α. The fixed effects model also assumes that the estimated coefficients of the explanatory variables are the same for all countries. In a graphical illustration, the constant ($\alpha + v_i$) identifies upward or downward movement (i.e., respecting the differences in the values of individual variables) and slope (development) of the time series that determines the value of the coefficient β. The panel data analysis will again try to analyse time trend and thereby determine the slope of the guidelines for the time series. The p-value will determine the statistical significance. It can be determined whether the direction of time series average for all countries and for all periods decreased or increased based on the p-value. Outcomes of the panel data analysis represent characters that are on average the same for all monitored elements entering into the analysis. Reports lead to a conclusion that shows us the commonality of the different characteristics.

3.4.3 Dynamic cluster analysis

Cluster analysis belongs among the multivariate analysis, and its benefits consist mainly in the clarity of assessing the similarities between multiple entities on the basis of several variables. After the calculation of the OCA index and alternative OCA calculation, we will need to decide what criteria, in which period, and what country will enter the cluster analysis. Meloun and Militky (2004) define the cluster analysis as a method for detecting similarities between objects based on a set of several variables. According to Kubikova, Skob, and Kubasek (2013), it is important to choose an appropriate method of clustering. Since I do not know the specific number of clusters that have to be created in advance, I will select the hierarchical clustering method. This method helps to determine the best number of clusters according to data entering the analysis. Hierarchical analysis works on the basis of agglomeration and dividing algorithms. Agglomerating mechanisms work with aggregation that gradually pile up other similar objects. Divisive algorithms begin with a single cluster and gradually divide into smaller clusters. Furthermore, it is necessary to determine the extent of distances, according to which it will calculate the distance between clusters. In this work, I used the most common measure of Euclidean distance.[8] The distance between the objects is calculated as the length of the shortest path from one point to another. The final decision that has to be made before the analysis is merging rule. We assume that for the assessment of homogeneity, the Ward's method will be the best for this purpose. This method is based on the analysis of variance. Objects of clusters are classified according to the sum of the sum of squares. The lower the sum of the squares, the more similar are the objects. It is a very effective method to measure homogeneity. Therefore, this work will be tested as a combination of multiple methods to verify the stability of our results. As we mentioned above, the cluster analysis is relevant for assessing the homogeneity of developments in the implementation of the selected OCA characteristics. The OCA index and the alternative OCA calculation will both be tested**.**

Table 2 below summarizes the number of different approaches to calculate the OCA characteristics.

[8] In two dimensions, it would measure the shortest distance from point A to point B using a ruler.

Figure 2: Summary of the OCA characteristics

OCA index (Bayoumi and Eichengreen, 1997)			
OCA criteria	**Variables**	**Dependent variables**	**Calculation**
Asymmetry of business cycles	SD	Euro area	Standard deviation of the difference in the logarithm of real output of each country pair.
Dissimilarity of export commodity structure	DISSIM	Euro area	Sum of the absolute differences in the shares of agricultural, mineral and manufacturing trade in total merchandise trade.
Trade intensity	TRADE	Euro area	Mean of the ratio of bilateral exports to domestic GDP for the two countries.
Economic size	SIZE	Euro area	Mean of the logarithm of the two GDPs measured in EUR.
Alternative OCA characteristics			
OCA criteria	**Variables**	**Dependent variables**	**Calculation**
Alignment of business cycles	SD EA	Euro area	Standard deviation of the difference in the logarithm of real output of each country pair.
Similarity of economic structure	SL	Euro area	Differences total value added of individual industries on the total value added.
Intensity of intra-industry trade	GL	Euro area	Share of export and import to GDP
Economic openness	OPEN	Euro area	Share of absolute value of intra-industrial trade on total foreign trade.

Source: Own processing

The main outcome of the empirical part focuses on the dynamic cluster analysis (Sørensen, Gutiérrez, 2006). The analysis will be based on the authors' methodology. Moreover, I will analyse the development of distance between clusters during the test period. Cluster analysis

is a typically static method because it can assess the similarity of the object for one period. Sørensen and Gutierrez (2006) have used cluster analysis to test the homogeneity in the process of financial integration in the Euro area. Their approach used a typical static nature of the cluster analysis in order to evaluate the evolution of the distance between clusters over time. The practical part of this work will be based on their methodology regarding examination of the convergence similarity of the OCA criteria fulfilment. Countries Austria, Belgium, Cyprus, Germany, Estonia, Spain, Finland, France, Greece, Ireland, Italy, Luxembourg, Malta, Netherlands, Portugal, Slovenia and Slovakia will undergo dynamic cluster analysis for the selected period 2005-2014. The establishment of clusters for each year will determine the similarity of the selected criteria in individual years and will compare the progress of the monitored years. If there is a decline between clusters of selected countries over the chosen period, I can confirm the homogeneity growth hypothesis of the Euro area members (i.e., that there is a convergence in the OCA characteristics).

4 Practical Part

At first, the practical part will construct the OCA index as well as the alternative OCA calculation, and both will be compared to the Euro area.[9] Furthermore, linear time trends as well as panel and dynamic cluster analysis will test both methods' individual variables. The group of countries entering the analysis will be the Euro area member states that have used the euro as a currency for at least four years. Those states are Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, Netherlands, Portugal, Slovenia, and Slovakia. The OCA index and the alternative OCA calculation and their variables will be reconstructed and examined within the selected time period of 2005 to 2014. The analysis of the individual components of the OCA index will not test its initial variable SIZE, because it does not act like a typical OCA characteristic. Moreover it is not possible to assess from its development the eventual convergence or divergence. This variable evaluates only the benefits of the monetary union integration through transactional importance of the national currency. To construct the OCA index, I used the original equation constructed by Bayoumi and Eichengreen (1997) with previously estimated regression coefficients. The estimated regression coefficients are subject to criticism because the coefficients were estimated for the period of 1983 to 1992. This work is aware of this deficiency, and objective of the work is to assess the risk of criticism of a static regression equation in time. As a result, the following sub chapter will work with the alternative OCA methodology.

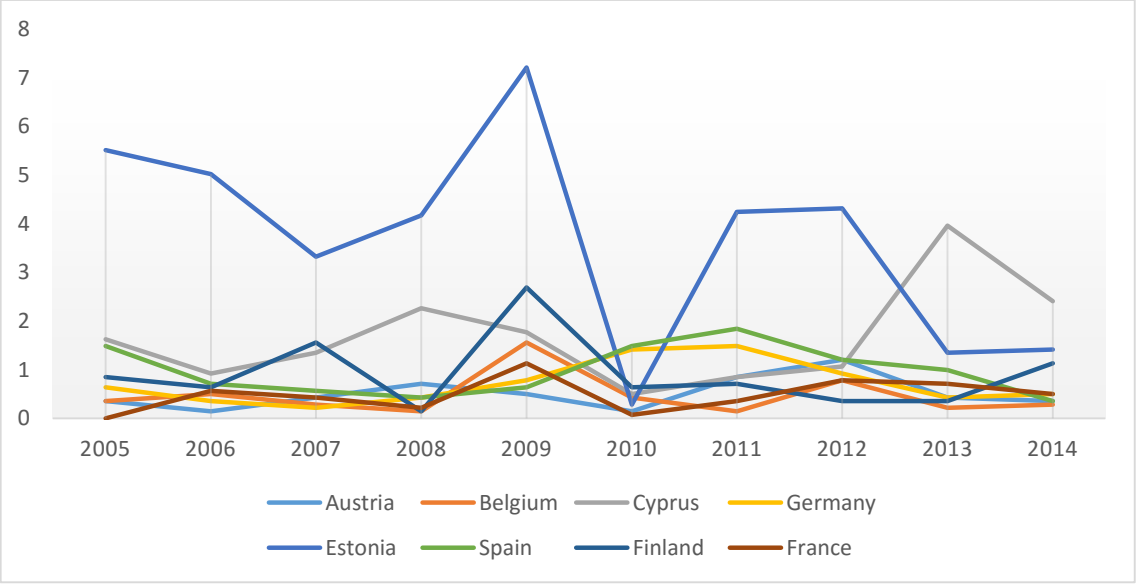
[9] [9] (EA11-2000. EA12-2006, EA13-2007, EA15-2008, EA16-2010. EA17-2013, EA18-2014, EA19)

4.1 OCA index

4.1.1 Business cycle synchronisation with Euro area (SD)

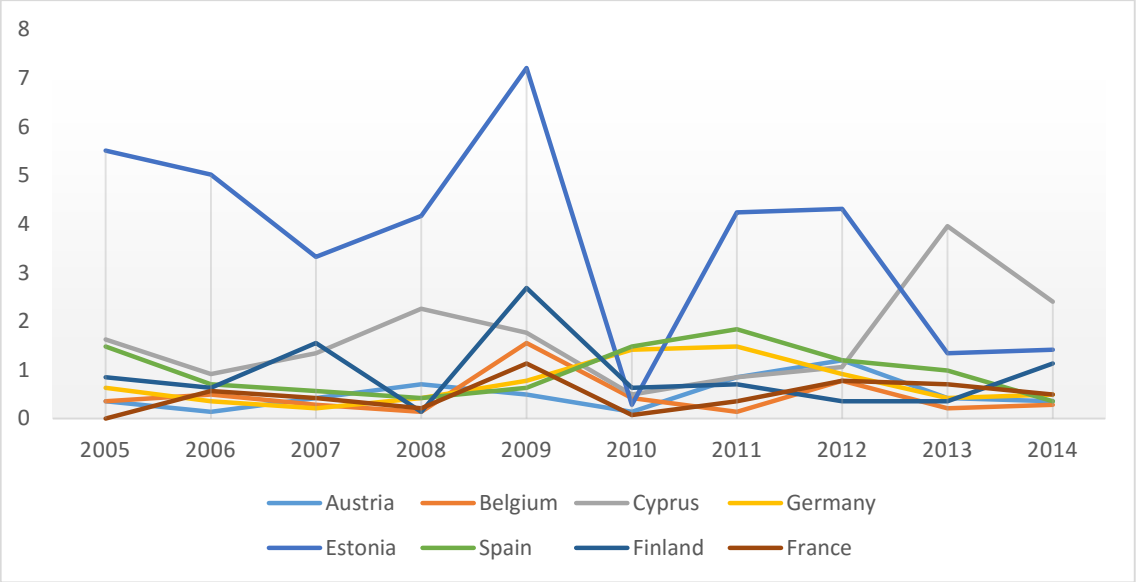
SD variable represents the business cycles synchronisation. The indicator is designed as a standard deviation difference in the relative output of the countries. The value is designed for each year as the standard deviation of one-year business cycle, which provides us with concrete information about development of the economic cycles. Values close to 0 indicate a substantial symmetry in the economic cycle with the Euro area. Conversely, values far from 0 indicate significant differences in the development of economic cycles of tested countries. EUROSTAT is used as a source of data for calculating this indicator.

Graph 1: Development of business cycles synchronisation with Euro area (SD) for period 2005-2014



Source: EUROSTAT, own processing

Graph 2: Development of business cycle synchronisation with Euro area (SD) for period 2005-2014



Source: EUROSTAT, own processing

Graphs 1 and 2 show that very low levels of SD indicate greater business cycle synchronisation with Euro area. Those countries are Austria, Belgium, Germany, France, and the Netherlands, which is not surprising due to their strong trade ties to the Euro area. Spain, Finland, Italy, and Portugal are countries with relatively good business cycle synchronisation. The worst levels of alignment of economic cycles with Euro area are Cyprus, Estonia, Greece, Ireland, Luxembourg, Malta, Slovenia, and Slovakia. These countries' values may be associated with the relative primary focus on the service sector, a higher degree on the agriculture sector, and low focus on the industrial sector. In 2009-2011. SD values had the worst results in most of the countries. These results may be caused by the Euro area debt crisis. The beginning of the Euro area crisis initially acted as a symmetric shock, which transformed into an asymmetric shock due to differences between the various economies. The original information about symmetric shock at the beginning of the crisis could have disappeared due to the methodology of SD computation for individual years.

Table 3: Linear time trend analysis of business cycle synchronisation with Euro area (SD) for period 2005-2014

	Coefficient	P-value	Significance
Austria	−8,13177e-05	0.3542	
Belgium	−0.000108382	0.1873	
Cyprus	0.000212	0.4736	
Germany	1.22E-05	0.9186	
Estonia	−0.000588842	0.2981	
Spain	−5,55312e-06	0.9593	
Finland	−4,67413e-06	0.9812	
France	−6,11068e-05	0.3077	
Greece	0.000217	0.7135	
Ireland	−0.000340925	0.3023	
Italy	−3,31508e-05	0.6469	
Luxembourg	−0.000334183	0.2408	
Malta	3,35E-05	0.8814	
Netherlands	−2.77482e-05	0.7576	
Portugal	0.000205	0.504	
Slovenia	−0.00109615	0.0449	**
Slovakia	−0.000321439	0.0794	*

Source: Statistical programme GRETL, own processing

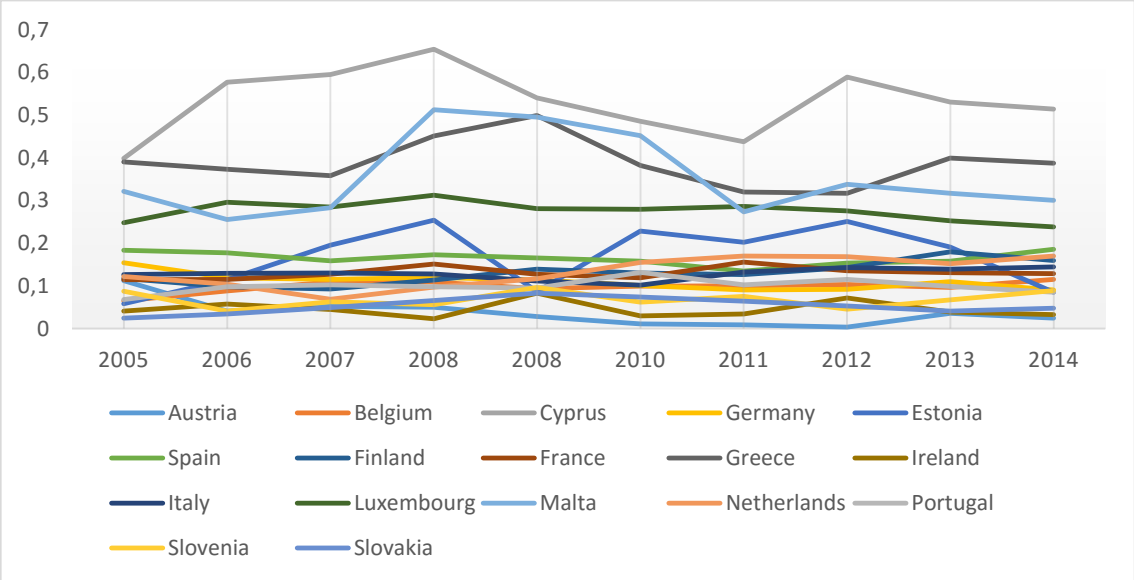
Table 3 shows that only two countries showed statistically significant deterioration with the Euro area. For the other countries, there was a statistically significant unchanged trend in the business cycles synchronisation with Euro area.

4.1.2 Dissimilarity of export commodity structure (DISSIM)

DISSIM variable represents the foreign trade export commodity structure. It illustrates the extent of trade specialization; therefore, it can be a suitable criterion for assessing the similarity of economies. Indicator in the case of the diminishing value, refers to the ongoing structural convergence of economies. On the contrary, it may highlight the growth of trade specialization because of the use of comparative advantage according to Krugman (1993 in

De Grauwe, 2012).[10] *DISSIM* variable values represent differences in total share of agriculture, mining, and manufacturing industries in total share of foreign trade commodity structure between tested countries and Euro area. Euro area data are divided according to the classification of single digit SITC1 that well corresponds with above mentioned categorization for variable *DISSIM*. SITC divisions 00. 01. and 04 correspond to agricultural commodities; groups SITC 02 and 03 represent industry sector; and the sum of SITC 05-09 represents the mining industry. Data were used from the COMEXT database.

Graph 3: Development of dissimilarity of export commodity structure with Euro area (DISSIM) for period 2005-2014



Source: COMTRADE, own processing

Despite the rising trend of the *DISSIM* variable in the Graph 3, Austria as a core country has one of best results in the export commodity structure in terms of similarity. At first glance, it is obvious that the development of Ireland cannot be explained by a linear trend. According to Euroekonom (2003), Ireland's entry into the European Community in 1973 started the process that significantly transformed the entire economy of the typically agricultural oriented country to a predominantly industrial economy with a high proportion of electronic, chemical, and IT sectors. These events could lead to a significant improvement in indicators *DISSIM* with Euro area. Indicator values can be significantly influenced by the crisis in 2008,

[10] Agglomeration effect

and this can be seen in the cases of Greece and Ireland. Both economies were affected the most by the crisis which resulted in a deterioration of indicators *DISSIM*.

Table 4: Linear time trend analysis of dissimilarity of export commodity structure with Euro area (DISSIM) for period 2005-2014

	Coefficient	P-value	Significance
Austria	−0.00731787	0.0223	**
Belgium	0.002756	0.0727	*
Cyprus	−0.000149006	0.9872	
Germany	−0.00514388	0.0043	***
Estonia	0.006332	0.4665	
Spain	−0.00159602	0.38	
Finland	0.007464	0.0021	***
France	0.001725	0.2886	
Greece	−0.00339768	0.6046	
Ireland	−0.000593650	0.7979	
Italy	0.001789	0.2439	
Luxembourg	−0.00311698	0.2361	
Malta	−0.00150538	0.8954	
Netherlands	0.009256	0.0072	***
Portugal	0.001672	0.3924	
Slovenia	0.000844	0.7042	
Slovakia	0.001571	0.4671	

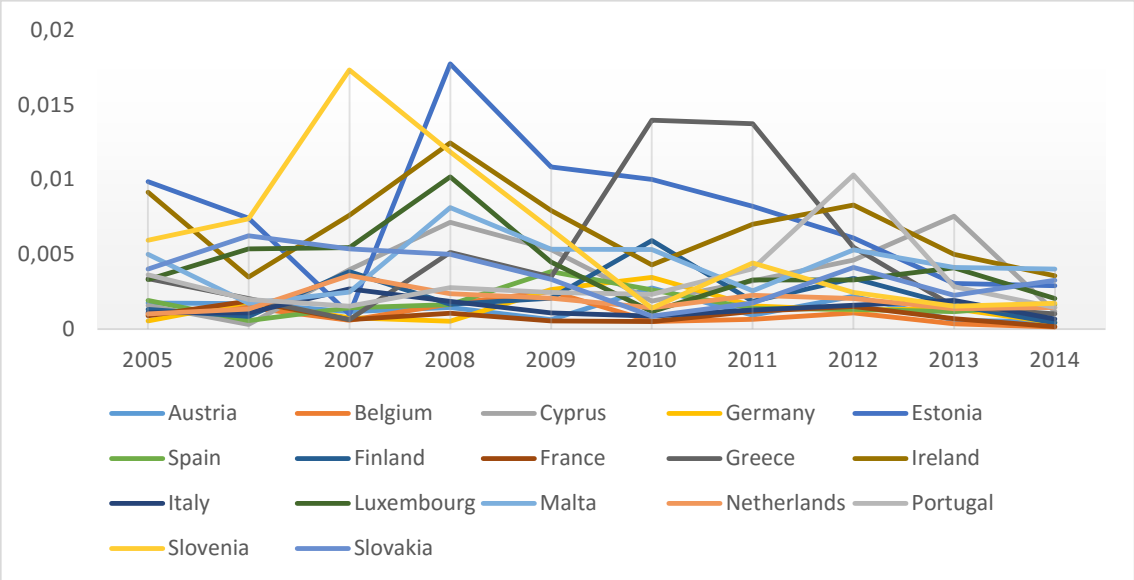
Source: Statistical programme GRETL, own processing

Table 4 above shows the results of development in time series trend analysis of dissimilarity of export commodity structure *(*DISSIM). It is important to note the development of values at a time when declining values show a continuing convergence in the countries surveyed. Similarity of export commodity structure with Euro area improved for Austria and Germany, who represent growth of homogeneity and decrease the risk of asymmetric shocks. Values of development in time series trend rather confirmed growth of specialization in Belgium, Germany, Finland, and the Netherlands. Development of linear time trend analysis of dissimilarity of export commodity structure (DISSIM) clearly confirmed the deterioration of Austria.

4.1.3 Trade intensity (TRADE)

Growth indicator TRADE in time suggests increasing business interdependence among examined countries and Euro area, and it represents economic openness. The indicator captures the mutual interdependence of trade and reflects the economic strength of the country. Growth in trade integration can be supported by the adoption of the single currency; therefore, it can have a very strong influence on the growth of the business cycle synchronisation if there is also the growth of intra-industry trade. Data are obtained from the COMEXT statistics and EUROSTAT. Graph 4 shows very good values, indicating the growth in trade with Euro area reached interdependence with Austria, Belgium, Germany, Spain, France, Italy, and the Netherlands. For other countries, the development of the TRADE indicator did not change much. Estonia, Greece, Ireland, and Slovenia experienced significant deterioration after joining the monetary union.

Graph 4: Development of trade intensity with Euro area (TRADE) for period 2005-2014



Source: EUROSTAT, own processing

The improvement of values occurs in 16 out of 17 tested countries. For one economy, Finland, the indicator did not change significantly. Six economies are considered core countries. Economic openness is essential to the growth of economic structure.

Table 5: Linear time trend analysis of trade intensity (TRADE) for period 2005-2014

	Coefficient	P-value	Significance
Austria	0.006693	0.03	**
Belgium	0.009832	0.0114	**
Cyprus	0.006597	0.0371	**
Germany	0.008291	0.0061	***
Estonia	0.020111	0.0012	***
Spain	0.0093	0.0024	***
Finland	0.00175	0.4793	
France	0.005715	0.0136	**
Greece	0.010817	0.0022	***
Ireland	0.025466	4,83E-07	***
Italy	0.006643	0.0134	**
Luxembourg	0.021052	0.0054	***
Malta	0.029717	0.0013	***
Netherlands	0.014315	0.0024	***
Portugal	0.011547	0.0016	***
Slovenia	0.012809	0.0057	***
Slovakia	0.014474	0.015	**

Source: Statistical programme GRETL, own processing

4.1.4 Panel data analysis of the OCA index

The following results will represent the change in the time series panel data analysis. Panel analysis shows the overall situation for all the countries and for the entire period, and it contains much more information than just time series trend analysis. Specifically, it takes into account information about individual countries. The length of the time series will match ten observations in accordance with the examined period of 2005 to 2014. Statistical software GRETL will be used.

Table 6: Linear time trend analysis of panel data of the OCA index (SD, DISSIM, TRADE) for period 2005-2014

	Coefficient	P-value	Significance
DISSIM	0.000706	0.5227	
TRADE	0.012663	1.34E-26	***
SD	−0.000136719	0.0484	**

Source: Statistical programme GRETL, own processing

Values from Table 6 confirmed that there has been no change of dissimilarity of export commodity structure *(DISSIM)*. Intensity of the trade *(TRADE)* indicator increased and therefore improved. The results for business cycle synchronisation *(SD)* are statistically significant but decreasing which highlights the increasing correlation of business cycles with Euro area.

The results are rather ambiguous, and it is necessary to obtain information for a much longer period of time, so it would be possible to determine if the increasing similarity of the economies has a decreasing impact on the asymmetric shocks with Euro area. According to the Table 7 results are rather ambiguous, and thus it is necessary to obtain information for a much longer period of time to determine whether the increasing similarity of the economies influences the decline of asymmetric shocks with Euro area.

According to the results of panel data analysis, limitations in the form of short time series are visible. The deterioration of business cycle synchronisation was due to symmetry of growing specialization. The results rather point to the fact that there are other influences that more strongly influenced the development business cycle synchronisation with the Euro area.

Table 7: Summary of the development of SD, DISSIM, and TRADE

	SD	DISSIM	TRADE	AVERAGE
Austria	2	3	1	2
Belgium	2	1	1	1.3
Cyprus	2	2	1	1.6
Germany	2	1	1	1.3
Estonia	2	2	1	1.6
Spain	2	2	1	1.6
Finland	2	1	2	1.6
France	2	2	1	1.6
Greece	2	2	1	1.6
Ireland	2	2	1	1.6
Italy	2	2	1	1.6
Luxembourg	2	2	1	1.6
Malta	2	2	1	1.6
Netherlands	2	1	1	1.3
Portugal	2	2	1	1.6
Slovenia	3	2	1	2
Slovakia	3	2	1	2

Source: Statistical programme GRETL, own processing

Table 6 shows the summary of results from linear trend analysis of business cycle synchronisation (SD), dissimilarity of export commodity structure (DISSIM) and intensity of the trade (TRADE), all in relation to the Euro area. Individual values in columns illustrate the nature of the development of the OCA criteria. A value of 1 represents the improving development criteria in terms of time, representing a value of 2 unchanged trend in terms of time and value 3 represents the worsening value in terms of time

The last column is the simple arithmetic average of above mentioned indicators. Among the countries, which averaged with improving values are Belgium, Germany, and the Netherlands. These countries have very open economy and are strongly linked to Euro area. Cyprus, Estonia, Spain, Finland, France, Greece, Ireland, Italy, Luxemburg, Malta and Portugal achieved slightly less improving values Countries whose values did not change much are Austria, Slovenia and Slovakia. For these countries were improving and worsening

individual indicators simultaneously, but on average the evaluation differences compensated.

4.2 Alternative OCA characteristics

The next chapter will evaluate developments of the alternative OCA calculation. The OCA calculations of characteristics that are similar to the OCA index are included.

In this work, the OCA index has a poor design and its results cannot be applied in the context of current economic conditions. First, criticism is bound to the static nature of the OCA index due to regression coefficients that were estimated for the years 1983-1992. Another criticism may be the inter-industry trade (Rozmahel, 2006) in a variable (DISSIM). Criticism also applies to indirect assessment of economic openness in the calculations (Horvath & Komarek, 2003). In the previous chapter, the OCA index tried fluently to build on the achievements of Bayoumi and Eichengreen (1997) who created the OCA index before the creation of the monetary union. Therefore, this work took into account the situation in relation to the whole monetary union and calculated them in relation to Euro area.[11] Since the monetary policy is based on the average of the monetary union as a whole, it may be important to improve the OCA characteristics in relation to the Euro area. The analysis will consist of indexes representing the business cycles synchronisation (SD)[12], similarity of economic structure (SL)[13], intensity of intra-industry trade (GL)[14], and economic openness (OPEN)[15] in the selected period from 2005 to 2014. Breakdown of this section will be similar to the previous chapter. We will test development of the OCA criteria for individual countries through regression time series analysis.

[11] (EA11-2000. EA12-2006, EA13-2007, EA15-2008, EA16-2010. EA17-2013, EA18-2014, EA19)

[12] Landesmann structural coefficient compared with Euro area: (EA11-2000. EA12-2006, EA13-2007, EA15-2008, EA16-2010. EA17-2013, EA18-2014, EA19)

[13] EUROSTAT database

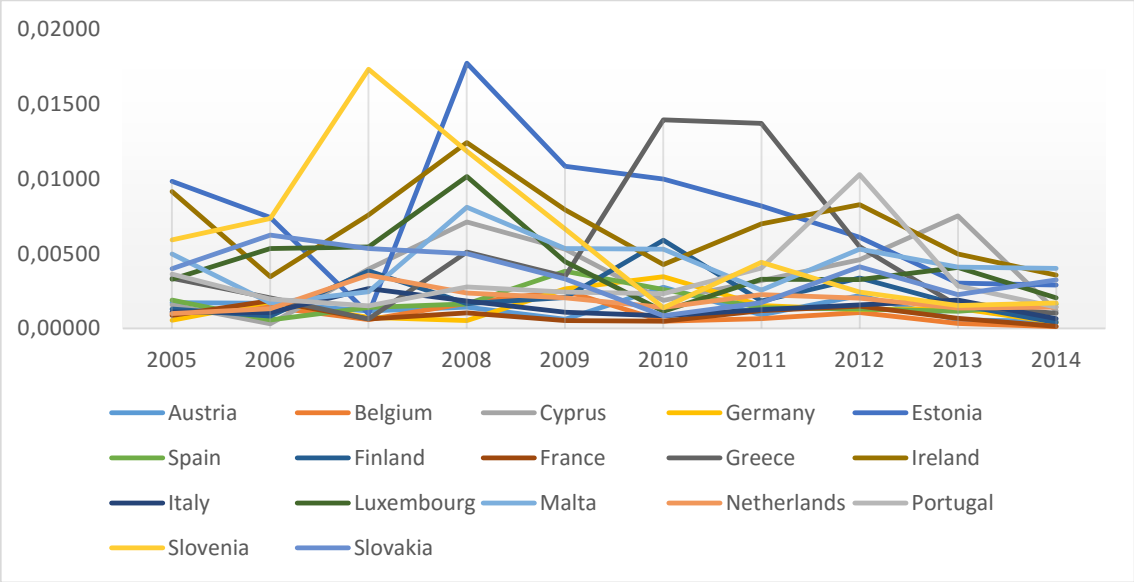
[14] EUROSTAT database

[15] Valid to the given year

4.2.1 Business cycle synchronisation with Euro area (SD)

Business cycle synchronisation in relation to Euro area will use the same technique as used by Bayoumi and Eichengreen (1997). The indicator will be measured as the standard deviation of the difference relative output of tested countries. Values near 0 indicate high alignment cycles, and values different from 0 indicate lower alignment economic cycles. In the selected period of 2005 to 2014, it will be important if there were improvements or deteriorations in the alignment of business cycles tested with the Euro area.

Graph 5: Development of business cycles synchronisation with Euro area (SD) for period 2005-2014



Source: EUROSTAT, own processing

Development of *SD* indicator provides an interesting insight to the events that were characteristic for our examined period of 2005 to 2014. The sharp deterioration with the Euro area business cycles occur from 2007 to 2011. which can be attributed to the Euro area debt crisis. Graph 5 shows that very low levels of SD indicate greater alignment of economic cycles with Euro area. If we analyse the specific values of business cycle synchronisation with the Euro area, Austria, Belgium, Germany, France, and the Netherlands scored low; these desirable values arise from the nature of their typically small and open economies.

Table 8: Time series trend analysis of business cycles synchronisation with Euro area (SD) for period 2005-2014

	Coefficient	P-value	Significance
Austria	−8,13177e-05	0.3542	
Belgium	−0.000108382	0.1873	
Cyprus	0.000212	0.4736	
Germany	1.22E-05	0.9186	
Estonia	−0.000588842	0.2981	
Spain	−5,55312e-06	0.9593	
Finland	−4,67413e-06	0.9812	
France	−6,11068e-05	0.3077	
Greece	0.000217	0.7135	
Ireland	−0.000340925	0.3023	
Italy	−3,31508e-05	0.6469	
Luxembourg	−0.000334183	0.2408	
Malta	3,35E-05	0.8814	
Netherlands	−2.77482e-05	0.7576	
Portugal	0.000205	0.504	
Slovenia	−0.00109615	0.0449	**
Slovakia	−0.000321439	0.0794	*

Source: Statistical programme GRETL, own processing

Table 6 shows that only two countries showed statistically significant deterioration with the Euro area. For the other countries, there was a statistically significant unchanged trend in the business cycle synchronisation with Euro area.

4.2.2 Similarity of economic structure (SL)

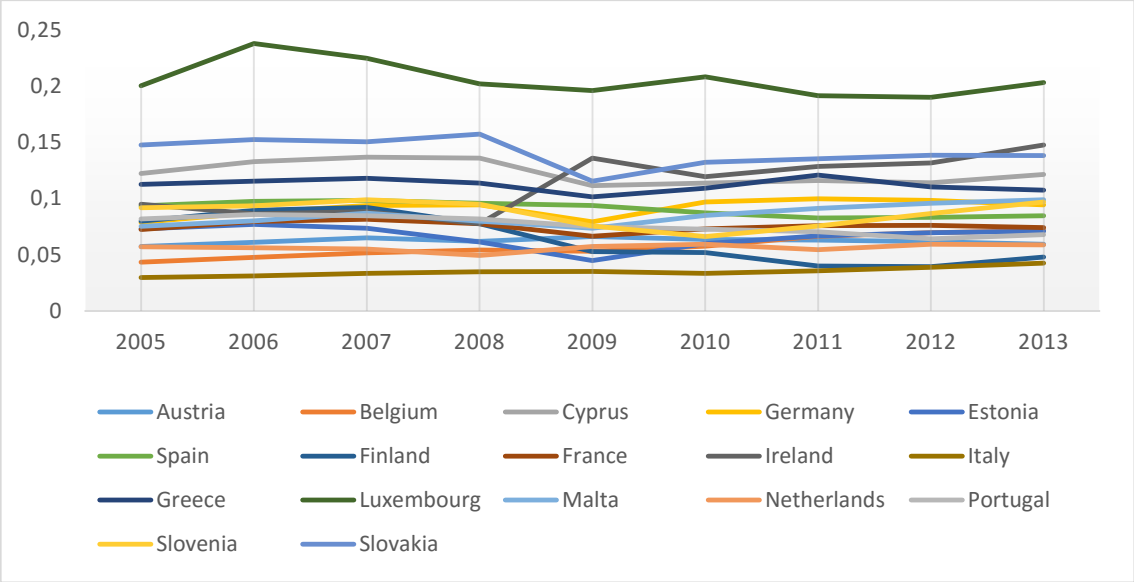
Overall structural similarity of economies will be computed with Landesmann's structural coefficient (SL), according to CNB methodology (2013). Its calculation is based on the difference between the share of basic economic sectors in total value added in country *A*

(selected Euro area countries)[16] compared to the country or area *B* (the Euro area). The index takes values from the interval (0.1). While low values suggest a strong similarity of the compared countries, high values may indicate low similarity in the structure of the countries compared, which is associated with a higher risk of asymmetric shocks in a monetary union. Data were obtained from EUROSTAT database and sorted according to NACE classification, which is broken down into 11 sectors: agriculture, forestry and fisheries; industry; manufacturing; construction; wholesale and retail trade; transport, accommodation, and catering and hospitality; information and communication; finance and insurance; real estate activities; professional, scientific and technical activities; administrative and support service activities; public administration and defence; education, health, and social care; cultural, entertainment, and recreation; other service activities; and activities of extraterritorial organisations and bodies**.** Before we attempt to summarize the results, which indicate a potential risk of an agglomeration effect, it is important to look at what values of the indicator were reached with individual countries and their degree of degradation.

Graph 6 shows very high similarity in the overall economic structure with the Euro area for most of the countries, except for Greece and Ireland. If we look at the evolution of SL indicators in some countries (e.g., Belgium), it can be seen that there has been an increasing trend several times within the period. The results suggest that countries that had high structural similarity with the Euro area (reaching low values) after the entry into the EMU really began to specialize.

[16] Austria, Belgium, Cyprus, Germany, Estonia, Spain, Finland, France, Greece, Ireland, Italy, Luxembourg, Malta, Netherlands, Portugal

Graph 6: The development of the similarity of economic structure (SL) for period 2005-2013



Source: EUROSTAT, own processing

From Table 6 above, it is clear that the highest values SL index by countries have Cyprus, Ireland, Greece, Luxembourg, and Slovakia. Countries such as Austria, Belgium, Italy, and the Netherlands reached among the lowest. Ireland's values are highly volatile, and it seems they are influenced by the nature of the analysis period. Later, the indicators improved, which again worsens the impact of the Euro area debt crisis in 2008.

Time trend development of this indicator, which is illustrated below in the Table 7, is not too encouraging. The results highlight the dangers of growing specialization in manufacturing industries with comparative advantage. The hypothesis of a growing development indicators can be confirmed in four countries of the 17 tested. Only Spain, Finland, and Portugal significantly decreased (i.e., their economic convergence the structure with Euro area).

Table 9: Time series trend analysis of the similarity of economic structure (SL) for period 2005-2014

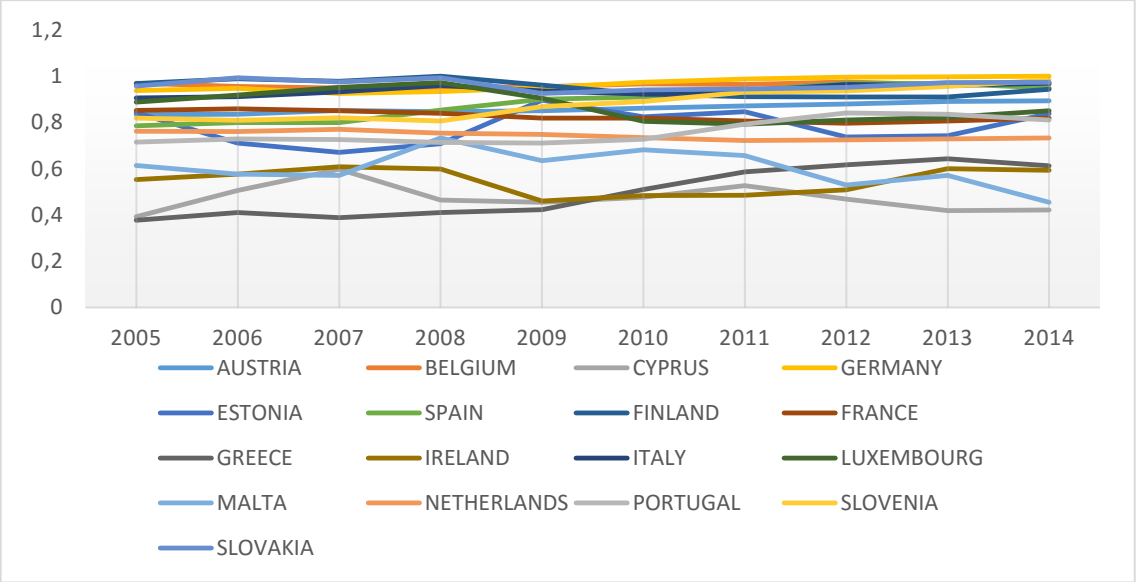
	Coefficient	P-value	Significance
Austria	0.013194	0.7326	
Belgium	0.352083	8,00E-06	***
Cyprus	−0.206528	0.1105	
Germany	0.184722	0.0636	*
Estonia	−0.0788889	0.5716	
Spain	−0.194306	0.0035	***
Finland	−0.675694	0.0019	***
France	−0.0273611	0.6538	
Greece	−0.0570859	0.4853	
Ireland	0.7825	0.0051	***
Italy	0.130694	0.0004	***
Luxembourg	−0.321667	0.1178	
Malta	0.2575	0.0099	***
Netherlands	0.043194	0.3205	
Portugal	−0.262500	0.0003	***
Slovenia	−0.127778	0.4304	
Slovakia	−0.219861	0.1985	

Source: Statistical programme GRETL, own processing

4.2.3 Intensity of intra-industry trade (GL)

The intensity of intra-industry trade can be calculated with the Grubel-Lloyd index (GL), according to CNB (2013) methodology. Calculation of this indicator is very sensitive to the degree of aggregation of the industry. In this work, I used aggregation based on single-classification SITC1 that divided industries into ten categories. Growth in intra-industry trade is important in terms of its effect on the business cycle synchronisation. The index is moving within the interval <0.1>, where higher values mean a higher share of intra-industrial trade. Data are obtained from a statistical database COMTEX from EUROSTAT.

Graph 7: Development of intensity intra-industry trade (GL) for period 2005-2014



Source: EUROSTAT, own processing

GL values are influenced by the calculation and are therefore close to 1 in most of the countries. The indicator was computed with the least detailed breakdown of SITC1 categorization, which divides the industry at ten basic groups. Therefore, most of the values achieve high numbers. If I used a more detailed breakdown, the value would be lower and more accurate. The worst share of intra-industrial trade is attributed to Cyprus, Greece, and Ireland. Intra-industrial trade is typical for countries with similar factor amenities. This explains the low values, particularly for less industrial and agricultural Greece with rather high proportions of tertiary sectors, especially tourism according to Businessinfo (1997-2014). Low values of Ireland can be caused by its developed industry sector in the chemical, pharmaceutical, and computer industries and advanced service sector mainly in insurance Businessinfo (1997-2014).

Table 10: Time series trend analysis intensity intra-industry trade (GL) for period 2005-2014

	Coefficient	P-value	Significance
Austria	0.007011	1.42E-06	***
Belgium	0.001092	0.2493	
Cyprus	−0.00481563	0.4951	
Germany	0.008677	0.0003	***

Estonia	0.00524	0.5639	
Spain	0.022865	2.00E-05	***
Finland	−0.00854008	0.0122	**
France	−0.00627931	0.0012	***
Greece	0.033358	5,09E-05	***
Ireland	−0.00177850	0.7956	
Italy	0.005882	0.0066	***
Luxembourg	−0.0142955	0.0339	**
Malta	−0.0112235	0.2198	
Netherlands	−0.00497508	0.001	***
Portugal	0.014735	0.0026	***
Slovenia	0.021166	1.49E-05	***
Slovakia	−0.00150682	0.5749	

Source: Statistical programme GRETL, own processing

The results of the Grubel-Lloyd index of intra-industry trade indicates permanence criteria for the whole period examined.

The time trend coefficient was statistically insignificant in the case of six countries (i.e., the indicator did not change). In Austria, Germany, Spain, Greece, Italy, Portugal, and Slovenia, coefficients were statistically significant and growing, indicating the growing influence of inter-industrial trade. The deterioration of the indicator occurred in Finland, France, Luxembourg, and the Netherlands. The general results of the development of inter-industrial trade cannot expect any increase business cycle synchronisation. Fidrmuc (2001) suggests that in order to achieve business cycle synchronisation in the monetary union, it is not enough to increase the economic openness. It is important that countries trade together in the same industry.

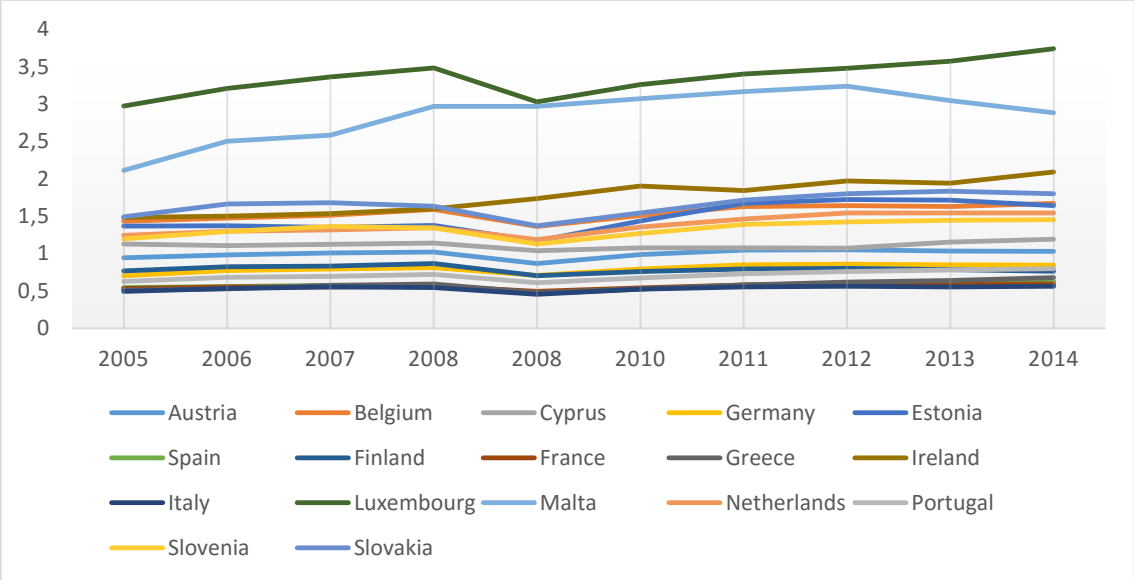
4.2.4 Economic openness (OPEN)

The criterion of economic openness plays an important role in the process of the European monetary integration. With the growth of openness of the economies, monetary policy becomes less effective, and for small open economies, the loss of openness in the process of monetary unification is not a major cost (McKinnon, 1963). The ratio is calculated in relation

to the Euro area, and the data are obtained from the European EUROSTAT database that includes 17 countries that are members of Euro area.

The criterion is measured by dividing the sum of exports and imports to GDP. Graph 8 shows growth of trade integration. The growth of Belgium and the Netherlands was very intense, and this is related to the fact that they are typically small and highly open economies. Larger economies such as Finland, France, Germany, or Greece did not grow so intensely.

Graph 8: Development of the economic openness (OPEN) for period 2005-2014:



Source: EUROSTAT, own processing

Graph 8 above shows the number of results indicators OPEN. It can be seen that the Directive trend for each country is statistically significant and growing (i.e., leads to improvement indicators over time).

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Table 11: Time series trend analysis economic openness (OPEN) for period 2005-2014:

	Coefficient	P-value	Significance
Austria	0.009381	0.1369	
Belgium	0.024908	0.0141	**
Cyprus	0.003213	0.5582	
Germany	0.014334	0.0106	**
Estonia	0.047759	0.0113	**
Spain	0.008136	0.1121	
Finland	−0.00345527	0.5132	
France	0.006542	0.0497	**
Greece	0.01535	0.0143	**
Ireland	0.070506	3,26E-06	***
Italy	0.005465	0.1608	
Luxembourg	0.060835	0.0089	***
Malta	0.089232	0.0091	***
Netherlands	0.036573	0.0019	***
Portugal	0.016015	0.0076	***
Slovenia	0.023787	0.0358	**
Slovakia	0.030124	0.0584	*

Source: Statistical programme GRETL, own processing

Table 9 shows the number of results indicators OPEN. It can be seen that direction of the time trend for 12 out of 17 countries is statistically significant and growing (i.e., leads to the improvement of indicators over time). There was a significant removal of trade barriers and the growth of openness of the economies in the examined period.

4.2.5 Panel data analysis of the alternative OCA calculation

Panel data analysis tests the average development of the individual variables as a whole in the studied group of countries for the selected period. The variable business cycle synchronisation (SD), openness economy (OPEN), a similar economic structure (SL), and the trade intensity (GL) will enter the analysis.

Table 12: Linear time trend analysis of panel data of the alternative OCA calculation (SD, SL, GL, OPEN) for period 2005-2014

	Coefficient	P-value	Significance
OPEN	0.0269825	1.11E-14	***
GL	0.00391825	7,30E-03	***
SL	−0.0241339	5,07E-01	
SD	−0.000136719	0.0484	**

Source: Statistical programme GRETL, own processing

The results in Table 12 lead to the conclusion that although the criterion of economic openness improved, there was a deterioration of the alignment of economic cycles with the Euro area. An analysis of individual indicators shows the main reason was the unchangeable or deteriorating indicator of the trade intensity. On average, this indicator changes, and the time is nearly constant. The results of the analysis indicate the hypothesis of the agglomeration effect, along with the growing specialization due to the monetary union membership. There is a rising risk of asymmetric shocks with an impact on reducing the business cycle synchronisation with the Euro area.

Table 13: Summary of SD, SL, GL, and OPEN for period 2005-2014

	SD	SL	GL	OPEN	AVERAGE
Austria	2	2	1	2	1.75
Belgium	2	1	2	1	1.5
Cyprus	2	2	2	2	2
Germany	2	1	1	1	1.25
Estonia	2	2	2	1	1.75
Spain	2	3	1	2	2
Finland	2	3	3	2	2.5
France	2	2	3	1	2
Greece	2	2	1	1	1.5
Ireland	2	1	2	1	1.5
Italy	2	1	1	2	1.5
Luxembourg	2	2	3	1	2
Malta	2	1	2	1	1.5
Netherlands	2	2	3	1	2
Portugal	2	3	1	1	1.75
Slovenia	3	2	1	1	1.75
Slovakia	3	2	2	1	2

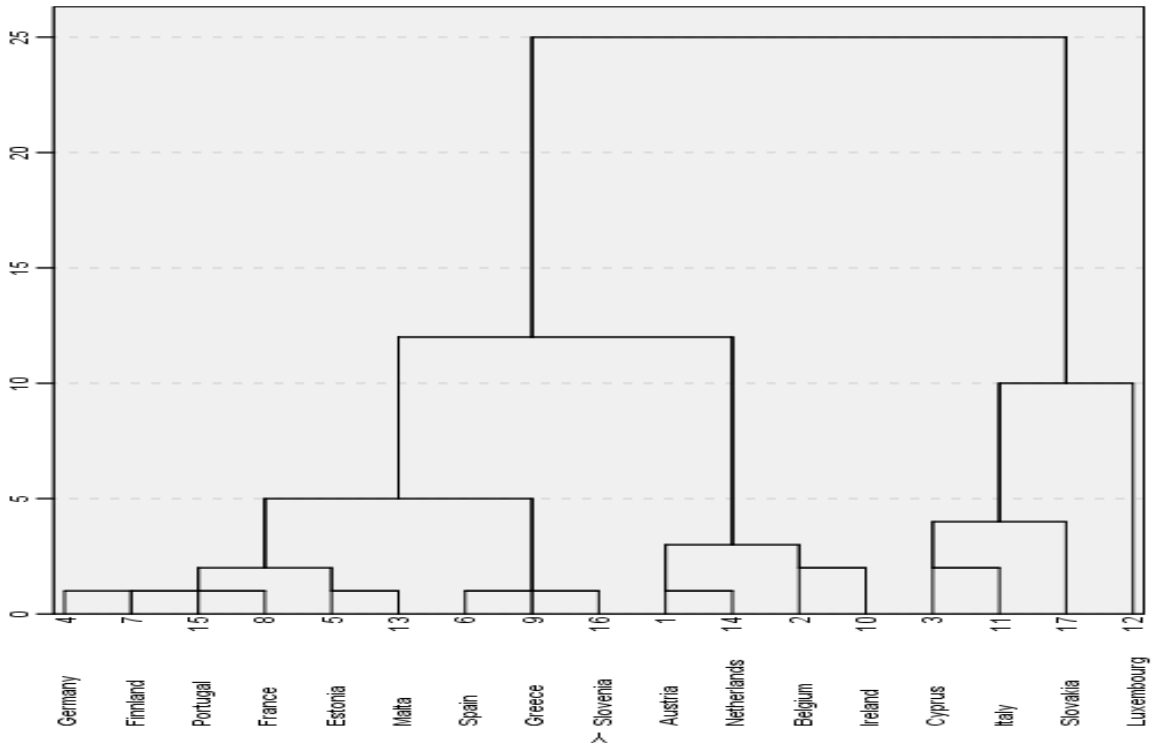
Source: Statistical programme GRETL, Own processing

4.2.6 Dynamic cluster analysis

In this part of the work, I will evaluate the overall development of selected characteristics of OCA via dynamic cluster analysis. Since we are working with a group of variables for the selected Euro area countries over a period of ten years, we will standardize them as panel data (i.e., we standardize data in both space and time for the entire dataset variables for the selected period of 2005 to 2014 and for each country for the states of Austria, Belgium, Cyprus, Germany, Estonia, Spain, Finland, France, Greece, Ireland, Italy, Malta, the Netherlands, Portugal, Slovenia, and Slovakia). The analysis will not include Luxembourg because of its atypical values. The purpose of clustering for each year is to find similarities in the selected years and to record comparisons of their development. If there is a decline within the tested time period between the tested countries, clusters confirm the hypothesis of growth of homogeneity between the Euro area members (i.e., that there is a convergence in the performance characteristics of the OCA). We cannot observe from the results if the criteria become better or worse, but we know whether there was a convergence in their degree of similarity. It may be interesting to follow the development of similar countries with other clusters generated during the selected period.

When interpreting the dendogram, we watch the x-axis individual objects in which we examined similarities in terms of entering variables. On the y-axis, we can see the distances on which the clumps join together. Objects that are associated with a fork are part of the cluster. Assessment of the degree of similarity depends on the distance at which there was a connection. The longer the vertical line in a particular subject, the lower its similarity to the nearest object. In Graph 9, we can see at first glance the three main clusters.

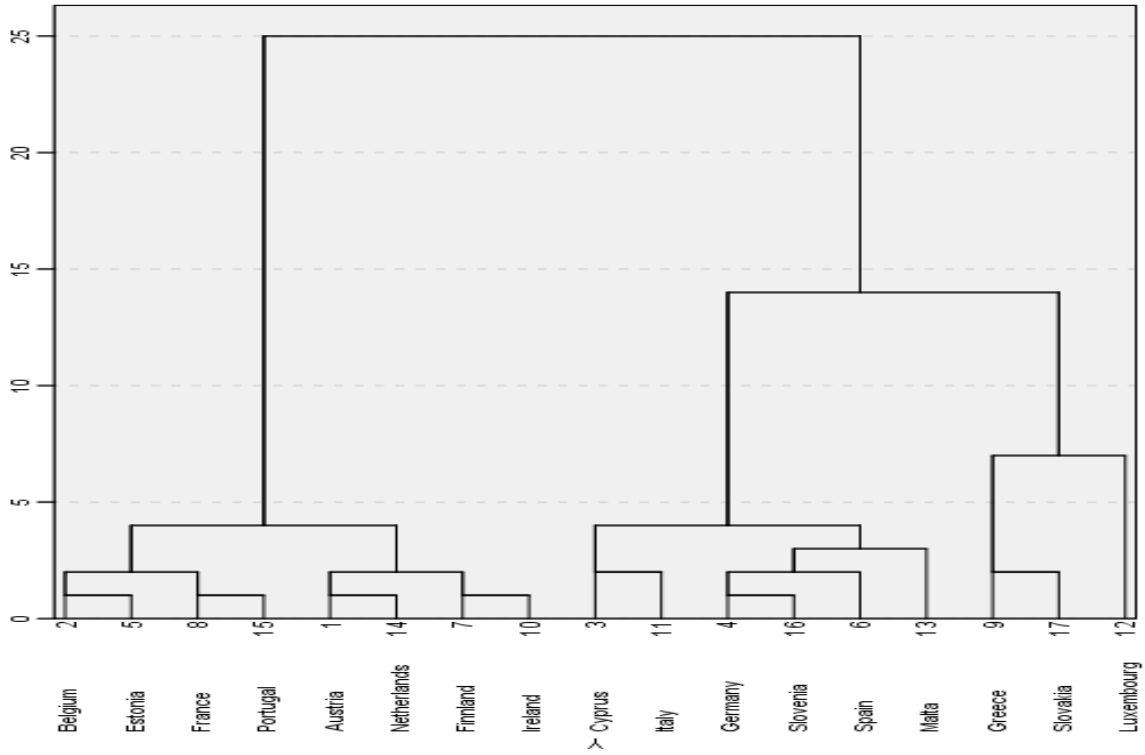
Graph 9: Dendogram of similarities between the OCA characteristics for the 2005



Source: Statistical software SPSS, own processing

These two main clusters form additional smaller and more similar clusters. The results indicate the existence of core and periphery. Bayoumi and Eichengreen (1997) divided the results of the OCA index in the group of countries suitable for adopting the single currency: Belgium, Austria, the Netherlands, and Ireland. Cluster analysis for 2005 confirms a similar result. According to our results, Germany falls into the second cluster and confirms the rather peripheral nature of this country, especially given the high differences in economic structure in comparison to the Euro area and its intense business ties outside of the monetary union.

Graph 10: Dendogram of similarities between the OCA characteristics for the 2013



Source: Statistical software SPSS, own processing

Comparing clusters from 2005 and 2013, Graph 10 also confirms a converging trend of countries Greece, Slovakia, and Italy which have moved from the less than similar cluster to the closer to the core of monetary union. Our results do not agree with Bayoumi and Eichengreen (1997) about the convergence nature of economies of Greece along with Ireland that fell into clusters. In turn, this suggested the slightest similarity in the development of the OCA characteristics of the analyzed Euro area member countries. There is a very similar trend of France and Germany, which is not surprising, given their weight in the Euro area. Along with Italy are the three largest Euro area economies developing, and the value of each OCA criteria is calculated in relation to the Euro area. Countries such as Austria, Belgium, and the Netherlands remained in the more or less same cluster. These small and open economies converged in the implementation of selected characteristics of the OCA characteristics.

5 Results and discussion

According to the results summarizing the OCA index, results of this thesis confirm the adequacy of some authors criticism concerning the static nature of the regression coefficients included in the calculation of the OCA index. This research proves that it is more important to analyse the development of individual parts of the OCA index than the actual OCA index as an aggregate (Rozmahel, 2006). This thesis confirmed the criticism of using the indicator SIZE in the OCA index due to different developments of GDP during construction of the OCA index (Horvath, Komarek, 2003). Regression coefficient of variable SIZE should be considerably smaller and relative to the current values of GDP. Results from the study of Bayoumi and Eichengreen (1997) confirm the conclusions of this thesis regarding the core group of the monetary union, to which belong Belgium, and Germany. Our results suggest sharp improvement variables OCA index variables after a certain period of participation in the monetary union. The concluding results of this thesis comply with results of the authors Bayoumi and Eichengreen (1997) on the converging nature of the countries of Greece, Spain and Portugal.

The following Table 14 shows values of the OCA index of 17 selected Euro area countries entering the equation for the period 2005-2014. Countries such as Austria, Belgium, Estonia, Ireland, Luxembourg, Malta, the Netherlands, Slovenia and Slovakia have among the lowest OCA index. We see that in comparison with the countries like Greece and Portugal (which are generally much worse values of the individual sub-variables) does not correspond to the actual development of the individual variables in the index. From the results we can see that these values do not correspond with reality. OCA index construction is not considered adequate for the current economic environment and we do not consider it an appropriate benchmark to assess the country to become a member of the monetary union.

Table 14: OCA index for period 2005-2009

SD(eij)	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Austria	0.040	0.038	0.037	0.037	0.039	0.039	0.035	0.037	0.035	0.035
Belgium	0.032	0.033	0.032	0.033	0.038	0.032	0.031	0.031	0.030	0.029
Cyprus	0.029	0.032	0.038	0.045	0.042	0.034	0.034	0.039	0.040	0.030
Germany	0.054	0.054	0.052	0.052	0.057	0.056	0.052	0.051	0.052	0.050
Estonia	0.030	0.029	0.022	0.047	0.035	0.033	0.026	0.024	0.019	0.017
Spain	0.055	0.053	0.054	0.055	0.060	0.056	0.052	0.051	0.051	0.052
Finland	0.040	0.038	0.042	0.039	0.044	0.048	0.041	0.043	0.042	0.040
France	0.055	0.056	0.055	0.056	0.057	0.055	0.056	0.055	0.054	0.053
Greece	0.055	0.053	0.050	0.059	0.060	0.070	0.067	0.053	0.048	0.046
Ireland	0.039	0.031	0.037	0.042	0.035	0.025	0.029	0.030	0.024	0.021
Italy	0.055	0.055	0.057	0.056	0.057	0.054	0.055	0.054	0.055	0.053
Luxembo-urg	0.004	0.004	0.002	0.009	0.007	-0.002	-0.001	-0.002	-0.003	-0.008
Malta	0.014	0.003	0.003	0.012	0.008	0.005	-0.005	-0.001	0.000	0.001
Netherla-nds	0.038	0.038	0.040	0.039	0.042	0.039	0.038	0.036	0.035	0.035
Portugal	0.045	0.043	0.042	0.044	0.045	0.044	0.044	0.052	0.040	0.038
Slovenia	0.031	0.031	0.046	0.039	0.035	0.024	0.026	0.022	0.020	0.021
Slovakia	0.025	0.027	0.026	0.028	0.030	0.023	0.022	0.023	0.019	0.022

Source: EUROSTAT, COMEXT, own processing

The estimated regression coefficients of the original equation index do not reflect the current economic development. Among other things, original equation index explains only 51% of the variability of the entire model according Bayomi and Eichengreen (1997). Comparing the results of the OCA index and to the alternative OCA calculation in relation to the Euro area, that the OCA calculation achieves slightly better results than the OCA index.

Table 15: Comparison of linear time trend analysis between SD, DISSIM, TRADE, SIZE, GL, and OPEN

	SD	DISSIM	TRADE	SL	GL	OPEN	MEAN	MEAN [17]
Austria	2	3	1	2	1	2	1.8	2
Belgium	2	1	1	1	2	1	1.3	1
Cyprus	2	2	1	2	2	2	1.8	2
Germany	2	1	1	1	1	1	1.2	1
Estonia	2	2	1	2	2	1	1.7	2
Spain	2	2	1	3	1	2	1.8	2
Finland	2	1	2	3	3	2	2.2	2
France	2	2	1	2	3	1	1.8	2
Greece	2	2	1	2	1	1	1.5	2
Ireland	2	2	1	1	2	1	1.5	2
Italy	2	2	1	1	1	2	1.5	2
Luxembourg	2	2	1	2	3	1	1.8	2
Malta	2	2	1	1	2	1	1.5	2
Netherlands	2	1	1	2	3	1	1.7	2
Portugal	2	2	1	3	1	1	1.7	2
Slovenia	3	2	1	2	1	1	1.7	2
Slovakia	3	2	1	2	2	1	1.8	2

Source: own processing

Values are rather invariable, but also improving. In the much longer term the effect of the monetary union may shift to a more positive direction of the OCA development. However it is possible that the development of the OCA criteria will turn to the opposite regarding of the alternative OCA calculation individual indicators. Therefore, the concluding remarks about the alternative OCA calculation are rather ambiguous when it comes to the business cycle synchronisation. The results from Table 15 showed that the intra-industry trade had much greater impact on the business cycle synchronisation, as the development of the intra-industry trade indicated in the panel data analysis. It demonstrated a strong and statistically significant effect of indicator GL on the business cycle synchronisation. The resulting average indicates the improving trend of the OCA characteristics, especially in countries as

[17] Rounded mean

Germany and Belgium. Rather unchanging values of the OCA characteristics are achieved by all other examined countries. There are no deteriorating values

6 Conclusion

The aim of this diploma thesis was to evaluate the applicability of the OCA index, which is used as a benchmark for assessing the benefits and costs associated with membership in a monetary union. One of the main questions was if the original equation (Bayoumi & Eichengreen, 1997) with already estimated regression coefficients is applicable to the current economic conditions.

Countries scoring the best partial values should rank the lowest OCA index (Belgium, Austria), but instead, they achieved much worse values than other countries in the OCI index. It concludes that the design of the OCA index is not considered adequate for the current economic environment, and we do not consider it an appropriate benchmark (in its original form) to assess if the country is suitable to become a member of the monetary union. The estimated regression coefficients of the original equation index do not reflect current economic development. Much valuable information can be gained from the development of individual parts OCA index, which represents the specific characteristics of the OCA.

Another aim was to assess the results of Bayoumi and Eichengreen's study (1997) on the division of the tested countries. According to their OCA index results, Austria, Belgium, Germany, the Netherlands, and Ireland belong to the core group. This thesis confirms that only Belgium and Germany belong to the core group. The results are in agreement on the converging nature of the countries Italy, Spain, and Portugal, which in the likeness of the performance characteristics of the OCA have moved closer to the core of the monetary union. According to our results, Greece, Italy, and Ireland moved to the closer to the core group. Our results also cannot confirm the results of the diverging nature of the OCA characteristics for France. In this country, there has been a convergence in the performance characteristics of the OCA with Euro area.

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8 Appendix

Appendix 1: Trade intensity (TRADE)

TRADE	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Austria	0,4244	0,4455	0,4598	0,4652	0,3992	0,4502	0,4781	0,4876	0,4863	0,4899
Belgium	0,5488	0,5699	0,5849	0,5979	0,5213	0,5774	0,6179	0,6302	0,6310	0,6435
Cyprus	0,4614	0,4605	0,4658	0,4523	0,4209	0,4474	0,4714	0,4835	0,5114	0,5237
Germany	0,3699	0,3973	0,4124	0,4167	0,3637	0,4065	0,4338	0,4485	0,4476	0,4523
Estonia	0,5108	0,5088	0,5134	0,5334	0,4787	0,5705	0,6424	0,6515	0,6540	0,6432
Spain	0,3046	0,3157	0,3259	0,3260	0,2881	0,3228	0,3543	0,3716	0,3799	0,3864
Finland	0,3825	0,4072	0,4174	0,4248	0,3561	0,3886	0,4055	0,4160	0,4142	0,4127
France	0,3131	0,3272	0,3330	0,3364	0,2951	0,3254	0,3487	0,3612	0,3627	0,3671
Greece	0,2878	0,2972	0,3100	0,3162	0,2696	0,3057	0,3374	0,3620	0,3731	0,3871
Ireland	0,5796	0,5865	0,6016	0,6205	0,6427	0,7108	0,7160	0,7546	0,7536	0,7922
Italy	0,3045	0,3225	0,3345	0,3343	0,2871	0,3211	0,3447	0,3615	0,3644	0,3714
Luxembourg	0,9867	1,0695	1,1183	1,1446	1,0074	1,0903	1,1378	1,1648	1,1980	1,2400
Malta	0,7031	0,8086	0,8451	0,9418	0,9134	0,9615	1,0085	1,0398	0,9991	0,9640
Netherlands	0,5143	0,5377	0,5488	0,5576	0,4905	0,5550	0,5965	0,6283	0,6333	0,6381
Portugal	0,3149	0,3409	0,3524	0,3551	0,3101	0,3446	0,3812	0,4071	0,4178	0,4239
Slovenia	0,4791	0,5148	0,5354	0,5300	0,4609	0,5166	0,5616	0,5851	0,5962	0,6063
Slovakia	0,5426	0,5977	0,6149	0,6007	0,5138	0,5780	0,6361	0,6775	0,6894	0,6830

Appendix 2: Business cycle synchronisation (SD)

SD	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Austria	0,0017	0,0017	0,0012	0,0014	0,0006	0,0028	0,0009	0,0022	0,0006	0,0005
Belgium	0,0010	0,0014	0,0006	0,0017	0,0025	0,0005	0,0007	0,0011	0,0003	0,0001
Cyprus	0,0016	0,0003	0,0040	0,0071	0,0053	0,0019	0,0032	0,0046	0,0075	0,0012
Germany	0,0006	0,0018	0,0007	0,0005	0,0026	0,0035	0,0015	0,0013	0,0014	0,0004
Estonia	0,0099	0,0074	0,0010	0,0177	0,0108	0,0100	0,0082	0,0061	0,0030	0,0029
Spain	0,0019	0,0006	0,0014	0,0016	0,0038	0,0026	0,0014	0,0013	0,0012	0,0016
Finland	0,0013	0,0008	0,0038	0,0017	0,0021	0,0059	0,0018	0,0034	0,0016	0,0004
France	0,0009	0,0019	0,0006	0,0010	0,0005	0,0005	0,0012	0,0015	0,0007	0,0001
Greece	0,0034	0,0020	0,0006	0,0051	0,0035	0,0140	0,0137	0,0055	0,0015	0,0010
Ireland	0,0092	0,0035	0,0076	0,0124	0,0079	0,0043	0,0070	0,0083	0,0050	0,0036
Italy	0,0011	0,0011	0,0027	0,0018	0,0011	0,0009	0,0013	0,0016	0,0019	0,0007
Luxembourg	0,0033	0,0054	0,0055	0,0102	0,0045	0,0012	0,0033	0,0033	0,0041	0,0020
Malta	0,0050	0,0017	0,0025	0,0081	0,0053	0,0053	0,0026	0,0053	0,0041	0,0040
Netherlands	0,0010	0,0013	0,0036	0,0024	0,0021	0,0014	0,0023	0,0020	0,0014	0,0014
Portugal	0,0036	0,0020	0,0015	0,0028	0,0024	0,0023	0,0040	0,0103	0,0028	0,0014
Slovenia	0,0059	0,0074	0,0173	0,0119	0,0067	0,0014	0,0044	0,0024	0,0015	0,0017
Slovakia	0,0040	0,0062	0,0054	0,0050	0,0033	0,0009	0,0017	0,0041	0,0023	0,0033

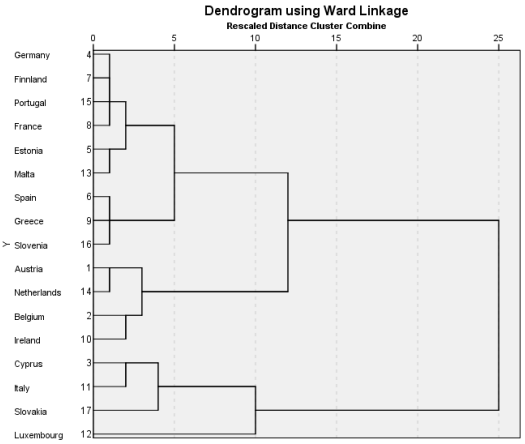
Appendix 3: Dissimilarity of export commodity structure (DISSIM)

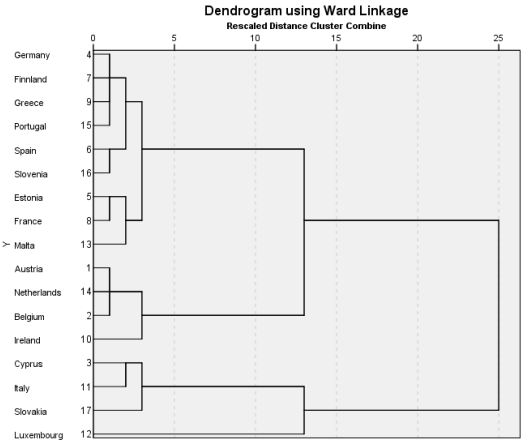
DISSIM	2005	2006	2007	2008	2008	2010	2011	2012	2013	2014
Austria	0,1121	0,0408	0,0522	0,0500	0,0285	0,0110	0,0091	0,0038	0,0358	0,0243
Belgium	0,0648	0,0884	0,1093	0,1093	0,0936	0,0996	0,1000	0,1028	0,0962	0,1153
Cyprus	0,3986	0,5772	0,5947	0,6545	0,5400	0,4853	0,4376	0,5888	0,5305	0,5139
Germany	0,1542	0,1186	0,1150	0,1199	0,1138	0,1012	0,0906	0,0921	0,1096	0,0908
Estonia	0,0583	0,1142	0,1951	0,2539	0,0871	0,2281	0,2024	0,2508	0,1909	0,0853
Spain	0,1834	0,1773	0,1590	0,1726	0,1655	0,1580	0,1348	0,1534	0,1579	0,1857
Finland	0,1172	0,0978	0,0926	0,1135	0,1393	0,1300	0,1263	0,1430	0,1794	0,1594
France	0,1147	0,1149	0,1274	0,1515	0,1269	0,1188	0,1559	0,1352	0,1310	0,1288
Greece	0,3904	0,3731	0,3583	0,4509	0,4987	0,3817	0,3201	0,3166	0,3991	0,3876
Ireland	0,0413	0,0578	0,0451	0,0232	0,0832	0,0297	0,0343	0,0715	0,0389	0,0327
Italy	0,1262	0,1292	0,1300	0,1280	0,1116	0,1014	0,1323	0,1427	0,1389	0,1441
Luxembourg	0,2478	0,2959	0,2844	0,3121	0,2808	0,2796	0,2863	0,2759	0,2522	0,2380
Malta	0,3211	0,2555	0,2833	0,5124	0,4953	0,4515	0,2730	0,3375	0,3172	0,3001
Netherlands	0,1217	0,1041	0,0685	0,0971	0,1168	0,1551	0,1696	0,1684	0,1520	0,1702
Portugal	0,0683	0,0976	0,1023	0,0981	0,0952	0,1315	0,1022	0,1155	0,0984	0,0856
Slovenia	0,0873	0,0412	0,0624	0,0556	0,0963	0,0621	0,0753	0,0456	0,0675	0,0889
Slovakia	0,0244	0,0343	0,0496	0,0658	0,0833	0,0740	0,0646	0,0532	0,0411	0,0474

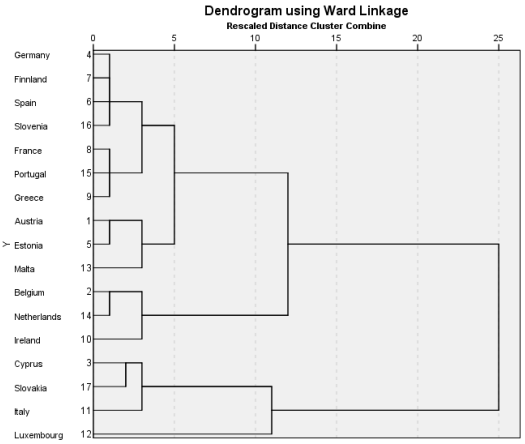
Appendix 5: Size of the economy

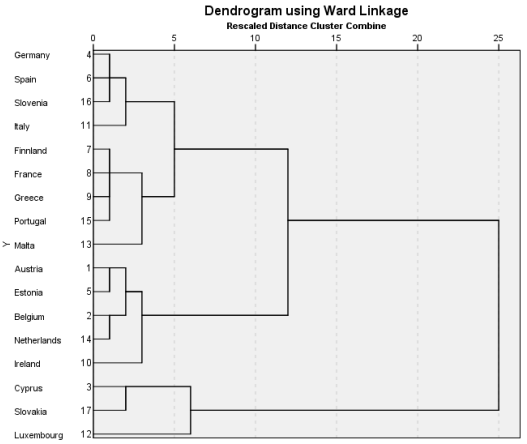
SIZE	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Austria	12,3305	12,3752	12,4239	12,4490	12,4246	12,4490	12,4806	12,4939	12,5061	12,5222
Belgium	12,4208	12,4637	12,5106	12,5329	12,5105	12,5421	12,5699	12,5809	12,5911	12,6074
Cyprus	11,1019	11,1575	11,2150	11,2584	11,2347	11,2612	11,2823	11,2821	11,2539	11,2450
Germany	13,2892	13,3286	13,3734	13,3923	13,3589	13,3914	13,4230	13,4328	13,4474	13,4693
Estonia	10,9790	11,0806	11,1839	11,2017	11,1185	11,1476	11,2131	11,2481	11,2761	11,3048
Spain	12,8961	12,9530	13,0069	13,0315	13,0010	13,0135	13,0207	13,0110	13,0104	13,0221
Finland	12,1432	12,1866	12,2440	12,2709	12,2257	12,2518	12,2854	12,2933	12,3052	12,3169
France	13,1758	13,2175	13,2622	13,2839	13,2555	13,2804	13,3049	13,3122	13,3227	13,3335
Greece	12,2267	12,2878	12,3399	12,3676	12,3436	12,3339	12,3072	12,2742	12,2532	12,2539
Ireland	12,1577	12,2166	12,2677	12,2569	12,1969	12,2002	12,2316	12,2354	12,2510	12,2812
Italy	13,1005	13,1395	13,1799	13,1965	13,1646	13,1851	13,2054	13,2004	13,2024	13,2119
Luxembourg	11,4006	11,4734	11,5386	11,5595	11,5274	11,5766	11,6168	11,6320	11,6649	11,6939
Malta	10,6385	10,6808	10,7334	10,7711	10,7560	10,7992	10,8287	10,8511	10,8807	10,9122
Netherlands	12,6642	12,7124	12,7608	12,7894	12,7586	12,7801	12,7993	12,8024	12,8105	12,8260
Portugal	12,1278	12,1703	12,2174	12,2363	12,2121	12,2348	12,2371	12,2191	12,2282	12,2438
Slovenia	11,3933	11,4487	11,5191	11,5630	11,5262	11,5391	11,5582	11,5489	11,5522	11,5763
Slovakia	11,5209	11,6066	11,7220	11,8023	11,7729	11,8083	11,8390	11,8526	11,8653	11,8829

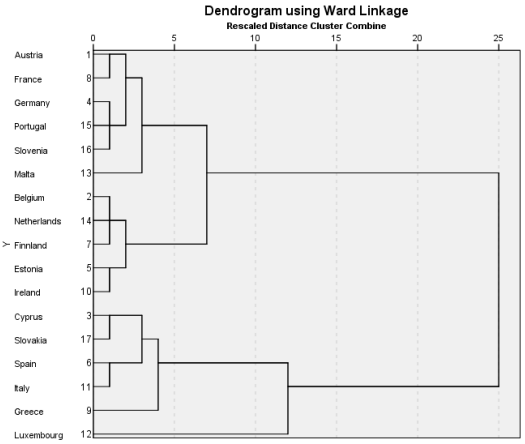
Appendix 5: Dynamic cluster analysis 2005-2013

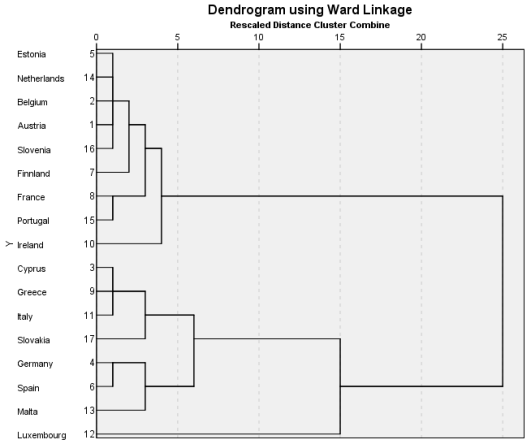


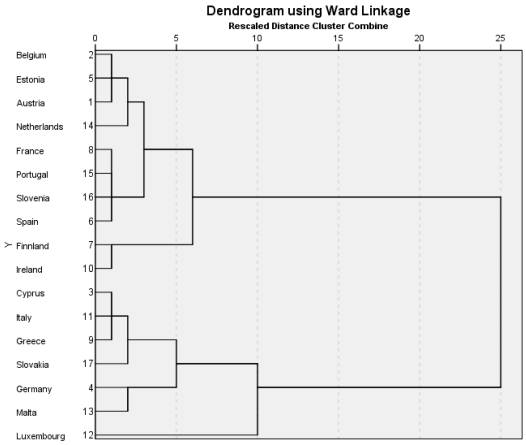


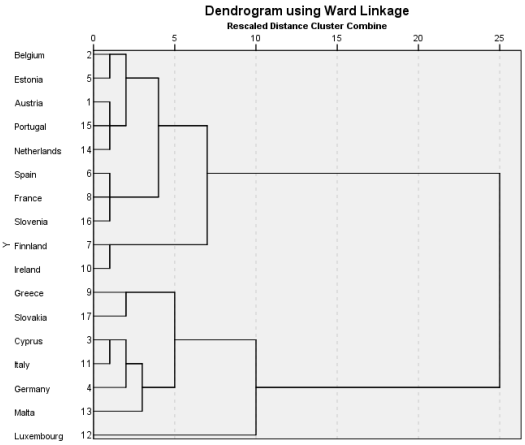


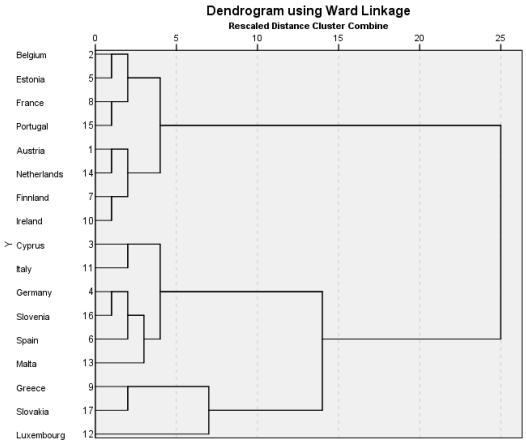







Dendrogram using Ward Linkage
Rescaled Distance Cluster Combine
0 5 10 15 20 25
Belgium 2
Estonia 5
Austria 1
Netherlands 14
France 8
Portugal 15
Slovenia 16
Spain 6
Finnland 7
Ireland 10
Cyprus 3
Italy 11
Greece 9
Slovakia 17
Germany 4
Malta 13
Luxembourg 12


Dendrogram using Ward Linkage
Rescaled Distance Cluster Combine
0 5 10 15 20 25
Belgium 2
Estonia 5
Austria 1
Portugal 15
Netherlands 14
Spain 6
France 8
Slovenia 16
Finnland 7
Ireland 10
Greece 9
Slovakia 17
Cyprus 3
Italy 11
Germany 4
Malta 13
Luxembourg 12


Dendrogram using Ward Linkage
Rescaled Distance Cluster Combine
0 5 10 15 20 25
Belgium 2
Estonia 5
France 8
Portugal 15
Austria 1
Netherlands 14
Finnland 7
Ireland 10
Cyprus 3
Italy 11
Germany 4
Slovenia 16
Spain 6
Malta 13
Greece 9
Slovakia 17
Luxembourg 12