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Article

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The Beta-Convergence of the EU-10 Countries and Regions in the Years 2004-2015

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Abstract

The article analyzes the beta-convergence of the EU-10 countries and the EU-15 for 2004 and 2015 at four levels - the state, NUTS 1, NUTS 2 and NUTS 3. The strongest beta-convergence is at the level of the EU-10 countries; however, the lower the level of the regional unit, the weaker the beta-convergence. At the NUTS 3 level in Poland, Slovenia and Hungary, divergence was found, which means there are convergence and divergence processes.

Keywords: CEE, integration, economic growth, economic beta-convergence

JEL: O47, R10, R19

Introduction

On May 1, 2004, eight Central and East European countries – the Czech Republic, Estonia, Lithuania, Latvia, Poland, Slovakia, Slovenia and Hungary, as well as two island states of Southern Europe – Cyprus and Malta, joined the European Union. Apart from Cyprus and Malta, the other countries had belonged to the socialist bloc, while Estonia, Lithuania and Latvia had been socialist republics of the Soviet Union until 1990. Between 1990 and 2004, the post-Soviet countries underwent a political and economic transformation, introducing the principles of a free-market economy and privatization and democratization processes. It should also be mentioned that the economies of these countries changed the direction of international cooperation radically – from the East – mainly the USSR and then the Russian Federation – to the West. These political and economic changes became even more apparent after the Czech Republic, Poland and Hungary joined NATO on March 12, 1999, and the other five (Estonia, Lithuania, Latvia, Slovakia and Slovenia) became NATO members on March 29, 2004. The enlargement of the European Union in May 2004 was the largest single expansion in the history of the EU – 10 countries with over 70 million inhabitants became citizens of the EU, and the EU-15 transformed into the EU-25.

The aim of the article is to examine the economic convergence of the beta-10 countries that joined the EU in May 2004 and the EU-15 at four levels – at the state level, NUTS 1, NUTS 2, NUTS 3 and internal convergence countries EU-10 at the above-mentioned levels the EU-15.

Beta-convergence

Beta-convergence refers to the integration process in which poor regions and countries grow faster than rich ones and therefore catch up with them. The concept of beta-convergence is related to the neoclassical theory of growth, where one of the key assumptions is that the factors of production are subject to a diminishing return, which means that the growth rate of poor economies should be higher and their GDP per capita should catch up with rich economies over time (Monfort 2008, p. 4). Beta-convergence is measured using the β -convergence index – it occurs when less developed economies with a lower level of GDP per capita according to purchasing power parity (PPP) show a faster rate of economic growth than more developed economies with a higher level of GDP per capita according to PPP. You can verify β -convergence using the regression equation:

$$\frac{1}{T}(\ln y(T) - \ln y(0)) = a_0 + a_1 \ln y(0) \quad (1)$$

where: $y(T)$ – GDP per capita according to PPP in the final year, $y(0)$ – GDP per capita according to PPP in the beginning year, $T + 1$ – number of periods (years). The con-

vergence of β occurs when parameter α_1 is negative (the closer it is to -1 , the greater the convergence), and β showing the convergence rate of economies is calculated according to the formula:

$$\beta = -\frac{1}{T} \ln(1 + \alpha_1 T) \quad (2)$$

The β coefficient tells you what percentage of the distance to long-term equilibrium (steady-state) the economy overcomes during the year. In the case of convergence described by the neoclassical model, it is assumed that individual countries are characterized by a decreasing rate of GDP per capita, because their growth rate is decreasing (according to theory); these countries must finally achieve (of course, theoretically) a state characterized by zero GDP growth per capita – long-term equilibrium. If we assume that all economies are approaching the same steady state (in terms of GDP per capita) beta-convergence is absolute, and less developed countries have to overcome a longer path than developed countries. It may be the case, however, that convergence will take place, but not necessarily at the same level (the same GDP per capita) because economies are diverse – then we have conditional convergence (Monfort 2009, pp. 26–28).

The β coefficient does not measure the rate of equalization of income levels (economic development), only the pace of convergence to the hypothetical long-term equilibrium. For example, if $\beta = 2\%$, each country overcomes 2% of the distance to long-term equilibrium in T years.

$$T = \frac{-\ln(0,5)}{\beta} \quad (3)$$

This means that it takes 35 years to halve the distance in relation to the common long-term equilibrium (Próchniak 2007, pp. 43–44). This result was calculated according to the formula (3) (Próchniak 2017, p. 37).

Levels of beta-convergence units under investigation

Studies of beta economic convergence will be conducted and analyzed at 4 levels – state (10 EU-10 countries and EU-15), NUTS 1 (17 NUTS 1 units from the EU-10 and the EU-15), NUTS 2 (42 NUTS 2 units of the countries surveyed and the EU-15), NUTS 3 (150 NUTS 3 units of the examined EU-10 countries and EU-15).

According to the definition, the NUTS classification is hierarchical – it divides each EU Member State into territorial units of the NUTS level 1, each of which is divided into NUTS level 2 territorial units, which in turn are divided into territorial units of NUTS level 3, where one territorial unit may represent several NUTS levels. The

classification assumes that units of each level from all EU countries should be similar in terms of population (Regulation 2003, pp. 197–198). Therefore, for the individual NUTS levels, the following boundaries of the state of the population inhabiting and working in these units were established:

Table 1. NUTS classification by level and population

Size / Level	NUTS 1	NUTS 2	NUTS 3
Minimum	3,000,000	800,000	150,000
Maximum	7,000,000	3,000,000	800,000

Source: NUTS Regulation 2003, p. 198.

The following Table 2 shows the number of NUTS regions for the countries of the EU-10 and EU-15.

Table 2. Number of NUTS regions by levels for 2013

No.	Country/Level	NUTS 1	NUTS 2	NUTS 3
1	Cyprusus	1	1	1
2	Czech Republic	1	8	14
3	Estonia	1	1	5
4	Lithuania	1	1	10
5	Latvia	1	1	6
6	Malta	1	1	2
7	Poland	6	16	72
8	Slovakia	1	4	8
9	Slovenia	1	2	12
10	Hungary	3	7	20
11	Total EU-10	17	42	150
12	Total EU-15	74	218	1076

Source: GUS 2013.

As we can see from the data included in Table 2, in 2013, Poland was a country with 35–48% of the total number of regions at NUTS 1–3 level in this group, which means Poland had a leading position in the EU-10. We also see that the EU-10 accounted for 12–18% of the total number of NUTS regions, depending on the level of regions in the EU-25.

Beta-convergence at the state and NUTS 1 level in the EU-10 and EU-15

For the calculations of beta-convergence according to formulas (1–2), the data of GDP per capita in the PPP for the period 2004–2015 of the EU-10 and the EU-15 groups is necessary.

Table 3. GDP per capita in the PPP of the EU–10 states and the EU–15 in 2004 and 2015

Country	GDP per capita 2004	GDP per capita 2015	lnGDP per capita 2004	lnGDP per capita 2015
Cyprus	21,900	23,800	9.99	10.08
Czech Republic	17,600	25,300	9.78	10.14
Estonia	12,200	21,700	9.41	9.99
Lithuania	11,000	21,700	9.31	9.99
Latvia	10,300	18,500	9.24	9.83
Malta	18,100	27,000	9.80	10.20
Poland	11,300	19,800	9.33	9.89
Slovakia	12,800	22,300	9.46	10.01
Slovenia	19,300	23,800	9.87	10.08
Hungary	13,700	19,700	9.53	9.89
UE15	25,600	31,600	10.15	10.36

Source: Eurostat 2018A, own calculation.

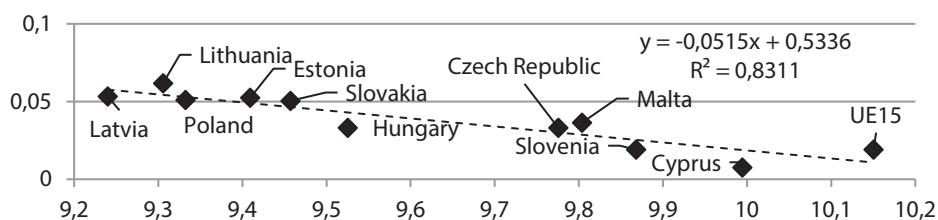


Figure 1. Convergence of beta countries of the EU–10 and the EU–15, 2004 and 2015

Source: based on data from Table 1.

The data of Figure 1 presents GDP growth per capita for 2004 and 2015 on the vertical axis in the logarithmic scale (ln), while on the horizontal axis – GDP per capita for 2004 in the logarithmic scale. We can see that the EU–15 countries have a high GDP per capita for 2004, but quite a low GDP growth rate in 2015 to 2004. In contrast, the EU–10 countries had quite a low GDP per capita in 2004, but they recorded a large GDP growth per capita in the PPP in 2015 to 2004. We can see from the graph that the α_1 index is negative (-0.0515), in which case we are talking about beta-convergence, and you can calculate the β coefficient which informs us about the convergence rate of the economies according to formula (2), in this case, $\beta = 0.075988$. It means that each year, the EU–10 countries, together with the EU–15, are approaching a state of equilibrium by 7.6%.

The analysis of convergence at the NUTS1 level from the EU–10 countries and the EU–15 group will be made in a similar way.

As in the case of the convergence study at the state level, at the NUTS 1 level, we can see from the data in Figure 1 and Figure 2 that virtually all countries from the EU–10 (except for Cyprus) and NUTS 1 (except NUTS 1 Cyprus CY0) had higher growth GDP per capita in 2015 compared to 2004 than the EU–15, but much lower GDP per capita for 2004. For convergence, NUTS 1 α_1 is negative

(-0.033), and $\beta = 0.040999$, which means that NUTS 1 regions from the EU-10, together with the EU-15, are approaching equilibrium by 4.1% each year.

Table 4. GDP per capita in PPP NUTS 1 EU-10 to EU-15 in 2004 and 2015

L.p.	NUTS 1 UE10 to UE15/GDP per capita	GDP per capita 2004	GDP per capita 2015	lnGDP_2004	lnGDP_2015
1	CY0 – Kypros	21,900	23,800	9.994242	10.07744
2	CZ0 – Česká republika	17,600	25,300	9.775654	10.13856
3	EE0 – Eesti	12,200	21,700	9.409191	9.985068
4	LT0 – Lietuva	11,000	21,700	9.305651	9.985068
5	LV0 – Latvija	10,300	18,500	9.239899	9.825526
6	MT0 – Malta	18,000	27,000	9.798127	10.20359
7	PL1 – Region Centralny	14,800	27,500	9.602382	10.22194
8	PL2 – Makroregion Południowy	11,500	19,500	9.350102	9.87817
9	PL3 – Region Wschodni	8,300	14,000	9.024011	9.546813
10	PL4 – Makroregion Północno-Zachodni	11,200	19,400	9.323669	9.873028
11	PL5 – Makroregion Południowo-Zachodni	10,900	20,600	9.296518	9.933046
12	PL6 – Makroregion Północny	10,000	16,800	9.21034	9.729134
13	SI0 – Slovenija	19,300	23,800	9.86786	10.07744
14	SK0 – Slovensko	12,800	22,300	9.4572	10.01234
15	HU1 – Közép-Magyarország	22,000	30,400	9.998798	10.3222
16	HU2 – Dunántúl	12,300	17,600	9.417355	9.775654
17	HU3 – Alföld és Észak	9,200	13,200	9.126959	9.487972
18	EU-15	25,600	31,600	10.15035	10.36091

Source: Eurostat 2018A, own calculation.

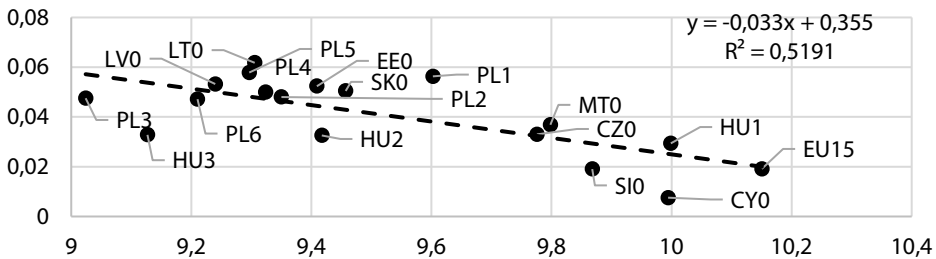


Figure 2. Beta-convergence of NUTS 1 EU-10 and EU-15, for 2004 and 2015

Source: based on data from Table 2.

The progressive convergence of the EU-10 and EU-15 and NUTS 1 from the EU-10 and the EU-15 can be observed on the basis of another important indicator, the so-called development gap, showing the GDP per capita in the PPP of a given unit to this indicator in the EU-15 (Tables 5–6) (Matkowski 2012, pp. 21–23). From the data in Table 5, we can see that the EU-10 development gap to the EU-15 decreased in 2004–2015 by 16.1 percentage points (p. p.), (Δ) which is a good result.

Table 5. Development gap of EU-10 countries in relation to EU-15 in 2004-2015 (GDP per capita according to PPP; EU-15 = 100)

Country/Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Δ
UE15	100	100	100	100	100	100	100	100	100	100	100	100	0
Cyprus	85.5	89.1	88.9	92.8	94.8	95.2	90.4	87.1	82.8	77.1	74.4	75.3	-10.2
Czech Republic	68.8	70.2	70.3	73.6	75.5	77.1	75.1	75.6	75.6	76.7	79.1	80.1	11.3
Estonia	47.7	52.8	57.0	62.0	61.7	57.6	58.7	64.5	67.4	69.2	69.8	68.7	21
Lithuania	43.0	46.4	48.7	53.8	56.6	50.9	54.8	59.9	63.9	67.1	69.1	68.7	25.7
Latvia	40.2	44.5	46.6	51.0	53.1	47.2	47.7	51.9	55.3	57.2	58.1	58.5	18.3
Malta	70.7	71.3	68.8	70.2	71.4	73.4	75.8	75.3	76.3	78.1	81.4	85.4	14.7
Poland	44.1	44.5	44.8	47.3	50.0	53.5	56.6	59.2	61.2	61.3	61.8	62.7	18.6
Slovakia	50.0	53.2	55.9	59.6	64.1	64.2	67.6	67.9	69.1	70.2	70.8	70.6	20.6
Slovenia	75.4	76.6	76.3	77.7	80.7	77.1	75.4	75.6	74.9	75.0	75.4	75.3	-0.1
Hungary	53.5	54.7	54.1	53.8	56.2	57.9	58.7	59.9	60.1	61.6	62.5	62.3	8.8
UE10	50.5	51.8	52.3	54.8	57.5	59.2	61.0	63.1	64.5	65.1	66.0	66.6	16.1

Source: Eurostat 2018A, own calculation.

Table 6. Development gap of NUTS 1 from EU-10 compared to EU-15 in 2004–2015 (GDP per capita according to PPP, EU-15 = 100)

NUTS 1/Year	2004		2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015		Δ
	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	
UE15	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	0
CY0 – Kypros	85.5	89.1	88.9	92.8	94.8	94.8	94.8	94.8	94.8	94.8	95.2	90.4	87.1	82.8	77.1	74.4	75.3	-10.2							
CZ0 – Česká republika	68.8	70.2	70.3	73.6	75.5	77.1	75.6	76.7	79.1	80.1	11.3														
EE0 – Eesti	47.7	52.8	57.0	62.0	61.7	57.6	64.5	67.4	69.2	69.8	68.7	21													
LT0 – Lietuva	43.0	46.4	48.7	53.8	56.6	50.9	54.8	59.9	63.9	67.1	69.1	68.7	25.7												
LV0 – Latvija	40.2	44.5	46.6	51.0	52.8	47.2	47.7	51.9	55.0	57.2	58.5	58.5	18.3												
MT0 – Malta	70.3	71.3	68.8	70.2	71.4	73.1	75.4	74.9	76.3	78.4	82.4	85.4	15.1												
PL1 – Region Centralny	57.8	59.6	60.2	63.7	66.6	73.1	77.9	81.5	84.5	85.3	86.0	87.0	29.2												
PL2 – Makroregion Płd.	44.9	44.5	44.8	46.9	50.0	53.9	55.9	59.2	60.1	59.9	60.5	61.7	16.8												
PL3 – Region Wschodni	32.4	32.5	32.3	34.2	36.9	38.7	40.6	42.5	43.6	44.2	44.2	44.3	11.9												
PL4 – Makroregion Płn.-Zach.	43.8	44.5	44.4	46.6	49.0	53.1	54.4	56.8	58.8	59.2	60.1	61.4	17.6												
PL5 – Makroregion Płd.-Zach.	42.6	43.8	45.2	48.6	51.0	55.4	59.4	62.7	64.3	63.7	64.5	65.2	22.6												
PL6 – Makroregion Płn.	39.1	39.2	39.8	41.8	43.1	46.5	48.4	50.5	52.2	52.4	52.2	53.2	14.1												
SK0 – Slovensko	50.0	53.2	55.9	59.6	64.1	64.2	67.6	67.9	69.1	70.2	70.8	70.6	20.6												
SI0 – Slovenija	75.4	76.6	76.3	77.7	80.7	77.1	75.4	75.6	74.9	75.0	75.4	75.3	-0.1												
HU1 – Közép-Magyarország	85.9	89.1	89.6	89.4	93.4	97.4	97.2	97.2	97.6	99.0	97.3	96.2	10.3												
HU2 – Dunántúl	48.0	47.9	47.0	46.2	47.9	47.6	49.8	51.9	51.5	53.1	55.5	55.7	7.7												
HU3 – Alföld és Észak	35.9	36.2	35.5	34.2	35.9	37.3	37.0	38.7	38.5	39.7	41.2	41.8	5.9												

Source: Eurostat 2018A, own calculation.

The situation is similar to the development gap of the NUTS 1 regions of the EU-10 group compared to the EU-15. The biggest changes in the development gap can be seen in NUTS 1 PL1 – Central Region, where there was a change by 29.2 pp, LT0 by 25.7 pp, and PL5 – the Southwestern Macroregion by 22.6 pp. It should also be noted that some NUTS 1 levels deteriorated, e.g., CY0 – Kypros by 10.2 pp.

Table 7. Standard deviation σ of the development gap compared to the expected value at the level of the EU-10 and NUTS 1, NUTS 2 and NUTS 3 countries in relation to the EU-15 in 2004–2015 (GDP per capita according to PPP, EU-15 = 100)

Level/ Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	$\Delta\sigma$
Country	42.6	40.3	39.3	36.5	34.5	35.7	34.4	32.3	30.9	30.0	29.2	28.9	13.7
NUTS 1	49.0	47.6	47.0	45.0	43.1	42.4	41.0	39.0	37.9	37.2	36.4	36.0	13
NUTS 2	51.7	51.2	50.9	49.7	48.0	47.2	46.4	44.8	44.0	43.7	42.7	42.7	9
NUTS 3	57.3	56.6	56.4	54.9	53.1	52.4	51.3	49.5	48.8	48.3	47.7	47.5	9.8

Source: Eurostat 2018A, Eurostat 2018B, own calculation.

The characteristic coherence of the development gap may be demonstrated by the standard deviation indicator σ development gap against the expected EU-15 = 100. From the data included in Table 7, we can see a decreasing trend of fluctuations in the development gap for countries and NUTS from the EU-10 group. From the data, we can see that the biggest changes ($\Delta\sigma$) took place at the level of states and NUTS 1 (respectively 13.7 pp and 13 pp.), which proves the greatest similarity of units.

Beta-convergence at NUTS 2 and NUTS 3 levels in the EU-10 and the EU-15

The analysis of the convergence at lower levels – NUTS 2 and NUTS 3 in the EU-10 countries and the EU-15 – was carried out in a similar way. (Due to the lack of space, some figures and tables have not been included in the text).

From Figures 3–7, we can see that the α_1 coefficients for the Czech Republic, Slovakia, Slovenia and Poland are negative, which indicates beta-convergence at the NUTS 2 level. The characteristics of these indicators will be made in the analysis of Table 8. The following diagrams present beta-convergence studies at the NUTS 3 level from the EU-10.

After the preliminary analysis of beta-convergence for the level of NUTS 2 regions (Figures 3–7), we can see that in 5 countries (the Czech Republic, Slovakia, Slovenia, Poland and Hungary) it is positive (coefficient α_1 is negative) and there is a convergence of β . In the case of the analysis of this convergence for the level of NUTS 3 regions (Figures 9–15), we can notice that in 5 countries (the Czech Republic, Estonia, Lithuania, Latvia, Slovakia) it is positive (coefficient α_1 is negative) and there is a convergence of β , and in three countries (Slovenia, Poland and Hungary) it is negative

(coefficient α_1 is positive) and there is no convergence of β . The charts also prove that the capital regions occupy the leading positions in catching up with the EU-15, both at the NUTS 2 and NUTS 3 level, which is consistent with previous studies carried out by other authors (Jóźwik 2014, p. 338).

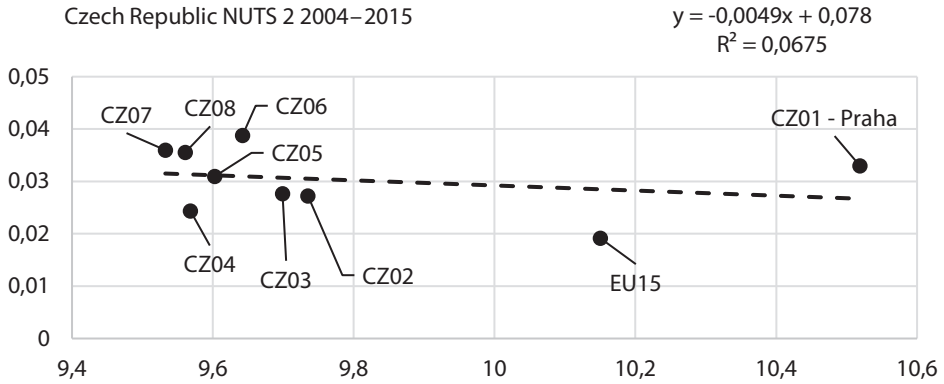


Figure 3. Beta-convergence in the Czech Republic for NUTS 2, 2004 and 2015
Source: Eurostat 2018A, own calculation.

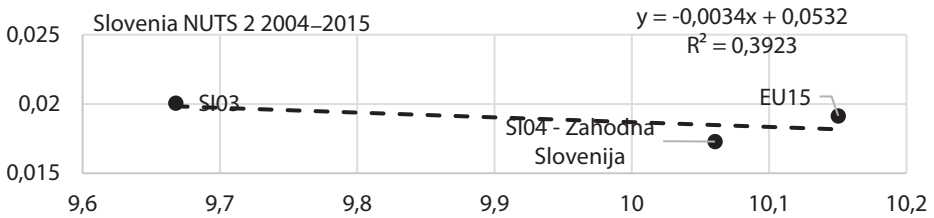


Figure 4. Beta-convergence in Slovenia for NUTS 2, 2004–2015
Source: Eurostat 2018A, own calculation.

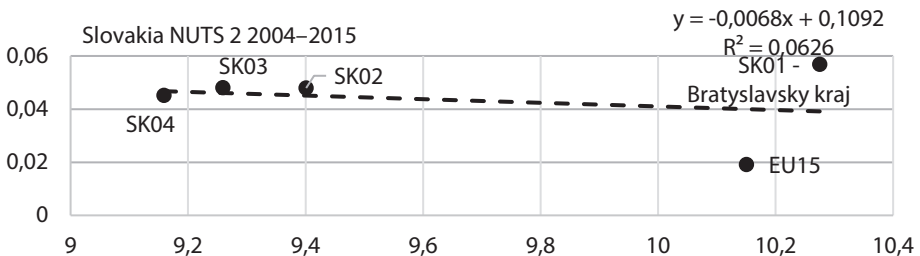


Figure 5. Beta-convergence in Slovakia for NUTS 2, 2004 and 2015
Source: Eurostat 2018A, own calculation.

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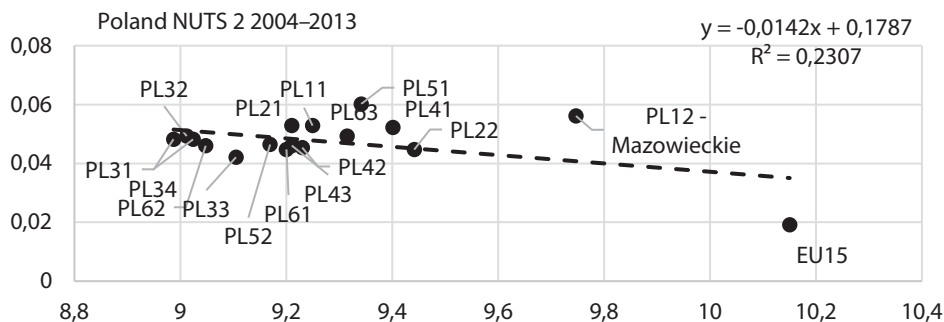


Figure 6. Beta-convergence in Poland for NUTS 2, 2004 and 2015
Source: Eurostat 2018A, own calculation.

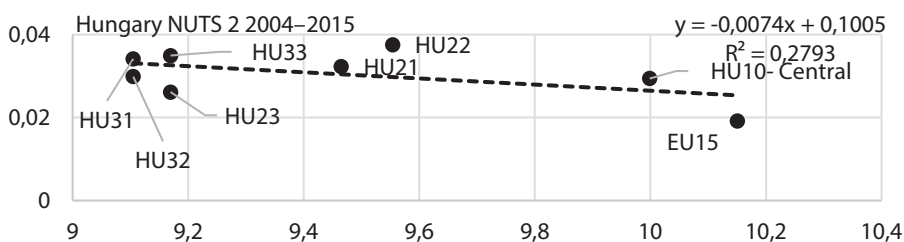


Figure 7. Beta-convergence in Hungary for NUTS 2, 2004 and 2015
Source: Eurostat 2018A, own calculation.

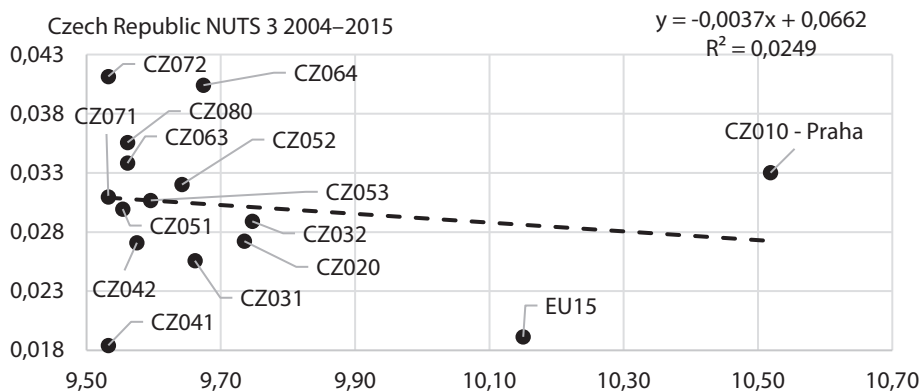


Figure 8. Beta-convergence in the Czech Republic for NUTS 3, 2004 and 2015
Source: Eurostat 2018B, own calculation.

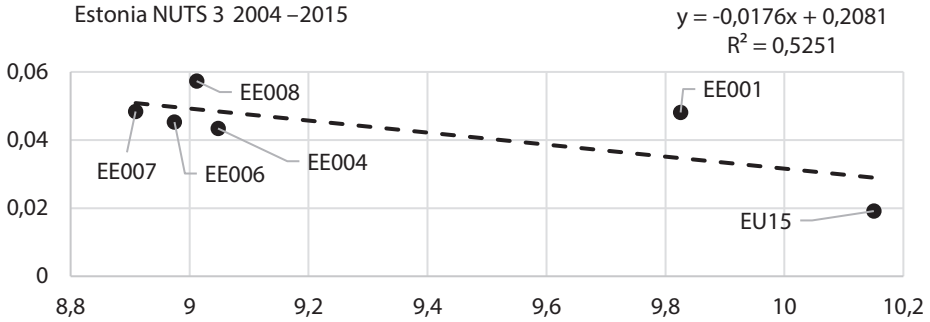


Figure 9. Beta-convergence in Estonia for NUTS 3, 2004 and 2015
Source: Eurostat 2018B, own calculation.

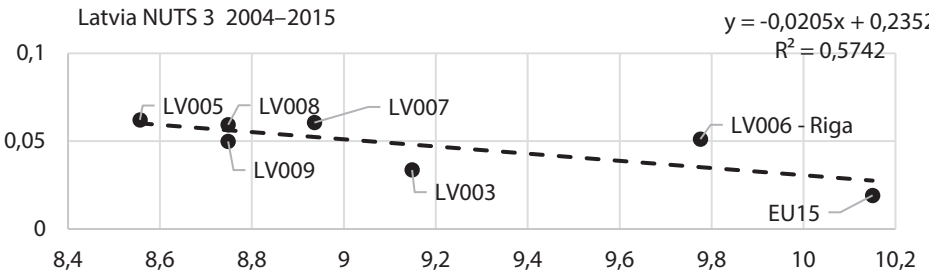


Figure 10. Beta-convergence in Latvia for NUTS 3, 2004 and 2015
Source: Eurostat 2018B, own calculation.

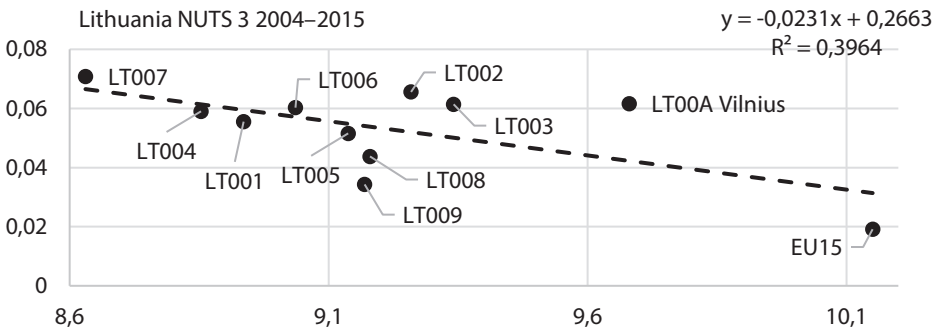


Figure 11. Beta-convergence in Lithuania for NUTS 3, 2004 and 2015
Source: Eurostat 2018B, own calculation.

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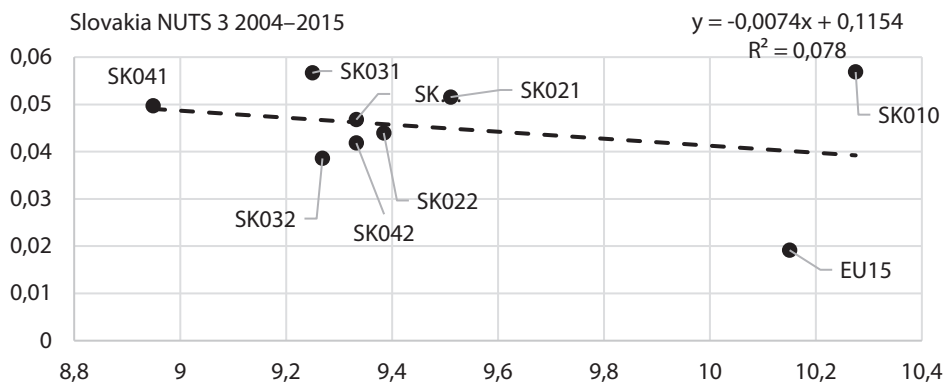


Figure 12. Beta-convergence in Slovakia for NUTS 3, 2004 and 2015

Source: Eurostat 2018B, own calculation.

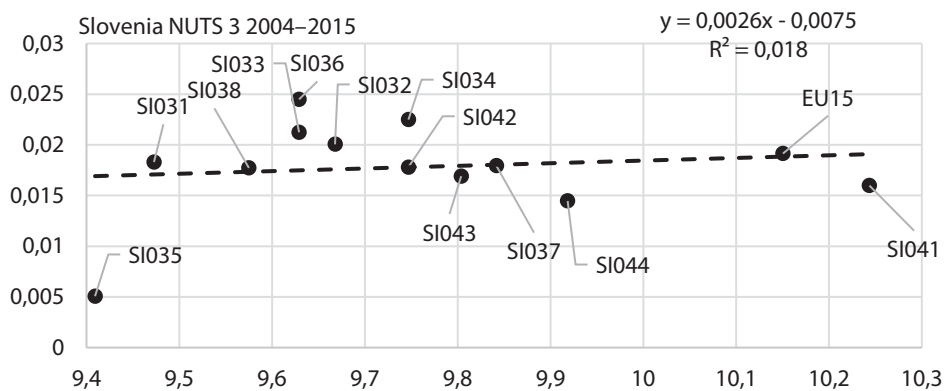


Figure 13. Beta-convergence in Slovenia for NUTS 3, 2004 and 2015

Source: Eurostat 2018B, own calculation.

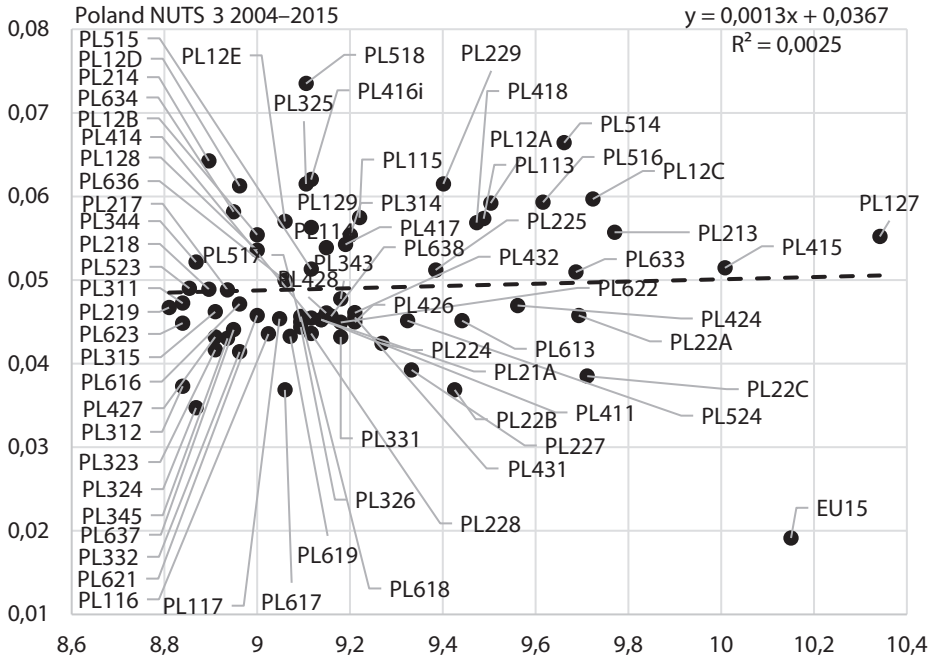


Figure 14. Beta-convergence in Poland for NUTS 3, 2004 and 2015

Source: Eurostat 2018B, own calculation.

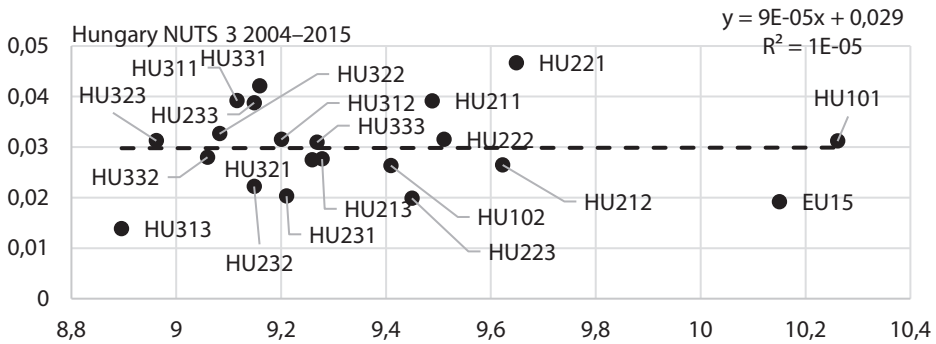


Figure 15. Beta-convergence in Hungary for NUTS 3, 2004 and 2015

Source: Eurostat 2018B, own calculation.

Final analysis – beta-convergence in the EU-10 and the EU-15

Analyzing the α_1 and β indices from Table 8, we conclude that the convergence at the level of the EU-10 countries was the most effective in this period as they overcame 7.6% of the distance to long-term equilibrium, whose half-year level will be reached in 9.12 years. Weaker convergence occurs at the NUTS 1 level (3.3% annually, and 16.91 years to beat the halfway route to long-term equilibrium).

Table 8. The values of beta-convergence ratios at the state level of the EU-10 and NUTS 1, NUTS 2 and NUTS 3 in relation to the EU-15 in 2004 and 2015 (GDP per capita according to PPP, EU-15 = 100)

Level/indicator	α_1	β	converg./diverg.	T (years)	R^2	σ 2004	σ 2015	Δ_σ
States UE10	-0.0515	0.075988	convergence	9.12	0.8311	42.6	28.9	13.7
NUTS 1 UE10	-0.0330	0.040999	convergence	16.91	0.5191	49.0	36.0	13
NUTS 2 UE10	-0.0154	0.016873	convergence	41.08	0.2034	51.7	42.7	9
NUTS 3 UE10	-0.0142	0.01544	convergence	44.89	0.1427	57.3	47.5	9.8

Source: Eurostat 2018A, Eurostat 2018B, own calculation.

Much worse results are at the NUTS 2 and NUTS 3 levels (1.5%–1.7% annually and 41–45 years to beat the half of the road).

Having considered these results, the conclusion is that the lower the level of regional unit, the weaker the beta-convergence (the value of the determination coefficient R^2 decreases with it and the standard deviation of the development gap σ with the expected EU-15–100 value increases). On the other hand, the overall results at these levels are not consistent and raise many objections. They result from the situation that took place in 2004–2015 which included many activities in the integration process in the context of achieving cohesion (Kosztowniak 2016, pp. 174–180).

The data included in Table 9 analyzing convergence within countries from the EU-10 group confirm the conclusions from Table 8. Beta-convergence is clearly visible inside the EU-10 countries at the NUTS 1 level (in those countries where NUTS 1 level exists), but much weaker at NUTS 2 and NUTS 3 levels (the scale of the β index is much lower for NUTS 3 and NUTS 2 compared to NUTS 1).

In the case of Poland, Slovenia and Hungary, at the NUTS 3 level, divergence was found (Adamczyk-Łojewska 2011, pp. 57–75), which means that convergence processes at the level of state and NUTS 1 show divergence processes at the regional level. This phenomenon has already been noticed in earlier studies on this subject in Poland (Markowska-Przybyła 2011, pp. 77–95).

Table 9. Values of beta-convergence ratios at the internal level of the EU-10 countries and NUTS 1, NUTS 2, NUTS 3 and the EU-15 in 2004 and 2015 (GDP per capita according to PPP, EU-15 = 100)

Level/ indicator	α_1	β	conver./ diver.	T years	R ²	σ_{2004}	σ_{2015}	$\Delta\sigma$
Czech Repub. NUTS 2	-0.0049	0.005037	conver- gence	137.61	0.0675	39.27	36.80	2.47
Czech Repub. NUTS 3	-0.0037	0.003777	conver- gence	183.50	0.0249	40.70	36.33	4.37
Estonia NUTS 3	-0.0176	0.019561	conver- gence	35.43	0.5251	57.28	46.40	10.88
Lithuania NUTS 3	-0.0231	0.026651	conver- gence	26.01	0.3964	60.77	45.05	15.72
Latvia NUTS 3	-0.0205	0.023231	conver- gence	29.84	0.5742	62.84	51.71	11.13
Poland NUTS 1	-0.0258	0.030345	conver- gence	22.84	0.5369	52.85	37.10	15.75
Poland NUTS 2	-0.0142	0.01544	conver- gence	44.89	0.2307	58.19	44.04	14.15
Poland NUTS 3	0.0013	-0.00129	diver- gence	-	0.0025	61.15	48.83	12.32
Slovakia NUTS 2	-0.0068	0.007068	conver- gence	98.07	0.0626	45.59	46.52	-0.93
Slovakia NUTS 3	-0.0074	0.007719	conver- gence	89.80	0.0780	50.95	50.95	0
Slovenia NUTS 2	-0.0034	0.003465	conver- gence	200.03	0.3923	22.65	22.56	0.09
Slovenia NUTS 3	0.0026	-0.00256	diver- gence	-	0.0180	35.23	35.91	-0.68
Hungary NUTS 1	-0.0109	0.011611	conver- gence	59.70	0.6652	41.84	36.63	5.21
Hungary NUTS 2	-0.0074	0.007719	conver- gence	89.80	0.2793	51.11	45.43	5.68
Hungary NUTS 3	0.00009	-0.090909	diver- gence	-	0.00001	55.97	51.36	4.61

Source: Eurostat 2018A, Eurostat 2018B, own calculation.

Conclusions

The article analyzes the beta-convergence of the EU-10 countries and the EU-15 group for the period 2004–2015. Beta-convergence studies were conducted on four levels – state, NUTS 1, NUTS 2 and NUTS 3, both as separate groups and also forming countries from the EU-10 group. The strongest beta-convergence is at the level of the EU-10 countries. However, the next conclusion is that the lower the level of the regional unit, the weaker the beta-convergence for these units. In the case of Poland,

Slovenia and Hungary, divergence was found at the NUTS 3 level, which means that convergence processes at the level of state and NUTS 1 show divergence processes at the NUTS 3 level.

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Beta-konwergencja państw i regionów UE10 w latach 2004–2015

W artykule została dokonana analiza konwergencji beta krajów ugrupowania UE10 i UE15 dla okresu 2004 i 2015 na czterech poziomach – państwa, NUTS 1, NUTS 2 i NUTS 3. Najsilniejsza konwergencja beta jest na poziomie państw ugrupowania UE10 jednak im niższy jest poziom jednostek regionalnych tym słabsza jest konwergencja beta. Na poziomie NUTS 3 Polski, Słowenii i Węgier stwierdzono dywergencję, co oznacza istnienie procesów konwergencji i dywergencji.

Słowa kluczowe: Europa Środkowa i Wschodnia, integracja, wzrost gospodarczy, gospodarcza konwergencja beta