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# OCA INDEXES AND CONVERGENCE PROCESS IN EUROPE

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**Abstract**

This paper evaluates the European monetary convergence for period 2001 and 2013. The main purpose of this contribution is the estimation of the so-called OCA index, which indicates the proximity of two economic areas. The paper is theoretically based mainly on the research of Bayoumi and Eichengreen (1997), and Horváth and Komárek (2003). Selection and calculation of variables precedes the econometric analysis, and those variables correspond to the basic characteristics of an optimum currency area. Although the estimated model fulfills the conditions of economic and econometric verifications, its explanatory capabilities are significantly reduced due to the limited set of input data. Results of the analysis point to relatively stable values of indices in the period, but their further examination of the development in time reveals a steady deterioration in the case of almost all economies. That means that the convergence process was not proven because a decrease in OCA indexes values over the time was not observed. According to the results of comparison, methodological approach of the OCA indexes cannot be considered reliable because minor differences in calculation give different outputs.

**Keywords:** EMU, OCA index, convergence, monetary policy, optimum currency area

**JEL classification:** E42, F33

## 1. INTRODUCTION

The article deals with the examination of economic convergence expressed through OCA indexes for the period of 2001-2013. The primary goal is to determine the character of the convergence process of the EU member states and of other European economies in the third millennium, using a simple, single-equation econometric model constructed upon the methodology by Bayoumi and Eichengreen (1997). In order to achieve this goal, several steps were taken. First, a search of the issue of defining the convergence through the quantification of the OCA indexes was elaborated. The convergence of selected countries to the euro area is expressed through time variability of those indexes: if the OCA index value decreases, there is convergence between the areas; if the value increases, the economies

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diverge from each other. Second, parameters of the single equation model were estimated upon data obtained from selected European countries. The parameter values were subsequently used as weights for the calculation of the OCA indexes. Third, the actual OCA index values were compared with the values of indexes that had been derived from the estimations of equations by Bayoumi and Eichengreen (1997), and Horváth and Komárek (2003). The main contribution of this paper lies in the new estimation of the regression model, which later serves to the calculation of OCA indexes, their comparison allows the identification of reliability of this methodological approach. Input data analysis provides a support for results and conclusions, which are drawn later.

## 2. BRIEF REVIEW OF SELECTED OCA INDEX STUDIES

The principle of the OCA theory (Optimum Currency Area) lies within the identification of criteria which may be utilized by individual countries for making decisions related to the formulation of recommendations whether it is advantageous to access the monetary union or not. The workforce mobility and labor costs flexibility were identified by Mundell (1961) as the key factors determining successful functioning of a monetary union. This basic criterion was later supplemented with the criterion of economy openness defined by McKinnon (1963), and with the criterion of production diversification defined by Kenen (1969). These criteria assume that the more open an economy is and the more diversified production it has, the higher its potential benefits from its membership in a monetary union will be.

From the 1970s the research in this field has been moving from the theory to empirical analyses. Within its focus, this article will reflect particularly an empirical research from the 1990s when the political will to establish a monetary union significantly strengthened and led to its formation in 1999. Modifications and an extended list of exogenous OCA criteria may be found, for example, in Fidrmuc (2002) or Mongelli (2002).

Attempts to implement the criteria into a complex empirical form led to the creation of a specific field of research including the quantification of the so-called OCA indexes whose values express the suitability (or unsuitability) of membership of the monetary union for a particular economy. Bayoumi and Eichengreen (1997), associated with the formation of this field of the OCA theory, modeled the bilateral deviation of the currency exchange rate depending on selected exogenous variables (they considered the GDP formation symmetry, the intensity of mutual trade relations, the export structure dissimilarity, and the size of the economies). The estimation method respects methodology in Bayoumi and Eichengreen (1997), which is based on the application of ordinary least squares (goal is to minimize the sum of the squares of the residuals). The estimated parameters of the exogenous variables were then used as weights for the OCA indexes calculation. The lower the final value of an OCA index, the higher the level of readiness of an economy to access a monetary union (the minimum deviation of the nominal exchange rate in the floating exchange rate regime is a significant precondition for the future efficiency of the economy within the monetary union, because there is no pressure on the recalculation of the central parity determined upon the adoption of the single currency).

Since the euro area de facto did not exist at that time, Germany was considered as the monetary union core by Bayoumi and Eichengreen (1997). The equation estimated by them corresponds, with its signs, to the preconditions of behavior of individual criteria.

$$SD(e_{ij}) = -0.09 + 1.46\,SD(\Delta Y_i - \Delta Y_j) + 0.022\,DISSIM_{ij} - 0.054\,TRADE_{ij} + 0.012\,SIZE_{ij} \quad (1)$$

where the $SD(e_{ij})$ variable represents the indicator of volatility of the bilateral exchange rate (expressed as a standard deviation of a change in the logarithm of the bilateral exchange rate between $i$ and $j$ countries upon a monthly basis), $SD(\Delta Y_i - \Delta Y_j)$ is symmetry of business cycles (expressed as a standard deviation of the difference of logarithms of real production between $i$ and $j$ countries), $DISSIM_{ij}$ is dissimilarity of the export structure (expressed as the sum of absolute differences in the shares of the chemical and engineering industries[1]), $TRADE_{ij}$ is the intensity of mutual trade relations (expressed as the mean of the bilateral export share in the domestic GDP for *i* and *j* countries), and $SIZE_{ij}$ is the size of the economy (expressed as the mean of logarithms of GDP of i and j countries). All exogenous variables are calculated upon an annual basis.

Upon the calculated OCA indexes, the authors formulated conclusions on the fact whether the individual economies show low or high exchange rate volatility in relation to Germany. Their conclusions show that the economy of the Czech Republic was rather similar to the economy of Portugal at the time monitored; however, its similarity with the European Union was significantly lower. They also proved the existence of a difference between transition economies and the EU core economies.

In the Czech Republic, the research was continued by Cincibuch and Vávra (2000), who adopted methodological procedures (including variables) from Bayoumi and Eichengreen (1997) and presented in their work the structural similarity of the economy of the Czech Republic and Germany and the EU. In their research they focused on the 1990s, and their results indicated convergence tendencies between the first and second halves of the decade.

Minor innovative changes in the structure of variables were made by Horváth and Komárek (2003), who replaced the variable expressing the size of the economy with its openness. This replacement was made due to the weak dependence between the $SIZE_{ij}$ variable and the endogenous variable. The newly created variable $OPEN_{ij}$ expresses the relation of two areas on the basis of the foreign trade turnover in relation to the GDP (specifically defined as the mean of share of export and import in the GDP of i and j countries). The results of their analysis clearly showed that countries close to Germany in the terms of economy were those that are also close to it geographically. Further, the authors questioned the relevance of the $DISSIM_{ij}$ variable due to the constantly low significance. Coefficients estimated by them also corresponded with their signs to theoretical preconditions.

$$SD(e_{ij}) = 0.177SD(\Delta Y_i - \Delta Y_j) + 0.007\,DISSIM_{ij} - 0.084\,TRADE_{ij} - 0.001\,OPEN_{ij} \quad (2)$$

The latest extensive studies include that of Hedija (2011). The author used the model of the original equation including the above-mentioned estimated coefficient by Bayoumi and Eichengreen (1997), and determined the OCA index for a partial period of 1999–2009. In her conclusions, the author pointed out rather similar results, when the OCA index was calculated in relation to Germany or the euro area. The economy of the Czech Republic achieved the lowest values in the analysis, which constantly converges both to the economy of Germany and the EMU. The worst values were achieved by the economies of the Baltic states for which the OCA indexes are relatively the highest from the selection set.

Generally it may be said that these latest studies (Cincibuch and Vávra, 2000; Horváth and Komárek, 2003; Hedija, 2011) have brought only the slightest methodological changes in the approach to the calculation of indexes, and their added value consists primarily in updating the OCA index values[2].

Significant methodological changes can be observed in Skořepa (2011, 2013) or in Vieira and Vieira (2010). In Vieira and Vieira (2010) is the volatility of nominal exchange rate estimated using the panel data, instead of cross-sectional data. The results of their analysis provide the same results as the generally accepted methodological approach defined in Bayoumi and Eichengreen (1997). According to these results is the methodology based on panel data no longer used in this field and next authors focus rather on the formulation of variables, than on the type of data or the estimation method.

Skořepa (2011, 2013) significantly modifies the methodological approach, instead of the standard deviation of the nominal exchange rate as endogenous variable is used the mean absolute value. According to the assumptions, this OCA index is sensitive to the real convergence, but also requires new exogenous variables. Skořepa in his research uses symmetry of business shocks, dissimilarity of export structure and mutual trade linkages. Definition of these variables is very similar to those in Bayoumi and Eichengreen (1997), but their calculation is slightly different. Size of the OCA indexes is very different from other researches, and points for example to the fact, that Czech Republic is very close to forming and optimum currency area with Germany (closer than France or Italy).

However, these new methodological approaches inherently involve limitations, which do not allow the comparison with other papers. For that reason this paper uses methodology of Bayoumi and Eichengreen (1997) and Horváth and Komárek (2003), which allows comparison with these two papers. In this paper are results compared only with these two papers, because they involve an original estimation of regression coefficients.

## 3. MODEL FORMULATION AND INPUT DATA ANALYSIS

This contribution is based on the quantification of the OCA indexes of European economies in 2001-2013. Unlike in the research performed by other authors (such as Hedija, 2011), the estimated parameters by Bayoumi and Eichengreen (1997)were not used as the OCA index weights, but the parameters were re-estimated from data of selected economies (of Croatia, Czech Republic, Hungary, Norway, Poland, Romania, Serbia, Sweden, Switzerland, and United Kingdom)[3], covering the period of 2001-2013. For the calculation of all data entering the model, Eurostat data have also been utilized. The resulting OCA indexes and their development were then compared with the results of Bayoumi and Eichengreen (1997) and of Horváth and Komárek (2003).

Meeting the OCA theory criteria decreases the exchange rate volatility. With respect to this precondition, regression coefficients in the following equation were estimated (variables' notations are same as in the models 1 and 2):

$$SD(e_{ij}) = a + b_1 SD(\Delta Y_i - \Delta Y_j) + b_2 DISSIM_{ij} + b_3 TRADE_{ij} + b_4 SIZE_{ij} + b_5 OPEN_{ij} \quad (3)$$

The analysis examines the relation of selected economies towards the EMU[4], with the estimated regression coefficients having the following assumed signs: the exchange rate volatility depends positively on the symmetry of business cycles, the export structure

dissimilarity, and the size of the economy, and negatively on the intensity of mutual trade relations. The sign of the economy openness is non-definable in terms of theory.

In the first section of this chapter, the basic characteristics of the data set, related to individual variables, are introduced. Table no. 1 shows that the exchange rate volatility is relatively stable in time, with the exception of 2008 when the US financial crisis started affecting Europe[5]. In recent years, it has tended to decrease slightly, which may be explained by the crisis dying out or by central banks using the exchange rate as a monetary policy tool for the minimum interest rates, i.e. for sustaining the exchange rate at stable depreciation of their domestic currencies.

**Table no. 1 – Volatility of exchange rates, monthly data (period 2001-2013)**

| **Year** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** |
|---|---|---|---|---|---|---|---|
| $SD(e_{ij})$ | 0.016 | 0.011 | 0.012 | 0.011 | 0.011 | 0.012 | 0.012 |
| **Year** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | |
| $SD(e_{ij})$ | 0.025 | 0.019 | 0.014 | 0.014 | 0.013 | 0.011 | |

*Note: volatility of exchange rates is calculated as a mean of standard deviation of a change in the logarithm of the bilateral exchange rate between the Eurozone and each of the ten countries that are included to the analysis, upon a monthly basis*

The exchange rate volatility among the selected economies given in Table no. 2 has been stable and relatively low in the long term, except for the exchange rates of Poland and Hungary in relation to those economies that will very probably not access the EMU (Sweden and United Kingdom) even in the long term. Detailed examination of the exchange rate volatility to euro shows that Croatia, the Czech Republic, and Sweden reach the lowest level of volatility of their national currencies.

**Table no. 2 – Volatility of nominal exchange rates (period 2001-2013)**

| | **Czech Republic** | **Poland** | **Hungary** | **Switzerland** | **United Kingdom** | **Sweden** |
|---|---|---|---|---|---|---|
| **Poland** | 0.020 | | | | | |
| **Hungary** | 0.020 | 0.020 | | | | |
| **Switzerland** | 0.020 | 0.028 | 0.026 | | | |
| **United Kingdom** | 0.023 | 0.028 | 0.027 | 0.020 | | |
| **Sweden** | 0.018 | 0.022 | 0.022 | 0.020 | 0.020 | |
| **Romania** | 0.021 | 0.023 | 0.023 | 0.024 | 0.022 | 0.021 |

*Note: volatility of nominal exchange rate is expressed as a standard deviation of a change in the logarithm of the bilateral exchange rate between two countries upon a monthly basis*

The first exogenous variable of the model is the symmetry of business cycles ($SD(\Delta y_i - \Delta y_j)$). The values reached between individual economies are presented in Table no. 3 which clearly indicates the relatively weak values of Hungary towards its Visegrad Group partners as well as, for example, Romania.

The indicators of harmonization of economic development of selected EMU non-members towards the euro area are not more stable compared to mutual relations between the non-members (the variability of indicators of the similarity of business cycles to the euro area compared to selected bilateral harmonies of non-members is comparable). The highest values of the business cycle harmonization indicator are recorded for Poland, Romania, and the Czech Republic (Table no. 4).

**Table no. 3 – Paired symmetry of business cycles between countries (period 2001-2013)**

| | | |
|---|---|---|
| Sweden | Switzerland | 0.023 |
| Sweden | Norway | 0.029 |
| Czech Republic | Romania | 0.030 |
| United Kingdom | Switzerland | 0.040 |
| Czech Republic | Switzerland | 0.056 |
| Czech Republic | Poland | 0.062 |
| Czech Republic | United Kingdom | 0.069 |
| Czech Republic | Hungary | 0.074 |
| Hungary | Romania | 0.094 |
| Poland | Hungary | 0.127 |

*Note: symmetry of business cycles is calculated as a standard deviation standard deviation of the difference of logarithms of real production between country and the Eurozone.*

**Table no. 4 – Symmetry of business cycles of countries included in model (period 2001-2013)**

| | |
|---|---|
| Norway | 0.019 |
| United Kingdom | 0.021 |
| Hungary | 0.034 |
| Switzerland | 0.036 |
| Sweden | 0.042 |
| Croatia | 0.051 |
| Serbia | 0.065 |
| Czech Republic | 0.077 |
| Romania | 0.101 |
| Poland | 0.121 |

*Note: symmetry of business cycles is expressed as a standard deviation of differences logs of real GDP of the Eurozone and certain country.*

**Table no. 5 – Mutual trade relationships and dissimilarity of exports (period 2001-2013)**

| | $TRADE_{ij}$ | $DISSIM_{ij}$ |
|---|---|---|
| Czech Republic | 0.206 | 0.694 |
| Hungary | 0.188 | 0.362 |
| Switzerland | 0.095 | 1.073 |
| Poland | 0.087 | 0.200 |
| Romania | 0.080 | 0.340 |
| Norway | 0.075 | 7.870 |
| Sweden | 0.075 | 0.381 |
| Serbia | 0.065 | 2.219 |
| United Kingdom | 0.056 | 0.830 |
| Croatia | 0.051 | 1.905 |

*Note: TRADEij is a mean of bilateral export related to GDP; DISSIMij is a sum of absolute differences in shares of chemical industry and mechanical engineering on total export.*

The variable of the mutual trade relations ($TRADE_{ij}$) does not give results undisputedly distinguishing between the EU member and non-member states (see Table no. 5). Although the economies of the Czech Republic and Hungary in relation to the euro area show strong trade relations, these two non-member countries also achieve results rather similar to certain non-member countries, such as Poland and Romania. However, thanks to the export structure

dissimilarity ($DISSIM_{ij}$), those non-member states with values significantly exceeding the EU[6] economies may be distinguished. If compared with the study of Horváth and Komárek (2003), the values of both the intensity of mutual trade relations and the export structure dissimilarity are significantly worse. This fact may be explained by the present more advance level of monetary integrity as well as the vanishing significance of the criteria considered as the fundamental assessors of the level of readiness for the monetary union membership.

To illustrate trade relations, Table no. 6 shows relations between the Czech Republic and its selected trade partners. The difference in the relation strength is particularly clear when partners from the Visegrad Group are compared with those from other countries[7].

**Table no. 6 – Mutual trade relationships between the Czech Republic and certain countries (period 2001-2013)**

| | | |
|---|---|---|
| Czech Republic | Poland | 0.0256 |
| Czech Republic | Hungary | 0.0179 |
| Czech Republic | United Kingdom | 0.0162 |
| Czech Republic | Romania | 0.0054 |
| Czech Republic | Switzerland | 0.0004 |

*Note: TRADEij is the mean of bilateral export in relation to the GDP for the Czech Republic and its selected partner.*

A brief evaluation of the calculated values of variables for the Czech Republic shows that they are not definitely positive. On one hand, the exchange rate of the economy of the Czech Republic to euro shows no tendencies to significant volatility and trade relations with the euro area are the strongest from among the selection set. On the other hand, the symmetry of business cycles and the export structure dissimilarity (when compared to other non-member states) do not indicate potentially trouble-free adoption of the single currency.

The differences in the input data (compared to Bayoumi and Eichengreen, 1997; Horváth and Komárek, 2003) are generally conditioned by a number of factors (such as a different character of the fiscal policy, structural changes in economic performance, different level of interconnection of the markets and the EU core, etc.). The variability of the regression analysis input data implies that different results will be probably achieved.

## 4. PARAMETERS ESTIMATION

The following section of this charter contains the estimation of an econometric model which meets the preconditions of a standard linear model and reaches a high determination coefficient (0.94), the signs of variables correspond to the generally accepted theory, and all variables are significant at the $\alpha = 0.01$ level.

The model has been estimated from the equation containing the $OPEN_{ij}$ and $SIZE_{ij}$ variables concurrently. These two variables were considered mutually replaceable by Horváth and Komárek (2003) due to strong interdependence; however, the interdependence has not been ascertained in our model. There is strong multicollinearity between the $TRADE_{ij}$ and $OPEN_{ij}$ variables (higher than 0.8), but since they are the basic criteria of the OCA theory, neither of them has been removed.

Upon the estimated model, the OCA indexes are calculated, representing the predicted value of the exchange rate variability. Due to the index structure, the lower its values reached, the higher the level of readiness for accessing the monetary union.

**Table no. 7 – Estimation of the model**

| | coefficient | t-ratio | |
|---|---|---|---|
| $SD(\Delta y_i - \Delta y_j)$ | 0.182 | 7.021 | *** |
| $TRADE_{ij}$ | -0.455 | -5.299 | *** |
| $DISSIM_{ij}$ | 0.002 | 5.405 | *** |
| $SIZE_{ij}$ | 0.019 | 6.638 | *** |
| $OPEN_{ij}$ | 0.202 | 5.652 | *** |
| $R^2$ | 0.94 | | |
| F-stat. | 12.817 | | |

The results of the econometric verification confirm that the LRM preconditions tested were met. The Breusch-Pagan test did not confirm the occurrence of heteroscedasticity (p-value: 0.766), and the Jarque-Berra test confirmed normal distribution of the random component (p-value: 0.639). Since summarized data are used in the analysis, autocorrelation of the residuals may not be tested.

## 5. OCA INDEX QUANTIFICATION AND RESULT COMPARISON

The results of the OCA indexes are given in Table no. 8. With some exceptions, all the countries have roughly the same level of the index. Croatia, the last to access the EU (on 1 July 2013), achieved the lowest values by far. On contrary, Poland and Hungary, having been members since 2004, achieved significantly worse values.

**Table no. 8 – OCA indexes according to authors, Bayoumi and Eichengreen (1997) and Horváth and Komárek (2003) - for the period 2001-2013**

| | Authors | Bayoumi and Eichengreen (1997) | | Horváth and Komárek (2003) | |
|---|---|---|---|---|---|
| **Croatia** | 0.0084 | 0.1821 | (5) | 0.0176 | (8) |
| **Switzerland** | 0.0147 | 0.1520 | (4) | 0.0053 | (4) |
| **Serbia** | 0.0148 | 0.2056 | (7) | 0.0211 | (9) |
| **Czech Republic** | 0.0150 | 0.1916 | (6) | 0.0004 | (1) |
| **Sweden** | 0.0152 | 0.1466 | (3) | 0.0033 | (2) |
| **Romania** | 0.0157 | 0.2237 | (8) | 0.0130 | (6) |
| **Norway** | 0.0157 | 0.2764 | (10) | 0.0517 | (10) |
| **United Kingdom** | 0.0159 | 0.1383 | (2) | 0.0045 | (3) |
| **Hungary** | 0.0199 | 0.1206 | (1) | -0.0081 | (5) |
| **Poland** | 0.0248 | 0.2573 | (9) | 0.0151 | (7) |

*Note: The OCA indexes are calculated upon coefficients of the actual model. The third and fourth columns include the placing (parenthesized) of the given country within the column.*

Besides the indexes calculated by the authors, the estimated equation is presented by the third and fourth columns including indexes calculated upon the parameters of regression equations by Bayoumi and Eichengreen (1997) and by Horváth and Komárek (2003). The results for 2001-2013 confirm no connection between the OCA indexes calculated upon all three equations because the placing of individual countries rather varies. It may be only stated that for example Poland, Norway, and Romania have repeatedly achieved worse values, and Switzerland and Sweden have achieved better values. This variability of results

supports the proposition about the limited reliability of the methodological approach of the OCA index quantification.

Table no. 9 presents the development of the OCA indexes quantified in four three-year periods between 2002 and 2013.

**Table no. 9 – OCA indexes of countries outside the Eurozone in specific periods**

| | 2002-2004 | 2005-2007 | 2008-2010 | 2011-2013 |
|---|---|---|---|---|
| **Croatia** | -0.0078 | -0.0002 | -0.0005 | -0.0005 |
| **Serbia** | 0.0206 | -0.0080 | -0.0080 | 0.0051 |
| **Norway** | -0.0101 | -0.0019 | -0.0019 | 0.0096 |
| **Czech Republic** | 0.0272 | 0.0095 | -0.0008 | 0.0116 |
| **Romania** | -0.0066 | 0.0068 | 0.0043 | 0.0140 |
| **Poland** | -0.0030 | 0.0096 | 0.0116 | 0.0184 |
| **Sweden** | 0.0008 | 0.0089 | 0.0138 | 0.0186 |
| **United Kingdom** | 0.0045 | 0.0095 | 0.0134 | 0.0258 |
| **Hungary** | -0.0024 | 0.0211 | 0.0228 | 0.0355 |
| **Switzerland** | -0.0098 | 0.0024 | 0.0069 | 0.0376 |

*Note: Once again, the OCA indexes are calculated upon the actual model.*

This approach allows, in compliance with the OCA index theory, improvements or deterioration of the state of readiness for accessing the monetary union to be identified. Decreasing values of the OCA indexes in time indicates a decrease in the risk of the nominal exchange rate volatility, with this volatility presenting a potential risk to the functioning of an economy within the EMU. Increasing values of the OCA indexes condition an increase of the risk. The OCA index sizes indicate constant deterioration of the index in the majority of the countries, with the exception of Serbia where the index development shows improvement.

Application of the results from this paper is significantly reduced, because the analysis does not assume the possibility of endogenous character of some variables. Since the convergence process' are only evaluated ex post, thus the practical implications of analysis results can be viewed only as complementary indicators.

## 6. CONCLUSIONS

The equation used for the estimation of the regression coefficients of exogenous variables, which are subsequently used as weights for the quantification of the OCA indexes, is based on the formulation by Bayoumi and Eichengreen (1997), and by Horváth and Komárek (2003). When comparing the calculation of the actual input data with both aforementioned studies it may be stated that the exogenous variable symmetries of business cycles and the intensity of mutual trade relations indicate balanced values in all three models included. Compared to Horváth and Komárek (2003), the estimated model identifies a higher level of symmetry of business cycles, and lower interconnection of mutual trade relations.

The model estimated by the authors meets both the conditions of economic verification and econometric verification. The high determination coefficient of the model and the significance of parameters speak in favor of the validity of the OCA index theory. However, the model is burdened with lower information ability due to a limited set of input data, because selected variables from ten European countries (EMU non-members) were only included in the model estimation for 2001-2013. This selection was made in order to obtain

more valid results for non-member European economies because this validity decreases when non-European economies are included.

The OCA indexes calculated for the whole period are at a similar level for the countries included in the study (with the exception of Poland and Hungary which have achieved relatively high values). When the index development during the period in question is examined, its gradual deterioration may be observed for the majority of the countries, except for the economy of Serbia. Thus, it cannot be stated that the OCA index decreases in time in the countries included in the study, i.e. that European economies show lower modelled volatility of the nominal exchange rate. This is an argument for thesis that the majority of included countries (which lies outside the European monetary union, except Serbia) did not improve complexly their characteristics that are important for smooth membership in the Eurozone.

Upon the comparison of the results of the OCA indexes calculated according to the weight estimated from the equations by Bayoumi and Eichengreen (1997) and Horváth and Komárek (2003) it may be stated that the methodical approach of the OCA indexes can hardly be considered reliable, because changes in the input data at the slightest methodological differences give different outputs (the size of the OCA indexes calculated according to different weights differs significantly for individual countries).

In consideration of the conclusions presented above, more detailed research should be focused on evaluation of individual criteria in each country (case by case approach for each individual criterion and country). "Complex" approach based on OCA indexes is not appropriate for purposes of evaluation of convergence process in Europe via OCA criteria.

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**Notes**

[1] According to the SITC classification, rev. 4, those are categories 5, 6, 7, and 8.

[2] Further studies that use the methodology based on quantification of the OCA indexes are mostly oriented on the area of Eastern Asia (Ogawa and Kawasaki, 2007; Volz, 2010; Achsani and Partisiwi, 2010), and Africa (Bangake, 2008; Vieira and Vieira, 2010).

[3] Only ten countries were selected due to the fact that the single currency euro has been adopted by a high number of European economies. Compared to Horváth and Komárek (2003), no non-European economies were included due to a significant heterogeneity of the selection data set which, as a result, decreases the validity of the model applied to European environment.

[4] The euro area is considered in the EUR-19 format.

[5] The strongest impacts of the crisis in Europe were evidenced in 2009; however, the exchange rate reacts to pessimistic anticipations into the future faster compared to other macroeconomic quantities, such as employments rates or products.

[6] In case of the $DISSIM_{ij}$ and $OPEN_{ij}$ variables, Switzerland is listed together with Lichtenstein.

[7] The characteristics given comply with the gravity model of international trade.

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