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Convergence chances of peripheral regions, with special regards on two territories from East-Central Europe

PhD thesis

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Miskolc
2016
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1. Introduction

The territorial social and economic inequality is one of the most fundamental characteristics of space economics (Nemes Nagy, 1990; Nagyné Molnár, 2007.). There are not two points in the space which have the same characteristics, because their economic, social and cultural parameters are different (Nagyné Molnár, 2007; Benedek-Kurkó, 2011.). The scale of difference can vary in time and space. According some researchers opinion there are two special positions in the space: the centre and periphery (Nemes Nagy, 2005.). In economics, centres are places where the positive social and economic effects are concentrating. On the other hand in the peripheral regions the negative social and economic effects are increasing, and according the theory of cumulative causation they result often a negative spiral (Nemes Nagy, 2005; Nagyné Molnár, 2007.). Most of the peripheral regions are not only in the case of some economic indicators (like GDP or number of enterprises) disadvantaged, but for example also in the life quality and migration. Because of this fact the decrease of the territorial inequalities and the catch up of the peripheries is a very important issue for the economic policy.

The analysis of the territorial inequalities is not new; several researchers have examined the positive convergence chances of the peripheries (for example nation states convergence process by Barro and Sala-i-Martin, 1992; Mankiw et. al., 1992; Romer, 1994; Sala-i-Martin, 1995; Quah, 1996).¹ In the catch up we have to distinguish two different processes which are the positive and negative convergence. „The catch up is positive if the relatively underdeveloped region can catch up to the more developed ones, and negative if the indicators of the more developed regions are approaching the ones of the underdeveloped territories.” (Nagyné Molnár, 2007. pp. 171.) In the centre of the convergence theories of economics is the economic growth. It examines how the economic catch up process of the peripheries goes. The empirical analysis of convergence dates back to the 1960s. In that time the neoclassical growth theories (for example Solow) were in the foreground of researches, which convergence process theories are based on market automatism. From the Solow model there were several theories according convergence which is summarized in my dissertation’s theoretical background.

The empirical analysis of convergence has generally two basic types: sigma and beta convergence analysis. The sigma convergence examines the standard deviation of the indicators, while the beta convergence analyse the regression between the GDP per capita of the initial period and its yearly average growth rate. Quah in his works has analysed the club-convergence theory, and has made a statement that the GDP per capita of the nations is not converging to the same steady state path, but the values are clustering and in these groups there is a convergence (Szőrfi, 2004.).

In the last time the empirical analyses show that the notion of convergence is controversial. “There are some researches which refuse (Baumol, 1986.; The Economist, 1992.; Barro, 1991.; Barro és Sala-i-Martin, 1992.), and there are some which underlie (Mankiw-Romer-Weil, 1992.; Sprout-Weawer, 1992.; Nelson-Wright, 1992.) the convergence process.” (Ligeti, 2002.)

According the analysis of Quah “in the distribution of the national income per capita there is an observable a kind of clustering tendency instead of convergence; the number of middle income countries is decreasing, and there are two main clusters, one with high income level and one with low income level” (Trón, 2009. p. 63). This process is a so called “twin-peaks”

¹ The convergence means generally: Cflows, information, and ideas catch up, nearing to each other” and „moving towards a special point in the space”. (Ferkelt, 2005.) The notion is used by several sciences like mathematics, biology, genetics, engineering, social sciences.
which indicates the polarization of the global economy. One peak contains the countries with high income level and another peak the countries with low income level. In Quah’s theory only the club-convergence can be verified in the world economy (Quah, 1995.). A convergence-club means countries whose steady-state paths are close to each other, so they show quasi-homogeneity from some economic and social aspects. (Benedek-Kocziszky, 2014; 2015.) Baumol’s opinion the convergence-clubs are clusters in which there is a convergence, but between the clusters there are increasing disparities.

The analysis of spatial inequalities and convergence has high priority also in the European Union. The preamble of the Roman treaty which has constituted the European Community contains the need for equalizing territorial differences and the catch up of the disadvantaged territories. The institutional framework was created first by the European Regional Development Found (1975) and then by the creation of cohesion policy (Single European Act – 1986). The reason for regional policy was that with the increasing number of EU’s member countries the economic and social disparities were also increasing. The EU examines the territorial inequalities since almost more than 20 years. According the Regional Yearbook of the Eurostat (2014) there is a 26 times difference between the richest Inner London, and the poorest Severozapaden (Bulgaria) region (in power-parity standard 11 times difference). The difference was in 2000 between the richest Inner London and poorest Extremadura (Spain) region only 7,5 times high (in power-parity standard 6 times high). (Figure 1)

![Figure 1. Differences of the regional GDP/capita in the European Union (2000-2013)](image)

Source: compiled by the author based on dates of the Eurostat

The so called negative convergence process is observable in the EU between 2008 and 2011, which cause was the decline of the Inner London region due to the economic and financial crisis (financial centre role). But as a summary between 2000 and 2013 the GDP differences were increasing among the regions of the EU. So the convergence process is relatively slow in spite of the huge regional support (347 billion Euro Structural Founds support between 2007 and 2013 to cohesion). That is why the analysis of convergence is very important.
1.1. Justification of the topic

My research topic is the analysis of the catch up process of the peripheral regions with special regards of the German and Hungarian inner convergence process with focus on the east-German provinces and the north Hungarian region. My main question was which factors have made significant effect on the inner convergence process in the case of Borsod-Abaúj-Zemplén county and Saxony-Anhalt province.

The analysis of the peripheral regions’ convergence process is a question since Solow, and there is not an exact answer to some questions of regional convergence also nowadays. So the topic is actual, especially in regions of which several micro regions are in a relatively disadvantaged situation in economic and social aspect. In Hungary the decrease of the differences between the western and eastern part of the country is since the 25 years from the regime change a big problem. Especially the Northern Hungarian region has big handicaps to the western part of the country. From the regime change the goal of the national and European Union’s support and economic policy was the decreasing the differences also with direct economic policy decisions (for example Bosch, Takata in Miskolc).

The question about the peripheries is also in Germany important, because the territories of the former GDR have huge disadvantages compared to the western part of the country. In the last 25 years from the reunification the German government made several development supporting program for the East German convergence (from 1990 to 2011 the Found for German Unity (160 billion DM) and the Solidarity Pact (82 and 156 billion Euro) (Harald, 2008.)). As a result of them it has started positive economic tendencies but the differences in economic and social aspect are also today huge. Germany is from the beginning member state of the EU, so they become structural support from the first time.

The main goal of my research is to analyse the convergence process of the peripheral regions in two countries, which have different initial conditions and economic policy. The question is whether the economic policy actions made on effect on the convergence of the peripheries. My interest about the topic is not new, I wrote my master degree final work in similar topic (title: Two sides of the German economy, or is the economic convergence of the provinces of the former GDR and FRG realized?). In my research I have made a statement that in Germany from 1995 to 1997, from 1998 to 1999, from 2001 to 2004 and from 2005 to 2008 the sigma convergence of the GDP per capita was realized, and between 1995 and 2008 also the beta convergence, but there are huge disparities between the two parts of the country. The inequalities are the highest in case of the GDP/capita, R&D activity and industrial enterprises. In terms of the unemployment rate there was a small convergence process between the two parts.

1.2. Introducing the research field

In my dissertation I made a special focus on two peripheral territories from the countries (in Germany it was Saxony-Anhalt and in Hungary Borsod-Abaúj-Zemplén County). The periphery is a relative notion, its situation can differ among countries (Pénzes, 2013; 2014.). My aim was to create quasi-homogenous territories, which are important for the territorial analysis (Dusek, 2004a.). “The goal is to create such territories which are from some aspects homogenous.” (Pénzes, 2014 p. 24.)

In my research I have followed the next logic in the selection of peripheral regions. I have examined some economic, social and infrastructural indicators. First I made a research of which are the most common used indicators in the theory according to Pénzes (2014). (Table 1.) From the indicators I have chosen eight ones which I supposed to be relevant in the case of the two countries.
Table 1. – Indicators of complex territorial disadvantages

<table>
<thead>
<tr>
<th>Type</th>
<th>Indicator</th>
<th>Type</th>
<th>Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constantly examined indicators</td>
<td>− migration</td>
<td>− vehicle ownership</td>
<td></td>
</tr>
<tr>
<td></td>
<td>− age structure</td>
<td>− dynamic of house building</td>
<td></td>
</tr>
<tr>
<td></td>
<td>− urbanity, structure of settlements</td>
<td>− water accessibility</td>
<td></td>
</tr>
<tr>
<td></td>
<td>− unemployment</td>
<td>− telephone accessibility</td>
<td></td>
</tr>
<tr>
<td></td>
<td>− income distribution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sometimes missed indicators</td>
<td>− educational attainment</td>
<td>− tourism</td>
<td></td>
</tr>
<tr>
<td></td>
<td>− employment structure</td>
<td>− accessibility of gas</td>
<td></td>
</tr>
<tr>
<td></td>
<td>− enterprises density</td>
<td>− sanitation</td>
<td></td>
</tr>
<tr>
<td>Newly examined indicators</td>
<td>− research and development</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>− social supports</td>
<td>− availability</td>
<td></td>
</tr>
<tr>
<td></td>
<td>− local taxes</td>
<td>− television accessibility</td>
<td></td>
</tr>
<tr>
<td></td>
<td>− waste collection</td>
<td>− internet accessibility</td>
<td></td>
</tr>
<tr>
<td>Skipped indicators</td>
<td>− agricultural situation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


In my dissertation the examined indicators are: share of young people in the population, unemployment rate, GDP per capita, passenger cars to 1000 inhabitants, house building to 1000 inhabitants, enterprises number to 1000 inhabitants, research and development in the percent of the GDP, and guest nights to 1000 inhabitants.

By calculating the indicators I have used a normalization, which counts with the minimum and maximum values (0-1 after the calculation).

$$Z_i = \frac{x_i - x_{\min}}{x_{\max} - x_{\min}}$$  \hspace{1cm} (1)

Although it was not used in official analysis but more research has applied this methodology (KSH: for building the most disadvantaged territories – Kezán, 2014. and micro regional HDI – Farkas, 2012.). I supposed a territory to be a periphery if its value is lower than 0,3 (by the unemployment rate I supposed reverse relation). My results were the following.

Table 2. – Indicators of peripherality in the case of Borsod-Abaúj-Zemplén and Saxony-Anhalt territories

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Borsod-Abaúj-Zemplén county</th>
<th>Saxony-Anhalt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Share of young people in the population</td>
<td>0,778</td>
<td>core region</td>
</tr>
<tr>
<td>Unemployment rate</td>
<td>0,955</td>
<td>periphery</td>
</tr>
<tr>
<td>GDP/capita</td>
<td>0,104</td>
<td>periphery</td>
</tr>
<tr>
<td>Passenger cars to 1000 inhabitants</td>
<td>0</td>
<td>periphery</td>
</tr>
<tr>
<td>House building to 1000 inhabitants</td>
<td>0,011</td>
<td>periphery</td>
</tr>
<tr>
<td>Enterprises number to 1000 inhabitants</td>
<td>0</td>
<td>periphery</td>
</tr>
<tr>
<td>Research and development in the percent of the GDP</td>
<td>0,263</td>
<td>periphery</td>
</tr>
<tr>
<td>Guest nights to 1000 inhabitants</td>
<td>0,089</td>
<td>periphery</td>
</tr>
<tr>
<td>Total points</td>
<td>0,275</td>
<td>periphery</td>
</tr>
</tbody>
</table>

Source: own compilation

According the results, Saxony-Anhalt is in most of the cases a periphery, only by the passenger cars number shows sign of a core region. In the case of Borsod-Abaúj-Zemplén there is also only one indicator where the county has core regional character; it is the share of
young people in the population. The complex indicator underlies in both territories the peripheral situation. According the complex indicator Saxony-Anhalt is the worst NUTS1 territory in Germany, as Borsod-Abaúj-Zemplén is the fifth worst among the counties of Hungary.

1.3. Aims and main questions of the research

Basic aim of my research is to analyse the convergence process and the catch up of the peripheries in two countries (Germany and Hungary) and its peripheral regions (Saxony-Anhalt and Borsod-Abaúj-Zemplén County). I tried to explain the processes beside the most common used GDP/capita indicator with a new self-created life quality indicator. Its components are: life expectancy, share of people with secondary and high school degree, new house building, health care, passenger car ownership and unemployment rate. The reason for multi-dimensional approach is that the only GDP based analysis cannot give information about the social processes of the territories, because it does not consider the welfare indicators. So beside the mainstream GDP analysis it is important to examine also some social indexes. The reason for the life quality indicator was that I would like analyse such index which does not contains the GDP.

Main research question of my dissertation:

1. What development had the growth and convergence theories of regional economics?
2. What kind of differences can be seen in the distribution of the economic and social indicators (GDP and life quality) in NUTS3 in Germany and Hungary? How can be grouped the regions according their geographic situation and socio-economic indicators?
3. What tendencies can be seen in the development of territorial inequality indicators?
4. What kind of influence has the situation of the territories and their neighbourhood relations on the dispersion of indicators?
5. In the case of the life quality the territorial or the structural factors are the most dominant ones?
6. Can be verified the sigma or beta convergence, or the club-convergence in the two countries? What kind of clusters can be made?
7. Which factors have a significant influence on the distribution of the GDP in the two countries?
8. What kind of connections are there between the indicators (GDP and life quality)?
9. What kind of actions was made in the two countries to reduce the inequalities and reach convergence? Which regional policy actions were used in the case of the peripheries?

The structure of my dissertation can be seen on Figure 2. My work has 4 main chapters. After a briefly introduction in the second chapter I summarized the main theories of growth and convergence theories of regional economics, with special regards on its characteristics. The third chapter is rather methodological; it summarizes the theories of the applied methods. In this chapter I have introduced the territorial inequality indices, spatial autocorrelation, convergence analysis, shift-share analysis and regression (OLS and spatial) analysis. The fourth chapter of my dissertation contains my thesis. In this part I have made some territorial analysis to see the convergence process with special regards on the GDP and life quality index. I have examined the distribution of them and also their tendencies. I made a special focus on neighbourhood relations and the effects of it.
In my dissertation I build up six hypotheses, which are the following.

**H1)** Not only the macroeconomic growth and development paths are different in the two countries, but according my assumptions also the mezo-economic paths can be different.

I have tested the hypothesis by making the dynamic analysis of the regional (NUTS2) and county (NUTS3) level GDP and life quality index (with the calculation of the average growth rate of GDP and life quality, and building convergence clubs).

**H2)** In the two countries there are observable different inequality paths, in the case of German NUTS3 districts there is a convergence while at the Hungarian county (NUTS3) level there can be supposed divergence process.

I have tested the hypothesis with the calculation of inequality indices.

**H3)** In NUTS3 level, the neighbourhood connections have influencing role in the dispersion of the GDP and life quality (significant spatial autocorrelation). I would like to prove, that some territories of Saxony-Anhalt and Borsod-Abaúj-Zemplén County are homogenous disadvantaged areas.
I have tested the hypothesis with the calculation of NUTS2, NUTS3, and LAU1 level Moran I indices, Local Moran indices and with the analysis of LISA cluster maps. By examining the territorial and structural effects I made a shift-share analysis.

**H4)** The dynamic of convergence is different in the peripheral regions of Germany and Hungary. It can be supposed that along the convergence process there was not great realignment in the ranking of the territories. The analysis made in different territorial level (NUTS2 – NUTS3) can lead to different results.

I have tested the hypothesis with sigma, beta and gamma convergence analyses, and with the calculation of inequality indices (range, Hoover index, Dual indicator).

**H5)** Because of different convergence dynamic there can be created convergence clubs in both countries, and as a result of them can be verified that the examined territories are still in peripheral situation. In the case of German territories the cluster members indicates convergence, while in Hungary it appears as divergence.

I have tested the hypothesis with cluster analysis (Ward method), while the intra-cluster convergence was tested with discriminant analysis.

**H6)** a) According my supposition the number of registered enterprises and the migration can make a great influence on the territories’ economic performance.

b) Because of the neighbourhood effects the validity of spatial models is presumable.

I have tested the hypothesis with factor analysis and with regression models. To test the neighbourhood effects I have applied spatial regression analysis (spatial lag and spatial error model).

2. New and novel statements of the research

2.1. Theoretical basis of the analysis

In my dissertation I had a special focus on summarizing the theoretical background of the topic. I have examined how the growth theories of regional economics were developed from the classical political economy up to our present day. I saw the neoclassical school, endogenous growth theory, and also the Keynesian school, and new economic geography’s main connections and the appearance of the convergence notion in the theories.

In regional economics there are two main directions to explain the territorial processes, which are:

a) location theories (oldest part of regional economics, it appeared in the beginning of the 1800s with Thünen and his followers; it analyse the spatial distribution of the economic activities),

b) regional economic growth theories (it has a focus on spatial aspects of economic growth and on the dispersion of income).

The theoretical and methodological base of the regional economics is the location theories which have mainly microeconomic and static viewpoints, but they have also macroeconomic and general equilibrium aspects. The regional economic growth theories are rather basically macroeconomic. (Capello, 2011.) In my dissertation I have focused mainly on this last category.
The theories can be grouped in two clusters. The first cluster contains such “schools”, which support the convergence: neoclassical theory, Keynesian theory, export base theory, endogenous growth theory. Instead of this the second cluster sums up theories which underlie the differentiation and divergence: growth pole theory, polarization theory, centre-periphery theory (Péli, 2014.).

2.1.1. Regional economic growth theories

In the times of classical political economics (main representatives: Smith, Ricardo, Malthus, Say and Thünen) the economy’s equilibrium was determined by the demand and supply. The limits for economic growth were the market barriers. According to Say (1803) “in the economy every production creates its own market, there is no oversupply and no unemployment”. They believed in the markets invisible hand, and in laissez fair, they thought that the state’s engagement makes turmoil in the economy. The role of space first appeared in the works of Smith and Ricardo. The geographical factors were basic parts of the competition (Lengyel-Rechnitzer, 2004.). The growth appeared first in the work of Malthus who examined the effects of population change. He has made a statement that: a) “the population, if there is no disturbing factor, will doubling in every 25 years, so it grows in geometrical progress” (Malthus, 1978. p. 4.) and b) “thinking on the Earth current situation, the groceries cannot be grow with higher speed than arithmetical progress” (Malthus, 1978. p. 6.). So while the population grows in geometrical progress, the groceries production only in arithmetical progress, the limits of population growth can be found in groceries production. Malthus had some questions, whether the population growth have positive effects on the country’s economy. There is no connection between the needs of population growth and the groceries production. (Varga, 2013.) The representatives of classical political economics have focused on macroeconomic level; they do not examine lower, for example mezo levels.

The neoclassical economics which is based on the marginalist’s marginal utility theory is a determining theory of the XX. century’s economics. The neoclassical growth model was developed by Solow (1956). In this model the growth of the output is explained by three exogenous factors (growth of the capital stock, population growth, and technological progress). The spatial inequalities will be disappearing because of the decreasing economies of scale in the case of capital and labour. The income levels of the poorest economies will be converging to the richer ones, because they tend to have higher growth rates, than the richer ones. (Barro, 1989. p. 407.) The exogenous or neoclassical growth model (Ramsley, Solow, Swan, Cass, Koopmans) was the determining one from the 1950s to the mid of 1980s.

There were some critics about the neoclassical growth model also in the 1950s and 1960s (existing divergence, questions about the economies of scale). The explanation of convergence developed only in the 1970s and 1980s. The changing situation of the world economy in the beginning of the 1970s (for example oil crisis) has resulted a new theoretical model. The main character of it is that the endogenous resources are very important. The main representatives of this endogenous growth theory are Barro, Sala-i-Martin, Romer and Lucas. While in the exogenous growth model the determining factors are exogenous like technological progress or labour, in the endogenous growth theory the technology is an endogenous factor (has several components like R&D or education). The technological progress has increasing economies of scale according the model (Romer, 1986.; Lucas, 1988.; Aghion – Howitt, 1998. stb.). In Romer’s (1986) opinion because of increasing economies of scale the regional or national convergence of per capita income is not inevitable.
Beside the neoclassical school from the 1930s there was another school existing parallel, which is named after Keynes. The Keynesian model focuses on demand side factors, and emphasises the need for states engagement. Because of existing inequalities the Keynesian models main aim is on understanding divergence. The convergence first appeared in the post-Keynesian model of Harrod-Domar. It was developed by Harrod (1939) and Domar (1957). According the models assumptions there is not an initial condition beside which the flow of factors brings the economy to equilibrium. The regions with import surplus can reach higher growth rates than others. The third statement is that the differences in the regions’ growth rates will be not decreasing but they will increase further. (Harrod, 1939.) (Domar, 1946.) (Capello, 2007.) If we assume that the poorer regions are importing capital from the richer, the model can reach in the long-term its steady state path (Capello, 2007.).

The export base theory is a type of Keynesian models which explains the regional economic growth with the strength of export sectors. In North (1955) opinion the export of limited resources creates the base of regional development in the core regions. In the theory the regional multiplicator effect has great role, its importance depends on how big part of the resources will be produced and how much imported. (Kuttner - Nagy - Sebestyénne Szép, 2014.) There were several critics also in connection with the export base theory like the difficulty to choose the basic sectors, or the ignoring of inner regional growth impulses (Lengyel-Rechnitzer, 2004.).

The polarization theories were based on the export base theory. They see the nature of regional development in the importance of divergence, and territorial inequalities. In the model the regions have different inner growth factors, there are strong interdependencies among them, and in the market there is an imperfect competition. Schumpeter emphasises the importance of innovation in the regional growth. Perroux made a statement that the motoric parts of the economy are the innovative sectors, which are such growth poles who improve or hold in the development. Myrdal in his cumulative causation theory explains the regional inequalities with two parallel effect, the spread and backwash effect.

The growth pole theory is a special type of polarization theories. Paelinck (1965) has defined sectoral growth poles, which can lead to geographical, income, and psychological polarization. Boudeville’s (1966) opinion the sectoral polarization leads to regional polarization, and this defines growth centres in the space. Nowadays in the regional economic growth theories there are new significant effects, the effect of space economics, and new economic geography, which can be characterized by Krugman, Fujita, Venables and Thisse. Its basics are the location theories of Thünen and Isard. Major statement is the spatial determination and spatial concentration of economic activities. In Krugman’s theory the main analysed areas are not the countries, but rather the subnational region, because the dispersion of economic activities does not follow the national borders (Krugman 1991a, 1993c; Varga, 2014.).

The new regionalism, similar to the new economic geography, concentrates to some super-star regions or cities. The resource of success can be found in some intra-regional factors, and the theory ignores the exogenous factors (Hadjimichalis – Hudson 2013.). There are some other theories which explain the regional economic growth with some historical, demographical, social or political factors, or with the stages of economic growth (theories of Rostow, Friedman, Richardson, Porter and Kondratieff).
2.1.2. Convergence theories

The convergence means generally: Cflows, information, and ideas catch up, nearing to each other” and „moving towards a special point in the space”. (Ferkelt, 2005.) The notion is used by several sciences like mathematics, biology, genetics, engineering, social sciences.

The economic growth is in the centre of the convergence theories of economics. The question of convergence is in several debates of development economics. They would like to know if the poorer countries can reach in the reality higher growth rates than the richer ones, and whether the convergence of life quality can be seen. Or there is an opposite tendency, so the richer tend to be richer, and the poorer much poorer (Sachs-Warner, 1995.). To measure the macroeconomic convergence the GDP is one of the most common used indicator in different territorial level: international level (Barro and Sala-i-Martin, 1992, 1997; Mankiw et al., 1992; Quah, 1996), regional level (Lopez-Bazo et al., 1999; Brunstad, 2005) and local level (Royuela és Artís, 2006.). (Royuela-García, 2013.)

In the treaty of the European Union the strengthening of economic and social cohesion is a crucial question. This is regulated by the 2. part of the treaty: “the Community improves the harmful and balanced development of economic activities with common strategic documents to reach convergence and positive economic performance. So it can lead to economic and social cohesion and solidarity among the member states.” (Eckey-Türck, 2007.) The convergence theories are summarized according Eckey-Türck in Table 3.

Table 3. – Convergence and divergence in the growth theories

<table>
<thead>
<tr>
<th>theory</th>
<th>causes of divergence</th>
<th>causes of convergence</th>
</tr>
</thead>
<tbody>
<tr>
<td>neoclassical growth model</td>
<td>-</td>
<td>the diminishing economies of scale underlies convergence (Solow, 1956; Swan, 1956; Barro – Sala-i-Martin 1990, 2004)</td>
</tr>
<tr>
<td>post-Keynesian model</td>
<td>spatial mobile demand and external shocks are causes of divergence (Schmidt, 1966.)</td>
<td>-</td>
</tr>
<tr>
<td>polarization theories</td>
<td>dominance of centripetal forces, as the causes of divergence (Hansen, 1975; Myrdal, 1957; Hirschman, 1965)</td>
<td>-</td>
</tr>
<tr>
<td>endogenous growth theories</td>
<td>positive external effects can cause also convergence and divergence (Romer, 1986, 1990; Rivera-Batiz – Romer, 1991.)</td>
<td></td>
</tr>
<tr>
<td>new economic geography</td>
<td>in the long term the transportation costs are the determinants of regional development lower transportation costs explain the spatial concentration of labour and the divergence (Fujita – Krugman, 2004; Fujita – Thisse, 2002; Krugman 1991, 1999.)</td>
<td></td>
</tr>
</tbody>
</table>


There are two methods of measuring real convergence: sigma and beta (the notions were first introduced by Barro and Sala-i-Martin in 1992). The sigma convergence compares the economies development in a given time period, mostly with the GDP per capita indicator. It measures standard deviation of the GDP from the average GDP value. The convergence realises if the standard deviation of the indicator is decreasing in time, in the opposite case there is a divergence (Eckey-Türck, 2007.).

Basic hypothesis of beta convergence is that the per capita income of the poorer countries grows rapidly than the income of richer ones, so the poorer regions can catch up (Nemes Nagy, 2005.). It has got two main types. In the first case every region converges to the same steady-state (absolute convergence), and in the second case if regions with similar initial
conditions converge to the same GDP per capita value in the long run (conditional convergence). (Eckey-Türck, 2007.)

Other explanation of convergence is the so called convergence clubs. A convergence-club means countries whose steady-state paths are close to each other, so they show quasi-homogeneity from some economic and social aspects. (Benedek-Kocziszky, 2014; 2015.) The theory was developed by Danny Quah in 1993. According the analysis of Quah “in the distribution of the national income per capita there is a observable a kind of clustering tendency instead of convergence; the number of middle income countries is decreasing, and there are two main clusters, one with high income level and one with low income level” (Trón, 2009. p. 63). This process is a so called “twin-peaks” which indicates the polarization of the global economy. One peak contains the countries with high income level and another peak the countries with low income level. In Quah’s theory only the club-convergence can be verified in the world economy (Quah, 1995.).

2.2. Convergence process of the German and Hungarian economy

In my dissertation I have built up six hypotheses which I have tested along two main dimensions (economic and social). The main applied indicators were the following (Figure 3.).

![Figure 3. – Dimension of the analysis](source: own compilation)

In the case of the economic indicators the basic factor was the GDP per capita, which is a macroeconomic result of consumption, investments, governmental consumption and net export. In my analysis I used also some extra indicators: income distribution, R+D+I expenditures and the number of registered enterprises. From the social indicators I used the life quality indicator, which is an artificial indicator with 6 main components: life expectancy at birth, educational attainment (1/3 secondary school and 2/3 high school degree), infant
mortality to 100000 inhabitants, passenger cars to 1000 inhabitants, new house building and unemployment rate.

The aim of the research is to analyse the indicators’ convergence (sigma, beta, gamma and club-convergence). The steps of the analysis are summarized on Figure 4.

Figure 4. – Methods of the analysis
Source: own compilation

In the first step the goal of the analysis was to examine the differences of the indicators, which can be a base to the further inequality and convergence analysis. I used first dynamic analysis, and inequality indices, and after came the real convergence analysis (sigma, beta, gamma and club-convergence). In the convergence question there is inevitable to examine the interconnection and interdependencies of the indicators. That is why I applied correlation, regression analysis, spatial autocorrelation tests and shift-share analysis. The results are following.

Polycentric social and economic space structure – different tendencies (GDP, life quality)

H1) Not only the macroeconomic growth and development paths are different in the two countries, but according my assumptions also the mezo-economic paths can be different.

To prove the hypothesis I used the dynamic analysis of the regional (NUTS2) and county level (NUTS3) GDP and life quality. In Germany at NUTS3 (434 territories) there were great differences among the districts in 2011. In the case of the GDP per capita the west-east development difference appears sharper than in the case of the life quality indicator. By the life quality indicator there are several hot spots also in the territory of the East German provinces which are clustering in the areas of the big cities (for example high school centres
of Magdeburg, Halle, or Dessau in Saxony-Anhalt, Leipzig, Chemnitz and Dresden in Saxony, Berlin). The cause for this can be found in the complex character of the life quality. In the index the life expectancy, health and unemployment indicator does not show big standard deviation among the territories (the values of the city regions are only a little higher than in the rural areas) but the educational component, the passenger cars ownership and the house building shows big differences among the areas.

There are also some common hot spots (spatial concentration) of the two indicators, like part of the Ruhr-area, South-Bavaria, Northeast-Baden-Württemberg, Hamburg, Bremen and Braunschweig. The most developed territories in the term of the GDP can be found in the city regions of Munich, Ingolstadt and the cities of Ruhr-area (for example Düsseldorf, Duisburg, Dortmund, Essen, Leverkusen), as the least developed ones are there in Mecklenburg-Vorpommern province.

Figure 5. – Dispersion of GDP per capita (left) and life quality, Germany, NUTS3, 2011.
Source: own compilation

The cause for the high GDP values can be found in the persistence of the capital intensive big enterprises. The relatively low GDP of Mecklenburg-Vorpommern can be caused by the character of the province, hence it is rather a rural area, and its big cities also do not have great dominance. So the differences in the economic structure are huge.

In the life quality indicator beside Munich and Frankfurt, Münster, Regensburg, Heidelberg, Darmstadt and Bonn also has good positions. In Munich and Frankfurt the educational component, passenger cars ownership and the house building is more above the average. In the case of Münster, Heidelberg, Darmstadt and Bonn the value of educational component is extremely high, which is because of the historical high schools. The life quality is the lowest in Thüringen (Sömmerda) and Saxony-Anhalt (for example Harz, Saale, Mansfeld-Südharz, Salzland districts), which is caused by several factors. The educational attainment is relatively low, there are not big university centres, and the health care also shows a disadvantage. So in the case of the GDP per capita the western and eastern territories show some different
clusters, while in the case of the life quality there are some spatial concentrations in the country.

In Saxony-Anhalt the big cities (Magdeburg, Halle, Dessau) are more developed according the life quality than the GDP, and they appear as hot spots. Here the educational component (high-school centres) and life expectancy is higher than the average. According the life quality Saxony-Anhalt seems to be more homogenous than in the GDP, so the inequalities are lower among the districts. Only the big cities are emerging in the space.

In Hungary the dispersion of the GDP shows homogenous, high developed (higher than the national average) north – north-western path (Vas, Győr-Moson-Sopron, Komárom-Esztergom, Fejér and Pest counties, and the capital), and in both indicators there is a highly developed Budapest-Miskolc, Budapest-Győr, Budapest-Szeged, Budapest-Keszthely and Budapest-Pécs axis. Along this axis is the highest both the GDP and life quality. In the case of the GDP the least developed territories can be found in the north-eastern – northern part of Hungary (Borsod-Abaúj-Zemplén, Nógrád, Szabolcs-Szatmár-Bereg counties), and in Békés county. The least developed one from these is Nógrád county. These territories are in terms of the accessibility and of the western capital intensive enterprises peripheral ones, in several cases only the county centre has significant economic potential. The most developed territories in the life quality are beside the capital in Veszprém, Pest, Fejér and Csongrád counties.

![Image of maps showing GDP and life quality dispersion in Hungary](image)

**Figure 6. - Dispersion of taxable income per capita (left) and life quality, Hungary, LAU1, 2011.**

Source: own compilation

I analysed the data also in Borsod-Abaúj-Zemplén County, and could make a statement that in both indicators the micro region of Miskolc and Szerencs is the most developed, caused by the relatively high enterprises density and good secondary education. The lowest values have the micro regions of the eastern periphery.

**Thesis 1. a)** In 2011 the life quality index, which has got social and infrastructural components, shows more polycentric space structure (following the city hierarchy) than the GDP per capita also in the case of the Hungarian LAU1 micro regions, and Germany NUTS3 districts. In the life quality there are some hot spots also in the GDP term more developed territories, like Eastern-Germany and Northern Hungary, which are mostly big city regions. The big cities of Saxony-Anhalt (Magdeburg, Halle, Dessau) and the centre of Borsod-Abaúj-
Zemplén County (Miskolc) is also hot spot. The cause for this can be found in the complex character of the life quality, in the given indicators there are different rankings. In the case of Hungary the difference is caused by the passenger car ownership and the house building. In the other indicators there is not great standard deviation among the territories. There are some common hot spots in the two indicators (spatial concentration), where beside the economic development there is also positive social and infrastructural situation (part of the Ruhr-area, South-Bavaria, Northeast-Baden-Württemberg, Hamburg, Bremen and Braunschweig in Germany and Budapest-Miskolc, Budapest-Győr, Budapest-Szeged, Budapest-Keszthely and Budapest-Pécs axis in Hungary).

Analysis of the dynamic of GDP and life quality

In my dissertation I have analysed the change of the GDP and life quality between 2000 and 2011 in the case of the German and Hungarian NUTS3 territories. I made some examination also in NUTS2, and saw that the members of the former EU-15 and EU-13 show other tendencies. In the EU-15 the best performing regions are mostly not the capital regions (except: Sweden, UK). In Germany Berlin had the lowest GDP growth rate between 1995 and 2011. In the EU-13 (so also in Hungary) the average growth rate of the GDP is higher than in the EU-15. The best performing region is in most cases the capital region (Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovakia and Slovenia) which indicates the deepening of regional inequalities. In Hungary the Central Hungarian region has 1,5 so high growth rate than the others.

![Figure 7. – Yearly average growth rate of GDP per capita 2000-2011 (NUTS3), Germany and Hungary](source: own compilation)

In the case of the Hungarian counties there is big standard deviation in the dispersion of the GDP growth rate. The highest values have beside the capital Pest and Komárom-Esztergom counties, which indicated the further development. In the North Hungarian region can be seen that the growth rates of Borsod-Abaúj-Zemplén and Heves counties the growth rate is about the national average (4,1%), but Nógrád had one of the lowest value in the whole country so it can fall strongly below the others. In Saxony-Anhalt the most dynamic districts are in 2000-2011 Börde, Salzland and Altmark while the big cities (Magdeburg, Halle, Dessau) showed relatively lower values, so there was a little convergence in this terms.
In the life quality there was a small divergence among the territories, because some initially high developed county could reach higher growth rate than the initially underdeveloped ones. The most dynamic growth had Veszprém, Csongrád, Nógrád and Fejér counties, while it was the lowest in Jász-Nagykun-Szolnok and Komárom-Esztergom.

The divergence is observable also in Germany. The initially high developed districts could reach higher growth rates than the initially underdeveloped ones. In the territory of the former GDR, the districts of Saxony-Anhalt, Thüringen, Brandenburg and Mecklenburg-Vorpommern had on the average lower life quality dynamic than the western part of the country.

**Thesis 1. b)** The dynamic of the life quality is highly lagged behind the GDP dynamic. Between 2000 and 2011 the GDP was growing yearly on the average with 3.05% in Germany and 4.03% in Hungary. Instead of this the life quality’s growth rate could not reach in the countries the 1% (Germany yearly average 0.09% and Hungary 0.93%). In county or district level in both countries the divergence of the life quality is observable. The initially (2001) underdeveloped territories could reach only lower growth rates than the initially high developed ones. In lower territorial level the centre-periphery relations are sharper, so the convergence of life quality is not fulfilled.

e) In Saxony-Anhalt, similar to the national tendency, there is a GDP convergence and life quality divergence observable. Borsod-Abaúj-Zemplén County’s GDP dynamic corresponds to the national average, which can lead to convergence, but the growth rate of life quality stays below the national average.

**Different life quality and GDP paths**

There were several actions in the two countries to reduce the territorial inequalities, but according the above seen dispersion of the economic and social indicators, I have supposed the following.

**H2)** In the two countries there are observable different inequality paths, in the case of German NUTS3 districts there is a convergence while at the Hungarian county (NUTS3) level there can be supposed divergence process.
I made more analysis on the inequalities of the GDP and life quality for the countries to see the disparities (Table 4 and 5).

**Table 4. – Inequality indices - Germany**

<table>
<thead>
<tr>
<th>Indices</th>
<th>NUTS 2</th>
<th>NUTS 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Germany – GDP/capita</strong></td>
<td></td>
</tr>
<tr>
<td>range (M)</td>
<td>decreasing inequalities</td>
<td>increasing differences</td>
</tr>
<tr>
<td>Dual indicator (Éltető-Frigyes index)</td>
<td>decreasing inequalities</td>
<td>decreasing inequalities</td>
</tr>
<tr>
<td>weighted relative standard deviation (V)</td>
<td>decreasing inequalities</td>
<td>decreasing inequalities</td>
</tr>
<tr>
<td>Hoover-index</td>
<td></td>
<td>decreasing inequalities</td>
</tr>
<tr>
<td></td>
<td><strong>Germany – life quality index</strong></td>
<td></td>
</tr>
<tr>
<td>range (M)</td>
<td>decreasing inequalities</td>
<td>increasing differences</td>
</tr>
<tr>
<td>Dual indicator (Éltető-Frigyes index)</td>
<td>decreasing inequalities</td>
<td>increasing differences</td>
</tr>
<tr>
<td>weighted relative standard deviation (V)</td>
<td>decreasing inequalities</td>
<td>increasing differences</td>
</tr>
</tbody>
</table>

Source: own compilation

From the dates can be seen that the choosing of the territorial level is important, because it has an influence on the inequalities. In the case of the GDP there are decreasing differences also in regional and districts level, while in Hungary the differences of the GDP are growing in both territorial levels. But while the life quality shows at regional level in both countries signs of a convergence, at NUTS3 the differences are increasing so there is rather a divergence process. So the territorial level is crucial in the analysis.

**Table 5. - Inequality indices - Hungary**

<table>
<thead>
<tr>
<th>Indices</th>
<th>NUTS 2</th>
<th>NUTS 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Hungary – GDP/capita</strong></td>
<td></td>
</tr>
<tr>
<td>range (M)</td>
<td>increasing differences</td>
<td>increasing differences</td>
</tr>
<tr>
<td>Dual indicator (Éltető-Frigyes index)</td>
<td>increasing differences</td>
<td>decreasing inequalities</td>
</tr>
<tr>
<td>weighted relative standard deviation (V)</td>
<td>increasing differences</td>
<td>increasing differences</td>
</tr>
<tr>
<td>Hoover-index</td>
<td>-</td>
<td>increasing differences</td>
</tr>
<tr>
<td></td>
<td><strong>Hungary – life quality index</strong></td>
<td></td>
</tr>
<tr>
<td>range (M)</td>
<td>decreasing inequalities</td>
<td>increasing differences</td>
</tr>
<tr>
<td>Dual indicator (Éltető-Frigyes index)</td>
<td>decreasing inequalities</td>
<td>increasing differences</td>
</tr>
<tr>
<td>weighted relative standard deviation (V)</td>
<td>decreasing inequalities</td>
<td>increasing differences</td>
</tr>
</tbody>
</table>

Source: own compilation

**Thesis 2. a)** The inequality indices underlie the decrease of the territorial differences of the GDP in Germany and Saxony-Anhalt in NUTS3. But in the case of the life quality divergence can be verified in NUTS3. In Hungary and also in the North Hungarian region the GDP shows increasing disparities, similar to the life quality.

**Thesis 2. b)** The territorial level of the analysis have great influence on the inequality indices of the life quality. In NUTS2 the differences of the life quality were decreasing from 2001 to 2011 also in Germany and Hungary, but in NUTS3 there were divergent tendencies in both economies.
Significant neighbourhood effects, western-eastern differences

"Everything is related to everything else, but near things are more related than distant things" (Waldo Tobler, 1970, p. 236.)

In the motto of the first law of geography I analysed the spatial autocorrelation of the GDP and life quality in the case of the German NUTS3 districts and Hungarian LAU1 level.

H3) In NUTS3 level, the neighbourhood connections have influencing role in the dispersion of the GDP and life quality (significant spatial autocorrelation). I would like to prove, that some territories of Saxony-Anhalt and Borsod-Abaúj-Zemplén County are homogenous disadvantaged areas.

My research question was how strong the influencing role of the neighbouring territories is. I have calculated Moran I and Local Moran indices. I made the analysis with more neighbourhood matrices. Table 6 shows the results for the German GDP per capita.

<table>
<thead>
<tr>
<th>Moran I</th>
<th>queen contiguity</th>
<th>nearest neighbours method (5)</th>
<th>threshold distance (mean centres; 56 km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>number of permutation</td>
<td>999</td>
<td>999</td>
<td>999</td>
</tr>
<tr>
<td>pseudo-p value</td>
<td>0,021</td>
<td>0,001</td>
<td>0,001</td>
</tr>
<tr>
<td>z score</td>
<td>2,2265</td>
<td>4,1514</td>
<td>4,4625</td>
</tr>
<tr>
<td>Local Moran clusters</td>
<td>high-high: 11</td>
<td>high-high: 19</td>
<td>high-high: 29</td>
</tr>
<tr>
<td></td>
<td>low-low: 68</td>
<td>low-low: 37</td>
<td>low-low: 71</td>
</tr>
<tr>
<td></td>
<td>low-high: 8</td>
<td>low-high: 15</td>
<td>low-high: 40</td>
</tr>
<tr>
<td></td>
<td>high-low: 18</td>
<td>high-low: 14</td>
<td>high-low: 17</td>
</tr>
<tr>
<td>significance levels</td>
<td>95-99,9%</td>
<td>95-99,9%</td>
<td>95-99,9%</td>
</tr>
</tbody>
</table>

Source: own compilation

Analysing the 5 nearest neighbours method I saw the following results. The Moran I value (0,1174) indicates weak, positive spatial autocorrelation. I made the analysis with 999 permutations to eliminate the random error. The pseudo-p value is low (0,001), and the z score is high (4,1514), so the autocorrelation can be verified. The analysis has showed 13 outliers, mainly city regions, but further they do not show significance, so do not have influence. The result of Local Moran shows Figure 9.
According the Local Moran analysis (999 permutation and minimum 95% significance) 349 of the examined 434 territories did not show significant autocorrelation, the other 85 territory can be grouped into 4 clusters. In 2011 there are 19 areas in the high-high cluster, where the examined territory and their neighbours also have above the average GDP values, so these are highly developed territories, and mainly city regions. All 19 districts can be found in the western part of country, mainly in Bavaria and Baden-Württemberg.

The second cluster members are such district where not only the examined area’s GDP is lower than the average, but also their neighbours’. These are mainly in the Eastern part of Germany. From Saxony-Anhalt 6 districts can be grouped into this cluster: Saugerhausen, Merseburg-Querfurt, Burgenland and Saale district (Halle region), Bernburg and Bitterfeld (Dessau region).

To the third cluster belong territories where the examined area has lower GDP than the average, but their neighbours are high developed. So the cluster members are relatively underdeveloped. There are 15 territories in this cluster, all in the western part of Germany. In the case of city region the cause for this can be that the city centre is not so developed as the agglomeration ring, as a result of the agglomeration process.

The last cluster contains areas with high GDP, which are higher than their neighbours’ and higher than the average. So they are emerging from their region. They are mostly city region, 15 territories belongs this category.

In the case of Hungarian LAU1 taxable income per capita the results are shown in Table 7 for 2012.

Table 7. – Local Moran analysis, Hungary taxable income per capita

<table>
<thead>
<tr>
<th></th>
<th>queen contiguity</th>
<th>nearest neighbours method (5)</th>
<th>threshold distance (mean centres; 56 km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moran I</td>
<td>0.556074</td>
<td>0.582369</td>
<td>0.48115</td>
</tr>
<tr>
<td>number of permutation</td>
<td>999</td>
<td>999</td>
<td>999</td>
</tr>
<tr>
<td>pseudo-p value</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td>z score</td>
<td>11.5805</td>
<td>12.7906</td>
<td>16.8644</td>
</tr>
<tr>
<td>Local Moran clusters</td>
<td>high-high: 28</td>
<td>high-high: 27</td>
<td>high-high: 38</td>
</tr>
<tr>
<td></td>
<td>low-low: 26</td>
<td>low-low: 22</td>
<td>low-low: 46</td>
</tr>
<tr>
<td></td>
<td>low-high: 1</td>
<td>low-high: 0</td>
<td>low-high: 5</td>
</tr>
<tr>
<td></td>
<td>high-low: 4</td>
<td>high-low: 2</td>
<td>high-low: 7</td>
</tr>
<tr>
<td>significance levels</td>
<td>95-99,9%</td>
<td>95-99,9%</td>
<td>95-99,9%</td>
</tr>
</tbody>
</table>

Source: own compilation

In Hungary the taxable incomes per capita show medium strong, positive spatial autocorrelation among the micro regions. It underlies the low value of pseudo-p (0.001) and the high value of z score (12.79).

According the Local Moran analysis (999 permutation and minimum 95% significance) 117 of the examined 168 micro regions did not show significant autocorrelation, the other 51 territory can be grouped into 4 clusters. The members of high-high cluster can be found mainly in the Central Hungarian and Central Transdanubian region. These are highly developed territories according the income per capita. To the low-low cluster 22 territories can be clustered, which have significantly below the average income, and their neighbours are also underdeveloped areas. They are mostly in South and North-eastern Hungary. To this cluster belongs also the micro region of Encs, Sátoraljaújhely and Sárospatak from Borsod-Abaúj-Zemplén County. These are relatively underdeveloped micro regions, so they underlie the peripheral situation of North-Borsod. The high-low cluster, which indicates emerging areas, has got two parts (Hajdú-Bihar: Debrecen micro region and Szabolcs-Szatmár-Beregi: Nyíregyháza micro region). Here the income is higher than the national average and they emerge from their neighbourhood.
Life quality

I also analysed the spatial autocorrelation of the life quality indicator in the two countries with the following results.

Table 8. – Local Moran analysis, Germany life quality

<table>
<thead>
<tr>
<th></th>
<th>queen contiguity</th>
<th>nearest neighbours method (5)</th>
<th>threshold distance (mean centres; 56 km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moran I</td>
<td>0,3016</td>
<td>0,2967</td>
<td>0,2327</td>
</tr>
<tr>
<td>number of permutation</td>
<td>999</td>
<td>999</td>
<td>999</td>
</tr>
<tr>
<td>pseudo-p value</td>
<td>0,001</td>
<td>0,001</td>
<td>0,001</td>
</tr>
<tr>
<td>z score</td>
<td>9,5247</td>
<td>8,8156</td>
<td>6,3719</td>
</tr>
<tr>
<td>Local Moran clusters</td>
<td>high-high: 37</td>
<td>high-high: 53</td>
<td>high-high: 77</td>
</tr>
<tr>
<td></td>
<td>low-low: 55</td>
<td>low-low: 49</td>
<td>low-low: 65</td>
</tr>
<tr>
<td></td>
<td>low-high: 0</td>
<td>low-high: 8</td>
<td>low-high: 17</td>
</tr>
<tr>
<td></td>
<td>high-low: 12</td>
<td>high-low: 10</td>
<td>high-low: 27</td>
</tr>
<tr>
<td>significance levels</td>
<td><strong>95-99,9%</strong></td>
<td><strong>95-99,9%</strong></td>
<td><strong>95-99,9%</strong></td>
</tr>
</tbody>
</table>

Source: own compilation

In Germany the life quality indicator shows positive, significant spatial autocorrelation (according p and z values), but it is weak. The members of high-high cluster can be found by every model in the territory of North Rhine-Westphalia, northeast of Rhine-area-Pfalz, west Baden-Württemberg, and in the area of Munich, Hamburg, and the capital, Berlin. These territories are emerging because of their educational component, and infrastructural situation. They are homogenous highly developed areas according the life quality. Instead of this the low-low cluster can be defined in northeast Bavaria, and Thüringen, Saxony and Saxony-Anhalt. The appearance of the low-high cluster is rare, can be seen only in some regions of Baden-Württemberg, Rhine-area-Pfalz and North Rhine-Westphalia. The high-low cluster can be found in the eastern part of the country, with city hot spots (Leipzig, Plauen).
In the case of the Hungarian life quality I got the following results (Table 9).

Table 9. – Local Moran analysis, Hungary life quality

<table>
<thead>
<tr>
<th></th>
<th>queen contiguity</th>
<th>nearest neighbours method (5)</th>
<th>threshold distance (mean centres; 56 km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moran I</td>
<td>0,08541</td>
<td>0,07255</td>
<td>0,08553</td>
</tr>
<tr>
<td>number of permutation</td>
<td>999</td>
<td>999</td>
<td>999</td>
</tr>
<tr>
<td>pseudo-p value</td>
<td>0,001</td>
<td>0,001</td>
<td>0,001</td>
</tr>
<tr>
<td>z score</td>
<td>5,1833</td>
<td>7,3914</td>
<td>7,5753</td>
</tr>
<tr>
<td>Local Moran clusters</td>
<td>high-high: 9</td>
<td>high-high: 5</td>
<td>high-high: 15</td>
</tr>
<tr>
<td></td>
<td>low-low: 12</td>
<td>low-low: 14</td>
<td>low-low: 23</td>
</tr>
<tr>
<td></td>
<td>low-high: 6</td>
<td>low-high: 6</td>
<td>low-high: 15</td>
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<tr>
<td></td>
<td>high-low: 7</td>
<td>high-low: 6</td>
<td>high-low: 8</td>
</tr>
<tr>
<td>significance levels</td>
<td>95.99,9%</td>
<td>95.99%</td>
<td>95.99,9%</td>
</tr>
</tbody>
</table>

Source: own compilation

In the case of the Hungarian micro regions’ life quality there is a significant, but weak, positive spatial autocorrelation, so the influencing role of the neighbouring territories is low. The tests of the analysis also underlie the significance.

The pattern of life quality underlines the medium strong connection between the GDP and life quality, because the higher GDP shows higher life quality patterns. The high-high cluster can be seen in the area of some micro regions of Pest, Komárom-Esztergom, Fejér and Veszprém counties, similarly to the GDP, while the low-low cluster is dominant in Szabolcs-Szatmár-Bereg, Hajdú-Bihar, Borsod-Abaúj-Zemplén and Baranya counties. The members of low-high cluster are in the peripheries of high-high cluster, and the members of high-low cluster in the peripheries of the low-low cluster.
Thesis 3. a) There is a provable weak, positive spatial autocorrelation in 2011 in the case of the German NUTS3 GDP and life quality. In the GDP per capita the forming clusters underlie the west-east differences. They verify that the homogenous high developed areas can be found mostly in the western part of the country, while the relatively underdeveloped ones in the eastern part. The members of high-low cluster are mainly city regions. Some districts of Saxony-Anhalt can be grouped to the low-low cluster according their GDP. In terms of life quality also weak, positive spatial autocorrelation can be verified. The members of high-high cluster can be found in the territory of North Rhine-Westphalia, northeast of Rhine-area-Pfalz, west Baden-Württemberg, and in the area of Munich, Hamburg, and the capital, Berlin. The low-low cluster can be defined in northeast Bavaria, and Thüringen, Saxony and Saxony-Anhalt.

b) The Hungarian LAU1 micro regions has showed in 2011 according their taxable income per capita medium strong, positive spatial autocorrelation, so it is stronger than in Germany. The members of high-high cluster are mostly in the Central Hungarian (Budapest and Pest County) and Central Transdanubian region. To the low-low cluster belongs also the micro region of Encs, Sátoraljaújhely and Sárospatak from Borsod-Abaúj-Zemplén County. In terms of life quality there is a weak, positive spatial autocorrelation. Similar to the income to the high-high cluster belong most micro regions of Pest, Komárom-Esztergom and Fejér counties, and the capital, while to the low-low cluster micro regions of Borsod-Abaúj-Zemplén, Szabolcs-Szatmár-Bereg, Baranya and Hajdú-Bihar counties. The members of low-high cluster are in the peripheries of high-high cluster, and the members of high-low cluster in the peripheries of the low-low cluster.

c) The patterns forming according the neighbourhood connections underlie the mostly homogenous, peripheral situation of Saxony-Anhalt and Borsod-Abaúj-Zemplén County.

Dominance of the territorial factors against the structural ones

The shift-share analysis examines the influential or effective factors of spatial development, so its focus is important for the regional inequality analyses. That is why I made the shift-share analysis of the life quality indicator to see, whether the territorial or the structural factors have more dominance in the given NUTS3 territories.
In the Hungarian county level life quality there is a divergence observable, as the more than 60% of the initially (2001) high developed territories could reach higher life quality growth or dynamic than the initially underdeveloped ones (category 3 and 4).

**Figure 13. – Hungarian counties according the categories of shift-share analysis (2001-2011)**

Source: own compilation

As a conclusion can be made a statement that in the Hungarian county level except two counties (Szabolcs-Szatmár-Bereg and Békés) the territorial factors have more dominance than the structural ones.

In the case of the German districts the shift-share analysis of the life quality also underlies the divergence between the western and eastern part of the country. The districts with positive life quality dynamic (territories of the category 1, 2, 3, and 4.) are clustering in the western part of the country while the districts with negative dynamic (category 5 and 6) can be found mainly in the eastern part. (Figure 14)

**Figure 14. – German NUTS3 districts according the categories of shift-share analysis (2001-2011)**

Source: own compilation
In the distribution of the life quality index the territorial factors are the determining ones, the structural factors (coming from the components of the life quality) are only in 10% of the territories the most dominant. The shift-share analysis underlies that in the case of Hungary at lower territorial levels the role of structural factors is increasing, so the components of the life quality are more dominant than the spatial situation. Instead of this in Germany the deepening of the territorial level has showed that the role of the territorial factors was growing.

**Thesis 3. d)** The shift-share analysis underlies the convergence of the regional, and divergence of the county level life quality index in both countries.

**e)** In the case of the regional and county level life quality the effect of the territorial factors is more dominant than the structural ones in the German and Hungarian economy. The structural factors (the differences of the life quality components) has only a 10% influence (German and Hungarian also) on the dispersion of life quality.

**Convergence vs. divergence?**

According the results of my dissertation there are convergent processes in the two economies, but I have the assumption that:

**H4)** The dynamic of convergence is different in the peripheral regions of Germany and Hungary. It can be supposed that along the convergence process there was not great realignment in the ranking of the territories. The analysis made in different territorial level (NUTS2 – NUTS3) can lead to different results.

In Germany and Saxony-Anhalt from 2000 to 2011 the sigma and beta convergence of the GDP per capita was realized at regional and districts level, but in Hungary and Northern Hungary there is an observable sigma and beta divergence. If I made the county level convergence analysis without the distortional effect of the capital, I saw realizing sigma and beta convergence also in Hungary.

The convergence analysis of the life quality at regional level has showed in both case (Germany and Hungary) sigma and beta convergence between 2001 and 2011, similar to the inequality indices. In territorial level NUTS3, both countries and Saxony-Anhalt and Northern Hungary there is a provable sigma divergence. To this process comes a beta convergence (except Northern Hungary).

In the case of the beta convergence the spatial autocorrelation can be also a significant factor, so I have tested the beta convergence with spatial effects (Table 10).

| Table 10. – Beta convergence with spatial effects |
|-----------------------------|-----------------------------|
|                             | NUTS 2                      | NUTS 3                      |
| **GDP**                     |                             |                             |
| Germany                     | significant spatial lag model | significant spatial lag model |
|                            | \( R^2 \text{ change: 0.2311-0.3192} \) | \( R^2 \text{ change: 0.0088-0.0225} \) |
|                            | \( \rho: 0.3497 \)          | \( \rho: 0.1502 \)          |
|                            | constant: 21264.72          | constant: 25568.49          |
|                            | beta: -2457.299            | beta: -868.4837            |
| Hungary                     | the spatial models are not significant | the spatial models are not significant |

**Life quality index**

| Germany                     | the spatial models are not significant | can be calculated only with assumed growth rates |
| Hungary                     | the spatial models are not significant | can be calculated only with assumed growth rates |

Source: own compilation
The Hungarian NUTS2 and NUTS3 GDP per capita and the Hungarian and German regional life quality index did not show significant spatial autocorrelation, but in the case of the German regional and district level GDP per capita the existence of spatial lag models can be verified. These models can explain the beta convergence more precisely.

I also calculated the gamma convergence in the case of the two counties’ GDP from 2000 to 2011. According the results can be made a statement that gamma convergence was realized in both territories but there was not great realignment in the GDP rankings. In Germany the value of the index was decreasing from 0.996 to 0.975, while in Hungary from 0.9925 to 0.9632. I made the gamma convergence analysis also for the life quality index to see whether there was a change in the ranking of the regions. In the time period of 2002 and 2011, in both countries the gamma convergence of life quality was realized (Figure 15).

![Figure 15. – Gamma convergence of the life quality (NUTS2; 2002-2011)](image)

Source: own compilation

**Thesis 4.** The sigma and beta convergence analyses of the GDP per capita have proved in Germany and Saxony-Anhalt also at regional and district level realizing convergence between 2000 and 2011, while in Hungary and Northern Hungary there is a provable divergence. In the case of the life quality there was a sigma and beta convergence from 2001 to 2011 at regional level in both countries, from which the beta convergence can be verified also at NUTS3 (except Northern Hungary). The gamma convergence analyses indicate in the case of both countries county level GDP and regional life quality realizing convergence. In term of the GDP there was greater realignment in Hungary, in the ranking of the territories, while by the life quality Germany had significantly higher realignment processes.

**Different growth paths – club-convergence**

By analysing the convergence I have examined the validity of the convergence club hypothesis of Quah in the two countries. I supposed:

**H5** Because of different convergence dynamic there can be created convergence clubs in both countries, and as a result of them can be verified that the examined territories are still in peripheral situation. In the case of German territories the cluster members indicates convergence, while in Hungary it appears as divergence.
In Germany the regional (NUTS2) convergence clubs underlie the realization of the small convergence process, as the initially underdeveloped East German territories (Chemnitz, Leipzig, Saxony-Anhalt, Mecklenburg-Vorpommern, Dresden, Thuringen) could reach on the average higher (about 4% yearly) GDP growth rates than the whole West German area (except some North Bavarian region). According the GDP per capita the 434 NUTS3 districts of Germany can be grouped into 6 convergence clubs, from which the highly developed areas are in the first club. Here the initial (2000) GDP per capita was very high, but the growth rate of the GDP was relatively low. 26 territories belong to this cluster, there are some rich city regions among them (Munich and its agglomeration, Darmstadt and Hamburg and their neighbourhood). In Saxony-Anhalt I could build up three clubs, from which the second contains the territories with relatively high initial GDP, and lower dynamic. Two districts, Halle and Magdeburg are the members of it.

![Figure 16. – Convergence clubs of the GDP per capita in Germany and Hungary (NUTS3; 2000-2011)](image)

Source: own compilation

In the case of the Hungarian counties I could build up four convergence clubs according the Ward method. The first club contains only one county, the capital. Budapest has a special situation, because it has got in 2000 a very high GDP per capita, to which a came a yearly average 5.3-5.4% growth rate. The second club contains three counties, which had relatively low GDP in 2000 but their growth rate was extremely high (5-6.5% yearly). The counties: Hajdú-Bihar, Pest and Komárom-Esztergom. The members of the third club are territories where the GDP was also in 2000 relatively high, but here the growth rate stayed below the average (Fejér, Vas and Győr-Moson-Sopron counties). The growth rate of the remaining 13 territories is average, or below the average, which could increase the initially lower GDP, but their catch up was not fulfilled yet. To this cluster belongs also Borsod-Abaúj-Zemplén County.
Life quality

According the Hungarian regional life quality index I could make three convergence clubs, from which the first contains the Central Hungarian region, where the life quality was prominently high, but the growth rate of it was one of the lowest beside the South Great Plain. As a result of the analysis can be seen that the regions with the initially lowest life quality could reach the highest growth rate, while the most developed ones (for example Central Hungarian region) had the lowest dynamic. This underlies the convergence process. In the case of Germany I also made three clubs for the regional life quality index which also prove the convergence.

Thesis 5. a) The convergence process can be observed in the case of the German and Hungarian regional and county level GDP, and regional life quality index. The territories with similar values and growth rates are clustering.
b) The club-convergence analysis of the GDP per capita verifies six convergence clubs in Germany, which draw up the western-eastern differences, and shows the realizing convergence. The members of the club with the highest growth rate can be found in the territory of the East German provinces. The Hungarian GDP can be grouped into four clubs. Borsod-Abaúj-Zemplén County belong to the club with average or below the average grows rate, and with relatively lower initial GDP. The regional level club convergence also underlies the German economy’s small western-eastern convergence process in the case of GDP and life quality, while in Hungary beside the county level GDP divergence comes a regional life quality convergence.

Regression analysis of the GDP – spatial models

In the case of the GDP per capita there are different processes in the examined countries. That is why it is important to examine the influencing factors of the GDP and to draw up the significant ones.

H6) a) According my supposition the number of registered enterprises and the migration can make a great influence on the territories’ economic performance.
b) Because of the neighbourhood effects the validity of spatial models is presumable.

In my dissertation I used factor analysis and regression models. I have tested the spatial effects with spatial regression models (spatial lag and spatial error).

Determining factors of the Hungarian taxable income per capita (2011)

Initially I have tested 20 indicators, from which according the factor analysis I have built up five factors:

1. factor: living conditions (unemployment rate, passenger cars to 1000 inhabitants, life expectancy at birth, marriages to 1000 inhabitants, new house building to 1000 inhabitants, educational attainment),
2. factor: tourism (commercial accommodation to 1000 inhabitants, guest nights to 1000 inhabitants, households waste to 1000 inhabitants),
3. factor: economic environment (enterprises with 250-499 employees to 1000 inhabitants, enterprises with more than 500 employees to 1000 inhabitants, functioning hospital beds to 1000 inhabitants, registered crimes to 1000 inhabitants),
4. factor: migration (migration to 1000 inhabitants, immigration to 1000 inhabitants),
5. factor: natural reproduction (life birth to 1000 inhabitants, death to 1000 inhabitants).

As a result of the regression analysis I built up the following model:

$$Y = 1603,675 + 215,925X_1 - 6,514X_2 + 78,873X_3 + 15,359X_4 + 78,590X_5$$  \hspace{1cm} (2)$$

This means if every factors are zero, then the average taxable income per capita is 1603,675 thousand Forint. If the living condition’s factor value is increasing by 1 point, with the assumption that every other factors stay unchanged, the taxable income per capita will be growing by 215,9 thousand Forint. As an effect of the economic environment and natural reproduction factor the change of the income is similar. The positive effect of the migration is relatively lower, than the taxable income per capita will be increasing by 15,35 thousand Forint. The effect of tourism factor is negative, the taxable income per capita will decreasing by 6,5 thousand Forint, with the assumption that every other factor remains the same.

The examination of the spatial effects is also crucial by the regression, so I have analysed the spatial effects in the model. By calculating the OLS (Ordinary Least Squares) regression, I have built into the model also a neighbourhood matrix, to see the applicability of spatial models. In the case of the Hungarian taxable income per capita the spatial error model can be verified, which calculates with spatially lagged error term. I have tested the model so with the new conditions and compared to the OLS the results are the following.

| Table 11. – OLS and spatial error model results (Hungarian taxable income per capita) |

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>OLS</th>
<th>Spatial error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>1603,675**</td>
<td>1607,922**</td>
</tr>
<tr>
<td>living conditions</td>
<td>215,925**</td>
<td>197,21**</td>
</tr>
<tr>
<td>tourism</td>
<td>-6,514</td>
<td>20,72</td>
</tr>
<tr>
<td>economic environment</td>
<td>78,873**</td>
<td>82,94**</td>
</tr>
<tr>
<td>migration</td>
<td>15,359</td>
<td>-4,39</td>
</tr>
<tr>
<td>natural reproduction</td>
<td>78,590**</td>
<td>42,81**</td>
</tr>
<tr>
<td>Lambda</td>
<td>-</td>
<td>0,7276**</td>
</tr>
<tr>
<td>$R^2$</td>
<td>72,96</td>
<td>82,66</td>
</tr>
<tr>
<td>Akaike criterion</td>
<td>2182,59</td>
<td>2119,88</td>
</tr>
<tr>
<td>Schwarz criterion</td>
<td>2201,33</td>
<td>2138,62</td>
</tr>
</tbody>
</table>

** significant (p<0,001)

Source: own compilation

The spatial error model compared to the OLS can better explain the dispersion of the Hungarian taxable income per capita. It proves that the explaining power has increased from 72,96% (OLS) to 82,66%.

If every factors are zero than the taxable income per capita is higher than by the OLS, it is 1608 thousand Forint. The coefficient of the spatially lagged error term (Lambda) is 0,7276 which means that it has significant, positive effect. The regression model:

$$Y = 1607,922 + 197,21X_1 + 20,72X_2 + 82,94X_3 - 4,39X_4 + 42,81X_5 + \varepsilon$$  \hspace{1cm} (3)$$

where $\varepsilon$ is the error term, $W$ the neighbourhood matrix, and $\xi$ is the vector of the uncorrelated error terms.
**Influencing factors of the German districts’ GDP (2011)**

Initially I have tested 21 indicators, from which according the factor analysis I have built up five factors:

1. factor: creative SMEs (unemployment rate, patent applications to 1000 inhabitants, new house building to 1000 inhabitants, death to 1000 inhabitants, enterprises with 0-9 employees to 1000 inhabitants),
2. factor: tourism (commercial accommodation to 1000 inhabitants, guest nights to 1000 inhabitants, marriages to 1000 inhabitants),
3. factor: living standard (educational attainment, live birth to 1000 inhabitants, deaths to 1000 inhabitants, life expectancy by birth),
4. factor: economic and infrastructural environment (enterprises with 50-249 employees to 1000 inhabitants, enterprises with 250 and more employees to 1000 inhabitants, hospital beds to 1000 inhabitants),
5. factor: migration (migration to 1000 inhabitants, immigration to 1000 inhabitants).

I have also tested the existence of spatial model in the case of the German NUTS3 GDP, but according the results neither the spatial lag, nor the spatial error model was significant (Table 12). So the results of the OLS are correct.

\[
Y = 27164.4 + 269.6X_1 - 67.39X_2 + 275.7X_3 + 618.8X_4 + 98.02X_5 \quad (4)
\]

<table>
<thead>
<tr>
<th>Test</th>
<th>Moran I/ degree of freedom</th>
<th>Value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moran I</td>
<td>0.050874</td>
<td>1.7727841</td>
<td>0.0762644</td>
</tr>
<tr>
<td>Lagrange Multiplier (lag)</td>
<td>1</td>
<td>0.1550800</td>
<td>0.6937273</td>
</tr>
<tr>
<td>Robust LM (lag)</td>
<td>1</td>
<td>0.0107533</td>
<td>0.9174090</td>
</tr>
<tr>
<td>Lagrange Multiplier (error)</td>
<td>1</td>
<td>2.4501408</td>
<td>0.1175143</td>
</tr>
<tr>
<td>Robust LM (error)</td>
<td>1</td>
<td>2.3058142</td>
<td>0.1288907</td>
</tr>
<tr>
<td>Lagrange Multiplier (SARMA)</td>
<td>2</td>
<td>2.4608941</td>
<td>0.2921619</td>
</tr>
</tbody>
</table>

Source: own compilation

**Thesis 6. a)** The influential factors of the taxable income per capita and the GDP are complex, they can be explained only by multidimensional factors. In both countries the tourism, the economic and infrastructural environment (big enterprises positive effect to GDP) and the migration is a significant factor. In the case of Hungary there is a connection also with the living conditions and natural reproduction factors (both positive), while in the case of Germany other significant positive effect has the living standard and creative SMEs factor.

**b)** In the distribution of the Hungarian taxable income per capita the spatial effects are significant, the spatial error model can better explain the dispersion of the values than the OLS. The coefficient of the spatially lagged error term (Lambda) is 0.7276 which means that it has significant, positive effect. In the case of the German GDP the existence of the spatial models is not provable.
3. Further usage of the results, further research questions

Further I would like to expand my research topic, and to make other directions to the analysis. This I suppose to do by expending the time horizon, deepening the territorial level (micro regional data). I plan to analyse other indicators beside the GDP per capita and the life quality, such as welfare indicator or enterprises, or the R&D activity. I also would like to use my results to educational goals.

My short term goals is the publication of my results in foreign language. According my hopes the dissertation can contribute to the deeper publicity of the regional convergence and spatial regression analysis.

The further directions of the analysis can be:
- path analysis to the influential factors of income,
- spatially expended convergence analysis,
- analysis of other peripheral regions of the countries to generalise results,
- the analysis of the support usage of the Structural Founds,
- fiscal federalism, centralization and decentralization analysis, to see the benefits, handicaps, and effects.

4. References


5. Reference publications of the author

[8.] Szendi D. (2015): Differences in the spatial patterns of selected German (NUTS3) economic factors, with special regards on GDP, unemployment and enterprises; University of Miskolc - MicroCad Conference


