

The Assessment of Convergence in the EU Using the Optimum Currency Area Index

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Abstract

Structural convergence is a crucial requirement of functioning economic and monetary integration in the European Union (EU). It can be overall examined using the Optimum Currency Area (OCA) index. The OCA index can be used as a tool for assessing the possibilities of successful working of countries in the single currency area and can help to avoid some negative effects of entering unsuitable countries to euro area. However, it is also used to assess the level and development of structural convergence in the EU in general. It can be then interpreted as a “level of convergence or variability” of particular EU country in relation to comparative economy. The OCA index is computed for EU members using panel regression in the period 1999-2009. Particular components of OCA index are also important factors of convergence. Other factor that is able to influence the development of the OCA index is the hypothesis of endogeneities of OCA. External shocks have influence on convergence and development of OCA index as well. There arises the necessity to assess the euro area entry possibilities of non-members carefully due to problems of current euro area. Countries can benefit from participation in euro area. The most important long-term impact of deepening integration and particularly euro area membership is the impact on economic growth. However, the level of structural convergence can be crucial for it. The aim of this paper is using the OCA index to assess the convergence in terms of OCA in the EU and describe aspects of global financial crisis for convergence process as well.

Keywords: Optimum Currency Area, Economic Shock, Convergence, Hypothesis of Endogeneities

JEL codes: F15

1. Introduction

It is possible to assess convergence of EU economies in several ways. One possibility is the usage of the Optimum Currency Area (OCA) theory that focuses on assessment of benefits and costs of monetary integration. It also introduces analyses focused on the choice of exchange rate regime. There are many criteria of the OCA. More of these criteria lead to contradictory results. So, it is not possible to satisfy all the criteria (or more of them) simultaneously. Moreover, the values for criteria are not quantified exactly. It is thus not possible to determine the threshold between insufficient and sufficient convergence. For that reason I chose the construction of OCA index that enables to quantify convergence according to the OCA theory. The level and development of convergence is described by the number or its development. This OCA index is computed by panel regression and it is instrumental in assessing the convergence and suitability of country for monetary union. However, index should be interpreted carefully due to complex mutual relations among variables, endogenous criteria, and

reciprocal causality between variables and so on. It is also necessary to analyse the component indices that are factors of convergence according to OCA as well. These are not analysed in depth considering the extent of paper. However, they are taken into account in suitable context. The chapter describing the hypothesis of endogeneity (endogeneities) is completed to explain some other links among convergence criteria in depth. The aspects of global financial and economic crisis are considered as well. The whole analysis is focused on EU countries. The aim of the paper is to analyse the convergence in the EU using the OCA theory and OCA index, analyse the aspects of hypothesis of endogeneity and aspects of global economic crisis for convergence in the EU.

The monetary union is considered as the area with common currency, mostly in connection with the euro area. However, the highest integration level in the EU is the Economic and Monetary Union (EMU) and the members are not only euro area countries.¹ Asymmetric shocks are the changes in the aggregate demand or supply that affect only some countries of euro area or all countries but with opposite effect. These are also shocks that affect all countries in the same way but with different intensity. Asymmetric shock also arises in the case of similar event with various impacts on aggregate demand or supply of economies or with various responses of economies to shock. Idiosyncratic shock is specific to economy without immediate impact on other countries. The opposite of asymmetric shock is the symmetric shock. Convergence is regarded as converging of EU economies that reduces the differences in especially macroeconomic indicators. Convergence measured by OCA criteria is often referred to as structural convergence. It can be understood as convergence of economic structures of economies. It is also necessary to take into account the real convergence mainly in connection with the euro area entry. It can be defined as the convergence of real GDP per capita of economies. Other important part of convergence is the nominal convergence that is also important for the membership in monetary union. It can have more meanings such as convergence of comparable price levels of economies or convergence of other nominal variables, especially Maastricht convergence criteria. Terms “euro area” and “Eurozone” are used as substitutes.

2. The origins, development and criteria of the OCA

2.1 A brief development of the OCA theory and criteria of the OCA theory

The early OCA theory was completely defined between the early sixties and mid-seventies. Since problems and limitations associated with analytical framework appeared it fell into disuse between the mid-seventies and eighties. The following years lead to an elimination of shortcomings and progress in the development of econometric techniques used to explore various aspects and factors of the OCA. So-called new theory of the OCA begins to develop. Overall, the research in the OCA theory developed at macroeconomic and microeconomic level, see Kučerová (2005). The microeconomic research explores market imperfections and rigidities, their impact on the exchange rate regime choice and it gives the theory microeconomic basics. Macroeconomic research explores the development of real and nominal exchange rates and problems of exchange rate regime choice. The second direction of the macroeconomic research focuses on analysis of economic shocks and their correlation. The following section is focused on the convergence criteria and their development within the OCA theory.

¹United Kingdom and Denmark have “opt out” clause from the third phase of EMU.

The OCA theory is based on original works of Mundell (1961), McKinnon (1963) and Kenen (1969). Three basic criteria that these authors defined within the theory are the mobility of production factors analysed by Mundell (1961), openness of economy included by McKinnon (1963) and diversification of production which was brought into the theory by Kenen (1969). Achieving of a high level of performance of these basic criteria by economies means that the benefits from participation in monetary union exceed the costs associated with it. Performance criteria may lead to the creation of the optimum currency area (OCA). Among the key criteria of the OCA theory from its early period we can include mobility of production factors, size and openness of economies, diversification of commodity production and consumption, price and wage flexibility (variability of real exchange rate), similarity of inflation rates and further factors that together with mobility of production factors can be classified as adjustment mechanisms to asymmetric shocks. These criteria are the integration of financial markets, fiscal and political integration. Within the modern theory of evolution in the nineties, after a period of lower interest about issues in the seventies and eighties, deepen the effort to quantify the performance criteria and to find appropriate indicators. Renewed interest into the theory is associated with the third phase of EMU which dates to the nineties. In this period another OCA criteria were defined, namely, synchronization of business cycles and the similarity (symmetry) of shocks and also the structural similarity of the economies are emphasized. All mentioned criteria can be applied as criteria of convergence in the EU and especially for assessing benefits and costs of monetary union.²

2.2 The hypothesis of endogeneity (endogeneities) and exogeneity of the OCA criteria

Assuming that the criteria are endogenous, a better convergence and higher levels of performance criteria for the deepening of integration, i.e. and joining the monetary union, can be achieved. There are several sources of endogeneity of convergence criteria (OCA). Endogeneity hypothesis of OCA criteria refers to the trade between economies. When talking about the endogeneities of the OCA criteria, other areas of endogeneity working than trade are considered. These include the endogeneity of financial integration, i.e. financial markets, the endogeneity of symmetry of shocks and synchronization of output, which are closely related to the endogeneity of trade endogeneity of labor market flexibility, endogeneity of foreign direct investments (FDI), which covers for example Warin et al. (2008). This hypothesis is further shifting the OCA theory. Endogeneity hypothesis (endogeneities) reduces the relevance of evaluating the development of convergence criteria ex post, because they are endogenous. It is the application of Lucas critique. This criticism is associated with the theory of rational expectations and stresses that economic subjects have also expectations in relation to economic policy. When assuming rational expectations, economic-political authorities are not able to eliminate the arising shocks. So, it is not possible to make conclusions about future from analysis of the historical data.

In addition to the hypothesis of endogeneity there is an exogeneity hypothesis of the OCA theory, (Mongelli, 2008). The OCA exogeneity is based on an assumption that institutional factors support the implementation of the OCA criteria, in other words, structural reforms in many areas. Specifically, just preparation for the EMU and adoption of the euro has intensified structural reforms implemented by EU institutions. Countries reaching worse values of the OCA indicators than others will be probably put under significant pressure from the European Commission, ECB etc. and they

² Lacina et al. (2007) or Mongelli (2008) summarize the OCA criteria which are the output of the traditional approach to the OCA theory. However a detailed description is beyond the scope of this article.

will be more motivated to structural reforms. There is a significant relationship between institutional and economic integration. Institutional integration promotes trade integration. Trade integration strengthens the institutional one as well, however, to a lesser extent (Mongelli, Dorucci, 2005). The emphasis in relation to a further continuation of EMU is put upon the structural reforms on product and labor markets of economies. If the idea of endogeneity and exogeneity in their interdependence is further developed, there is an opinion that these reforms will be continuing, because there is no other alternative. When there is a loss of autonomous monetary policy, economies must strengthen their market mechanisms to effectively face asymmetric shocks (Mongelli, 2008). However, this is an optimistic view. Many euro area countries still show significant price and wage rigidities or imperfect competition in important sectors and measures taken are still inadequate.

2.3 The background for measuring convergence using the OCA index

Bayoumi and Eichengreen (1997), who first used the OCA index, talk about a symbiotic relationship between economic and monetary integration. They claim that countries where completion of single market (SM) led to the most significant increase in bilateral trade have experienced the highest increase in their readiness for the monetary integration according to the OCA index. So, the economic integration increased the readiness for the monetary integration. Conversely, if a stable exchange rate supports trade, monetary integration has deepened the economic integration in the presence of the European Monetary System within the EC. The final argument is that the EMU and SM can create a virtuous circle in which the individual components reinforce each other. Derived aspects justify usage of the index. However; it is necessary to analyze many others factors which complicate its interpretation.

3. The application of the OCA index for exploring the convergence within the EU

3.1 Methodology

In the OCA index there is described and used as an explained variable the nominal exchange rate volatility of two economies. However, the value of index is interpreted as a level of convergence among the studied economics. Based on resulting values the index shows whether benefits from the adoption of a common currency exceed the associated costs. In more general sense it is a tool for the assessment of structural convergence in terms of the OCA theory using certain criteria of the OCA theory. The index is calculated via panel regression, a model with fixed effects. The OCA index can be calculated for a pair of economies or in relation to average value of group of countries. This is relevant within the EU and euro area. The original equation which is used by Bayoumi and Eichengreen (1997) has the following form:

$$SD(er_{ij}) = \alpha + \beta_1 * SD(\Delta y_{ij}) + \beta_2 * DISSIM_{ij} + \beta_3 * TRADE_{ij} + \beta_4 SIZE_{ij} + \mu_{ij} \quad (1)$$

$SD(er_{ij})$ expresses the volatility of bilateral exchange rate (it is a standard deviation of the change in the logarithm of the end-year nominal exchange rate between economies i and j). $SD(\Delta y_{ij})$ captures asymmetric shocks at a national level (standard deviation of the difference in the logarithm of real output between economies i and j). $TRADE_{ij}$ is an indicator of the intensity of trade relations (average share of bilateral exports of countries i and j to GDP). $DISSIM_{ij}$ evaluates asymmetric shocks at the sectoral level (sum of absolute differences of shares of agriculture, mineral and manufacturing trade of countries i and j in overall bilateral trade). $SIZE_{ij}$ represents size of economy and evaluates the benefits

from maintaining/abandonment of its own national currency (arithmetic average of logarithms of GDP countries i and j).

Modified alternative of the relationship that includes openness of economies rather than their size should be taken into account (openness of economies is the basic criteria of the OCA theory) as well:

$$SD(er_{ij}) = \alpha + \beta_1 * SD(\Delta y_{ij}) + \beta_2 * DISSIM_{ij} + \beta_3 * TRADE_{ij} + \beta_4 * OPEN_{ij} + \mu_{ij} \quad (2)$$

Variable $OPEN_{ij}$ expresses openness of the economy. It is calculated as the average share of trade (export + import) of i and j country to their GDP. Modification of the relationship was used by Horvath and Komarek (2003) or Horvath, Komarek and Čech (2003).

The volatility of nominal exchange rate of economies interpreted as a level or move of convergence of economies reflecting their benefits of joining monetary union depends proportionally upon the existence of asymmetric shocks at the national level which is expressed by the value $SD(\Delta y_{ij})$. It depends also on asymmetric shocks at sectoral level represented by the value $DISSIM_{ij}$, which describes inequality in the export commodity structure. Lower values of variables indicate greater similarity of economic shocks (and also structures especially in the case of $DISSIM_{ij}$) of economies. The higher symmetry of shocks leads to lower costs from loss of its own monetary policy. Proportional dependence is also typical for the size of the economy ($SIZE_{ij}$). However, its interpretation is slightly different. It represents benefits of single currency and these are generally higher for the larger economy than smaller economy. The single currency compared with the national is more significant from an international perspective. The lower is the value of the indicator $SIZE_{ij}$, the higher are the benefits of the single currency. The exchange rate volatility is inversely dependent on trade linkages ($TRADE_{ij}$). Higher values of the indicator mean higher mutual trade. The benefits should arise mainly from the reduction of the exchange transaction cost.

It is possible to flexibly adapt the index construction to the purpose of analysis, to include also other criteria of the OCA theory or convergence criteria generally. It can be summarized that the OCA index value indicates the extent of variability or convergence. The lower the index value is, the higher level of structural convergence between economies is achieved and therefore they are structurally suitable for creating the monetary union. It is necessary to follow the development of its sub-indices. Bayoumi and Eichengreen (1997) indicate the existence of a core and periphery within the EU (euro area), while Horvath and Komarek (2003), respectively, Horvath and Komarek and Cech (2003) do not confirm such significant differences between them. From recent studies work of Vieira C. and Vieira I. (2011) can be pointed out. It uses the OCA index in its original establishment as compiled by Bayoumi and Eichengreen (1997), monitoring development of the index at the time at economies of the EU (excluding Luxembourg) and Switzerland and Norway in relation to Germany. Moreover, they are associating values of the OCA index in 1998 with fiscal characteristics and the characteristics of the external balance in specific economies in 2009. Thus, the index is used as a tool for the prognosis of certain trends in convergence and successful functioning of the economies in a monetary union also in connection with competitiveness.

3.2. The results of the analysis

3.2.1 The results of three models of the OCA index

This section presents three models of the OCA index expressed by three equations where two are the result of my own analysis using a panel regression. Below each equation there is a table with added values of the OCA index for the whole period 1999-2009, sub-periods and two partial years.

Compared to the above mentioned works dealing with the OCA index starting from Bayoumi and Eichengreen (1997) I used in the calculation of the OCA index certain modifications due to some problems with data. In the period 1999-2009, for which the data to calculate the index of OCA were available, have already most of the older member states joined the Eurozone. Eleven economies were members since 1999, Greece joined two years later and five of the twelve new member states joined gradually euro area in the following years. Instead of explaining the variable $SD(er_{ij})$ which is the nominal exchange rate variability I used the variable $SD(neer_{ij})$. Variable $SD(neer_{ij})$ is the variability of NEER index (nominal effective exchange rate or currency index weighted by trade) which monitors changes in currency values in relation to the country's main trading partner. It is calculated as a weighted geometric average of bilateral exchange rates against the currencies of these partners. There was also used variable $OPEN_{ij}$ from modification of Horváth and Komárek (2003). On the contrary, I have not included in the final model variables $TRADE_{ij}$ and $SIZE_{ij}$ because they were statistically insignificant. However, the economic significance of bilateral trade is important for convergence too.

The first method used for the assessment of convergence used in this work was based on substituting the values of sub-indicators of the OCA index in equation (1) in general and the equation (3) specifically, what is the equation of the OCA index derived by Bayoumi and Eichengreen (1997).

$$SD(er_{ij}) = -0,09 + 1,46 \times SD(y_{ij}) + 0,022 \times DISSIM_{ij} - 0,054 \times TRADE_{ij} + 0,012 \times SIZE_{ij}$$

n = 210; R² = 0,51; (3)

Table 1 contains the resulting values of the index obtained from the equation (3). It is possible to follow the development of the index, while two sub-periods 1999-2003 and 2004-2009 were selected. In table 1 there are values of the OCA index for each of the EU economy for the whole period 1999-2009, base year in 1999 and last observed year 2009. Four groups of EU economies are color-coded in all three tables (1, 2, and 3).

Table 1: Index OCA calculated by substituting data into equation (3) with the EU-27 for 27 Member States EU1999 and 2009, the average of 1999-2009, 1999-2003 and 2004-2009 averages

Ek.	1999	Ek.	2009	Ek.	1999-2009	Ek.	1999-2003	Ek.	2004-2009
BE	0,07276	CZ	0,06648	BE	0,072794808	BE	0,071788521	BE	0,073633381
LT	0,07573	SK	0,06649	AT	0,08066687	CZ	0,077427338	NL	0,079889957
HU	0,07686	MT	0,07083	NL	0,081904935	AT	0,080489151	AT	0,08081497
AT	0,0769	LU	0,07384	DK	0,087321894	SL	0,084038476	MT	0,083593397
DK	0,08265	NL	0,07909	HU	0,087490381	NL	0,084322909	HU	0,08583302
FI	0,08617	AT	0,07931	CZ	0,088405844	FI	0,085600666	DK	0,087884156
CZ	0,08694	BG	0,08756	PT	0,090181655	DK	0,08664718	LU	0,089997172
FR	0,08909	BE	0,09094	SE	0,091257445	PT	0,08751998	SE	0,091380049
BG	0,08996	DK	0,09144	FR	0,092587487	HU	0,089479213	PT	0,092399717
PT	0,09039	ES	0,09246	LU	0,093384404	FR	0,089630997	ES	0,094456662
GR	0,09257	SE	0,09398	CY	0,093938622	CY	0,090629023	FR	0,095051229
SL	0,09417	DE	0,09423	SL	0,094110474	SE	0,091110321	DE	0,096027086
UK	0,09467	UK	0,10202	FI	0,094743835	PL	0,092641578	CY	0,096696621
NL	0,09628	IT	0,10259	UK	0,097763487	SK	0,093415424	UK	0,097065336
SE	0,09701	HU	0,10297	ES	0,098813527	LU	0,097449082	CZ	0,0975546
CY	0,09736	PT	0,10385	DE	0,099117296	UK	0,098601269	FI	0,102363142
SK	0,0984	CY	0,10673	MT	0,099403428	IT	0,099073031	SL	0,102503806
PL	0,10066	FR	0,10993	IT	0,102922101	DE	0,102825549	GR	0,103918961
DE	0,10318	RO	0,11606	SK	0,104781652	ES	0,104041764	IT	0,10612966
EE	0,10395	GR	0,11753	GR	0,108778	BG	0,106927761	SK	0,114253509
ES	0,10602	SL	0,12069	PL	0,111006639	GR	0,114608846	BG	0,121485311
IT	0,1101	IE	0,13552	BG	0,114868242	MT	0,118375464	IE	0,124603104

MT	0,117296	FI	0,13906	RO	0,129058217	RO	0,123266703	PL	0,126310857
LV	0,12582	PL	0,16388	IE	0,131837777	LT	0,130169867	RO	0,133884478
RO	0,12822	EE	0,21084	EE	0,139709803	EE	0,130992563	EE	0,14697417
LU	0,13699	LV	0,2343	LV	0,142376483	LV	0,133029758	LV	0,150165421
IE	0,17285	LT	0,28852	LT	0,161139189	IE	0,140519385	LT	0,186946957

Source: Eurostat, own calculations

The so-called core economies are highlighted in pink and I include here also countries which are traditionally referred to this attribute: Germany, Austria, Belgium, Netherlands, Luxembourg and France, and I include another original EC country here, i.e. Italy and the Nordic economies, which is difficult to put into any particular group, i.e. Finland. The second group is the older Member States outside the euro area: United Kingdom, Denmark, Sweden, indicated in blue. Other older Member States are classified as cohesive economies, i.e. Greece, Spain, Portugal and Ireland and they are highlighted in yellow color. New Member States are highlighted in purple.

Equation (3) does not include variable $OPEN_{ij}$, but it works with variables $TRADE_{ij}$ and $SIZE_{ij}$ which in my own specification of the appeared to be statistically insignificant and therefore it is clear that the results will differ to some extent. The inclusion of variables $SIZE_{ij}$ as an explanatory variable with a positive sign increases the value of the OCA index for large economies and in the upper parts of table 1 with lower index values are rather small core EU economies. This is justified by the greater contribution of the single currency for small economies. However, participation of large and significant economies, such as Germany or France, is essential for the monetary union and stability of the monetary union. Overall, the small core economies (Belgium, Netherlands, Luxembourg, and Austria) achieve the lowest values of the OCA index. Most of the new Member States can be found at the bottom of table 1, i.e. with a high index values. This is particularly valid for the Baltic economies, Bulgaria, Romania and Poland. An exception from the new Member States is particularly Hungary, which is consistent with the conclusions of several authors about the highly cyclical consistency of economy with the EU and the euro area. Low values of ĀR, Malta and Slovakia in 2009 should be interpreted carefully. There was a reduction in the indicator $SD(\Delta y_{ij})$, i.e. higher synchronization of development of the real GDP in that period which can be largely attributed to the economic crisis.

The following table 2 shows calculations of the OCA index obtained by substituting into equation (4), which was one of the best estimates for the model designed for calculation of the OCA index. The aim was to include as many explanatory variables of the original equation of Bayoumi and Eichengreen (1997). However, the alternative equation seemed to be more preferable specification, i.e. without variable $SIZE_{ij}$ and instead with $OPEN_{ij}$ indicator. Equation (4) expresses the model of dependence of NEER variability only on $OPEN_{ij}$ and $DISSIM_{ij}$. The second model expressed by Equation (5) includes standard deviations of the relative output $SD(\Delta y_{ij})$ as explanatory variables. In equation (4) there are used the natural logarithms of explanatory variables and in equation (5) the absolute values. The interpreted variable is in both models in the form of natural logarithms.³ Indicator $TRADE_{ij}$ in both models is statistically insignificant. Conversely, $OPEN_{ij}$ indicator is statistically significant and has a negative sign. Between the sum of exports and imports to GDP of economies and NEER variability of nominal exchange rate with the EU-27 shows the negative correlation. The first alternative of the OCA index resulting from my own analysis is expressed by equation (4). Table 2 contains the resulting index values obtained from equation (4).

$$SD(neer_{ij}) = - 3,98096 + 0,9398 \times DISSIM_{ij} - 1,9399 \times OPEN_{ij} \quad (4)$$

n = 297; R = 0,593;

³ For equation (4) and (5) the OCA index is designed in the following way: index $OCA = e^{\ln SD(neer_{ij})}$

Table 2: The OCA Index calculated by substituting data into equation (4) with the EU-27 for 27 Member States of EU1999 and 2009, the average of 1999-2009, 1999-2003 and 2004-2009 averages

Ek.	1999	Ek.	2009	Ek.	1999-2009	Ek.	1999-2003	Ek.	2004-2009
LU	0,004218707	LU	0,002752	LU	0,002683755	LU	0,002988288	LU	0,00243
BE	0,004864333	MT	0,004928	BE	0,00438923	BE	0,004352117	BE	0,00442
SK	0,005992296	BE	0,005555	SK	0,004994557	SK	0,005319149	SK	0,004724
IE	0,006360532	DE	0,005628	NL	0,005902867	CZ	0,006382659	AT	0,005061
CZ	0,006735766	AT	0,005959	AT	0,005951031	NL	0,006467305	MT	0,005332
MT	0,006790105	NL	0,005988	MT	0,006077904	IE	0,006921493	EE	0,005409
NL	0,006872459	FR	0,006403	CZ	0,006191258	MT	0,006973556	NL	0,005433
HU	0,007116449	SE	0,006641	EE	0,00632514	AT	0,007019005	SE	0,005538
SE	0,007292164	SK	0,006896	SE	0,006985501	HU	0,007388404	DE	0,005965
AT	0,00822396	SL	0,007314	FR	0,007424816	EE	0,007424202	FR	0,005971
EE	0,009862638	CZ	0,007417	DE	0,007440205	SE	0,008722228	CZ	0,006032
FR	0,010165964	EE	0,007803	HU	0,007633768	FR	0,009169571	SL	0,006445
DE	0,011087999	HU	0,007895	SL	0,007976635	DE	0,009210025	HU	0,007838
SL	0,011572915	ES	0,010211	ES	0,008870464	ES	0,009640936	ES	0,008228
ES	0,011744632	DK	0,010316	IE	0,009108649	SL	0,009814816	PL	0,008245
UK	0,013159714	PL	0,010405	DK	0,010939671	UK	0,011922844	DK	0,009857
K	0,013990286	IE	0,011981	UK	0,011406072	DK	0,012238367	IE	0,010931
FI	0,016640849	IT	0,012254	PL	0,012001384	IT	0,014624177	UK	0,010975
IT	0,016812199	LV	0,012308	IT	0,012854921	FI	0,014727352	LV	0,011229
BG	0,017840369	FI	0,013391	LV	0,013636112	PL	0,016508863	IT	0,011381
PT	0,018861802	LT	0,013678	FI	0,01366602	LV	0,016524886	CY	0,011956
LV	0,020366324	UK	0,013757	CY	0,015131745	PT	0,017709093	FI	0,012782
CY	0,020956672	CY	0,013969	PT	0,015627197	BG	0,018808299	PT	0,013892
PL	0,024342274	BG	0,014715	BG	0,016137263	CY	0,018942424	BG	0,013911
LT	0,032094976	PT	0,016474	LT	0,02185068	LT	0,028973929	LT	0,015915
GR	0,040072535	RO	0,016594	RO	0,022793268	RO	0,029971355	RO	0,016812
RO	0,040278534	GR	0,025446	GR	0,027709154	GR	0,032467972	GR	0,023743

Source: Eurostat, own calculations

The second alternative of the OCA index resulting from my own analysis is expressed by equation (5). It includes also the explanatory variable $SD(\Delta y_{ij})$. Although a different interpretation from the point of view of different models creating can be used (natural logarithms or absolute values of variables are used), it is not necessary to pay attention i.e. deal with comparison of index values between two alternative models in details with respect to alternatives in the explanatory variables. Conversely, in the particular model is relevant to analyze the sequence and changes of index values over time. Decrease of values means variability reduction, respectively, convergence between the economies of the observed indicators of convergence in terms of the OCA theory. Tab. 3 contains the resulting values for the OCA index derived from equation (5).

$$SD(neer_{ij}) = - 3,9309 + 9,8202 \times SD(y_{ij}) + 2,6385 \times DISSIM_{ij} - 2,2311 \times OPEN_{ij} \quad (5)$$

n = 297; R = 0,608;

Table 2 and 3 show that even without the inclusion of variable $SIZE_{ij}$ from the original equation of Bayoumi and Eichengreen (1997) small core economies achieve low OCA index values again. Cohesive economies once again achieve high levels of the OCA index, and the low convergence is by using equation (4) and (5) more visible. For the new member states resulted from equation (3) the highest levels of variability for the Romania, Bulgaria, Latvia, Lithuania and Poland and Cyprus reach the highest index values resulting from these models of the OCA index. Slovenia, Hungary and

Estonia are located around the central parts of tables based on equations (4) and (5), i.e. they reach average values of the EU. Among the new member states remain three economies which achieve the lowest values of the OCA index using equation (4) and (5). These are Malta, Slovakia and ČR. Index values of the previous trio of economies are often similar and sometimes even lower. There arises the importance of development of index to assess the convergence. The decrease of index means convergence or lowering the variability in relation to EU.

Table 3: The OCA Index calculated by substituting data into equation (5) with the EU-27 for 27 Member States EU1999 and 2009, the average of 1999-2009, 1999-2003 and 2004-2009 averages

Ek.	1999	Ek.	2009	Ek.	1999-2009	Ek.	1999-2003	Ek.	2004-2009
LU	0,003854	LU	0,001125	LU	0,001499191	LU	0,001990893	LU	0,001089439
BE	0,004149	MT	0,003939	BE	0,003495335	BE	0,003589624	BE	0,003416761
HU	0,006069	NL	0,004744	NL	0,004839948	SK	0,005252853	NL	0,004329992
NL	0,0063	BE	0,004823	SK	0,005069258	NL	0,005451895	MT	0,00453438
SK	0,006389	AT	0,005381	AT	0,005404882	CZ	0,005599322	AT	0,004691894
CZ	0,006444	SK	0,00545	CZ	0,005597677	AT	0,006260467	SK	0,004916262
AT	0,007005	CZ	0,0057	MT	0,006056946	HU	0,006878938	SE	0,005559098
SE	0,007506	DE	0,005836	SE	0,006585882	SE	0,007818022	CZ	0,005596306
MT	0,00765	SE	0,006346	HU	0,006955968	MT	0,007884025	DE	0,005878376
FR	0,008659	HU	0,007874	DE	0,007021444	FR	0,008054806	SL	0,006534028
IE	0,009508	FR	0,008029	FR	0,007359466	DE	0,008393126	FR	0,006780016
DE	0,009606	SL	0,008531	SL	0,007635424	IE	0,008510013	HU	0,00702016
UK	0,010097	ES	0,008784	ES	0,008415292	SL	0,008957099	ES	0,007733462
ES	0,010596	DK	0,008829	EE	0,008745399	ES	0,009233488	EE	0,007943922
DK	0,010945	IT	0,010223	DK	0,009081172	UK	0,009666343	DK	0,008240681
SL	0,011211	UK	0,01075	UK	0,009267668	EE	0,009707171	UK	0,008935439
EE	0,011458	CY	0,014414	IT	0,010522489	DK	0,010089762	PL	0,009632467
FI	0,013166	PL	0,014481	PL	0,01128058	IT	0,011324933	IT	0,009853786
IT	0,013354	PT	0,01455	FI	0,011947459	FI	0,011855261	PT	0,011707048
PT	0,015057	BG	0,015088	IE	0,012224575	PL	0,013258316	CY	0,011901893
PL	0,019694	FI	0,015287	PT	0,012831147	PT	0,014180065	FI	0,012024291
BG	0,022874	RO	0,016839	CY	0,017067443	CY	0,023266102	IE	0,015320043
LV	0,027646	EE	0,017013	LV	0,020932552	LV	0,024288591	LV	0,018135854
CY	0,027697	IE	0,020687	BG	0,02354069	BG	0,027659599	BG	0,020108266
GR	0,041074	GR	0,023278	GR	0,028217668	GR	0,036232181	RO	0,021331466
LT	0,055499	LV	0,032609	RO	0,032235235	RO	0,045319759	GR	0,021538907
RO	0,064285	LT	0,049942	LT	0,052415807	LT	0,070667684	LT	0,037205909

Source: Eurostat, own calculations

3.2.2 Overall evaluation of the OCA index results

The results of my own analysis are different in some countries in comparison by substituting of sub-indicators into the equation of Bayoumi and Eichengreen (1997). It is connected with the fact that alternatives use different partial indicators of convergence. Usage of other alternative indicators could lead to different results again. A common feature is the high index values and thus variability to the EU-27 economies in the two Baltic economies, i.e. Lithuania and Latvia, two economies with the lowest level of real convergence in terms of GDP per capita, i.e. Bulgaria and Romania, and also Poland and Cyprus, from the new Member States. From the old Member States achieve the highest index values cohesive economies with some variations of the order and better results of some economies in certain index alternatives or at certain times. Greece reaches a high index values and so low level convergence in almost every index alternative and in most periods.

The lowest OCA index values are traditionally associated with economies labeled as "core." Based on the results of the analysis this group includes Belgium, the Netherlands, Luxembourg and Austria. Of course, I include here two biggest Eurozone economies, i.e. Germany and France. In the first alternative of the OCA index based on equation (3) the index values for these two highest economies are the highest, probably also due to the inclusion of $SIZE_{ij}$ variable. Bayoumi and Eichengreen (1997) claim that for smaller economies will benefits in the form of the single currency higher. Different argument, however; brings a Tavlas Dellas (2010), who argue that monetary union is more appropriate for larger economies in the union next to the union with smaller economies. The benefits of monetary union are higher for larger economies, because monetary policy observes mainly the development of a larger economy. In this sense, the core euro area economies are mainly Germany and France and generally they achieve a high level of convergence with the EU. The highest index values from the older Member States reach Finland and Italy in almost all alternatives. There are two groups of new member states where results in the convergence measured via the OCA index are similar and relatively low in a number of alternatives or periods. One group is Hungary, Estonia and Slovenia and the second is Malta, Slovakia and ČR. The results from the equations (4) and (5) show a high level of convergence, especially the second group, which are the most open economies of the new Member States. The first group reaches medium values of the index, comparable with some cohesive economies or older member states outside the Eurozone. The results in the equation (3) are not substantially similar to the results of these two alternatives. The lowest values, comparable with core economies in 1999-2003 are achieved by ČR and Slovenia in the period 2004-2009, Hungary and Malta for the whole period of 1999-2010, Hungary and ČR.

3.2.3 The hypothesis of endogeneities and exogeneity and convergence measurement aspects using the OCA theory

Convergence may be rising by deepening of integration, either spontaneously (endogeneity/ies hypothesis), or by taking appropriate measures and structural reforms to promote convergence. Consideration of these aspects is particularly relevant when entering monetary union. Assuming those ways of improving convergence and reducing the OCA index value is thus possible that euro membership will be associated with higher benefits rather than costs.⁴ So, the Eurozone member states may show a higher level of convergence, because they are members of the Eurozone and there is a strengthening of the convergence, because criteria are endogenous, or they are forced to accelerate structural reforms (exogeneity). However, it is possible to point to the opposite site of this development. As Hallet and Piscitelli (2001) claim, without any noticeable structural convergence introduction of a single currency will lead to divergences of economies. Endogeneity hypothesis depends on the level of structural characteristics by the integration into the monetary union. In other words, not all economies have prerequisites for functioning of endogeneity hypothesis or implementation of appropriate structural reforms to promote convergence with the EU and the eurozone.

If monetary union enhances trade between economies, as argued by Rose (2000), then the Eurozone economy should achieve higher bilateral trade, which in equation (3) means a lower value of the OCA index. Frankel and Rose (1998) and Fidrmuc (2001) claim that trade integration of economies increases the correlation of their business cycles. It is thus endogenous in relation to their bilateral trade. Frankel and Rose (1998) argue that the structure of economies is constantly changing and in particular when joining the monetary union. Countries that did not meet the criteria of the OCA theory, ex ante are likely to satisfy them ex post. However, Fidrmuc (2001) includes in the model

⁴ These aspects are also associated with Lucas critique.

structural characteristics and argues that the convergence of business cycles relates to intra-industry trade. However, there is no direct relationship between the intensity of bilateral trade and economic cycles. If the intra-industry trade is positively correlated with the intensity of trade, the hypothesis of endogeneity of the OCA theory may be confirmed.

From all these aspects follows that in the OCA index the reduction of $DISSIM_{ij}$ indicator could encourage the business cycle correlation or reduction of $SD(\Delta y_{ij})$. It is also advisable to use for observing the intra-sectoral trade of Gruber-Lloyd index (GLI), which uses for example Fidrmuc (2001). This indicates a high share of intra-sectoral trade in most EU economies. Special exceptions with low share represent Cyprus, Greece, Malta and Ireland. Other EU economies reach the share of total intra-sectoral trade with the EU over 70% in 2010.⁵ Intra-industry trade should be a good precondition for economic convergence within the EU, shocks affecting the economy should be more symmetrical. That may partly explain the high levels of the OCA index for Greece, Cyprus and Ireland.⁶ In relation to the hypothesis endogeneity (trade channel), it is necessary to mention the results of the analysis which are brought by Frankel and Rose (2002). The closure of their analysis is that the single currency promotes bilateral trade and another conclusion is that the single currency promotes overall openness of the economy (relative to GDP). They do not confirm the hypothesis of trade diversion from non-members of monetary union at the expense of trade between EMU members. By increasing of global trade monetary union promotes growth of GDP per capita of economies. This is a strong conclusion from the point of view of overall benefits from the integration process in the EU. It is true that highly open economies of the EU, with a few exceptions, are the ones that achieve the highest shares of intra-EU trade. However, the order of openness since the late nineties did not change too much. The impact on economic growth needs to be analyzed in a broader context. There are many other factors of economic growth.

In connection with the hypothesis of endogeneity come into account other issues and problems with the inclusion of variables into the model to calculate the OCA index, their interdependence, causality. Moreover, there are other channels of endogenities. If the situation of the economy towards convergence improved, it could just be due to the deepening of the integration process with other economies, i.e. the hypothesis of endogeneity is working. Convergence can also be strengthened through appropriate measures of domestic and EU institutions, i.e. exogeneity of convergence criteria or the OCA criteria plays a role. There are many other aspects for further analysis.

3.2.4 The Impact of external shocks on the indicators of convergence

At last I should not leave unmentioned aspects of global shocks as the global economic crisis after 2008. Such a shock acts symmetrically to all EU economies, most of them in 2009, plunged into recession. Misleading may be the results of the OCA index in 2009. So the economic development in all economies may be more congruous. Typical was the reduction of value $SD(\Delta y_{ij})$, especially in new member states. In the past period several of them showed a high standard deviations of real output also due to significantly higher rates of economic growth and hence real convergence in terms of catching the real GDP per capita. It has also changed the characteristics of the trade. For many economies, a decline in their openness and bilateral trade (in terms of foreign trade relative to GDP) occurs due to

⁵ The GL index includes differences of exports and imports of commodity groups according to SITC classification (six groups) between the economies i and j (EU) divided by the sum of total exports and imports of country i in relation to j . The 0% value for GL index means the complete specialization of countries, while 100% means only intra-industry trade.

⁶ I emphasize that the constant $DISSIM_{ij}$ in comparison with GL index includes only the differences of exports according to SITC.

the recession. The reasons are decline in demand, consumption and exports and imports of the economies.⁷ Analysis of data from Eurostat showed that the openness of the economies of all EU except Ireland between 2008-2009 decreased, significantly in some economies. The decline of over 20 percentage points experienced Bulgaria (33.1), Belgium (27,34), Slovakia (27,3), Estonia (23,9), Slovenia (22,6), Luxembourg (22,1), Lithuania (20,9). These economies are relatively open. The smallest drop experienced Poland and the United Kingdom, which are less open economies. The open economies were the most affected in this respect. Between 2009-2010 openness increased in all EU economies, while more significantly in relatively open economies. Moreover, there is a decrease in intra-EU trade in all EU economies between 2008-2009 in all EU economies, most notably in Belgium, Slovakia, Estonia and Slovenia, at least in Poland, the United Kingdom and Ireland. This again indicates the largest declines for the economies with the highest shares of intra-trade and vice versa. Development intra-industry trade does not show clear trends. Overall, based on the development of convergence characteristics due to external shocks affecting all economies symmetrically we can wrongly consider that they converge, while this development is caused by external forces and may have additional adverse effects on long-term economic growth. It is not easy to recommend how the integration grouping should be prevented. However, long-term development of convergence of the economies is important also before the shock occurred. If economies are already members of the euro area, there are seriously limited the possibilities of autonomous economic policies. In case that that the economy is not competitive enough and has accumulated a high budget deficits and government debt, the possibilities of fiscal policy are limited as well (see Greece and other economies) with an unfavorable impact on the economy and further the whole integration grouping.

3.2.5 Other aspects relating to the OCA index and summary

In conclusion it is it is possible to say that the size of the index depends mainly on sub-variables of the convergence that are included in the index. The development of the index can be further influenced by several factors, notably the hypothesis of endogeneity and exogeneity convergence criteria or by external shocks. Possible application of the OCA index is in connection with other macroeconomic aggregates, such as fiscal indicators, and balance of payments current account balance. Vieira C. Vieira and I. (2011) confirm the significant positive correlation between the OCA index in 1998 and the government deficit in 2009. The same is valid for the correlation of current account deficits and the OCA index, although to a lesser extent. However, this correlation was not visible before the creation of the euro area. It is generally assumed that macroeconomic stability will improve economic competitiveness via the endogeneity hypothesis. Loss of competitiveness, however, occurred in many economies after their entry to the Eurozone and loss of exchange rate policy instrument. The OCA index, when including appropriate convergence factors, may also have important prognostic ability. Although the correlation of fiscal characteristics values and external balance with the index may be confounded to some extent due to similar impact of external shock on all economies, adverse trends in less competitive EU economies can be observed for a longer period. For the working of the endogeneity convergence criteria is necessary to show some structural characteristics of economies generating monetary union and the sufficient level of competitiveness, otherwise the inability to use exchange rate policy will probably cause significant costs from participation in the euro area. Individual conditions are difficult to quantify. However, in the monitoring of index over a longer period of time can be assumed that the lack of convergence or divergence is caused by structural factors or problems with competitiveness. The OCA index can be used as a tool for assessing

⁷ However, it helped especially new member states (e.g the Baltic economies) to reduce or eliminate trade deficits in more significant declines in imports.

structural similarity or variability and its development, but with taking into account all of its shortcomings and the limited number of factors of the OCA which it contains.

4. Conclusion

In this paper were presented results of the analysis of convergence denoted as "structural convergence" in terms of the OCA theory. Total index was calculated by substituting values of sub-indices to the equation used in the original publication dealing with the calculation, namely, Bayoumi and Eichengreen (1997). Except this, the panel model with fixed effects was used to compile my own OCA index for the period 1999-2009. Because of the Eurozone existence during this period was used an alternative explanatory variable that could replace the variability of nominal exchange rate used by Bayoumi and Eichengreen (1997) in the form of nominal effective exchange rate in the EU-27. Two variants of index were calculated with alternative explanatory variables and with this explaining variable. Overall, the index is regarded as an additional tool of „indicator of convergence or variability" between EU economies. For deeper insight into the trends of convergence in the EU is necessary to examine the sub-indicators used as explanatory variables also in relationships with other criteria of the OCA theory. Due to the lack of quantification of the OCA criteria may be the index a useful tool, because it is the number. It is possible to follow the development of values and compare the EU countries and developments of convergence with each other. However, there is no threshold value of the index or other criteria of the OCA, to accurately assess the degree of convergence. It is also possible to consider usage of alternative criteria in the OCA index.

There cannot be left unmentioned two factors that may reduce the explanatory ability of the OCA index and argue for a deeper analysis of the convergence via sub-indices of the OCA and other criteria of the OCA theory or convergence in general. Firstly it is the hypothesis of endogeneity of OCA criteria of convergence. There is not so clear-cut causal relationship between explanatory variables of the OCA index and explained variable. It may be noted that that exchange rate stability and the existence of a monetary union should promote bilateral trade between economies. Providing the prevalence of intra-industry trade should increase synchronization of business cycles of economies. Assuming growth of trade between economies without diversion, openness of the economy should increase (Frankel and Rose, 2002), which is one of the basic criteria of the OCA theory, and then they confirm the positive growth impact of openness on economic growth. This is a long-term goal of integration within the EU. There are also links among variables of the OCA index and other convergence criteria. Relationship characteristics of trade and openness with synchronization of business cycles has several aspects and in combination with criteria of macroeconomic stability, i.e. with Maastricht criteria has also impacts on long-term economic growth in the EU and the long-term goal of integration processes. Moreover, it is necessary to establish endogeneity convergence criteria and the possibilities of exogeneity criteria, i.e. institutional integration should promote trade. It means that institution should take measures to improve the convergence. There are still ways to improve convergence, although processes in the economies do not operate self-sufficiently.

The second aspect is related to external factors and impacts of external shocks, generally development of world economy. The investigation period of convergence is mainly about the global economic crisis of cca 2007-2010 and its impact on the convergence and long-term economic growth in the EU. The OCA index may show improvement, i.e. reduction of the value due to the greater symmetry of some or more convergence criteria, because the global economic crisis affects the EU economies (together with the other economies of the world economy) as a symmetric shock. The most obvious example is that a reduction in relative output variations, which are part of the OCA index. The

increase of correlation of economic activity can reduce the overall OCA index. The second significant aspect is the reduction of bilateral trade between different EU economies and reduction of the overall openness in a recession. New member states were significantly affected by the decline in demand and exports to the economies of older member states which are their major trading partners. The reduction of the openness of the economies may further negatively effect the economic growth (Frankel and Rose, 2002). OCA index value in 2009 may be significantly distorted due to the consequences of this economic crisis and distorted partial indicators of the OCA index.

Implication for the whole EU is that when assessing the convergence, it is necessary to take into account the external shocks, both internal structural and other characteristics of the convergence of EU economies. The impact of the global economy is extensive and the EU is relevant to consider how to prevent adverse effects, or at least how to alleviate them partially. In connection with that economic crisis the development of long-term adverse fiscal characteristics was fully manifested in many economies. The emphasis on macroeconomic stability and mainly fiscal discipline is especially a challenge for solving the institutions at the level of member states but also the EU. The exogeneity criteria and support of the macroeconomic stability of convergence broadly would again be the subject of interest from the relevant institutions in order to improve the possibility of long-term economic growth of the grouping.

References

BAYOUMI, T. – EICHENGREEN, B. (1997). Ever Closer to Heaven? An Optimum-Currency-Area Index for European Countries. *European Economic Review*, 41, pp. 761–770.

DELLAS, H. – TAVLAS, G. S. (2010). *An Optimum Currency Area Odyssey*. CEPR Discussion Paper No. DP7645.

HALLETT, H. – PISCITELLI, L. (2001). The Endogenous Optimal Currency Area Hypothesis: Will a Single Currency Induce Convergence in Europe? *Paper Presented at The Royal Economic Society Annual Conference*, University of Durham, April 9-11.

HORVÁTH, R. – KOMÁREK, L. (2003). *Optimum Currency Area Indices: Evidence from the 1990s*. Warwick Economic Research Papers No. 665.

HORVÁTH, R. – KOMÁREK, L. – ČECH, Z. (2003). *Optimum Currency Area Indices: How Close is the Czech Republic to Eurozone*. The Working Paper series of the Czech National Bank 10/2003.

FIDRMUC, J. (2001). *The Endogeneity of the Optimum Currency Area Criteria, Intra-industry Trade and EMU Enlargement*. Discussion Paper No. 14, Institute for Economies in Transition (BOFIT), Bank of Finland.

FRANKEL, J.A. – ROSE, A.K. (1998). The Endogeneity of the Optimum Currency Area Criteria. *Economic Journal* 108, pp. 1009–1025.

FRANKEL, J.A. – ROSE, A.K. (2002). *An Estimate of the Effects of Currency Unions of Trade and Growth*. Centre for Economic and Policy Research Discussion Paper, no. 2631, National Bureau for Economic Research Working Paper, no. 7857.

KENEN, P.B. (1969). The Theory of Optimum Currency Areas: An Eclectic View. In Mundell, R.A. – Swoboda A.K. (eds.) *Monetary Problems of International Economy*, Chicago: University of Chicago Press.

KUČEROVÁ, Z. (2005). *Teorie optimální měnové oblasti a možnosti její aplikace na země střední a východní Evropy*. Studie Národohospodářského ústavu Josefa Hlávky.

LACINA, L. et al. (2007). *Měnová integrace. Náklady a přínosy členství v měnové unii*. 1. vyd. Praha: C.H. Beck.

McKINNON, R.I. (1963). Optimum Currency Areas. *American Economic Review* 53(4), p. 717–725.

MONGELLI, P., F. (2008). *European Economic and Monetary Integration and the Optimum Currency area Theory*. Economic Papers 302/ February 2008, European Commission.

MONGELLI, F. P. - DORRUCCI, E. - AGUR, I. (2005). *What does European Institutional Integration tell us about Trade Integration?* Occasional Paper Series, No. 40/December 2005. Frankfurt am Main: European Central Bank.

MUNDELL, R. A. (1961). A Theory of Optimum Currency Areas. *The American Economic Review*, vol. 51, no. 4, pp. 657–665.

ROSE, A.K. (2000). One Money, One Market: Estimating the Effect of Common Currencies on Trade. *Economic Policy*, vol. 15, no.30, April 2000, pp. 7-46.

VIEIRA, C. - VIEIRA, V. (2010). *Assessing the Endogeneity of OCA Conditions in EMU*. CEFAGE-UE Working Paper 2011/01.

WARIN, T. - WUNNAVA, P.V. - JANICKI, H.P. (2008) *Testing Mundell's Intuition of Endogenous OCA Theory*. Discussion Paper No. 3797. Institute for the Study of Labor (IZA), Research Paper Series.