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DO CENTRAL AND EASTERN EUROPEAN COUNTRIES BECOME MORE SIMILAR IN TERMS OF SECTORAL STRUCTURES AS THEIR REAL CONVERGENCE WITH THE EURO AREA INCREASES? ANALYSIS ON THE LAST DECADE

Abstract. *In this paper we analyze the real and structural convergence with the Euro area (EU - 17) of 10 Central and Eastern European countries (Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia) during 2000 – 2010. We use a real-structural convergence matrix, made up of indexes, to assess the evolution of economic convergence in 2010 as compared to 2000. Then, we compute an econometric regression in order to study the effect of real convergence on structural convergence. The analysis shows that real convergence has a positive effect on structural convergence and that the impact is even stronger when using labor shares for assessing the structural convergence index. We also report important progress in terms of real and structural catch-up with the Euro area. However, Romania and Bulgaria remain behind the other CEE countries.*

Keywords*: real convergence, structural convergence, Central and Eastern European countries, Euro area.*

JEL Classification: **F15, F43, F44, C23, C43**

1. Introduction

Poor regions and countries with higher growth rates than rich countries have received important attention in the literature regarding economic growth and development. From this point of view, the accession of Central and Eastern European (CEE) countries to the European Union (EU) and the European integration process are very interesting and still present challenges to answer to.

In 2004 and 2007, we assisted to two accession waves of 10 CEE countries: Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia. That these countries have significantly lower development

levels as compared to the EU, is not a surprise. However, they do not benefit from an opt-out clause, like UK or Denmark, which means that sooner or later they will become Economic and Monetary Union (EMU) members. Until now, just 3 countries succeeded in gaining EMU membership: Slovenia in 2007, Slovakia in 2009 and Estonia in 2011.

In spite of the EMU accession requirement, there are no structural or real convergence conditions to be observed, apart from the nominal convergence criteria. Real together with structural convergence remain important when considering the cost of adopting the euro. As a consequence, the current study focuses on real and structural convergence of CEE countries with the Euro area, irrespective of their EMU membership.

Real convergence plays a fundamental role in assessing the readiness of countries to enter the EMU and to evaluate the costs and benefits of membership (Šikulová, 2006). The catching-up up surely depends on the initial condition of the country, its capacity to grow at superior rates as compared to EU or Euro area, the disinflation strategy implemented and also the exchange rate regime. Real convergence is a long-term process and no one expected that this process would be carried out before the CEE countries accession to the EU or Euro zone.

When considering real convergence, the main factors under scrutiny are the differences in GDP per capita in purchasing power parity (PPP), in labor productivity and in price levels. A lot of studies have concentrated on the distribution of income per capita real convergence. It seems that human capital can contribute essentially to the speed of real convergence.

Structural convergence is equally important from two standpoints. First of all, from a short- and medium-run point of view, structural convergence has implications for the international transmission of business cycles: if macroeconomic shocks are sector-specific, it should increase international business cycles correlations (Imbs, 2000).

Secondly, from the long-run point of view, structural convergence is important for analyzing the process of development: in the case of structural convergence, countries follow similar stages of development characterized by the rise and fall of similar types of sectors as income grows and they may converge to a structural “steady-state”, in which the sectoral mix of output becomes more uniform across countries. Imbs and Wacziarg (2000) show that the sectoral concentration of labor follows a U-shaped pattern over the course of development for a broad sample of countries.

In addition, the determinants of structural convergence play a major role when analyzing the dynamic pattern of international specialization on the long-run. For example, if bilateral trade intensities affect sectoral similarity negatively, this means that we are dealing with a classical (inter-industry) specialization. If they effect is positive, this can be interpreted as indicating the expansion of intra-industry trade (Imbs, 2000).

The point of departure of this study is the hypothesis that countries that converge in terms of per capita income also tend to converge in terms of their sectoral similarity. This paper provides a validation of this hypothesis through a fixed effects econometric regression. We also use a real – structural convergence matrix index, measuring structural convergence by both labor shares and gross value added, in order to emphasize the progress of CEE countries economic convergence over time. The chosen period of analysis, which is 2000 – 2010, offers us the opportunity to grasp the economic convergence of CEE countries in the last decade.

The rest of the paper is organized as follows. In section 2 we review the related literature on real and structural convergence. In section 3 we detail the research methodology used in this study. Section 4 presents the data used in the analysis, the sources of the data and some preliminary remarks of the final results. Section 5 presents the results of this research and section 6 concludes.

2. Related literature

A lot of research papers have focused either on real or structural convergence. Real convergence, mainly expressed by income levels convergence, was referred by Galor (1996), who formulated three major hypotheses regarding convergence: absolute (unconditional) convergence hypothesis, conditional convergence hypothesis and convergence clubs hypothesis.

The first hypothesis, of absolute convergence, makes reference to long term income per inhabitant convergence of countries, regardless of their initial conditions. Failure in the process of convergence is explained through institutions.

The second hypothesis, regarding conditional convergence, differs from the first one by the fact that countries must have identical fundamental structures. Per capita income of these countries convergence to one another in the long run independently of their initial conditions.

The convergence club hypothesis requires both identical conditions and fundamental structures of the countries. It supposes that per capita incomes of countries of these countries converge to one another in the long run.

Quantitative definitions of convergence mostly used β and σ convergence. β convergence implies higher growth rates of poor regions or countries as compared to rich regions or countries. σ convergence refers to dispersion reduction of GDP per inhabitant within a group of regions or countries.

In a recent paper Spruk (2011) examines the dynamics of income per capita convergence in high-income transition countries from Central Europe (Czech Republic, Croatia, Estonia, Hungary, Poland, Slovakia and Slovenia) in the period 1991-2007, by presenting a beta convergence model. He comes to the conclusion that human capital had a major contribution to the speed of real convergence.

Miron, Dima and Păun (2009) conducted a comprehensive study on CEE countries regarding their real convergence with the Eurozone between 1999 and 2007. They define real convergence through the use use of several indicators: GDP growth rate, GDP per capita, exports to GDP, foreign direct investments intensity, stock market capitalization, unemployment rate, labor cost and R&D expenditures made by private sector. The study concludes that Poland and the Czech Republic have been the most successful in approaching the Euro area in terms of real convergence.

A previous study, of Próchniak and Matkowski (2004), focuses on income and cyclical convergence in CEE countries during 1993 and 2004. Their conclusion is that CEE countries convergence between themselves and towards the EU in terms of income levels and they also synchronize well with the European Union.

Sikulova and Palenik (2007) conclude in their paper that the timing of euro adoption in the new member states remains an open question because the insufficient level of their real convergence will cause more heterogeneity and higher risks of asymmetric shocks. Euro adoption requires the fulfillment of nominal convergence criteria, established by the Treaty of Maastricht. The relationship between real convergence and nominal convergence has brought about important policy dilemmas. Real convergence cannot be de-coupled from nominal convergence, the connection between them being given by the dynamics of the real exchange rate. It is the Balassa – Samuelson effect that refers to the correlation between general price level of a country and its level of per capita income. An increase in the productivity level of a country leads to an increase in the level of prices, which endangers the nominal convergence criteria achievement (Păun, 2010).

The literature on structural convergence and especially on economic structure convergence and the dynamics of its components has been developing in the last years in the light of its influence on the business cycle synchronization. This is significant for the way national economies respond to the common monetary policy and other economic shocks.

Convergence analyzes of the Gross Domestic Product (GDP) structures are quite numerous. According to the Monetary Policy Committee task force of the European Central Bank (2004) the composition of the GDP by economic sectors is relevant to the monetary policy, due to its influence on the transmission mechanisms.

Angeloni *et al*. (2005) consider that the output composition is an important indicator for structural convergence and a benchmark for assessing the stage of economic development. Following Krugman's methodology (1991), the above authors compute the divergence index of output structure towards the Euro area and estimate it for the new member states. Von Hagen and Traistaru (2005) calculate the dissimilarity index and analyze its dynamics, for the same purposes.

Much work has been devoted to analyzing similarities and differences in industrial structures across countries, because dissimilarities in industrial structure means that countries participating in EMU would be more vulnerable to sectoral shocks in the absence of an exchange rate or monetary instrument.

Darvas and Szapary (2004) conducted an empirical analysis on the behavior of production structure components in Hungary, Poland and Slovenia and noticed a high correlation to the Euro area in industrial production.

Bojesteanu and Bobeica (2008) found that there is a common business cycle in the Euro area, by analyzing the degree of business cycle synchronization between the newest member states and the Euro area. In addition, most of the candidate countries to the Euro area record convergence with this group, with the remarkable exception of Estonia, Lithuania, Slovakia and Romania.

Apart from the literature on real and structural convergence, taken separately, there are some studies that have concentrated on the relationship between real and structural convergence.

A study conducted by Barrios, Barry and Strobl (2002) explores the relation between convergence of industrial structure and income convergence in four cohesion countries: Greece, Spain, Portugal and Ireland. They conclude that industrial structure convergence is associated with income per head convergence. More exactly, as countries' GDP per inhabitant converge, their industrial structures become more similar. This means that increases in real convergence drives increases in structural convergence. They conducted the analysis on 4 year cycles: 1980-1983, 1988-1991 and 1993-1996, by using Krugman specialization index.

Wacziarg (2001) empiric work establishes the existence of structural convergence: country pairs that converge in terms of per capita income also tend to converge in terms of their sectoral similarity, measured by the bilateral correlation of their sectoral labor shares. The author employs data for an important number of international countries and covers a large time period from the '60s until 1997.

However, the number of studies on the relationship between real and structural convergence is limited. The current study takes the research further. We investigate this relationship by employing indexes for both real and structural convergence in the 10 CEE countries during 2000 – 2010. In particular we are interested to determine how real convergence index influences the structural convergence index through a fixed effects econometric regression. The structural convergence index is computed by using employment data, respectively gross value added data. In addition, we provide a matrix format to analyze the catch-up process of CEE countries.

3. Research methodology

This paper uses a quantitative analysis based on a Structural Convergence Index (SCI) and a Real Convergence Index (RCI), an exploratory matrix analysis in order to emphasize the progress of the CEE countries' economic convergence with the Euro area, but also a fixed effects econometric regression in order to assess the relationship between the two indexes. Both the real and structural convergence indexes are

computed by comparison with the Euro area average (EA -17), being the relevant benchmark for any country wishing to adopt the euro.

The analysis developed in this paper covers the 10 CEE countries included in the EU enlargement process in 2004 and 2007. We analyze the period 2000 – 2010.

As regards the Real Convergence Index, it comprises three indicators: GDP per capita at purchasing power parity (PPP), labor productivity per hour worked and price convergence, as percentage of the Euro area average.

GDP per capita at PPP is expressed in relation to the Euro area average set to equal 100. If the indicator of a country is higher than 100, the country's level of GDP per head is higher than the Euro area average. If the indicator of a country is lower than 100, the country's level of GDP per head is lower than the Euro area average. By expressing the figures at PPP, the differences in price levels between countries are eliminated, allowing for meaningful comparisons between countries' GDP per capita.

Labor productivity per hour worked gives an overall impression of countries productivity, in relation to the Euro area average. If the indicator of a country is lower than 100, this country's level of labor productivity is lower than the Euro area average and vice versa.

Price convergence is expressed through comparative price levels of final consumption by private households including indirect taxes. If the indicator of a country is lower than 100, this country's level of price convergence is lower than the Euro area average and vice versa.

Each of these indicators has values between 0 and 100, expressing the distance against the Euro area average, as follows: 0 means no convergence with the Euro area average, while 100 means full convergence with the Euro area average. In obtaining the Real Convergence Index our approach was founded on the research methodology employed by the Group of Applied Economics (GEA) in the handbook for assessing the regional competitiveness of Romania, which was published in 2007. They create a competitiveness index by aggregating weighted averages of economic, social and technological indicators, the shares being established according to the results of a focus group of GEA experts.

The RCI is obtained by weighted average of these three indicators described above. The highest share, of 50%, is given to the labor productivity per hour worked, in accordance with the highest share employed by GEA in computing the economic indicator. GDP per capita at PPP and price convergence receive equal shares of 25% each. The two of them received equal shares, being equally important and expressing productivity and nominal catch-up with the Euro area. Even in the GEA study, the GDP per capita indicator receives a reduced share compared to labor productivity.

The RCI formula is:

$$RCI_{i,EA} = \frac{GDP}{capita} \times 0.25 + Labor\ productivity \times 0.5 + Price\ convergence \times 0.25$$

where $RCI_{i,EA}$ – index of real convergence with the Euro area of country i and the indicators are those described above.

In order to compute the Structural Convergence Index, we chose both the gross value added (GVA) and the sectoral employment (as percentage of the total population), as analysis units of the activity level. The SDI is based on six main sectors, corresponding to the NACE-A6 standard: agriculture, industry, construction, wholesale and retail trade, financial services and other service activities. Using these six sectors, the production structure of each country is compared to the Euro area as a whole.

Generally speaking, most of the studies consider gross value added data, but we also use employment data in order to avoid problems associated with the transfer pricing behavior of foreign-owned corporations located in relaxed fiscal environments. Transfer pricing arises because it is in the interest of foreign companies to exaggerate the level of value added created in low tax environments.

This study employs the index of structural divergence proposed by Krugman in 1991 and previously used in many other studies (Clark and van Wincoop, 2001; Imbs, 2004; Traistaru, 2005etc.) for computing the SCI. The output divergence index was developed in order to measure the degree of specialization in any given country compared to another country or group of countries. The index is the sum of the absolute differences in share between the given country and the benchmark in the six economic sectors. The SCI construction shows that a country is more similar to the Euro area as its value is close to 100:

$$SCI_{i,EA} = 1 - \sum_{k=1}^{K} abs\,(S_{k,i} - S_{k,EA}),$$

where:

$SCI_{i,EA}$ – index of structural convergence with the Euro area;

K – number of sectors taken into account;

$S_{k,i}$ – the share of the gross value added/emploment of the *k* sector in the total gross value added/population of country *i*;

$S_{k,EA}$ – the share of the gross value added/employment of the *k* sector in the total gross value added/population of Euro area.

We compute a matrix taking into account both the RCI and the SCI (by GVA and by employment, respectively) in order to give a brief image about the CEE countries' convergence progress in the last decade.

We develop in our analysis a matrix containing the RCI and SCI, in 2000 and 2010, and we divide it in 4 Quadrants. The characterization of the four Quadrants is as follows:

1. **1st Quadrant – Low Performance** – here are included countries with both RCI and SCI lower than 50 points out of 100;
2. **2nd Quadrant – Medium-Structural Performance –** here are included countries with RCI higher than 50 points, but with SCI lower than 50;

3. **3rd Quadrant – High Performance –** here are included countries with both RCI and SCI higher than 50 points out of 100;
4. **4th Quadrant – Medium-Real Performance –** here are included countries with SCI higher than 50 points, but RCI lower than 50 points.

In order to assess the relationship between RCI and SCI, we compute a panel data econometric regression by using the Ordinary Least Squares (OLS) method. The endogenous variable is SCI and the exogenous one RCI. The regression covers 11 years of analysis for 10 CEE countries between 2000 and 2010. We use balanced data panel, meaning that all countries have data for all the years included in the analysis. We employ cross-section fixed effects in order to analyze the impact of variables that vary over time and to control for the individual characteristics that may impact of bias the predictor or the outcome variable. In this way, we elminate those time-invariant characteristics and we can assess the predictors' net effect (Torres-Reyna).

The equation with fixed effects model turns into:

$$Y_{it} = \beta_1 X_{it} + \alpha_i + e_{it},$$

where:

Y_{it} - is the dependent (endogenous) variable, with i = entity and t = time;

X_{it}- represents the independent (exogenous) variable;

β_1 - is the coefficient for the independent variable;

α_i - is the unknown intercept for each entity (n entity – specific intercepts) and i=1…n;

e_{it}- is the error term.

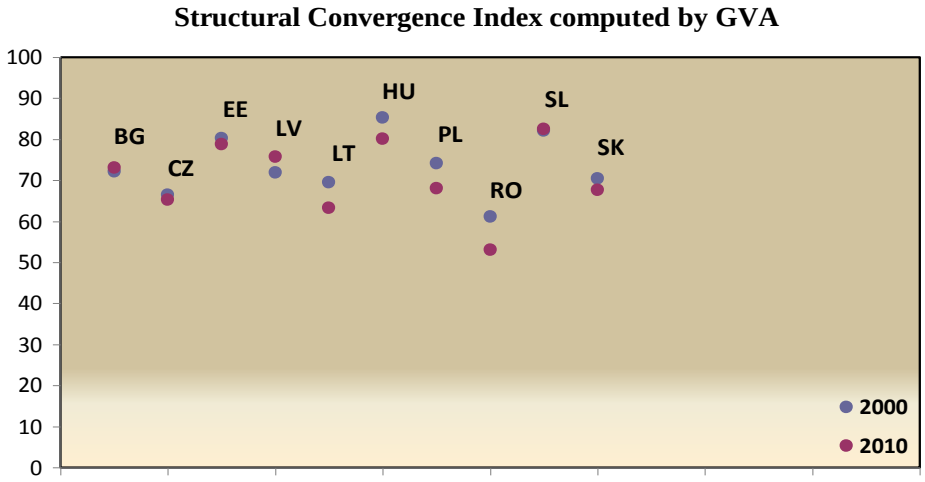
The data have been processed in Eviews 7, version 7.1.

4. Data analysis

The data in this study comes from the Eurostat database and cover the period between 2000 and 2010. In the case of indicators included in the SCI, the Euro area average taken into consideration is calculated by Eurostat. In the case of indicators included in the RCI, the Euro area average is calculated by the authors based on Eurostat data for European average, equal to 100, and for the CEE countries, expressed in comparison to the EU average.

The real and structural convergence indexes computed are presented below for each country, in 2000 and 2010.

Figure 1



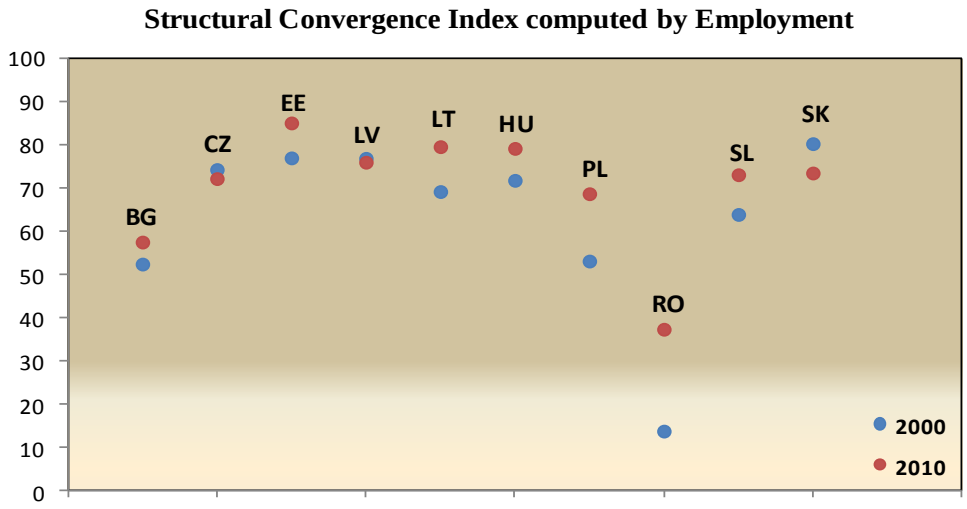
Source: Authors' work

The above table shows us that between 2000 and 2010 the majority of the CEE countries have been experiencing growing gaps with the Euro area concerning the structural convergence index by gross value added. Only Latvia and Bulgaria have seen their structural convergence increase. Slovenia recorded an almost steady evolution. The rest of the countries recorded divergent paths of the structural convergence index. Out of these countries, it is easy to notice that Romania had the most remarkable decrease of structural convergence index. Even Estonia, which entered the Euro area recently, in 2011, and Slovakia, which became an EMU member in 2009, have been confronted with losses in terms of structural convergence of the GVA by economic sectors.

When computing the structural convergence index by employment, we obtain quite different results. This time the most successful countries were, in this order, Romania, Poland, Lithuania, Slovenia, Estonia, Hungary and Bulgaria. Romania records such a high score because there has been a shift of employed people from agriculture and other primary sectors towards services, industry and trade. Slovakia

records the largest decrease of the SCI partly due to the shift of people from industry to trade sectors.

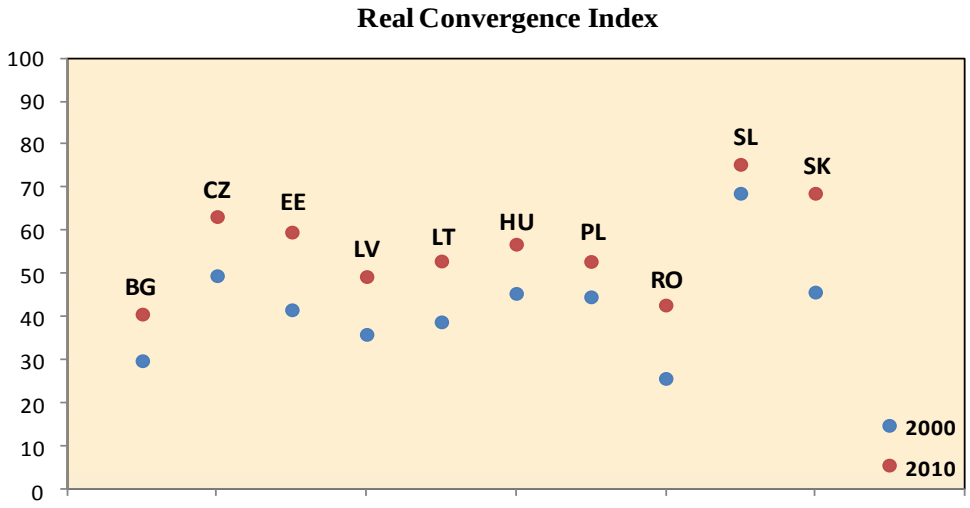
Figure 2



Source: Authors' work

In the case of real convergence index evolution described in the figure below, we can easily notice that all the CEE countries recorded increases in their real convergence with the Euro area. Remarkably, Slovakia and Romania made the biggest steps towards reaching the Euro area average. This comes as a result of important improvements in all the indicators included in the real convergence index. Out of all these 10 CEE countries Romania had the lowest level of real convergence index in 2000, equal to 25.8 points, followed by Bulgaria with 29.9 points out of 100.

Figure 3



Source: Authors' work

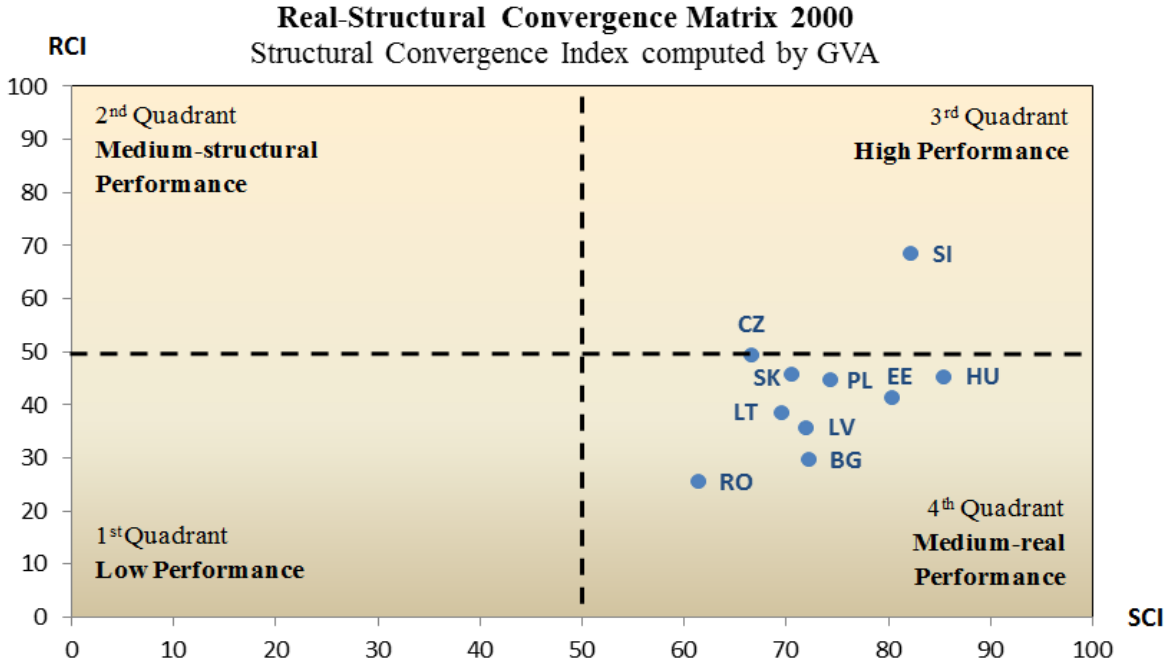
5. Results and discussion

5.1. Real – Structural Convergence Matrix

First of all, we compute the structural convergence index by GVA in 2000 and 2010. Taking a look at the matrix in 2000, we notice that almost all the countries were situated in the 4th Quadrant – Medium-Real Performance. Romania ranks last in this Quadrant and the Czech Republic stands just at the border to advance to the 3rd Quadrant – High Performance. Only Slovenia records a high performance both at real and structural level.

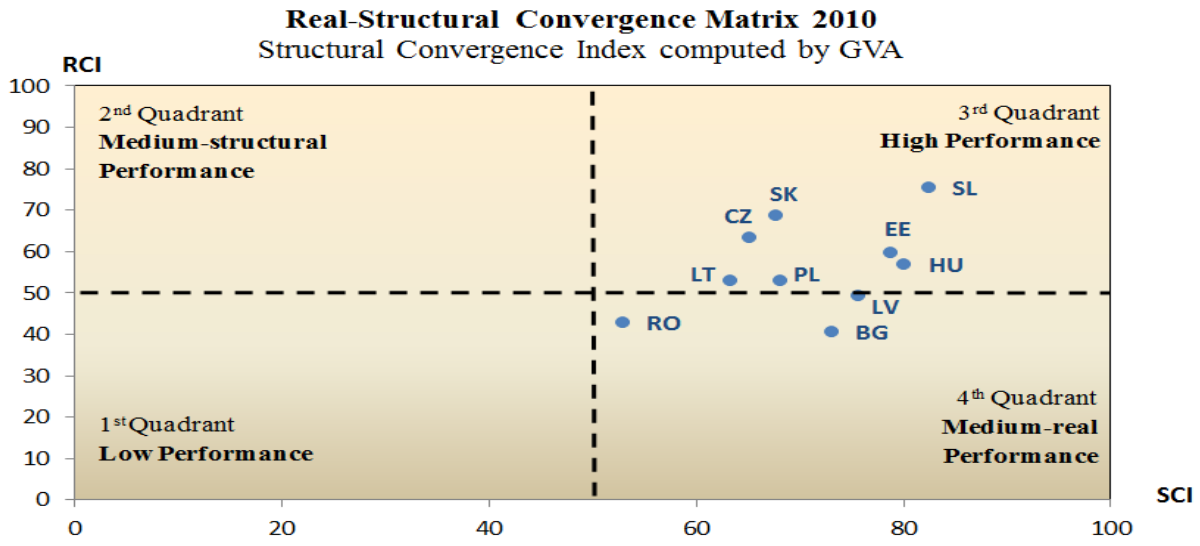
In comparison to the 2000 situation, in 2010 another 6 CEE countries (Slovakia, Czech Republic, Lithuania, Poland, Estonia and Hungary) have succeeded in bridging the gaps and advancing to the 3rd Quadrant. Only Romania and Bulgaria remain in the Medium-Real Performance Quadrant. In the case of Romania, we can also notice that it has been experiencing diverging paths in structural terms. In case of Latvia, this Baltic country seems to struggle to make it to the 3rd Quadrant with a RCI equal to 49.4 points.

Figure 4



Source: Authors' work

Figure 5



Source: Authors' work

Secondly, we compute the structural convergence index by GVA in 2000 and 2010.

In 2000, we have 7 countries in the 4th Quadrant, recording lower levels in terms of real convergence. Slovenia remains the country with the best performance and Czech Republic is very close to access the High Performance Quadrant. Surprisingly or not, Romania records the lowest performance among CEE countries, being the only country in the 1st Quadrant of the matrix.

In 2010, another 6 CEE countries join Slovenia in the High Performance club. Latvia is very close, but has not reached yet the club. Bulgaria remains in the 4th Quadrant, even if it is clear that there has been some progress both at the real and structural level. Romania further remains the only country in the 1st Quadrant, but it is noticeable that huge steps have been made during all this period of time.

Figure 6

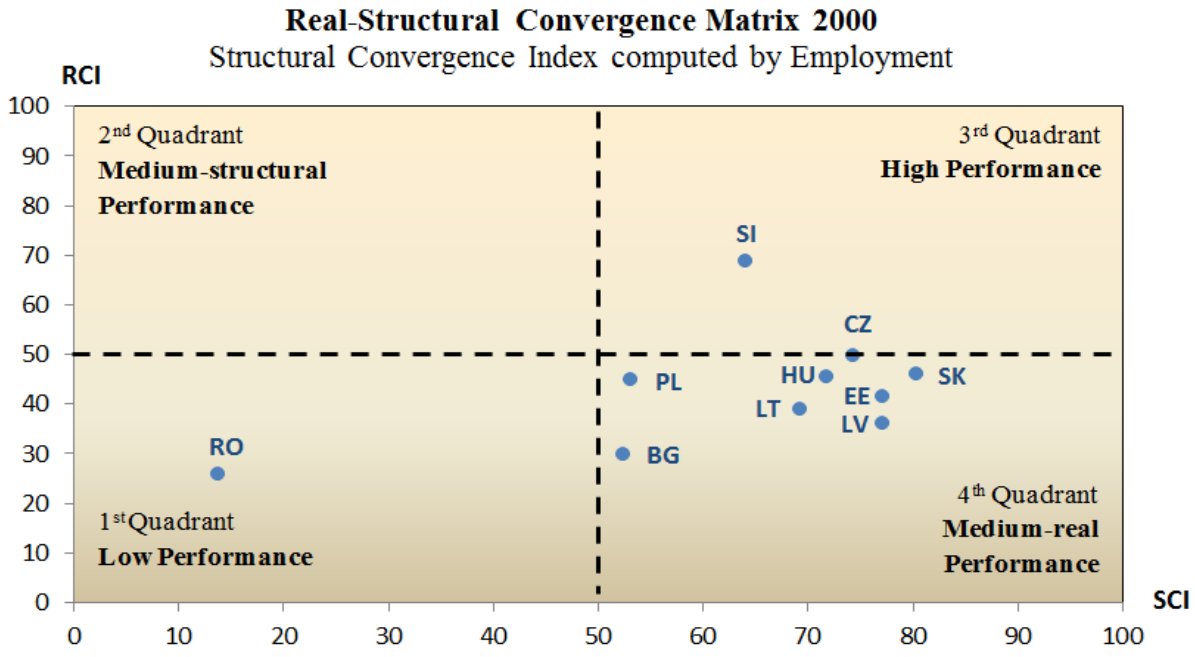


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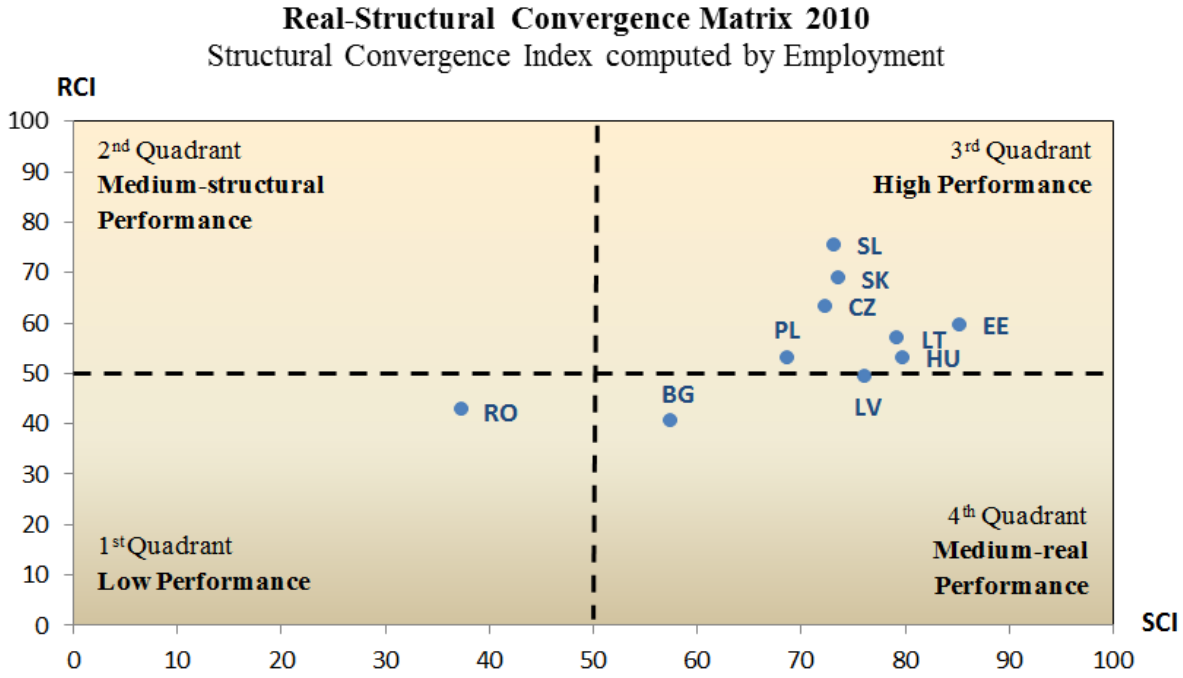
Figure 7



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5.2. Econometric regression

A. Structural Convergence Index by GVA

By using the OLS method in Eviews 7 and cross-section fixed effects we obtain the results presented below.

- Estimated parameter: $\hat{b}$ =0.39. Standard error of parameter: $\hat{\sigma}_{\hat{b}}$ =0.06. T-Student statistics: ($t_{\hat{b}} = \hat{b} / \hat{\sigma}_{\hat{b}}$): $t_{\hat{b}}$=6;
- R-squared=0.28 and adjusted R-squared, $\overline{R}^2$ = 0.21;
- Durbin-Watson statistics, for testing autocorrelation of errors, DW= 2.79;

- Residual term variance: $\hat{\sigma}_{\varepsilon}^2 = 7.38$;
- F-statistic = 3.91. Prob (F-statistic) is approximately 0.

Figure 8 – Estimation of parameter through OLS

Equation: EC_FIXED_EFFECTS Workfile: REZ EVIEWS CU VAB::Untitled\

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: STRUCTURAL_CONVERGENCE_I
Method: Panel Least Squares
Date: 10/13/11 Time: 23:02
Sample: 2000 2010
Periods included: 11
Cross-sections included: 10
Total panel (balanced) observations: 110

Variable	Coefficient	Std. Error	t-Statistic	Prob.
REAL_CONVERGENCE_IND...	0.393596	0.065090	6.046941	0.0000
C	51.86614	3.351212	15.47683	0.0000

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.283349	Mean dependent var	71.67818
Adjusted R-squared	0.210961	S.D. dependent var	8.315503
S.E. of regression	7.386486	Akaike info criterion	6.931821
Sum squared resid	5401.458	Schwarz criterion	7.201869
Log likelihood	-370.2501	Hannan-Quinn criter.	7.041354
F-statistic	3.914264	Durbin-Watson stat	2.797722
Prob(F-statistic)	0.000166		

Source: Authors' work in Eviews

t-Student test for the parameter

Hypotheses of the test:

$H_0 : b = 0$ (the slope of regression is not statistically different from 0) and $H_1 : b \neq 0$ (the slope of regression is statistically different from 0).

For $\hat{b}$ the value of t-Student statistics is 6.

Because $P\left(\left|t_{\hat{b}}\right| > t_{n-1;\alpha} \middle| H_0\right) = \text{Prob} = 0$, we reject the null hypothesis and we accept that the explanatory variable is statistically significant and is correctly introduced in the regression model.

The same is true for the constant term, which is correctly kept in the regression model.

Validating the model

The error terms vector average is 0, which means E(e) = 0. This hypothesis is not problematic, being always true when using OLS estimators.

We use Durbin-Watson to test if the error terms are independent:

$\text{cov}(e_i, e_j) = 0, \forall i \neq j.$

Hypotheses of the test:

$H_0 : \rho = 0$ and $H_1 : \rho \neq 0$.

According to Eview results: DW= 2.79. Because the value is very close to the standard values from the tabel ([1.69, 4-1.69]), we can accept the null hypothesis, meaning that errors at moment t and t-1 are statistically independent.

When testing the repartition of error terms, we obtain Jarque Berra probability very close to 0, which means that we have to accept that errors do not follow a normal distribution. The solution here would be to increase the number of observations and to use the central limit theorem, ensuring us that when the sample is very large, the errors follow a normal repartition.

Consequently, through OLS method, **we obtain the following liniar regression between real convergence index and structural convergence index – by GVA:**

$\boldsymbol{SCI_{i,t} = 51.8 + 0.39 \times RCI_{i,t} + e_{i,t}}$ with i=1,...,10 (the 10 CEE countries)

and t = 2000,..,2010.

This means that the real convergence index influences positively the structural convergence index. Specifically, an increase by 1 point in the RCI leads to a 0.39 increase in the value of SCI.

The model explains 28% of the cases.

B. Structural Convergence Index by Employment

By using the OLS method in Eviews 7 and cross-section fixed effects we obtain the results presented below.

- Estimated parameter: $\hat{b}$ =0.73. Standard error of parameter: $\hat{\sigma}_{\hat{b}}$ =0.11. T-Student statistics: ($t_{\hat{b}} = \hat{b} / \hat{\sigma}_{\hat{b}}$): $t_{\hat{b}}$ =6.2;
- R-squared=0.29 and adjusted R-squared, $\overline{R}^2$ = 0.22;
- Durbin-Watson statistics, for testing autocorrelation of errors, DW= 1.13;
- Residual term variance: $\hat{\sigma}_{\varepsilon}^2$ = 13.4;
- F-statistic = 4.19. Prob (F-statistic) is approximately 0.

Figure 9 – Estimation of parameter through OLS

Equation: ECUATIE_CU_EMPLOYMENT Workfile: REZ EVIEWS CU EMPLOYM...

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: STRUCTURAL_CONVERGENCE_I
Method: Panel Least Squares
Date: 10/15/11 Time: 19:34
Sample: 2000 2010
Periods included: 11
Cross-sections included: 10
Total panel (balanced) observations: 110

Variable	Coefficient	Std. Error	t-Statistic	Prob.
REAL_CONVERGENCE_IND...	0.738205	0.118302	6.239996	0.0000
C	30.04624	6.090882	4.932986	0.0000

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.297756	Mean dependent var	67.20455
Adjusted R-squared	0.226822	S.D. dependent var	15.26780
S.E. of regression	13.42506	Akaike info criterion	8.126762
Sum squared resid	17842.98	Schwarz criterion	8.396810
Log likelihood	-435.9719	Hannan-Quinn criter.	8.236295
F-statistic	4.197656	Durbin-Watson stat	1.134585
Prob(F-statistic)	0.000073		

Source: Authors' work in Eviews

t-Student test for the parameter

Hypotheses of the test:

$H_0 : b = 0$ (the slope of regression is not statistically different from 0) and $H_1 : b \neq 0$ (the slope of regression is statistically different from 0).

For $\hat{b}$ the value of t-Student statistics is 6.2.

Because $P\left(\left|t_{\hat{b}}\right| > t_{n-1;\alpha} \middle| H_0\right) = \text{Prob} = 0$, we reject the null hypothesis and we accept that the explanatory variable is statistically significant and is correctly introduced in the regression model.

The same is true for the constant term, which is correctly kept in the regression model.

Validating the model

The error terms vector average is 0, which means E(e) = 0. This hypothesis is not problematic, being always true when using OLS estimators.

We use Durbin-Watson to test if the error terms are independent:

$\text{cov}(e_i, e_j) = 0, \forall i \neq j.$

Hypotheses of the test:

$H_0 : \rho = 0$ and $H_1 : \rho \neq 0$.

According to Eview results: DW= 1.13. Because the value is very close to the standard values from the tabel ([1.69, 4-1.69]), we can accept the null hypothesis, meaning that errors at moment t and t-1 are statistically independent.

When testing the repartition of error terms, we obtain Jarque Berra probability very almost 0, which means that we have to accept that errors do not follow a normal distribution. However, by increasing the number of observations and by using the central limit theorem, we can make sure that errors follow a normal repartition.

Consequently, through the OLS method, **we obtain the following liniar regression between real convergence index and structural convergence index – by Employment:**

$\boldsymbol{SCI_{i,t} = 30 + 0.73 \times RCI_{i,t} + e_{i,t}}$ with i=1,...,10 (the 10 CEE countries)

and t = 2000,...,2010.

This means that the real convergence index influences positively the structural convergence index. Specifically, an increase by 1 point in the RCI leads to a 0.73 increase in the value of SCI.

The model explains almost 30% of the cases.

Discussion

As we can notice from the results above, real convergence has a more important impact on structural convergence measured by labor shares in the six economic sectors than on structural convergence measured by gross value added in the six economic sectors. This means that as CEE countries converge with the Euro area in terms of real indicators, they will converge more strongly in terms of labor shares in their economic sectors, in comparison to gross value added in their economic sectors. This is due to the fact that increases in real convergence levels lead to better living standards, higher shares of educated people and consequently lead to a an important shift of employment concentration from primary sectors to secondary and then tertiary sectors. However, the impact on gross value added structure convergence is lower because the 10 CCE countries still have to develop technology-intensive sectors, where the gross value added is higher.

6. Conclusions

In this paper we confirm the results of previous research papers. The current study demonstrates that CEE countries that catch-up with the Euro area in terms of real convergence also become more similar to the Euro area in terms of sectoral structures. Interestingly, the positive effect of the real convergence on structural convergence is stronger in the case of structural convergence index computed by Employment. The Real-Structural Convergence Matrix is a very important tool which allows us to clearly distinguish the CEE countries progress in the last decade. While the majority of them manage to advance to the area that includes the best performers in terms of real and structural catch-up, Romania and Bulgaria remain behind. Moreover, when computing the structural convergence index by Employment, Romania remains even behind Bulgaria, with poor performance both in terms of real and structural convergence.

The research can be further improved by including more indicators in the analysis and by creating more complex real and structural convergence indexes. A particular attention will be paid to the extension of the period of time analyzed in order to consolidate the econometric model.

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ANNEX

Table 1 - Structural Convergence Index computed by GVA and by Employment and Real Convergence Index, for the CEE countries - in 2000 and 2010

Country	SCI by GVA		SCI by Employment		RCI	
	2000	2010	2000	2010	2000	2010
BULGARIA	72.1	73.1	52.5	57.6	29.9	40.7
CZECH	66.5	65.2	74.4	72.3	49.6	63.3
ESTONIA	80.2	78.8	77.1	85.2	41.7	59.7
LATVIA	71.9	75.7	77	76.1	36	49.4
LITHUANIA	69.5	63.3	69.3	79.7	38.9	53
HUNGARY	85.3	80.1	71.9	79.3	45.5	56.9
POLAND	74.2	68.1	53.2	68.8	44.7	52.9
ROMANIA	61.2	53	13.8	37.4	25.8	42.8
SLOVENIA	82.1	82.5	64	73.2	68.7	75.4
SLOVAKIA	70.4	67.7	80.4	73.6	45.8	68.7

Source: Authors' work