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Faculty of regional development and international studies

Regional convergence of V4 countries

Bachelor thesis

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STATUTORY DECLARATION

I declare I have elaborated the Bachelor thesis “Regional convergence of V4 countries“independently in the course of references.

Brno

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ABSTRACT

Name: Jana Opletalová

Title of the bachelor work: Regional convergence of V4

This bachelor work is focused on the analysis of process of regional convergence in the Visegrád countries from 1997 to 2008. It surveys convergence or divergence among the regions according to indicators of economic regional growth - GDP per capita in PPS on the level of NUTS 2. In Poland, Slovakia and Hungary was found in the long run from 1997 to 2008 both sigma divergence and beta divergence. In the Czech Republic was found sigma divergence and beta convergence. In spite of the fact that regional support has an impact on the lagging regions and contributes to their economic growth, in case of Hungary, Poland and Slovakia it doesn't result in regional convergence.

Key words: convergence, GDP, Visegrád countries, regional disparities, NUTS

ABSTRAKT

Jméno: Jana Opletalová

Název bakalářské práce: Regionální konvergence ve státech V4

Tato bakalářská práce je zaměřená na proces regionální konvergence Visegrádských států od roku 1997 do roku 2008. Práce zkoumá konvergenci a divergenci mezi regiony podle indikátoru ekonomického regionálního růstu – HDP na osobu v PPS na regionální úrovni NUTS 2. V Polsku, Slovensku a Maďarsku byla zjištěna z dlouhodobého hlediska od roku 1997 do 2008 jak sigma divergence, tak beta divergence. V České republice byla zjištěna sigma divergence a beta konvergence. I přes to, že regionální

podpora má vliv na zaostávající regiony a souvisí s tím ekonomický růst, v případech Maďarska, Polska a Slovenska stále nedochází k regionální konvergenci.

Klíčová slova: konvergence, HDP, Visegrádské země, regionální rozdíly, NUTS

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1. INTRODUCTION

This work is focused on the process of regional convergence in the Visegrád countries with the following members: Czech Republic, Hungary, Poland and Slovakia. These papers survey convergence of economic regional growth on the level of NUTS 2.

I chose this topic because nowadays is dealing of the convergence actual problematic on the global, international and national level. The regional convergence is not just aim of the countries in the European Union but aim all around the world. There is a question how to manage a systematic growth of the regions without big disparities. This problematic was already solved in the past decades in many works. Regional and structural policy of EU tries to deal this situation. There are some structural funds to ensure uniform development of all regions. These funds are especially for the regions that are behind the European average.

2. OBJECTIVE

The goal of bachelor work is to introduce the basic terms like what are Visegrád countries and closer look to regional disparities of the regions and their division according to NUTS. There will be explained how we can define convergence and measurement of beta-convergence and sigma-convergence.

It will deal convergence on the national level. I would like to compare regions at NUTS 2 level of the Visegrád group and apply to them a process of convergence from the accessible data on the portal Eurostat for the years from 1997 to 2008. The main indicator of comparing will be regional GDP – gross domestic product, per capita. There is a question if the chosen regions between themselves have tendency to converge or diverge through the years. The results we will know from the measurement of beta convergence and sigma convergence. Development of indicators will be presented graphically.

3. LITERATURE SEARCH

3.1. CHARACTERISTIC OF THE CONVERGENCE

We can understand convergence like a possible reducing of income inequalities across regions or countries over time. There is an example when the poor economies have tendency to grow faster than richer. On the contrary when richer economies grow faster than the poor, we spoke about divergence (Fuente, 2002).

One of the priority targets of EU is convergence of less developed regions. There are still big differences between the regions of poor and rich countries. We can see big distinctions among the west Europe and the east. We can include there the new members of the Visegrád countries – Czech Republic, Hungary, Poland and Slovakia. These regions should have less than 75% HDP per human of European average to be supported from the European funds for regional development.

Poor countries should increase investment in the production and human capital, improve the environment and ability to adopt to social and other changes, develop innovation and more use informational and communicational technologies to avoid high unemployment. There are 3 aspects for keeping of development:

1. Good technical infrastructure and human capital
2. Ability to innovate
3. Ecological sustainable development

The collective of authors tried to characterize the main symptoms of regional disparities. There is big difference between the regions of the capitals like Praha, Budapešť, Warsaw, Bratislava in the main aspects (GDP per head, wages, unemployment) and rural areas are disadvantaged in compare of urban areas (Wokoun at al., 2008).

According to the study of (Kadeřábková, 2007) gross domestic product (GDP) growth strongly accelerated in the years 2004-2006 in most countries especially Visegrád countries. This speed up is linked with the entry to the EU and can be caused by many factors, mainly by foreign direct investment.

The convergence of European regions has been discussed during the past decades. Nowadays dealing of territorial disparities and regional convergence – divergence got into the centre of interest especially in the European Union (EU).

There are many reasons:

- The incorporation has expanded in sections in the past decades (1990, 1995, 2004 and 2007) accordingly the socio-economic heterogeneity significantly rose within the EU, which drew the attention to the analysis of the efficiency of Common Regional Policy;
- The EU has to compete with faster and rapidly growing countries on the global market which is called The Competitiveness and Innovation Framework Program.
- The Eurostat – Statistical office of the European Communities provides a lot of economic data which makes both cross-sectional and times series analyses possible.
- These mentioned issues are generating a number of papers on regional growth and its effect on regional differences.

(Kuttor, 2007)

In relationship with convergence we are interested in whether within a country differences between regions in income levels tend to disappear or tend to increase over time. We can be also interested in whether the regions that are relatively poor now are the same as the ones which were relatively poor one hundred years ago. If the poverty tends to persist over time, we can realize public aid programs to allow the poor regions to escape this predicament. In the contrary if the economies that are relatively poor now won't remain relatively poor in the future than we don't have to worry about the country-wide distribution of income (Sala i Martin, 1994).

Statement of the spatial disparities in per capita incomes should converge over the long run is one of the main assumptions of the neoclassical growth model. This will occur because capital will flow from the richer to poorer regions and labor will go in the opposite direction until returns to capital and labor are equalized. Poor regions can benefit from technology catch-up. It can be observed the convergence of GDP per capita between regions. It is important to differed two types of convergence. There is beta-convergence and sigma-convergence. The basic differences between them are follows:

B-convergence occurs when poor regions grow faster than wealthy ones. This implies a negative relationship between the growth of per capita income (over several decades) and the level of per capita income at the start of the period.

Sigma-convergence is a more conventional measure of income inequality and is simply a measure of the dispersion of per capita income between regions at a given point in time. Convergence occurs in this case when the dispersion of per capita income between regions falls over time (Armstrong, Taylor, 2000).

3. 2. CHARACTERISTIC OF THE VISEGRÁD COUNTRIES

The Visegrád Cooperation (otherwise known as the Visegrád countries, Visegrád Four or V4) is the regional organization of the Czech Republic, Hungary, Poland and Slovakia. The aim of this cooperation is to represent the economic, diplomatic and political interests of these central European countries and coordinate potential initiatives. This cooperation was established by signing of the Visegrád Declaration on 15 February 1991 (www.nfu.hu, 2010).

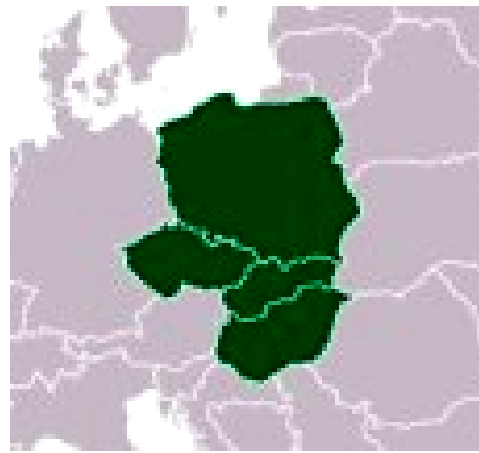


Fig. 1- *The map of the Visegrád countries*

Adapted from National development agency

3. 3. REGIONAL DISPARITIES

According to (Horváth, 2004) development of market economy brought intensification of regional inequalities. Transformation of economic structure influenced different regions in various ways. Regional economic performance influences two basic components. First of them is urbanization level and second composition of economic activity. The regions depending mostly on services are placed around capital cities. Like an example we can take the region Prague or Bratislava. In the table 1 we can see the least developed regions and the most developed regions of V4. There is like a comparative criterion used GDP per capita. We can see big differences between least developed regions and most developed regions in Visegrád four.

Table 1: *Regional differences in GDP per capita in Visegrad countries, 2008*

Country	Least developed region	Region's GDP per capita in PPS	Most developed region	Region's GDP per capita in PP
Czech Republic	Severo-západ	15 600	Praha	43 200
Poland	Podkarpacie	9 700	Mazowieckie	22 200
Hungary	Észak-Magyarország and Észak-Alföld	10 000	Közép-Magyarország	26 800
Slovakia	Východné Slovensko	12 700	Bratislava	41 800

Source: Eurostat

Detailed information about each country of Visegrád Four is analyzed thereafter. Inquiries about certain regions of countries under division NUTS 2 are taken from the work of (Horváth, 2004).

3. 3. 1. THE CZECH REPUBLIC

The most economic developed region in this country is region Prague which creates for a long period quarter of the Czech Republic's gross domestic product. The amount of Prague's per capita GDP is even much higher than majority of the current EU regions. The most problematic regions are North-West and Moravia-Silesia where is high unemployment. The Czech Republic undergoes major modification in the past years. The shares in industry and agriculture sector in GDP generation decreased and the share of services sector increased.

Structural changes in regions were influenced by these factors:

- Decreasing of fuel mining, heavy chemistry and metallurgy in the North-west and Moravia-Silesia regions (these industries still remain dominant in these regions)
- In the South-west region the process of restructuring the heavy machinery industry
- Decreasing share of agriculture in the economic activity of the South-east region in mountain areas
- High degree of the textile, leather and food industries in the North-east, Central Moravia and South-east regions

3. 3. 2. HUNGARY

In Hungary there are significant social, economical and infrastructure differences. These are more visible between the capital city and the rest of the country and between regions. In Budapest live 17 per cent of inhabitants and contributes 35 per cent to the GDP of the country. It is a centre for business and financial services and innovation transfer centre. 28 per cent of the companies are operating in Budapest. The large economic and social potential of Budapest has effect only in the agglomeration, but not in the further regions of the country. There is a big gap among the east and the west regions in the level of economic development, household incomes and unemployment. The current

dynamics of the north-western regions comes primarily from the geographical position of these regions and from the closeness to western markets mainly with neighboring Austrian provinces. The reason for the poorer region was the inherited industrial structure with low income capacity and low efficiency. These regions were dominated by heavy industries, mining, the agro-business and the loss of the eastern market had dramatic impact on them. The industrial restructuring of the 1990's had the most unfavorable effect in North Hungary.

3. 3. 3. POLAND

The most developed region in Poland is Mazowieckie voivodship, which has the largest area with the biggest population in the country. In the region are almost one third of the companies registered in the country with participation of foreign capital, which has the lowest unemployment rate, the lowest number of unemployed per one job offer, the highest salaries in the country and the highest positive migration balance. The highest employment rate, the highest education level, and the lowest negative birth rate also characterize Mazowieckie voivodship. There are regions with high development and competitiveness like following: Małopolskie, Mazowieckie, Pomorskie, Śląskie and Wielko-polskie. The regions have advantage from the high efficiency of the production sector, high human resources potential (research centers) and developed infrastructure. With this potential they have the biggest chance to participate in the European development processes (globalization). Regions in the eastern part of Poland have following factors that limit their development: ineffective employment structure, low productivity of agriculture, low quality of human resources, low development level of industry, low urbanization indices and low involvement of foreign capital.

3. 3. 4. SLOVAKIA

The territorial imbalance is caused by economic transformation from completely planned economy to the market economy. The actual inequalities are seen mainly on: unemployment rate, the region's share of GDP, level of income of population, establishment of new firms in the regions and level of entering new capital in some regions. Only the region of Bratislava differs significantly. Among the other regions there aren't so big differences, in GDP per capita. The radical transformation of the economic structure affected different regions in different ways. The losers of transition, like in the most other European countries, where the areas with heavy industry or mining and the extensive agricultural areas. The market economy brought the strengthening of regional inequalities.

3. 4. DIVISION ACCORDING TO NUTS 2

The European Union introduced the nomenclature of territorial units for statistics -NUTS. The book from (Wokoun at al., 2008) complains that this determination is important not just for statistical usage of EU, but also for classification of regions to the certain level of regional and structural policy. You can see data freely available for public on EUROSTAT. These data for regions are divided on 3 levels. Each member state is divided into territorial unit NUTS 1, from this are again territorial units dived on NUTS 2 and on the same principle it continues with NUTS 3. Each member state has the right for other detailed territorial division. There is provided minimal and maximal values for division of NUTS.

Table 2 – *Amount of inhabitants for each NUTS*

Level	Minimum	Maximum
NUTS 1	3 million	7 million
NUTS 2	800 000	3 million
NUTS 3	150 000	800 000

Source: (Wokoun at al., 2008)

European commission chose NUTS2 regions like a target group for the process of convergence. They chose this geographical level like an acceptable for measuring of persistence or disappearance of disparities. (Fischer, Stumpner, 2008)

According to (Eurostat yearbook, 2010) the NUTS classification has developed a regional classification for European countries when comparing the data. Anyway these classifications were used for the regional statistics for many decades.

In the Appendixes there are maps of each country according to division on NUTS 2.

4. MATERIAL AND METHODOLOGY

It compares data from the period 1997-2008 that are taken from the international statistical office Eurostat. Like a comparable indicator is taken Regional gross domestic product (PPS per inhabitant) for NUTS 2 regions. PPS (purchasing power standards) is a fictive currency unit used by Eurostat for the international comparison. Her value is taken from the purchasing power of Euro in the countries of EU.

Gross domestic product (GDP) or gross domestic product per inhabitant are indicators of a country or region's economic activity for the certain time period and are thus suited to measuring and comparing the degree of economic development of countries or regions. The GDP is not equivalent to the income ultimately available to private households in a given country or region. Expressing GDP in PPS eliminates differences in price levels between countries. Calculations on a per inhabitant basis allow for the comparison of economies and regions significantly different in absolute size. GDP per inhabitant in PPS is the key variable for determining the eligibility of NUTS 2 regions in the framework of the European Union's structural policy (Krueger, 2010).

Indicator GDP on the regional level is very important in the connection with the structural policy of EU. It is engaged as a decisive criterion for the assessing of requirement for the regional support from them structural EU funds.

For all countries it will make analysis Beta-convergence and Sigma convergence.

Than will be measured the coefficient of determination. In a linear regression model with an absolute member lies the value r^2 in the interval $<0, 1>$ and indicates what proportion of variance in the observation of the dependent variable is able to explain through the regression. Larger values indicate more successful regression (Friesl, 2004)

4. 1. CALCULATION OF SIGMA CONVERGENCE

We can speak about sigma convergence when there is in the time systematic decreasing of variability of observed indicator measured by standard deviation. Because of optimal deviation we work instead of the basic indicator's values with their natural logarithm.

The indicator of sigma convergence is than standard deviation:

$$\sigma_t = \sqrt{\frac{1}{m-1} \sum_{j=1}^m (\log y_{jt} - \overline{\log y_t})^2}$$

Where $t = 1, 2 \dots T$

$j = 1, 2 \dots m$

Standard deviation is collected into a table and plotted as a line graph. In case of convergence values systematically decrease. Before the start of the calculation we have to confirm if some values are not isolated (disparities). Including the outliers in the data can misrepresent the results of the analysis (Dufek, Minařík, 2009).

The standard deviation is the most common measure of statistical dispersion. The rate of the average distance of data values from their average. If the values are all close to the average than the standard deviation is low (close to zero). If the values are far from the average, standard deviation is high (away from zero). If all data values are equal, then the standard deviation of the data will be zero.

4. 2. CALCULATION OF BETA CONVERGENCE

Beta convergence is the concept where poorer regions grow faster than richer. The regions in the certain time period converge if entrance value on j-region where $j = 1, 2, \dots, m$ relates with a higher value of average growth rate on this region and vice versa. The easiest way for measurement of beta convergence is logarithmic transformation of both variables – $\log \bar{k}$, $\log y_0$. When we put on the graph first from both variables horizontally and the second one vertically, it is possible to express their relationship by express line:

$$\log \bar{k} = c_0 + c_1 \log y_0.$$

Direction of this line predicates her value about speed of process and through the sign about type of process. Negative value ($c_1 < 0$) means predominant tendency for convergence of regions. Positive value ($c_1 > 0$) means tendency for divergence of regions. Zero value indicates about stability among regions. We can see on the graph if there is some region which is totally away from main tendency and the course of line spacing is depended primary on his position, we can speak about disparity. Statistical significance of convergence is evaluated through the coefficient of determination. This coefficient indicates how much variability in average growth rates in the regions is explained by their different levels of default. When we extract the coefficient determination value, we get the coefficient of correlation (Dufek, Minařík, 2009).

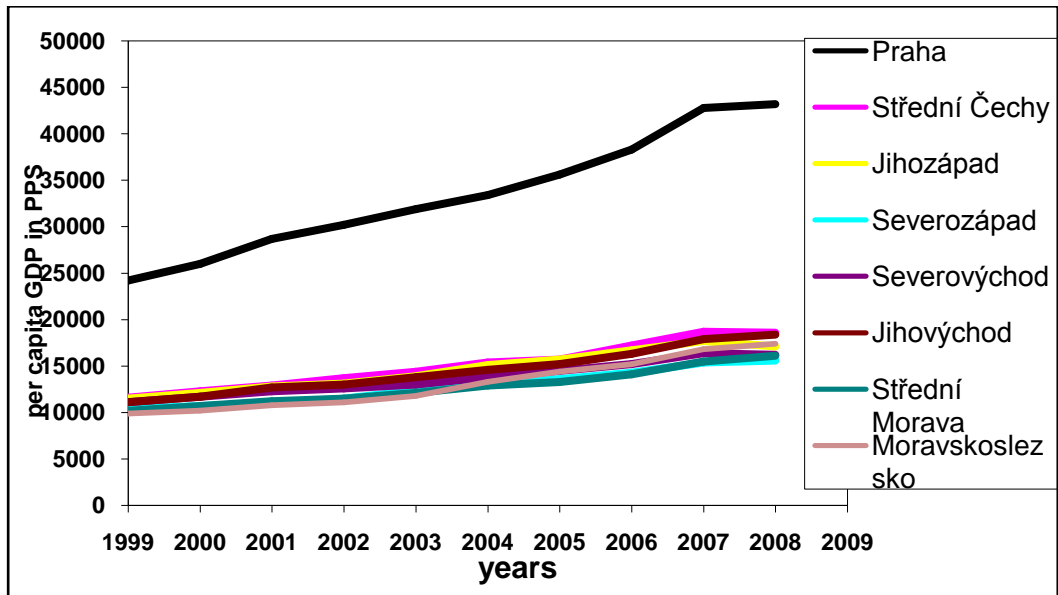
4. 3. DATA SOURCES

Tables 3-10 are placed in appendixes. They show the values of GDP in the Visegrád countries of NUTS 2 regions over the period 1997-2008. In the tables there are clear significant positive disparities, which are the regions with the capital cities. In some countries they reach during whole period to double GDP values compared to other regions, therefore were excluded from further evaluation. In the Czech Republic it is region Praha, in Hungary region Közép-Magyarország, in Poland region Mazowickie and in Slovakia Bratislava region.

5. RESULTS AND DISCUSSION

5. 1. The Czech Republic

Before the own results there is a graph 1 displaying applied data. How we can observe there is dramatic difference among the capital Praha and other regions.



Graph 1- Real GDP per capita in PPS of analyzed regions in the Czech Republic

Source- Own calculation

Tables 11, 12 show the calculated natural logarithms of GDP values from the Table 3, 4 because the distribution of values approaches for normal distribution. In the last rows of Tables 11, 12 are calculated standard deviations.

Table 11- *Natural logarithms of GDP with standard deviation (1997-2002)*

	1997	1998	1999	2000	2001	2002
Střední Čechy	9,239899	9,287301	9,35876	9,417355	9,464983	9,525151
Jihozápad	9,332558	9,323669	9,350102	9,400961	9,4572	9,480368
Severozápad	9,259131	9,239899	9,249561	9,277999	9,305651	9,350102
Severovýchod	9,287301	9,287301	9,3147	9,367344	9,417355	9,441452
Jihovýchod	9,277999	9,287301	9,3147	9,367344	9,449357	9,472705
Střední Morava	9,230143	9,21034	9,230143	9,277999	9,323669	9,350102
Moravskoslezsko	9,230143	9,20029	9,20029	9,230143	9,287301	9,3147
Standard deviation	0,037248	0,045986	0,061653	0,071547	0,077874	0,08041

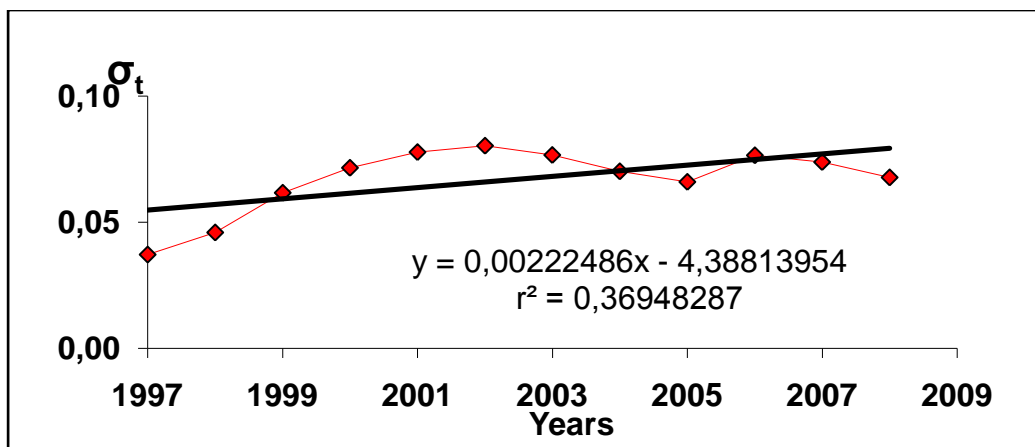
Source- own calculation

Table 12- *Natural logarithms of GDP with standard deviation (2003-2008)*

	2003	2004	2005	2006	2007	2008
Střední Čechy	9,574983	9,642123	9,661416	9,752665	9,836279	9,830917
Jihozápad	9,539644	9,62245	9,661416	9,723164	9,78132	9,746834
Severozápad	9,425452	9,487972	9,517825	9,568015	9,642123	9,655026
Severovýchod	9,472705	9,532424	9,581904	9,629051	9,705037	9,692767
Jihovýchod	9,532424	9,588777	9,629051	9,69892	9,792556	9,820106
Střední Morava	9,400961	9,464983	9,495519	9,55393	9,648595	9,686575
Moravskoslezsko	9,375855	9,495519	9,574983	9,629051	9,729134	9,764225
Standard deviation	0,076642	0,070186	0,066009	0,076498	0,073853	0,067803

Source- own calculation

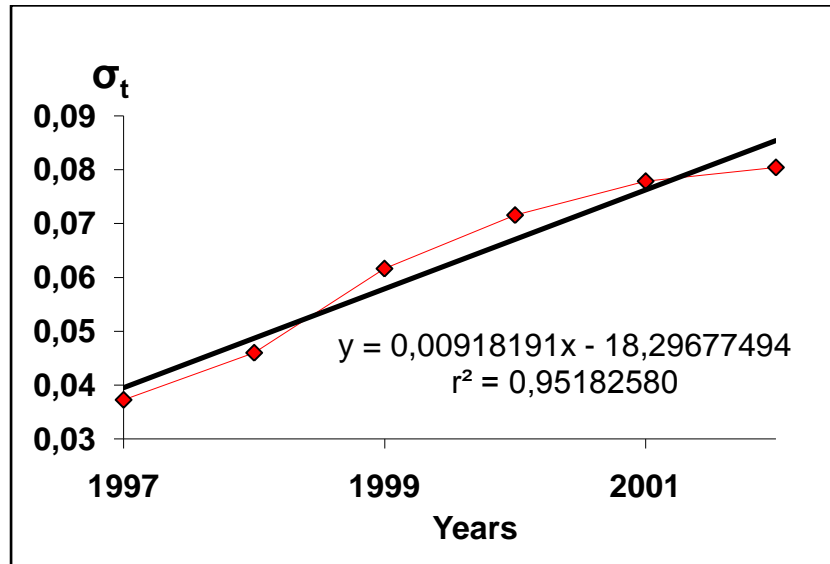
Sigma convergence - In the Graph 2 in the period 1997-2008 is a clear trend of increasing disparities between regions, so there is a sigma divergence between regions. For the graph output are used standard deviations from Table 11, 12. Although from the long term there is a widening gap between regions, we can be observed in these period significant disruptions. These faults, which changed the development of convergence and divergence in the contrary, were in 2002, 2005 and 2006. The most important turning point is 2002, so there are created graphs for two seasons.



Graph 2- *Sigma convergence per capita GDP in PPS (1997-2008)*

Source- Own calculation

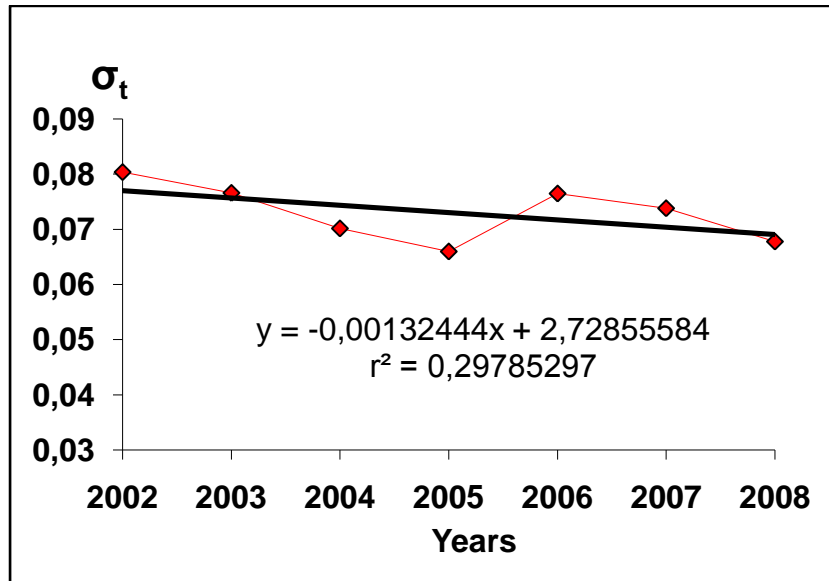
From the graph 3 is seen significant divergence between regions, which is caused by different economic development in these regions during the period 1997-2002.



Graph 3- *Sigma convergence per capita GDP in PPS (1997-2002)*

Source - own calculation

In the graph 4 it is already apparent opposite trend - convergence, which is characterized by reducing economic development disparities between regions. This is due to action after joining the EU in 2004 and the preparatory period for which results have shown since 2002.



Graph 4 - Sigma convergence – per capita GDP in PPS (2002-2008)

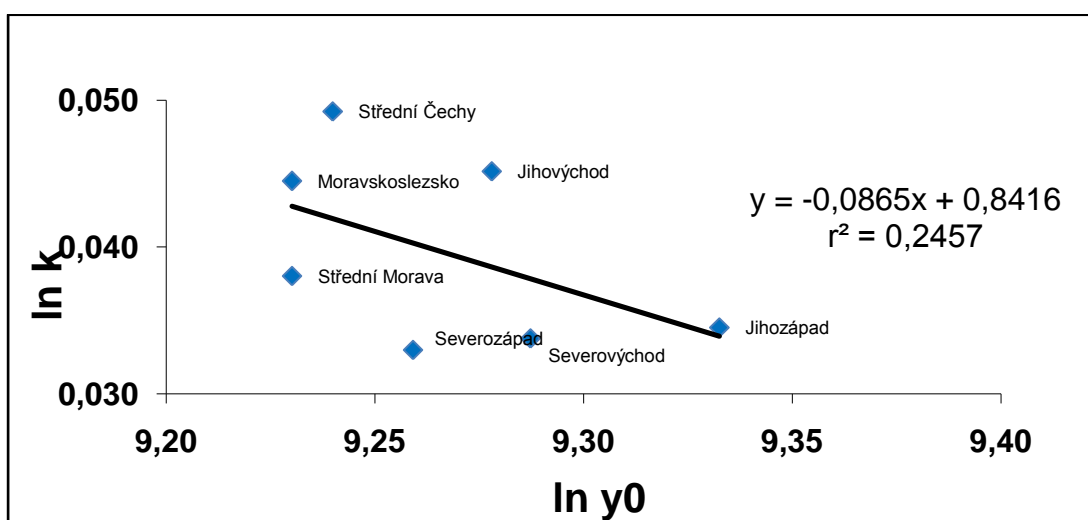
Source- own calculation

Beta convergence - In table 13 there are values of natural logarithms for the first year of observation and average grow coefficient during the time period of certain regions. Differences between regions have been decreasing and how we can see according to graph 5 there is a beta convergence. Regressive line is decreasing and c_1 is higher than 0. We can observe from the graph that poor regions grow faster than richer. The coefficient of determination is 0,25 so the relation between regions is statistically significant.

Table 13 – Values of beta convergence for the years 1997-2008

	Beta convergence	Average grow coefficient
Střední Čechy	9,239899174	0,049251474
Jihozápad	9,332558005	0,034522978
Severozápad	9,259130536	0,032991305
Severovýchod	9,287301413	0,033788759
Jihovýchod	9,27799902	0,045175577
Střední Morava	9,230142999	0,038035963
Moravskoslezsko	9,230142999	0,044506874

Source- own calculation



Graph 5– Beta convergence of regional GDP (PPS per inhabitant) by NUTS 2 regions in CR (1997 – 2008)

Source- own calculation

5. 2. Hungary

Table 14, 15 show the calculated natural logarithms of GDP values from the Table 5,6 because the distribution of values approaches for normal distribution. In the last rows of Tables 14, 15 are calculated standard deviations.

Table 14: *Natural logarithms of GDP with standard deviation (1997-2002)*

	1997	1998	1999	2000	2001	2002
Közép-Dunántúl	9,011889	9,10498	9,11603	9,220291	9,296518	9,3147
Nyugat-Dunántúl	9,11603	9,230143	9,323669	9,392662	9,409191	9,472705
Dél-Dunántúl	8,824678	8,881836	8,948976	8,987197	9,059517	9,126959
Észak-Magyarország	8,665613	8,748305	8,779557	8,824678	8,922658	8,987197
Észak-Alföld	8,716044	8,764053	8,764053	8,824678	8,961879	9,011889
Dél-Alföld	8,839277	8,881836	8,909235	8,961879	9,024011	9,082507
Standard deviation	0,172498	0,192734	0,214078	0,227313	0,195577	0,189945

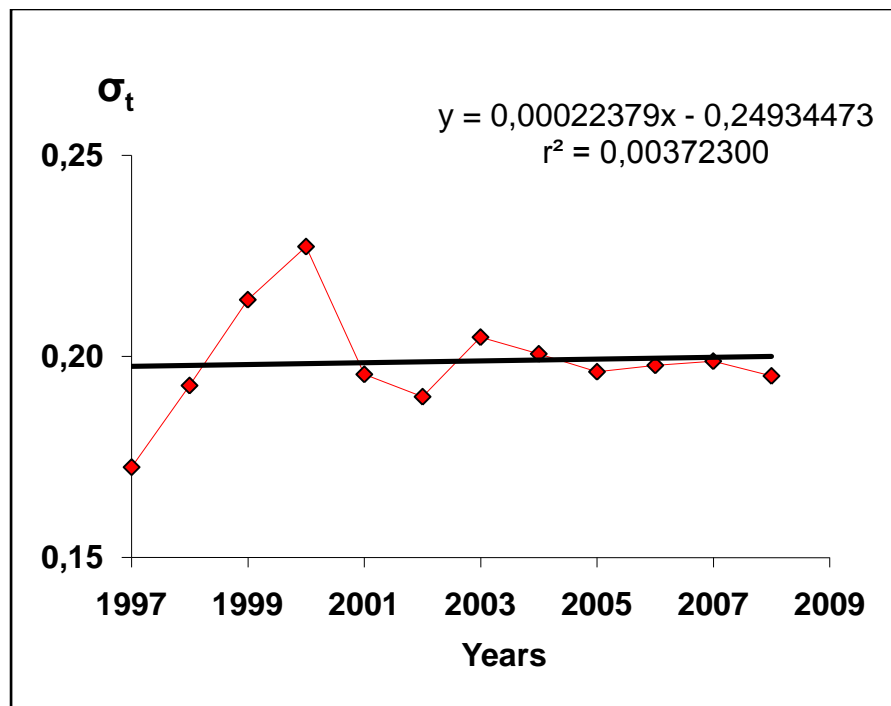
Source- own calculation

Table 15: *Natural logarithms of GDP with standard deviation (2003-2008)*

	2003	2004	2005	2006	2007	2008
Közép-Dunántúl	9,392662	9,472705	9,495519	9,50301	9,568015	9,581904
Nyugat-Dunántúl	9,546813	9,568015	9,55393	9,609116	9,629051	9,661416
Dél-Dunántúl	9,159047	9,179881	9,190138	9,220291	9,268609	9,3147
Észak-Magyarország	9,035987	9,11603	9,13777	9,159047	9,20029	9,21034
Észak-Alföld	9,071078	9,10498	9,10498	9,148465	9,179881	9,21034
Dél-Alföld	9,10498	9,159047	9,169518	9,20029	9,230143	9,287301
Standard deviation	0,204737	0,200604	0,196213	0,197799	0,19882	0,195117

Source- own calculation

Sigma convergence - In the graph 6 in the period 1997-2008 is low trend of increasing disparities between regions but still there is a divergence between regions. For the graph output are used standard deviations from tables 14, 15. The biggest increasing dispersion was from the year 1997 to 2000 so it caused bit regional disparities. In 2000 the dispersion started to decrease until 2004. From the year 2004 the situation is more stable.



Graph 6- *Sigma convergence per capita GDP in PPS (1997-2008)*

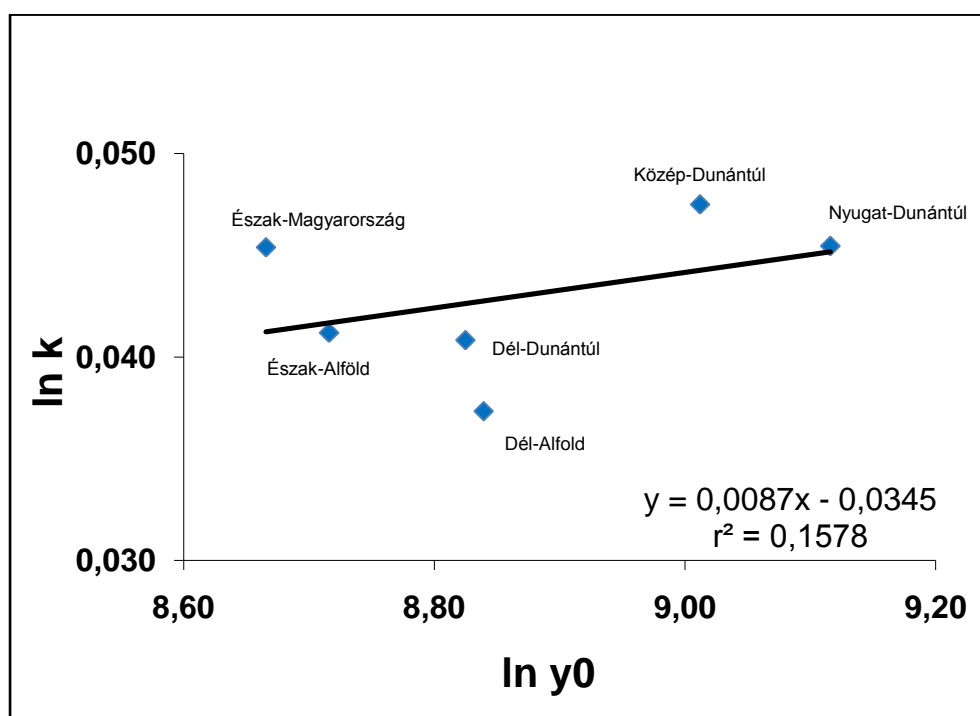
Source- own calculation

Beta convergence - In table 16 there are values of natural logarithms for the first year of observation and average grow coefficient during the time period of certain regions. Differences between regions have been increasing and how we can see according to graph 7 there is a beta divergence. Regressive line is increasing and negative. We can observe from the graph that relatively rich regions from 1997 have still high average grow than in the case of poorer regions. The coefficient of determination is 0,16 so the relation between regions is statistically significant.

Table 16- Values of beta convergence for the years 1997-2008

	Ln of GDP in 1997	Average grow coefficient
Közép-Dunántúl	9,011889	0,047501
Nyugat-Dunántúl	9,11603	0,045449
Dél-Dunántúl	8,824678	0,040835
Észak-Magyarország	8,665613	0,045394
Észak-Alföld	8,716044	0,041191
Dél-Alföld	8,839277	0,037335

Source- own calculation



Graph 7– Beta convergence of regional GDP (PPS per inhabitant) by NUTS 2 regions in Hungary (1997 – 2008)

Source- own calculation

5. 3. Poland

Tables 17, 18 show the calculated natural logarithms of GDP values from the tables 7, 8 because the distribution of values approaches for normal distribution. In the last rows of tables 17, 18 are calculated standard deviations.

Table 17 - *Natural logarithms of GDP with standard deviation (1997-2002)*

	1997	1998	1999	2000	2001	2002
Malopolskie	8,809863	8,89563	8,922658	8,987197	8,974618	9,047821
Slaskie	9,059517	9,082507	9,13777	9,20029	9,220291	9,287301
Lubelskie	8,665613	8,699515	8,716044	8,764053	8,809863	8,853665
Podkarpackie	8,648221	8,699515	8,732305	8,764053	8,794825	8,839277
Swietokrzyskie	8,648221	8,732305	8,809863	8,86785	8,881836	8,935904
Podlaskie	8,716044	8,748305	8,764053	8,839277	8,89563	8,935904
Wielkopolskie	8,974618	9,047821	9,10498	9,190138	9,21034	9,230143
Zachodniopomorskie	8,935904	8,987197	9,071078	9,148465	9,148465	9,179881
Lubuskie	8,853665	8,909235	8,961879	9,024011	9,024011	9,071078
Dolnoslaskie	8,974618	9,011889	9,10498	9,169518	9,159047	9,230143
Opolskie	8,839277	8,881836	8,881836	8,961879	8,948976	8,987197
Kujawsko-Pomorskie	8,824678	8,922658	8,935904	9,035987	9,059517	9,10498
Warmińsko-Mazurskie	8,699515	8,748305	8,824678	8,881836	8,86785	8,922658
Pomorskie	8,922658	8,987197	9,082507	9,11603	9,126959	9,20029
Lódzkie	8,809863	8,86785	8,961879	8,961879	9,024011	9,047821
Standard deviation	0,130551	0,12935	0,143843	0,149652	0,142256	0,144487

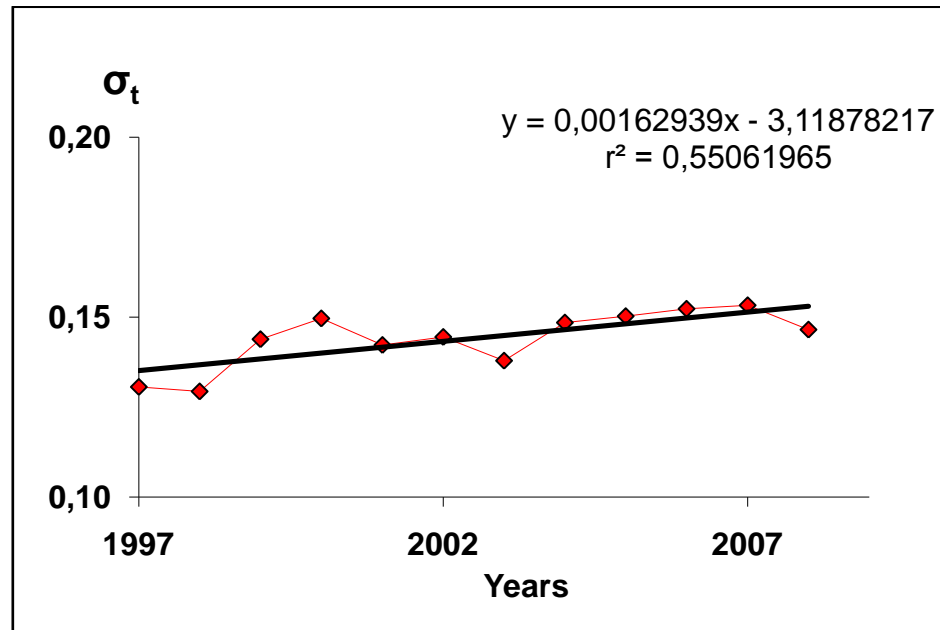
Source- own calculation

Table 18- Natural logarithms of GDP with standard deviation (2003-2008)

	2003	2004	2005	2006	2007	2008
Malopolskie	9,071078	9,148465	9,20029	9,268609	9,367344	9,409191
Slaskie	9,305651	9,417355	9,433484	9,472705	9,574983	9,629051
Lubelskie	8,881836	8,935904	8,974618	9,024011	9,126959	9,190138
Podkarpackie	8,881836	8,935904	8,987197	9,035987	9,126959	9,179881
Swietokrzyskie	8,974618	9,047821	9,059517	9,13777	9,259131	9,332558
Podlaskie	8,948976	9,011889	9,047821	9,10498	9,220291	9,239899
Wielkopolskie	9,268609	9,375855	9,417355	9,464983	9,560997	9,595603
Zachodniopomorskie	9,169518	9,230143	9,277999	9,323669	9,409191	9,4572
Lubuskie	9,082507	9,190138	9,249561	9,296518	9,392662	9,400961
Dolnoslaskie	9,249561	9,323669	9,384294	9,480368	9,602382	9,629051
Opolskie	8,987197	9,148465	9,169518	9,20029	9,332558	9,392662
Kujawsko-Pomorskie	9,11603	9,190138	9,220291	9,277999	9,375855	9,409191
Warminsko-Mazurskie	8,987197	9,047821	9,082507	9,13777	9,220291	9,259131
Pomorskie	9,21034	9,277999	9,332558	9,400961	9,50301	9,50301
Lódzkie	9,10498	9,13777	9,220291	9,268609	9,332558	9,433484
Standard deviation	0,137888	0,148457	0,150273	0,152339	0,153284	0,146553

Source- own calculation

Sigma convergence- In the graph 8 in the period 1997-2008 is low trend of increasing disparities between regions but still is there a divergence between regions. For the graph output are used standard deviations from the tables 17, 18. From the year 2004 to 2007 was the situation almost optimal with almost no dispersions.



Graph 8- *Sigma convergence per capita GDP in PPS (1997-2008)*

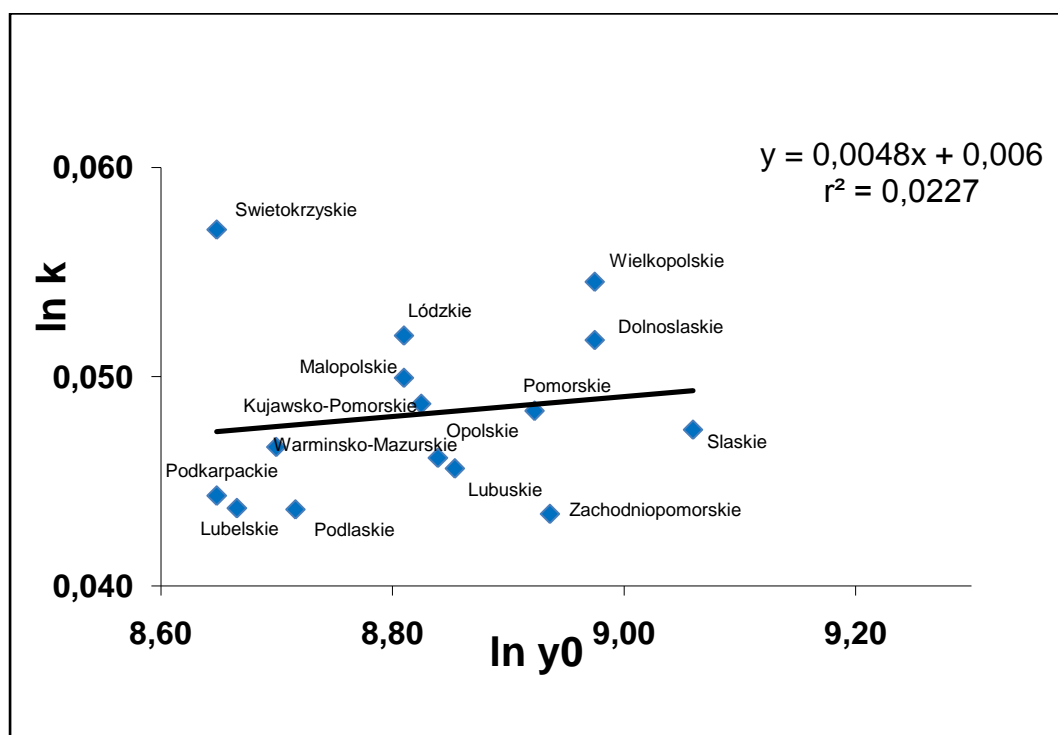
Source- own calculation

Beta convergence - In table 19 there are values of natural logarithms for the first year of observation and average grow coefficient during the time period of certain regions. Differences between regions have been increasing a little and how we can see under graph 9 there is low beta divergence. Regressive line is increasing and c_1 is negative. There are regions which were relatively rich in 1997 like Wielkopolskie or Dolnosaskie and their grow is still high but there is also region like Swietokrzyskie that belonged at the beginning of observation to the poorest regions but has high grow coefficient and now is the richest from these regions. The coefficient of determination is 0,022 so the correlation between regions is relatively low.

Table 19- Values of beta convergence for the years 1997-2008

	Ln of GDP in 1997	Average grow coefficient
Malopolskie	8,809863	0,049944
Slaskie	9,059517	0,047461
Lubelskie	8,665613	0,04371
Podkarpackie	8,648221	0,044305
Swietokrzyskie	8,648221	0,057028
Podlaskie	8,716044	0,043655
Wielkopolskie	8,974618	0,051749
Zachodniopomorskie	8,935904	0,043441
Lubuskie	8,853665	0,045608
Dolnoslaskie	8,974618	0,054536
Opolskie	8,839277	0,046115
Kujawsko-Pomorskie	8,824678	0,048709
Warminsko-Mazurskie	8,699515	0,046635
Pomorskie	8,922658	0,048363
Lódzkie	8,809863	0,051968

Source- own calculation



Graph 9- Beta convergence of regional GDP (PPS per inhabitant) by NUTS 2 regions

Source- own calculation

5. 4. Slovakia

Tables 19, 20 show the calculated natural logarithms of GDP values from the tables 9, 10 because the distribution of values approaches for normal distribution. In the last rows of tables 19, 20 are calculated standard deviations.

Table 19- *Natural logarithms of GDP with standard deviation (2003-2008)*

	1997	1998	1999	2000	2001	2002
Západné Slovensko	8,961879	9,024011	9,059517	9,10498	9,169518	9,220291
Stredné Slovensko	8,839277	8,89563	8,909235	8,974618	9,071078	9,13777
Východné Slovensko	8,748305	8,824678	8,824678	8,881836	8,974618	9,035987
Standard deviation	0,107177	0,101036	0,118943	0,112098	0,097452	0,092319

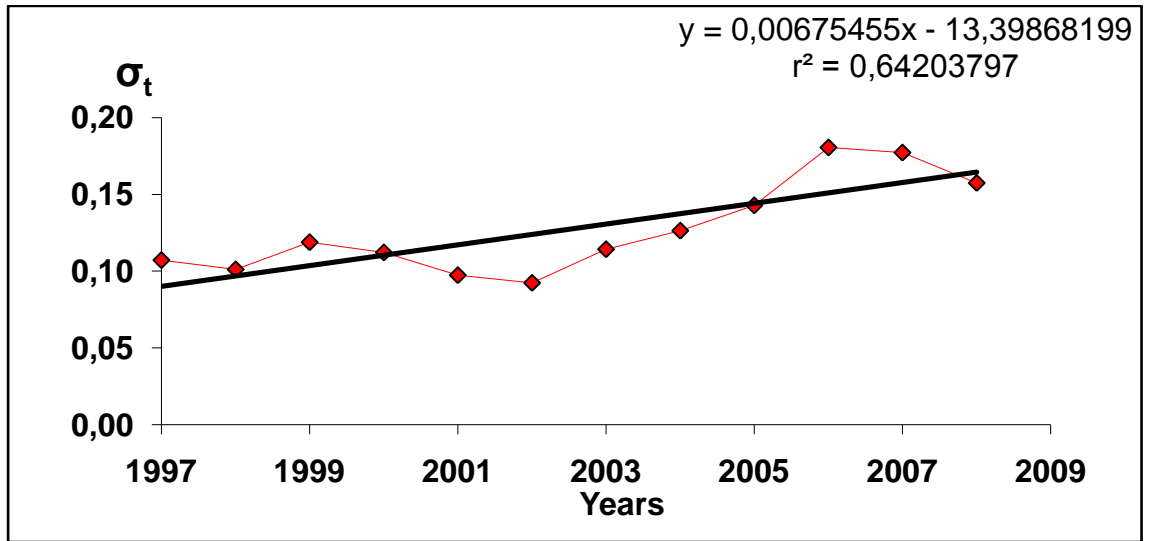
Source- own calculation

Table 20- *Natural logarithms of GDP with standard deviation (2003-2008)*

	2003	2004	2005	2006	2007	2008
Západné Slovensko	9,287301	9,367344	9,4572	9,602382	9,711116	9,764225
Stredné Slovensko	9,159047	9,220291	9,259131	9,35876	9,50301	9,602382
Východné Slovensko	9,059517	9,11603	9,179881	9,249561	9,35876	9,449357
Standard deviation	0,114193	0,126263	0,142839	0,180628	0,177139	0,157455

Source- own calculation

Sigma convergence- In the Graph 9 in the period 1997-2008 is a trend of increasing disparities between regions, there is a sigma divergence between regions. For the graph output are used standard deviations from the tables 19, 20. From the year 1999 to 2002 dispersions were decreasing together with regional disparities. From 2002 to 2006 there was high grow of dispersions that means also raise of regional disparities. From the year 2006 dispersions again started to decrease.



Graph 9- *Sigma convergence per capita GDP in PPS (1997-2008)*

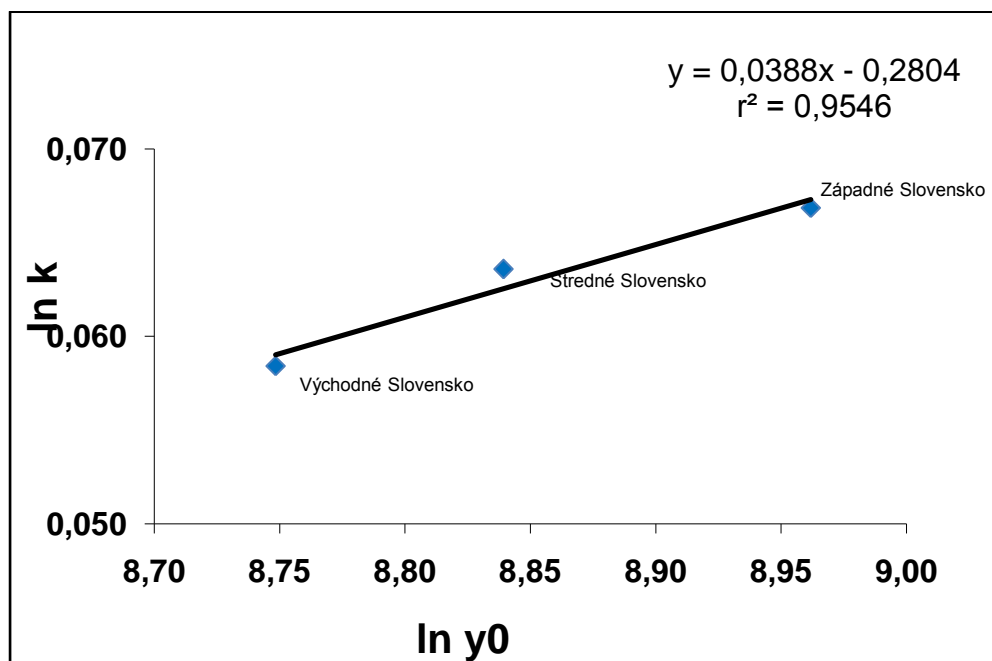
Source- own calculation

Beta convergence - In table 21 there are values of natural logarithms for the first year of observation and average grow coefficient during the time period of certain regions. From the graph there is clearly visible beta divergence. Differences between regions have been increasing, regressive line is increasing and c_1 is higher than 0. The richest region in 1997 *Západné Slovensko* has biggest average grow coefficient and the poorest region *Východné Slovensko* has the lowest average grow coefficient. The coefficient of determination is 0,95 so the relation between observed indicators is high.

Table 21- Values of beta convergence for the years 1997-2008

	Ln of GDP in 1997	Average grow coefficient
Západné Slovensko	8,961879	0,066862
Stredné Slovensko	8,839277	0,063592
Východné Slovensko	8,748305	0,058421

Source- own calculation



Graph 9 – Beta convergence of regional GDP (PPS per inhabitant) by NUTS 2 regions in Slovakia (1997 – 2008)

Source – own calculation

6. CONCLUSION

Evaluation of convergence was implemented by measuring of beta and sigma convergences. There were observed big regional disparities in all V4 countries which could lead to misinterpretations. For this reason the capitals of all countries were removed from analyzed sample. However even after this separation big disparities among the regions in each country of V4 still remained which could misrepresent the results of measurement.

In Poland, Slovakia and Hungary was found in the long run from 1997 to 2008 both sigma divergence and beta divergence. In the Czech Republic was found sigma divergence and beta convergence. However it seems that situation has been changing in the Czech Republic and Slovakia from 2007 and for Hungary and Poland from 2006 and we may observe starting tendency to sigma convergence. This trend should be confirmed by further analysis including successive years following analyzed period. Approaching the end of analyzed period regional disparities have been decreasing.

From these results we may conclude that in spite of the fact that regional support has an impact on the lagging regions and contributes to their economic growth, in case of Hungary, Poland and Slovakia it doesn't result in regional convergence. Lagging regions are not approaching to the more developed. Convergence of lagging regions with those which are more developed may be observed only in the case of the Czech Republic. However we cannot speak about reducing of disparities between regions if we include capitals. This holds true for all observed countries.

We may conclude that gravitation forces of capitals, which are at the same time economic centers of the countries, overweight supportive impact of EU policies aimed on regional development of less developed regions and convergence of these regions to the more developed. We can include among the less developed regions the areas that are dependent mainly on agriculture. It is typical for the mountain and sub mountain regions and for rural areas in the nearby of big cities. Then we can include there declining industrial regions and

border areas with low density of population. Concretely in the Czech Republic there are big disparities between region Praha and other regions. There are problems of industrial regions. In Hungary there are disparities between Budapest and other parts of the country. There is a difference between central and others NUTS 2 regions. In Poland there is deepening gap between western regions and rural and old industrial regions in the north and in the east. In Slovakia there is strong increase of region Bratislava and its surroundings.

There is a goal to have the same chances and opportunities for the regions and their adequate use of demographical, natural and economical potential. We can sum up that even if many studies confirm that differences in the economical level between European countries are decreasing, decline of differences on regional level isn't convincing. For increased efficiency of EU regional support would be suitable to implement a specific regional policy with the goal to make lagging regions more attractive. It should distribute financial resources mainly into these regions and concentrate especially on business, human development, environment, culture, tourism, and infrastructure.

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9. APPENDEXES

Table 3- Regional GDP (PPS per inhabitant), by NUTS 2 regions in Czech Republic

Region/Year	1997	1998	1999	2000	2001	2002
Praha	21100	22600	24200	26000	28700	30200
Střední Čechy	10300	10800	11600	12300	12900	13700
Jihozápad	11300	11200	11500	12100	12800	13100
Severozápad	10500	10300	10400	10700	11000	11500
Severovýchod	10800	10800	11100	11700	12300	12600
Jihovýchod	10700	10800	11100	11700	12700	13000
Střední Morava	10200	10000	10200	10700	11200	11500
Moravskoslezsko	10200	9900	9900	10200	10800	11100

Source: Eurostat

Table 4- Regional GDP (PPS per inhabitant), by NUTS 2 regions in Czech Republic

Region/Year	2003	2004	2005	2006	2007	2008
Praha	31900	33400	35600	38300	42800	43200
Střední Čechy	14400	15400	15700	17200	18700	18600
Jihozápad	13900	15100	15700	16700	17700	17100
Severozápad	12400	13200	13600	14300	15400	15600
Severovýchod	13000	13800	14500	15200	16400	16200
Jihovýchod	13800	14600	15200	16300	17900	18400
Střední Morava	12100	12900	13300	14100	15500	16100
Moravskoslezsko	11800	13300	14400	15200	16800	17400

Source: Eurostat

Table 5- Regional GDP (PPS per inhabitant), by NUTS 2 regions in Hungary

Region/Year	1997	1998	1999	2000	2001	2002
Közép-Magyarország	12700	13600	14500	16200	18500	20600
Közép-Dunántúl	8200	9000	9100	10100	10900	11100
Nyugat-Dunántúl	9100	10200	11200	12000	12200	13000
Dél-Dunántúl	6800	7200	7700	8000	8600	9200
Észak-Magyarország	5800	6300	6500	6800	7500	8000
Észak-Alföld	6100	6400	6400	6800	7800	8200
Dél-Alföld	6900	7200	7400	7800	8300	8800

Source: Eurostat

Table 6- Regional GDP (PPS per inhabitant), by NUTS 2 regions in Hungary

Region/Year	2003	2004	2005	2006	2007	2008
Közép-Magyarország	20800	22000	23200	24900	25900	26800
Közép-Dunántúl	12000	13000	13300	13400	14300	14500
Nyugat-Dunántúl	14000	14300	14100	14900	15200	15700
Dél-Dunántúl	9500	9700	9800	10100	10600	11100
Észak-Magyarország	8400	9100	9300	9500	9900	10000
Észak-Alföld	8700	9000	9000	9400	9700	10000
Dél-Alföld	9000	9500	9600	9900	10200	10800

Source: Eurostat

Table 7- Regional GDP (PPS per inhabitant), by NUTS 2 regions in Poland

Region/Year	1997	1998	1999	2000	2001	2002
Mazowieckie	10800	12100	13200	13900	14700	15300
Malopolskie	6700	7300	7500	8000	7900	8500
Slaskie	8600	8800	9300	9900	10100	10800
Lubelskie	5800	6000	6100	6400	6700	7000
Podkarpackie	5700	6000	6200	6400	6600	6900
Swietokrzyskie	5700	6200	6700	7100	7200	7600
Podlaskie	6100	6300	6400	6900	7300	7600
Wielkopolskie	7900	8500	9000	9800	10000	10200
Zachodniopomorskie	7600	8000	8700	9400	9400	9700
Lubuskie	7000	7400	7800	8300	8300	8700
Dolnosaskie	7900	8200	9000	9600	9500	10200
Opolskie	6900	7200	7200	7800	7700	8000
Kujawsko-Pomorskie	6800	7500	7600	8400	8600	9000
Warmińsko-Mazurskie	6000	6300	6800	7200	7100	7500
Pomorskie	7500	8000	8800	9100	9200	9900
Lódzkie	6700	7100	7800	7800	8300	8500

Source: Eurostat

Table 8- Regional GDP (PPS per inhabitant), by NUTS 2 regions in Poland

	2003	2004	2005	2006	2007	2008
Mazowieckie	15800	16700	18300	19600	21800	22200
Malopolskie	8700	9400	9900	10600	11700	12200
Slaskie	11000	12300	12500	13000	14400	15200
Lubelskie	7200	7600	7900	8300	9200	9800
Podkarpackie	7200	7600	8000	8400	9200	9700
Swietokrzyskie	7900	8500	8600	9300	10500	11300
Podlaskie	7700	8200	8500	9000	10100	10300
Wielkopolskie	10600	11800	12300	12900	14200	14700
Zachodniopomorskie	9600	10200	10700	11200	12200	12800
Lubuskie	8800	9800	10400	10900	12000	12100
Dolnoslaskie	10400	11200	11900	13100	14800	15200
Opolskie	8000	9400	9600	9900	11300	12000
Kujawsko-Pomorskie	9100	9800	10100	10700	11800	12200
Warminsko-Mazurskie	8000	8500	8800	9300	10100	10500
Pomorskie	10000	10700	11300	12100	13400	13400
Lódzkie	9000	9300	10100	10600	11300	12500

Source: Eurostat

Table 9- Regional GDP (PPS per inhabitant), by NUTS 2 regions in Slovakia

	1997	1998	1999	2000	2001	2002
Bratislavský kraj	17900	19000	19200	20700	22900	25000
Západné Slovensko	7800	8300	8600	9000	9600	10100
Stredné Slovensko	6900	7300	7400	7900	8700	9300
Východné Slovensko	6300	6800	6800	7200	7900	8400

Source: Eurostat

Table 10- Regional GDP (PPS per inhabitant), by NUTS 2 regions in Slovakia

	2003	2004	2005	2006	2007	2008
Bratislavský kraj	25900	27900	33000	35000	40200	41800
Západné Slovensko	10800	11700	12800	14800	16500	17400
Stredné Slovensko	9500	10100	10500	11600	13400	14800
Východné Slovensko	8600	9100	9700	10400	11600	12700

Source: Eurostat

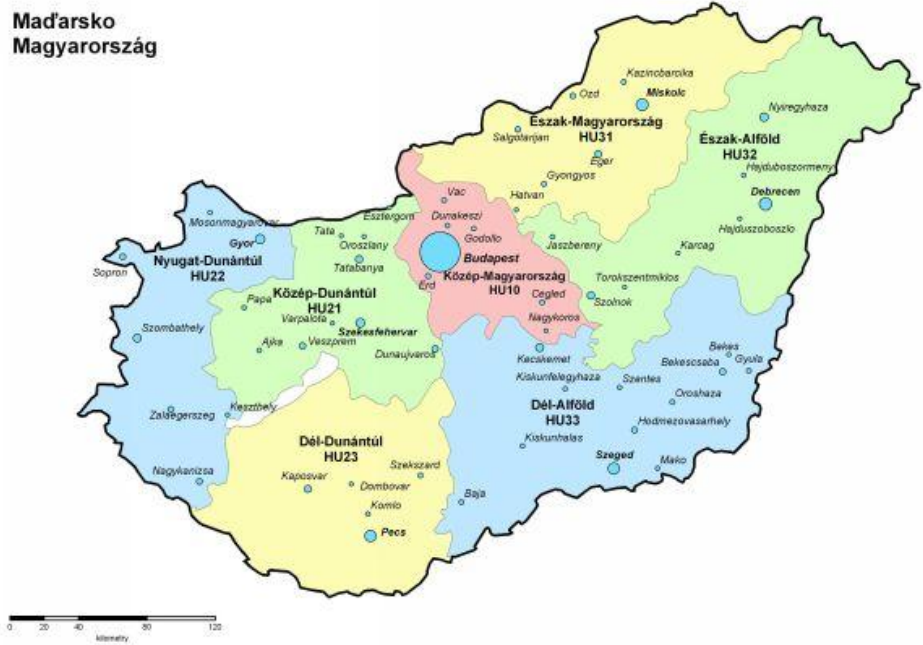
Fig. 2- division of Czech Republic according to NUTS 2



Adapted from the Czech statistical office.

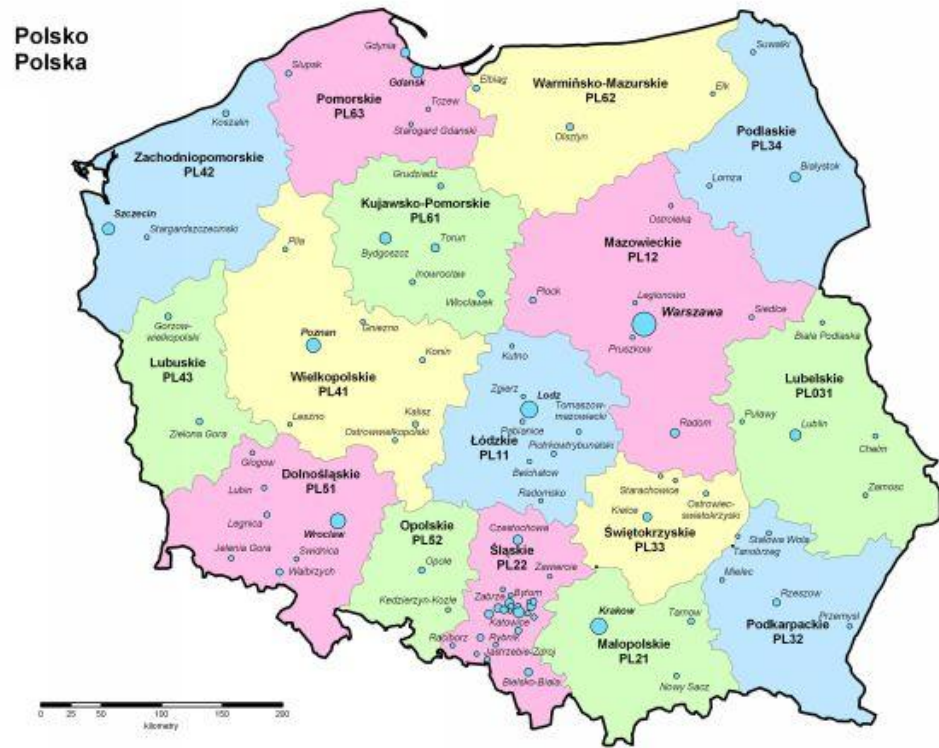
(<http://www.czso.cz>)

Fig. 2 - division of Hungary according to NUTS 2



Adapted from the Czech statistical office.
(<http://www.czso.cz/cz/mapy/nuts2/index.htm>)

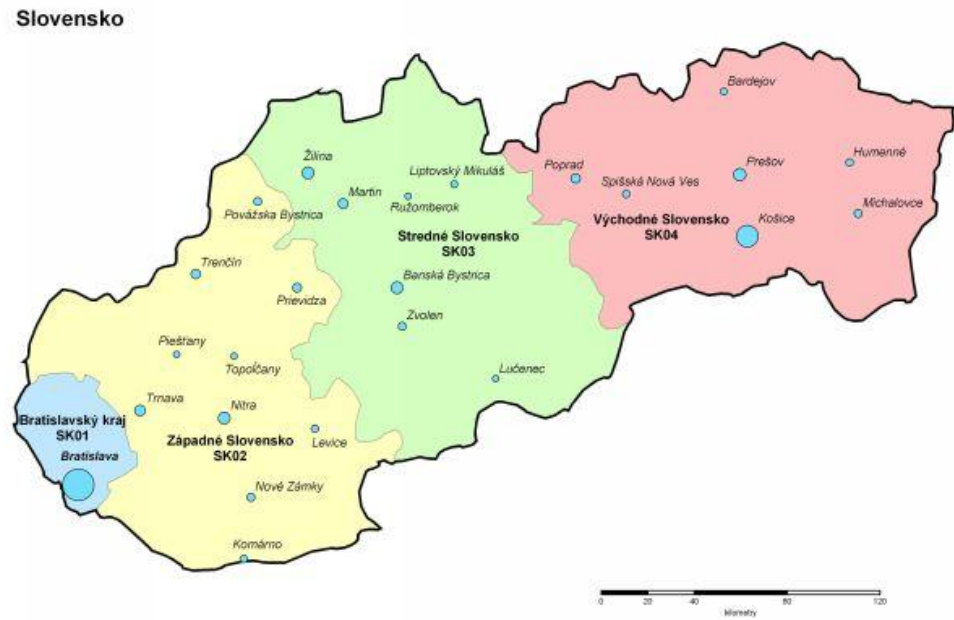
Fig. 4– division of Poland according to NUTS 2



Adapted from the Czech statistical office.

(<http://www.czso.cz/cz/mapy/nuts2/index.htm>)

Fig. 5– *division of Slovakia according to NUTS 2.*



Adapted from the Czech statistical office.

(<http://www.czso.cz/cz/mapy/nuts2/index.htm>)

