ECONOMIC COHESION OF POLISH AND EUROPEAN UNION REGIONS

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Abstract

In recent years we can observe a growing interest in the problem of cohesion because of its crucial role in sustainable development. Economic cohesion is usually considered at the macroeconomic level, but it should be noted, that it is possible the situation in which the development gaps between countries will be reduced but at the level of regions the differences will increase. Objective of the study is to assess the economic cohesion of Polish regions and cohesion of Member States of the European Union. In the analysis are used the GDP per capita in terms of GDP per capita in Poland and in the European Union. The study allows to verify the hypothesis that the convergence processes between Polish regions and countries of the European Union occur. Sigma and beta convergence methods and Markov chains are applied in the evaluation of the economic cohesion. The research is based on the data from Central Statistical Office in Poland and data from Eurostat in the years 2000–2009.

Key words: economic cohesion, sigma and beta convergence, Markov chain

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Introduction

The idea of the European community is based on the concept of economic, social and territorial cohesion of EU regions and countries. The implementation of the EU cohesion policy is to be conducive to the reduction of developmental distance in relation to the average level in the EU. The observation of the level of development of individual economies allows for the conclusion that the existing disproportions in development do not always show a vanishing trend in spite of the conducted activities in the sphere of economic policy. Therefore, it seems justified to constantly monitor regional inconsistencies that will enable better design of the cohesion policy.

The subject of this elaboration is the evaluation of the economic cohesion of Polish regions and EU member states. Classical convergence indicators have been used to estimate economic cohesion. Calculations are based on data concerning the gross domestic product

(GDP) throughout NUTS-2 and NUTS-3 regions. Data from the period 2000-2009 taken from the Central Statistical Office in Poland and Eurostat has been used in the research.

1 Economic cohesion and its measurement

It is assumed that in order to deepen the economic cohesion it is required to equalise the level of GDP *per capita* across regions (cohesion at a country level) or countries (cohesion in the international dimension). Literature devoted to the issues of economic growth[1] demonstrates different varieties of convergence, including e.g. σ-convergence and β-convergence that are classified as classical convergence. The former occurs when the dispersion of GDP *per capita* across countries (regions) in the examined group decreases over time. The concept of β-convergence, in turn, concerns the dependence between an average growth rate of GDP *per capita* and its initial value. Two varieties can be distinguished: absolute (unconditional) convergence which assumes that all tested economies strive at the same determined condition (steady state), i.e. also the same level of affluence expressed by income *per capita,* and conditional convergence which assumes that each country aims at its established condition that depends on the characteristics of its economy (e.g. average level of education, structure of income) (Nowak, 2007, p. 71–76).

The mentioned convergence concepts are interrelated. β-convergence is a condition necessary for σ-convergence to occur, yet not sufficient.

The dispersion of GDP *per capita* at the regional level (σ-convergence) is usually measured with the use of standard deviation (or variance) of the logarithm of GDP *per capita* of the examined countries (regions). The proof of the existence of σ-convergence is the decreasing trend in the standard deviation of natural logarithms of GDP *per capita* observed in time. From a different perspective, σ-convergence may also be tested by estimating the regression equation in the following form (Próchniak & Rapacki, 2009, p. 308):

$$\sigma_t = \alpha_0 + \alpha_1 t + \xi \qquad (1)$$

where σ_t means standard deviation of the natural logarithm of GDP *per capita* in year *t*. If parameter α_1 is negative, then σ-convergence occurs. Alternatively, variation coefficient of GDP *per capita* is used to measure σ-convergence.

The analysis of absolute β-convergence is connected with the estimation of the parameters of the regression equation in which the average real growth rate of GDP *per capita*

[1] Theoretical considerations on convergence based on Neo-classical growth were presented in the works of, for example: (Barro & Sala-i-Martin, 1992) and (Sala-i-Martin, 1996).

is affected by its initial level and – when testing conditional convergence – other structural variables. The regression equation mentioned above takes the following form (Próchniak & Rapacki, 2009, p. 308):

$$T^{-1}\ln(\frac{y_{iT}}{y_{i0}}) = \alpha_0 + \alpha_1 \ln(y_{i0}) + \varepsilon_{it} \qquad (2)$$

therefore: $\beta = -\frac{1}{T}\ln(1+\alpha_1 T)$, where: y_{i0} and y_{iT} – GDP *per capita* in *i*-th country/region in the initial and final time unit; T – duration of the examined period; β – rate of convergence coefficient; α_0 – constant; ε_{it} – random variable.

The negative dependence (negative parameter α_1) between the growth rate and the initial income means the existence of convergence[2].

The criticism of classical methods of examining convergence has drawn the attention of researchers to the possibility of using the Markov chain (Fingleton, 1997). It is one of the methods of analysing the dynamics of the structure of a given phenomenon. The initial distribution of income is divided into a finite number of ranges referred to as income classes[3], on the basis of which the state-transition matrix is estimated: $P = \left[\widetilde{p}_{ij}\right]$. The elements of this matrix are the probabilities of transition p_{ij} of individual countries (regions) from income class i to class j ($i, j = 1,...,m$) in the determined time unit t ($t = 0, 1, 2, ..., T$). The obtained probabilities inform us about the percentage number of countries (regions) that were initially in a given class of income and in the successive period remained in it or were transferred to other classes.

The probability of transition is created by the so-called boundary (ergodic) probability vector. This probability is the main tool of convergence analysis. More or less unimodal probability distribution (transition of probability mass towards the class of income containing an average value) suggests that there is no evidence against convergence while multimodal distributions of this probability suggest the convergence of "clubs“ (probability mass is concentrated in extreme classes). If its distribution is close to uniform (similar elements of ergodic probability vector), then we deal with divergence (Łaźniewska & Górecki, 2012, p. 4).

[2] Coefficient β shows what percentage of distance from the long-term balance (steady state) is covered by the economy during one period. Coefficient β does not, however, measure the rate of equalising income levels (economic development), but the rate of convergence to the hypothetical state of long-term balance (Próchniak & Rapacki, 2009, p. 308).

[3] The arbitrary choice of ranges dividing individual income classes is a limitation of the described method; different divisions may lead to different results.

The state-transition matrix may also be used to calculate measures that evaluate the rate of convergence. One of them is half-life, i.e. the number of periods[4] after which the present state is to converge with the stationary state in half. The lower the value of this measure, the better. It can be calculated with the formula (Geppert & Stephan, 2008, p. 196):

$$hl = \frac{-\ln 2}{\ln|\lambda_2|} \qquad (3)$$

where λ_2 means the second eigenvalue of the state-transition matrix.

The second measure was proposed by G. Pellegrini and it is the stability index *S* which for the state-transition matrix with the dimension $m \times m$ takes the form (Łaźniewska & Górecki, 2012, p. 5):

$$S = \sum_{\substack{i=1 \\ j=j}}^{m} \frac{p_{ij}}{m} \qquad (4)$$

where the numerator of fraction means the sum of elements on the diagonal. It takes values from 0 to 1. Its high value indicates the stable process in which the chances of changing the state are rather slim.

2 Economic cohesion of the regions of Poland

The analysis of the diversification of the income situation from the perspective of regions (NUTS 3) and its changes in time allows for drawing conclusions on their economic cohesion. In order to evaluate the economic convergence of regions, data from the years 2000–2009 regarding the gross domestic product per one resident at the level of NUTS 3 from Local Data Bank[5] was used.

Tab. 1: Results of estimating parameters of the regression model of σ-convergence for NUTS 3 regions in Poland in the period 2000–2009

Description	*Alfa*	Standard error	*A*	Standard error	*t*(8)	*p*-value
Constant			0.3032	0.0040	75.24	0.0000
Time (*t*)	0.7715	0.2250	0.0022	0.0006	3.43	0.0090
R^2= 59.52%; $F(1.8)$=11.76; p<0.00896						

Source: own calculations based on the data from Local Data Bank for the period 2000–2009.

[4] Periods for which the state-transition matrix was determined, e.g. year, 10 years, etc., should be taken into consideration.

[5]Necessary data concerning 66 sub-regions taken from website of the Central Statistical Office of Poland.

Table 1 shows the estimation of the parameters of equation 1 in which the explained variable is the standard deviation of logarithms of GDP *per capita*. The positive parameter α_1 gives grounds to draw conclusions on the decreasing σ-convergence in Poland.

Next, an attempt is made to evaluate the mobility of Poland's regions in terms of their affluence (determined by the income situation). Regions were divided into groups according to income value. In this examination, five income classes measured by the share (in %) of GDP *per capita* in a given region in relation to GDP *per capita* for Poland in a given year were used. The state-transition matrix for the entire examined period is presented in table 2.

The calculated stability index based on the trace of state-transition matrix amounted to 0.79, which confirmed the relatively high constant of distribution (table 2). Regions in which GDP *per capita* stayed at the level of 75–100% of GDP *per capita* for Poland changed their position to the greatest extent. In other distinguished groups, one can observe greater dynamics of changes. The poorest sub-regions had better chances of relative enrichment than the chances of the wealthiest ones becoming poorer. Strong tendencies to relative impoverishment are confirmed by an ergodic vector: all probability mass is cumulated in two groups of the poorest sub-regions, which is not obviously practicable but it shows synthetically the dynamics of the relative distribution of GDP *per capita* across sub-regions.

Tab. 2: State-transition matrix between income classes for NUTS 3 regions in Poland

Income group		2009				
		[0–60]	(60–75]	(75–100]	(100–150]	>150
2000	[0–60]	0.667	0.333	0	0	0
	(60–75]	0.158	0.842	0	0	0
	(75–100]	0	0.037	0.963	0	0
	(100–150]	0	0	0.167	0.667	0.167
	>150	0	0	0	0.200	0.800
Summary statictiocs						
Stationary distribution		0.321	0. 679	0	0	0
Half-life		18.37 periods				
Stability index (*S*)		0.79				

Source: own calculations based on the data from Local Data Bank for the period 2000–2009.

Even though a ten-year period of examination was taken into account, changes in the income situation of individual regions occurred only one level upwards or downwards. This

results from the fact that income convergence at the mesoeconomic level is a very slow process. This is also confirmed by the half-life indicator that amounts to 18.37, which means that in about 184 years (18.37 × 10 years) the current state is to converge with the stationary one in half.

3 Economic cohesion of EU member states

Convergence is driven by the process of reducing backwardness as weakly developed EU regions progress at a faster rate than highly developed regions. An answer to the question of the occurrence of convergence processes at the level of European Union countries may be formulated on the basis of the results presented in chart 3. The parameters of the model (formula 2) that says about absolute β-convergence were estimated for the whole tested period and for the years 2000–2004 and 2004–2009. Negative values of parameter α_1 of models estimated for all separated periods confirm the hypothesis of the appearance of β-convergence at the level of European Union countries. The calculated rate of convergence differs, depending on the examination period. If one assumes results for the years 2000–2009, it can be stated that the covering of the half-distance to the state of long-term balance will take about 36 years[6].

Tab. 3: Results of the estimation of the parameters of the regression model that describes the dependence of real growth of GDP *per capita* from its initial level in European Union states (UE-27) in the period of 2000–2009

Period	α_0	α_1	$t(\alpha_0)$	$t(\alpha_1)$	R^2	β-convergence	β
2000–2004	0.2349	-0.0216	7.19	-6.33	0.6156	yes	0.0226
2004–2009	0.1708	-0.0163	7.27	-6.72	0.6439	yes	0.0170
2000–2009	0.1904	-0.0179	11.17	-10.02	0.8006	yes	0.0195

Source: own calculations based on the data from Eurostat.

The above conclusions are also confirmed by the results of calculations presented in table 4 (model estimated on the basis of formula 1). At this level of aggregation (EU states), one can also speak about the occurrence of σ-convergence processes. This means that year by year the diversification of GDP *per capita* among EU member states is decreasing.

[6] The number of years necessary to liquidate half of the initial inequalities is calculated according to formula: $\tau = \frac{\ln(2)}{\beta}$ (Romer, 1996, p. 22–23).

Tab. 4: Regression results for σ-convergence for European Union countries (UE-27) in the period of 2000–2009

Description	*Alfa*	Standard error	*A*	Standard error	*t*(8)	*p*-value
Constant			0.9033	0.0056	162.07	0.0000
Time (*t*)	-0.9893	0.0516	-0.0172	0.0009	-19.18	0.0000
R^2= 97.87%; *F*(1.8)=367.94; *p*<0.001						

Source: own calculations based on the data from Eurostat.

The above results show that the countries of Central and Eastern Europe that joined the European Union are characterised by convergence in their development with Western Europe in terms of the level of income per one resident. This is confirmed by β and σ coefficients that demonstrate the tendency to equalise the income level. What it results from is the fact that in the last decade these countries developed faster than highly developed countries of Western Europe. As a result, one can speak of decreased distance in terms of income between Central and Eastern Europe and Western Europe. However, this does not change the fact that differences in the level of income are still substantial and the process of equalising the levels of social and economic development is to last a few more years.

Tab. 5: State-transition matrix between income classes for regions (NUTS 2) of European Union member states (UE-27) in the period of 2000–2009

Income group		2009				
		[0–50]	(50–75]	(75–100]	(100–150]	> 150
2000	[0–50]	0.5625	0.4375	0	0	0
	(50–75]	0	0.8333	0.1333	0.0333	0
	(75–100]	0	0	0.9538	0.0462	0
	(100–150]	0	0	0.2366	0.7204	0.0430
	>150	0	0	0	0.1429	0.8571
Summary statistics						
Stationary distribution		0	0	0. 797	0.156	0.047
Half-life		5.31 periods				
Stationary index (*S*)		0.79				

Source: own calculations based on the data from Eurostat.

The examination of cohesion at the level of EU member states was also conducted on the basis of data on the lower degree of aggregation with the use of the alternative research method – the Markov chain. For this purpose, data concerning GDP *per capita* for the regions

of EU member states (NUTS 2)[7] has been used. In this case, changes can also be observed towards improved income. Five classes of income measured by share (in %) of GDP *per capita* in a given region in relation to GDP *per capita* for the European Union (UE-27) in a given year were adopted for examination. Table 5 shows the state-transition matrix between groups of income for regions at the NUTS 2 level.

The state-transition matrix shows a relatively constant distribution. Values on the diagonal are very high, which suggests high probability of remaining in the same class of GDP *per capita*. This confirms the value of the stability index (*S*), which in this case amounted to 0.79. Generally, one can state that the probability of relative enrichment of regions is higher than the probability of relative impoverishment. Changes in terms of belonging to the adopted income groups are visible to a greater extent in extreme income groups. It can also be generally stated that in the regions with GDP *per capita* lower than 100% of the mean for the European Union, transitions (of regions) towards higher categories of income are definitely more frequent than movements downwards. Above this threshold, one can observe more frequent transitions to lower income classes. This suggests the convergence process according to which poorer regions catch up with richer regions. Elements beyond the main diagonal of the matrix also indicate that transitions to other categories are relatively slow, which is evidenced by the calculated half-life indicator (5.31 periods). This means that in about 53 years, the current state will converge with the stationary state in half.

The progressing convergence process is also confirmed by the ergodic vector. In the long-term, one can expect that the majority of regions will be shifted to the central class of income and only several percent will remain in the richest group.

On the basis of the calculations presented above, it can be stated that in the period of 2000–2009 the processes of economic convergence identified with the level of GDP *per capita* with reference to GDP *per capita* for the entire European Union have occurred in 27 EU states.

Conclusion

On the basis of the conducted analyses, it can be concluded that at the level of Polish regions convergence does not occur in fact. One should rather point at increasing diversification or even regional divergence.

[7] Data concerning GDP *per capita* for regions at the NUTS 2 level in UE-27 states was taken from the Eurostat database. Due to the lack of data in 2000 for the regions of Austria, Hungary and Italy, they were not taken into account in the analysis (234 regions were considered).

The results of the analysis conducted for European Union states confirm the hypothesis of the occurrence of β-convergence between them. At this level of aggregation, there are also processes of σ-convergence. This means that year by year the divergence of GDP *per capita* across states belonging to the European Union is decreased. These observations are confirmed by the application of Markov chains for examining economic cohesion. The results of analyses show the convergence process according to which poorer regions catch up with the more affluent regions. In the long-term, one can expect that the majority of regions will shift to the middle class of income and only several percent will remain in the richest group.

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