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Number: aedc2e4a-41c4-4e63-b4a4-a6930f13b5c5

Fiscal Policy in Context of Regionalisation and Globalisation: Methodological Approaches in Measuring Convergence with Applications to European Regions

PhD. thesis

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PhD. thesis

Field: 67-11-9 Forecasting

Institute: Institute for forecasting, Slovak academy of sciences

Supervisor: Juraj Renčko, Ing. CSc.

ISBN: 978-80-970204-1-5

Bratislava 2010 **Mgr. Ing. Michal Páleník**

ABSTRACT

PÁLENÍK Michal: Fiscal Policy in Context of Regionalisation and Globalisation: Methodological Approaches in Measuring Convergence with Applications to European Regions; Faculty of National Economy of University of Economics in Bratislava; Institute for forecasting, Slovak academy of sciences; Ing. Juraj Renčko, CSc. – Institute for forecasting, Slovak academy of sciences

Cohesion policy is an important part of European Union fiscal policy. In the times of continuing reginalisation and globalisation, sustaining such heterogenous entity as European Union, without too large internal differences is extremely important. In order to achieve this goal, it is important to monitor and quantify differences among regions.

In this work, we study seven variables which are used to measure economic and social quality of a region: gross domestic product, disposable income, share of services on value added and share of tertiary education on all workers as indicators of economic quality, employment rate, unemployment rate and economic activity rate as indicators of social quality. Most important ones are gross domestic product, disposable income and employment rate. We studied these variables in fourteen regions. In these there is assumption of continuous convergence. It is shown that metropolitan regions are different and that they behave almost independently.

The rate of convergence is measured by various metrics. Beta and sigma convergences are widely used, however these rely on strong assumption of normality and independence of observations. Therefore we used Spearman's rank coefficient, which is robust against distributions which are not normal. Apart from beta and sigma convergence, other metrics were used as well. Comparing these metrics, we identified four clubs of convergence metrics. The first one is sigma convergence. Gini coefficient, Theil coefficient and entropy fall into this group as well. The second one is IQR (inter quartile range). The third group is μ convergence, which studies development of number of regions below 90% of median. Kurtosis, as the fourth moment of distribution, describes the source of sigma. These four metrics behave very differently and they are practically uncorrelated. So each of them describes convergence from a different point of view.

For the goals of measuring convergence for economic policy, we suggest to use μ convergence. This convergence is robust against development of extremely positive values (high growth of several regions will not affect this metric), against changes around the center (slight unimportant changes of regions in the core will not affect it), as well as against values of negative outliers. It only studies percentage of these regions and expects its decline.

For research with to goal to study and understand regional convergence and divergence processes we suggest to use several metrics that describe different sides of this process. The four metrics are sigma convergence, μ convergence, IQR a kurtosis.

Keywords: European union, cohesion policy, convergence, Spearman's rank coefficient, μ convergence, inter quartile range convergence, kurtosis and skewness convergence, gross domestic product, disposable income, employment rate

ABSTRAKT

PÁLENÍK Michal: Fiškálna politika v kontexte regionalizácie a globalizácie: Metodologické prístupy pri meraní konvergencie s aplikáciou na Európske regióny; Národohospodárska fakulta Ekonomickej univerzity v Bratislave; Prognostický ústav Slovenskej akadémie vied; Ing. Juraj Renčko, CSc. – Prognostický ústav Slovenskej akadémie vied

Kohézna politika je dôležitou súčasťou fiškálnej politiky Európskej únie. Najmä v čase postupujúcej regionalizácie a globalizácie je udržovanie tak heterogénneho celku ako je Európska únia bez priveľkých vnútorných rozdielov veľmi dôležité. Aby sa tento cieľ podarilo dosiahnuť, je potrebné sledovať a kvantifikovať rozdiely medzi regiónmi.

V práci je sledovaných sedem premenných používaných na meranie hospodárskej a sociálnej kvality regiónu: hrubý domáci produkt, disponibilný príjem, podiel pridanej hodnoty v službách a podiel pracovníkov s vysokoškolským vzdelaním ako ukazovatele hospodárskej kvality, mieru zamestnanosti, mieru nezamestnanosti a mieru ekonomickej aktivity ako ukazovatele sociálnej kvality regiónu. Najdôležitejšie sú hrubý domáci produkt, disponibilný príjem a miera zamestnanosti. Tieto premenné sú sledované v štrnástich skupinách regiónov, v ktorých je predpoklad pokračujúcej konvergencie. Ukazuje sa, že metropolitné regióny sú iné ako ostatné a vyvíjajú sa prakticky nezávisle.

Miera konvergencie je meraná rôznymi metódami. Bežne sú merané beta a sigma konvergenciou, avšak pri metóde výpočtu týchto konvergencií sú veľmi silné predpoklady normality a nezávislosti pozorovaní. Preto bola v práci použitá metóda Spearmanovej poriadkovej štatistiky, ktorá je robustná voči podkladovému rozdeleniu, ktoré nespĺňa podmienky normality. Okrem beta a sigma koeficientov boli použité aj iné metódy. Ich vzájomným porovnaním sme dospeli k štyrom klubom konvergenčných mier. Prvým je sigma konvergencia, kam spadá aj Gini koeficient, Theilov koeficient a entropia. Druhým je IQR (rozdiel medzi kvartilmi). Treťou je μ konvergencia, ktorá popisuje vývoj počtu regiónov s hodnotou premennej menej ako 90% mediánu. Špicatosť, ako štvrtý moment rozdelenia premennej, bližšie popisuje zdroj disperzie premennej. Tieto štyri metriky sa správajú veľmi rozdielne a sú prakticky nekorelované. Teda každá z nich popisuje konvergenciu z úplne iného uhla.

Pre potreby merania konvergencie v rámci potrieb hospodárskej politiky odporúčame používať μ konvergenciu. Táto konvergencia je robustná voči vývoju extrémne pozitívnych hodnôt (vysoký rast niektorých regiónov neovplyvňuje metriku), voči zmenám okolo stredu rozdelenia (nezaujímavé presuny regiónov v jadre rozdelenia ju neovplyvňujú), aj voči hodnotám negatívnych outlierov. Metrika sleduje iba percento negatívnych regiónov a očakáva ich zníženie.

Pre výskumné potreby s cieľom teoretického komplexného pochopenia a popisu regionálnych konvergenčných a divergenčných procesov odporúčame použiť niekoľko metrík, ktoré charakterizujú rôzne stránky týchto procesov. Konkrétne ide o tieto sigma konvergenciu, μ konvergenciu, IQR a špicatosť.

Kľúčové slová: Európska únia, kohézna politika, sigma konvergencia, mí konvergencia, Spearmanova poriadková štatistika, medzikravtilový rozptyl, konvergencia podľa šikomosti a špicatosti, hrubý domáci produkt, disponibilný príjem, miera zamestnanosti

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Introduction

One of the goals of European Union founding, was creation of single market, which could effectively compete with other large economies. A great advantage of common market is effective allocation of factors, which leads to competitive production. Globalisation at European level inevitably leads to regionalisation and partially to widening differences among regions. One of the goals of fiscal policy is support of lagging regions in order to EU being a relatively homogenous entity. In case of too large regionalisation, social problems or destabilisation of EU could occur.

European Union is historically relatively heterogeneous entity. It consists of several countries, that only a while ago had very limited economic and political connections. In the latter period, these connections are enhancing. This is a result of administrative and legislative changes that ease communication, trade and factor movement. Also, EU cohesion policy (as a part of fiscal policy) has its main goal in support lagging regions not only by means of direct financial help, but also by creating new connections with other regions.

The process of globalisation leads to more economic connections of economic regions, from point of view of both geographical as well as structural. Therefore very complex relationships and linkages appear and lead to expected as well as unexpected results. Intense theoretical and empirical study of theses processes is needed. An important aspect of this is regional view, including progress in the theory of regional development and empirical regional models coming from available empirical data.

Inspirational and for Slovakia relevant field of research is regional development of the European union at the time of ending cold war era and continuous globalisation. Processes of real convergence in post socialist countries tend to close the gap of economic level difference to the old members of European union. This convergence is supported by preaccession aid and cohesion policy of European union. It is not a short and simple process. It started by transformation recession and required drastic structural changes which are connected to rising of regional disparities.

During the period of planned economy, targeted policy of nivelisation of economic level was used. It was one of the main reasons of slowing down economic growth of planned economy states. Transition to market economy started with nivelised regions and therefore transformation recession was connected to necessary divergence processes leading to different regional economic levels, as is typical for a market economy.

A very important and complex question is, which regional differences are optimal. They should be large enough not to stop economic growth and small enough not to affect social stability and therefore economic growth. There are several different views on adequateness of regional differences. These views also include methodology and indicators of empirical quantification of regional difference rate.

The first goal of this work is to investigate different methods of measuring inequalities, including beta and sigma convergence. Similarities and differences of measurements will be examined. An expected result is grouping of these metrics into several groups with the same behaviour, using empirical means.

The second goal of this work is to choose metrics, which well describe convergence or divergence in Europe. Using these chosen metrics, we will describe vergence in several subregions. The third partial goal is to identify regions and variables which cause metrics to behave differently.

The first chapter of this thesis summaries various quantitative coefficients of convergence, as is used by other authors. Second chapter describes cohesion variables. Four variables in economic cohesion and thre variables in social cohesion are studied. Most important are gross domestic product, disposable income and employment rate.

Third chapter shows methodology used in this thesis. Main contribution of this methodology is independence from statistical distribution of variable. This is achieved by using Spearman's rank statistics. Fourth chapter describes various selected regions of European Union.

Fifth chapter gives results of presented methodology. Since convergence is multidimensional problem, results are given from each of the dimension: the metric used, the variables and subregion of EU. Each of the dimensions gives a different view. Last chapter compares metrics used. This comparison is based on empirical results on each of region and coefficient.

Chapter 1. Quantitative Coefficients of Convergence

Several theories on development of regionalisation exists. Some of them suggest divergence is the natural development, some suggest its convergence. A good summary of these teories is in [Blazek2002], [Bucek2008], [Radvansky2009] or [Bucek2008a]. Each of the theories relies on quantitative measurement of convergence.

While quantifying convergence among regions, several problems are encountered. If a variable well defying quality of a region (e.g. GDP per capita in PPS) is found, several methods for measuring differences among regions are possible. Main methods are dispersion (sigma convergence) and econometric beta-convergence. Less used methods are Gini coefficient, kurtosis or several non-parametric methods.

Several works on possible quantitative coefficients of convergence are mentioned later in this chapter. As it can be seen from latter sections, authors use only specific methods for specific datasets: GDP convergence is usually measured by sigma or beta convergence, income distribution is measured by Gini or Theil coefficients. However there are no technical obstacles to use e.g. Gini coefficient for GDP distribution.

Beta Convergence

Beta convergence is widely used convergence measurement among researchers. Its popularity comes from simple and logical idea that poorer must grow faster than richer in order to close the gap. This is based on Solow model and has clear interpretation in case of growing variables (e.g. GDP). In case of variables that do not increase (e.g. employment rate), the interpretation is not very visible.

Formally, beta convergence is partial correlation between growth of a variable and its initial value. In case beta convergence is present, this value is negative.

A result of this analysis can be like "economies converge at two percent a year" [Sala1996]. [abreu2005mab] show that wide spread note of 2 percent convergence rate shown by several author in several population samples may be underestimated. They also find that correcting for endogenity in the explanatory variables has a substantial effect on the estimates, and that measures of financial and fiscal development are important determinants of long-run differences in per-capita income levels.

Several variations of the econometric model exist. Several authors do not make logarithms of variables, several make logarithms of dependent and several of independent variables. These changes are mainly to optimise statistical indicators and to describe as much of variance as possible.

As can be seen, such relatively simple model is based on several assumptions. Firstly it is assumed that coefficients are constant among regions and over time. Second is relatively strong assumption that growth is relatively stable without external shocks. Third assumption is on random component. If we cannot assume its independence it is necessary to use more complex methods of estimations and to have neighbouring matrix (the Section called *Distances Among Regions* in Appendix A). It is also notable that homoscedasticity among regions with different sizes does not have to occur. Also normality of the random element is questionable. Beta coefficient is calculated using spatial econometrics(Appendix A).

Beta convergence was calculated by many authors (e.g. [barro1992c], [Brauninger2005] and [Sandy2003]).

Robert Barro and Xavier Sala-i-Martin in [barro1992c] study convergence across the 48 contiguous U.S. states. They exploit data on personal income since 1840 and on gross state product since 1963. The U.S. states provide clear evidence of convergence, but the findings can be reconciled quantitatively with the neoclassical model only if diminishing returns to capital set in very slowly.

Brauninger and Niebuhr in [Brauninger2005] analysed gross domestic product in 192 NUTS 2 regions from EU15, data were Cambridge Regional Economics data for period 1980 to 2002. Regression of beta coefficient included (apart from others) country specific effects, agglomerations dummy variable, and spatial effects. Country specific effects were positive for five relatively small countries (AT, BE, DK, IE, LU) and was negative only in Greece. Main

result is proven convergence, but with agglomerations and rural regions converging to possibly different stable states. Spatial effects were only weakly proven, with a lot more significant country specifics.

Sandy Dall'erba in [Sandy2003] conducted a research on productivity convergence among Spanish regions. There were 48 NUTS 3 regions and data for years 1980 to 1996. Variables measured were GDP per capita and labour productivity in three sectors (agriculture, industry and services). According to this paper, there is clear evidence of β convergence in income (using spatial error model). Also, there is convergence in labour productivity in each sector, however total labour productivity is not converging. Sigma convergence occurs in aggregate labour productivity, but not in productivity by sector, caused by convergence of productive structure among regions.

[Arbia2005] show methodology for studying convergence that extends the traditional models by considering a specific treatment of the spatial correlation among the intercept terms, and a rigorous spatial analysis of the residuals obtained in the various models. They use data from 10 EU countries and for period 1980 to 1995. The results show convergence, however slightly lower than in other studies.

R. Cellini and A.E. Scorcu in [cellini2000ssc] analyze the stochastic convergence in per capita income levels among the current G-7 over the period 1900 to 1989. They show that, in the presence of possible structural breaks, the strong condition of stationary pair-wise differences between per capita GDP holds in more cases than previously supposed. However, convergence occurs more frequently in the first half of the century than in the second half of the century.

De la Fuente in [Fuente2002] explores the sources of convergence in income per capita across the Spanish regions using a decomposition into employment and productivity factors and an estimate of a regional production function. The results differ among periods. In 1965 to 1975, beta convergence was composed almost equally from productivity (income per job) and employment (job per capita). However in periods 1975 to 1985 and 1985 to 1995, this convergence was caused only by productivity convergence, whilst employment divergence cause slowing down of this convergence.

Dobson and Ramlogan in [dobson2002cad] examine the process of convergence in Latin America over the period 1970-98. In the paper, there is little support for the convergence hypothesis over the sample period as a whole, although the beta coefficient is positive, it is insignificant. They prove strong convergence in the 1970s which disappeared by the 1990s. They do not have any evidence of a narrowing in the cross-country dispersion of income (sigma convergence) for the sample period as a whole. The results offer little support for the neo-classical growth model, poorer countries in Latin America have not grown faster than richer ones.

Drennan and Lobo in [drennan1999stc] explore beta and sigma convergence in metropolitan areas of United States of America in years 1969 to 1995 in the fields of per capita personal income and average wages. Their results conclusively support convergence of per capita personal income and of wage per worker for metropolitan areas in the United States, however sigma convergence could not be proven.

Evans and Karras in [Evans1996] examine whether 48 U.S. states converge during the period 1970 to 1986. Authors generalise their findings to other countries and argue that convergence is likely to be observed across countries that are sufficiently similar to have eventual access to technical knowledge. Moreover, divergence is unlikely unless barriers to technological transfer are sufficiently pervasive to prevent some countries from ever utilizing technical knowledge available to other countries. By contrast, absolute convergence is highly unlikely even across very homogenous samples of developed countries. For samples that include both less developed and developed countries, the hypothesis of absolute convergence is still more unlikely.

Lall and Yilmaz in [lall2001rec] study per capita income in US states for the period 1969 to 1995. Results from the empirical analysis show that the speed of convergence is influenced by region specific characteristics and the availability of trained labor in neighboring regions.

[Lugovoy2006] studies convergence in regional GDP among 77 Russian regions. Their work claim climate and physical geography as an important factor of regional growth and regional disparities. Climate and physical geography affect growth via migration and investment. In addition, such factors as quality of infrastructure and agglomeration seem to be significant. The result of the work shows weak sigma convergence and strong conditional beta convergence.

In this work, three types of beta convergence are used. Beta convergence is correlation between value and growth rate of the variable. Beta2 convergence is correlation between logarithm of growth and the value. Beta3 convergence is correlation between growth rate and logarithm of the value. As the Section called *Comparison of Betas* in Chapter 6

shows, all three coefficients behave the same. However it must be noted that we use very different definition of beta convergence.

Methodology used in calculations is discussed in the Section called *Beta Convergence* in Chapter 3. The results of these calculations are displayed in the Section called *Beta Convergence* in Chapter 5.

Coefficients of Variance

Coefficients of variance are set of coefficients which generally describe spread of variable values. Most common coefficient is sigma coefficient.

Equation 1-1. Coefficients of variance

$\sigma_t = 1/N \sum f(Y_{i,t} - \mu_t)$

f is a non-negative non-decreasing function, usually it is second power, absolute value, or a trimmed function.

μ is an equilibrium value, usually mean or median.

If we use f as second power and μ as mean, we obtain sigma coefficient.

Sigma Convergence

Sigma coefficient is statistical variance or the second moment of a variable. It is calculated as sum of squares of difference between value and mean value. This is then normalised by number of observations and average value. In case the variable has normal distribution, variance has chi square distribution with degree of freedom connected to number of observations.

In case of convergence of regions, sigma coefficient is decreasing in time.

According to [Higgins2007] beta convergence is a necessary but not sufficient condition to sigma convergence. This does not occur, when poorer region overtakes the richer one.

Membere T. Workie in [Workie2006] and [Workie2003] empirically shows that poorer countries tend to have higher growth rates than the richer ones, only if they are only a little poorer and they are members of stronger economic group. These conditions are probably valid within regions of European union.

Zlata Sojková in [Sojkova2002] analyses per capita Gross national product in US dollars in 27 European countries within years 1995 to 1999. Author empirically proves both sigma and beta convergence, except for Bulgaria and Romania.

Methodology used in calculations is discussed in the Section called *Sigma Convergence* in Chapter 3. The results of these calculations are displayed in the Section called *Sigma Convergence* in Chapter 5.

Gini Convergence

Gini coefficient is a measurement of inequality among variable values. It was first defined by Corrado Gini in [Gini1912] and more specified in [Gini1921].

Another interpretation of Gini coefficient is that it is the area between actual variable distribution and Lorenz curve (as defined in [Lorenz1905]). Lorenz curve describes most equal distribution of variable.

If the value of Gini coefficient is decreasing over time, convergence occurs.

Gini coefficient is well described in [Cowell2000]. Its main usage is in the field of measuring poverty and is usually connected to income distribution. [bergesen2002] used Gini to measure convergence among income in world countries between 1965 to 1990.

Methodology used in calculations is discussed in the Section called *Gini Convergence* in Chapter 3. The results of these calculations are displayed in the Section called *Gini Convergence* in Chapter 5.

Entropy Convergence

Entropy is a term historically linked to thermodynamics ([Boltzmann1981]). It is a measure of the unavailability of a system's energy to do work ([Daintith2005]). Information entropy was in the name inspired by entropy in physics.

For the purposes of convergence measurement, we consider entropy as a measurement of variable distribution. The lower entropy, the less differences in variable distribution. If entropy decreases, convergence occurs.

In current literature, entropy is not used to measure inequality of economic development. Historically Gini and Theil coefficients are used to measure income inequality.

Methodology used in calculations is discussed in the Section called *Entropy Convergence* in Chapter 3. The results of these calculations are displayed in the Section called *Entropy Convergence* in Chapter 5.

Theil Convergence

Theil convergence is well described in [Cowell2000].

[Terrasi2002] studies convergence in EU between 1975 and 1997 using Theil index on a mixture of NUTS1 and NUTS2 regions between 1975 and 1997. His finding draw attention to inequalities within regions. Zheng Wang and Zhaopan Ge in [Wang2004] describe convergence within Chinese regions. They show that China as whole does not converge, but three subregions converge to different equilibriums. [kunrong2002] studied income distribution in Brasilia between 1935 and 1995. He used several methods, Theil index being one of them.

Takahiro Akita in [akita2003] studies convergence in income distribution in China (between 1990 and 1997) and Indonesia (1993-1997). Conclusion of this work show, that majority of income inequalities come from intra region inequalities, rather than inter region inequalities. José Villaverde Castro had similar finding in [castro2003]. He studied EU regions between 1980 and 1996.

Rafael Salas in [salas2002] studies convergence among Spanish regions GDP between 1980 to 1995 using Theil index and his own index. He discusses wrong assumptions on normality of data and shows that both indexes produce similar results. Sergio J. Rey in [rey2004] analyses US states between 1929 and 2000 using Theil index. He compared Theil index with degrees of spatial autocorrelation and spatial clustering,

Methodology used in calculations is discussed in the Section called *Theil Convergence* in Chapter 3. The results of these calculations are displayed in the Section called *Theil Convergence* in Chapter 5.

Skewness Convergence

Skewness is after average and variance third moment of variable distribution. Skewness describes how a variable is asymmetric. If skewness is positive more of the variable is on left side, if it is positive more is on right side.

Kurtosis was first defined by Karl Pearson in 1905 in [Pearson1905]. See [Joanes1998] for comparison of various kurtosis measurements. It this work, we use the original definition by Pearson.

Moments of distributions are by definition statistically independent. First moment is mean or average. Second moment is variance used in sigma convergence. Third moment is skewness. Fourth moment is kurtosis. Several well known distributions have fixed moments. For example normal distribution has skewness and kurtosis equal to zero, mean and variance are parameters of distribution. Uniform distribution has skewness of 0 and kurtosis of 1.25. Wigner semicircle distribution has skewness of 0 and kurtosis of -1. [Skewness] gives more examples of skewness values in distributions.

Since skewness is the third moment of distribution, it is independent from variance (sigma), which is the second moment. Hence skewness gives extra information on type of convergence.

If there is no sigma convergence, the value of sigma stays relatively stable throughout the period. However, changes within the distribution can occur. If the skewness is increasing, there are more observations on the far right. In case of studying convergence of regions, the lower skewness, the more regions with extreme low values.

The European cohesion policy has the goal of creating economically and socially homogeneous area. This is done by transferring of funds from higher developed regions to lower developed ones, which should allow the lower developed to catch up. So the focus is on those below average and mainly on negative outliers, variance coming from regions well above average is not important. Therefore we removed some metropolitan regions, which are positive outliers (see the Section called *Region Agglomerations* in Chapter 4). This did not solve the problems of positive outliers entirely, so some measurements which would ignore positive outliers is needed. Therefore we will use skewness, which describes development of the regions including asymmetry development. The goal is to minimize negative outliers.

Hence if skewness is increasing, we consider regions converging, if skewness is decreasing, we consider regions diverging. This is rather different from other measurements, where the decreasing means convergence. Therefore we will understand skewness as standard skewness with different sign. If skewness is changing whilst sigma is stable, distribution of regions follows non-normal distribution. Normal distribution has always skewness of zero.

Methodology used in calculations is discussed in the Section called *Skewness Convergence* in Chapter 3. The results of these calculations are displayed in the Section called *Skewness Convergence* in Chapter 5.

Kurtosis Convergence

Kurtosis after average, variance and skewness is the fourth moment of variable distribution. It describes peakness of variable. If kurtosis is high, variance is composed from extreme values.

Kurtosis was first defined by Karl Pearson in 1905 in [Pearson1905]. See [Joanes1998] for comparison of various kurtosis measurements. In this work, we use the original definition by Pearson.

Moments of distributions are by definition statistically independent. First moment is mean or average. Second moment is variance used in sigma convergence. Third moment is skewness. Fourth moment is kurtosis. Several well known distributions have fixed moments. For example normal distribution has skewness and kurtosis equal to zero, mean and variance are parameters of distribution. Uniform distribution has skewness of 0 and kurtosis of 1.25. Wigner semicircle distribution has skewness of 0 and kurtosis of -1. [Kurtosis] gives more examples of kurtosis values in distributions.

Since kurtosis is fourth moment of distribution, it is independent from variance (sigma), which is the second moment. Hence kurtosis gives extra information on type of convergence.

If there is no sigma convergence, the value of sigma stays relatively stable throughout the period. However, changes within the distribution can occur. If the kurtosis is increasing, more of the variance is obtained from extreme values. In case of studying convergence of regions, the higher kurtosis, the more variance is from regions with extreme values. If the kutrosis is low, more of the variance is from regions around the mean. Hence if kurtosis is decreasing, we consider regions converging, if kurtosis is increasing, we consider regions diverging. If kurtosis is changing whilst sigma is stable, distribution of regions follows non-normal distribution. Normal distribution has always kurtosis of zero.

Kurtosis convergence has clear interpretation only in cases, where sigma neither convergence nor divergence occurs. In such case, kurtosis divergence can be clearly interpreted as regions with extreme variable values gaining their importance. Kurtosis convergence can be interpreted as spreading the variable variance more equally among regions.

If sigma convergence occurs as well as kurtosis convergence, then overall spread of variable is decreasing and extreme regions are loosing their importance. If sigma convergence occurs with kurtosis divergence, overall spread is decreasing, however importance of extreme values is increasing. Importance of extreme values in GDP means, that poorer regions are getting poorer and richer regions are getting richer.

Kurtosis is relatively abstract view on variable distribution and it has a clear interpretation only when no sigma convergence occurs. Also interpretation if convergence occurs when kurtosis is decreasing or increasing is not absolutely clear. I was unable to find publications using kurtosis as a measurement of convergence.

Methodology used in calculations is discussed in the Section called *Kurtosis Convergence* in Chapter 3. The results of these calculations are displayed in the Section called *Kurtosis Convergence* in Chapter 5.

μ Convergence

Apart from standard parametric coefficients of convergence, several nonparametric methods exist. In case of nonparametric methods, traditionally it is problematic to verify statistical significance of such coefficient.

Nonparametric criterions are used in EU policy. A typical criterion of economic convergence is, whether a region has output above 75% of average.

In this work, we define term μ measurement as percent share of regions which are more than 10% far away from median on the negative side. This describes development of the negative outliers. Regions away from median, but in the positive direction, do not affect this coefficient. If this percentage decreases in time, convergence occurs.

Methodology used in calculations is discussed in the Section called μ *Convergence* in Chapter 3. The results of these calculations are displayed in the Section called μ *Convergence* in Chapter 5.

$\varkappa$ Convergence

Standard criterion used in EU policy is whether a region has output above 75% of average.

In this work, $\varkappa$ measurement is percent share of regions which are more than 75% far away from mean on the negative side. This describes development of the negative outliers. Regions away from mean, but in the positive direction, do not affect this coefficient. If this percentage decreases in time, convergence occurs.

Methodology used in calculations is discussed in the Section called $\varkappa$ *Convergence* in Chapter 3. The results of these calculations are displayed in the Section called $\varkappa$ *Convergence* in Chapter 5.

IQR Convergence

Another possible measurement of convergence is distance between minimum and maximum values. This measurement is very unrobust against outliers. In order to avoid this, we will remove outliers from the set and measure distance between upper and lower quartile. Therefore the name IQR, or inter quartile range, convergence will be applied here.

Since this approach is implemented by plotting box and whisker plots, we will reuse this technique. Boxplots were well analysed in [Tukey1977] and in [McGill1978].

For the purpose of measuring convergence, we will compute the distance between lower and upper quartile. This estimation is robust against outliers ([Emerson1983]) and is rather insensitive to underlying distribution of the sample.

IQR convergence was used by Kang and Lee in [Kang-Lee2004] and by Andrade in [Andrade2002]. As Kang and Lee state in their article, IQR convergence has main advantages in robustness against extreme values and in similar results in both log and non-log version. This has advantage in explaining the results.

Several works on convergence in carbon emissions use inter quartile range. These include [Stegman2005] and [Aldy2006]. Results of their works prove that convergence occurs in case of OECD countries, however neither convergence nor divergence occurs in case of full sample, including developing countries. This confirms the general hypothesis that convergence is rather to occur in similar and connected countries.

[Weden2007] uses IQR to monitor convergence of mortality among various racial groups. [Ahearn2007] uses IQR to study convergence in heights of Italians in 69 provinces. In the work, authors avoid assumptions on normality.

Methodology used in calculations is discussed in the Section called *IQR Convergence* in Chapter 3. The results of these calculations are displayed in the Section called *IQR Convergence* in Chapter 5.

Boxplot Convergence

Another possible measurement of convergence is distance between minimum and maximum values. This measurement is very unrobust against outliers. In order to avoid this, we will remove outliers from the set.

Since this approach is done by plotting box and whisker plots, we will reuse this technique. Boxplots were well analysed in [Tukey1977] and in [McGill1978].

For the purpose of measuring convergence, we will compute the distance between minimum and maximum (excluding outliers). Outliers are considered any points, which are more away from a quartile than 1.5 times inter quartile range. This in accordance to [Emerson1983]. This estimation is rather insensitive to underlying distribution of the sample.

Methodology used in calculations is discussed in the Section called *Boxplot Convergence* in Chapter 3. The results of these calculations are displayed in the Section called *Boxplot Convergence* in Chapter 5.

Chapter 2. Cohesion in Case of European Union

Cohesion and cohesion policy, which should serve to reach cohesion, are a traditional part of European community. The reason for this is the goal of creating economically and socially homogeneous area, which would be stable in long term and would not create divergence tendencies.

In the Lisbon strategy from 2000, several goals of European cohesion policy were defined. These goals were enlarged in 2007 Lisbon treaty. Economic and social cohesion was accompanied with territorial cohesion.

European cohesion policy uses several indicators for various funds. The reform of the Structural Funds, and their extension to new Member States, has been embodied in [Comm1999] and [Comm2003]. The first of these lays down general provisions on the Structural Funds for the current period, stating that regions whose per capita GDP measured in PPS is less than 75% of the Community average are eligible for Structural Funds allocations. It also says that the criteria are to be calculated using objective statistical data. The second of these acts amends those principles to cover new Member States too.

This new legal basis contrasts with the previous situation, in which the only statutory reference to PPPs in relation to the Structural Funds was in [Comm1988], which simply stated: "Whereas [...] this list should comprise administrative level NUTS II regions where per capita GDP measured in terms of purchasing power parity is less than 75% of the Community average, ... ". There was no implementing clause in the body of the Regulation. Currently, the Structural Funds requirements are met by combining regional GDP values and national PPPs.

[Comm1994] states that it is the Community's task to promote economic and social cohesion and solidarity between the Member States, and Cohesion Fund is an instrument to accomplish this. Article 2(1) states that: "the Fund shall provide financial contributions to projects, which contribute to achieving the objectives laid down in the Treaty on European Union, in the fields of environment and trans-European infrastructure networks in Member States with a per capita gross national product (GNP), measured in purchasing power parity, of less than 90% of the Community average."

Enlargement of European union to ex socialistic countries gives extra attention to cohesion policy. By this enlargement, disparities largely increased. See [Palenik2007] for a description of these processes.

Recent development during financial crisis put yet another stress on cohesion policy. Even though some parameters of disparities were lowered during the crisis ([Palenik2009]) or some changes outside of scope of this model occured ([Pauhofova2009]), this development needs to be studied more. Due to availability of data, only pre crisis period is described in this thesis.

Territorial cohesion (see the Section called *Territorial Cohesion*) is gaining importance in practical economic policy. Criteria used to quantify territorial cohesion are being clarified. It is an important scientific goal to test used indicators and methods and to propose new solutions to existing problems.

In order to analyse and to affect convergence processes, it is necessary to monitor them. To quantify convergence several variables are used. All variables used in this paper, are published by European statistics office [Eurostat]. Most of the variables are available from 1999 to 2005, which is seven observations for each region. Variables used to monitor cohesion are described later in this chapter. Together there are 372 regions (including countries and higher NUTS regions). These regions are described in [NUTS] and Appendix B.

Six variables are used to monitor convergence. These variables are in detail described in this chapter:

- the Section called *Gross Domestic Product*
- the Section called *Percentage of Working Population with University Degree*
- the Section called *Value Added in Services*
- the Section called *Disposable Income*
- the Section called *Employment Rate*
- the Section called *Unemployment Rate*

- the Section called *Economic Activity Rate*

All of these variables are by definition normalised. Slight exceptions GDP and disposable income, where maximum values can hypothetically go to infinity, however real maximum value is 300% in London. Other values are by definition between zero and hundred. This avoids the necessity to normalise data. As a result, standard interpretation of beta convergence cannot be used. On the other hand, measuring differences from mean solves the problem with rising sigma coefficient with rising mean.

The choice of these variables was based on previous works by various authors. Most authors use Gross domestic product or disposable income. Several use employment or unemployment rates to monitor social cohesion.

Economic Cohesion

Economic cohesion is defined as closing gap between economic performance. Indicator for economic performance is usually gross domestic product (GDP), gross national product (GNP), national income (NI), disposable income or by other indicators.

It should describe development in the field of economic power of regions. It also describes total utility of people living in the region (see [Pauhofova2005]).

Gross Domestic Product

Gross domestic product (GDP), as is defined through national accounts, is well used variable describing country or region economy performance.

GDP per capita is standardly used when comparing economic performance of regions or economies. It is problematic, whether it is more convenient to calculate this based on inhabitants of region or based on those working in region. This difference is highly visible in regions of Hamburg or Paris (Ile-de-France).

Calculation of GDP on comparable units is done by several means. First is by nominal exchange rate on common currency, typically Euro.

The second is by purchasing parity standard (PPS), which takes into account various price levels in different regions. According to [Comm2006], purchasing power parities (PPP) means spatial deflators and currency converters, which eliminate the effects of the differences in price levels between countries, thus allowing volume comparisons of GDP components and comparisons of price levels. Purchasing Power Standard (PPS) means the artificial common reference currency unit used in the European Union to express the volume of economic aggregates for the purpose of spatial comparisons in such a way that price level differences between countries are eliminated.

A problematic part is that PPS is commonly evaluated at higher levels than NUTS 2 level (mandatory on country levels and sometimes on NUTS 1 levels). This negatively affects usability of this index, however it remains the most used index. [Lugovoy2006] partially solves the problem for Russian regions by inderect methods described in [Granberg2003].

Results of convergence according to GDP per capita in PPS of EU average are in the Section called *GDP Per Capita in PPS of EU Average Convergence* in Chapter 5

Gross National Product

Gross national product (GNP) takes into account geographical location of output factor owner (typically work and capital). This is in opposition to gross domestic product which takes into account geographical location of the production. Main differences are incomes of workers abroad, who spend a great part of their income in domestic country, or incomes from capital which are transferred back to domestic country. So production does not have to be territorially done at the region. Similarly, gifts and inherits are calculated differently. From the point of view of European cohesion policy, economic connection of countries with European union is important. Country's membership in union makes GNP lower, eurofunds, on the other hand, make GNP higher.

As is written above, GNP is a better indicator of regions economic development than GDP. However, data on GNP at NUTS 2 regions are not available and there are no data usable for calculation GNP. So GNP can be used for better comparison of countries, however at regional this is not possible due to absence of this data.

Percentage of Working Population with University Degree

Percentage of working population with university degree is the number of working people with university degree divided by total number of working population. Data are taken from labour force sample survey, see the Section called *Social Cohesion* for more detailed description of labour force sample survey.

This variable describes quality of regions. If we assume that people with university degree have higher income and produce products with higher value added, this variable indirectly describes the same as Gross domestic product.

This variable is problematic from the point of different understanding of university in different countries. Even though this process is being standardised in EU, it is not finished. The differences can be visible in comparing Spain and Portugal, the latter having considerably lower share of workers with university degrees. Similarly Visegrad countries have lower share than eastern part of Germany.

Results of convergence according to Share of employees with university degree are in the Section called *Share of Employees with University Degree Convergence* in Chapter 5

Value Added in Services

Another way to assume quality if a region, is by value added in services. If we assume that services produce more value added than say agriculture or industry, value added in services as a percentage of total value added in region can identify regions with higher quality.

Services in this meaning is NACE classification from G to K, as defined by [NACE2002] and [NACE2006]. These include wholesale and retail trade, repair of motor vehicles, motorcycles and personal and household goods; hotels and restaurants; transport, storage and communication; financial intermediation; and real estate, renting and business activities. It does not include public services, as these are not based on quality of region, but rather on administrative or political decisions. Also higher public services, including police, does not mean that regions is better in any sense (see Sicily or Northern Ireland). Education and research is considered a part of public services and cannot be distinguished on regional level.

Value added in services describes structure of value added, not necessary its absolute value as Gross domestic product does.

Availability of this data is limited, United kingdom does not publish data on value added in services in its regions.

Results of convergence according to Value added in services are in the Section called *Value Added in Services Convergence* in Chapter 5

Disposable Income

A great part of the works on regional inequalities take income, and its inequalities within and among regions. It is one of standard measurements of regional quality.

Measuring income brings a lot of questions on the definitions. The first methodological question is whether we measure net, disposable or gross income, before or after social transfers. Another question is whether we measure income of an individual or of family. Third, but again the important question is on the unit. Whether a currency (Euro) or PPS just as is the case of GDP.

In this work we use average net disposable income of households in Purchasing power standard based on final consumption per inhabitant in EU regions. The income is published in PPS, so we normalise it to EU average by dividing by the average in each year (EU average is not published so we divide it by average of regions' estimates).

Results of convergence according to Disposable income are in the Section called *Disposable Income Convergence* in Chapter 5

Social Cohesion

European social cohesion pays its attention to closing indicators in the field of labour market and other social issues. Social development is very important not only in times of demographic problems, that are occurring in EU ([Palenik2009b]).

Harmonised data on employment and unemployment are gathered from labour force sample survey (LFS). This survey is done quarterly by national statistics offices in all EU countries. LFS is a system of questionnaires for the whole families, questionnaires are filled by statistics office staff. Families used in survey are changed after some period (in Slovakia after 5 quarters, in Hungary after 6 quarter and after 2 years they are questioned once again). Since most of the questionnaire is common among countries, the results are comparable. Data are available for all NUTS 2 regions and several NUTS3 regions ([Eurostat]).

Employment Rate

Employment rate show which percentage of inhabitants of given region and given age is working. It does not show, which portion of employed is working in given region. If a person is part-timer, he is counted with the same weight as full-timer. As a result, regions with high usage of part-time jobs have higher employment rate.

According to LFS, a person is employed if he worked at least one hour for a reward during last week, or if he could work but did not work due to temporary reasons (illness, vacation, strike, bad weather).

European employment strategy, founded during Luxembourg meeting in 1997 and more defined at Lisbon meeting (2000) and Stockholm meeting (2001), defines target for year 2010 in the fields of employment as follows: total employment rate above 70%, employment rate of women above 60%, and employment rate of 55 to 64 years old above 50%.

According to [ECO], EU employment data is collected from two different sources: from the Labour Force Sample Survey and from the Structural Business Statistics (SBS), both administrated by Eurostat. The LFS includes data on at most 3-digit NACE level for most, but not all, NUTS 2 regions. SBS statistics is mainly sourced from business registers and includes structural data over the economy. These data however lack small enterprises. On NUTS 2 regional level Eurostat only administers data on NACE 2 digit level. 4 digit level data are collected on national level, but not for all NACE categories. The 4 digit level is in turn available for NUTS 1 regions (countries). In many cases a more detailed data can be obtained from National Statistical Offices, but Eurostat still remains the main source for such countries as Italy, Spain, Czech Republic and Romania.

Quantitative measurement of convergent in the field of employment is done by [Perugini2004]. Their work did not prove neither beta nor sigma convergence of these parametres. These parameters are defined at the Section called *Sigma Convergence* in Chapter 1.

Results of convergence according to Employment rate are in the Section called *Employment Rate Convergence* in Chapter 5

Unemployment Rate

There are two principal methodologies to calculate unemployment rate: from labour force sample survey or from labour office statistics.

The conditions under which people are included into labour office files differ among countries. This is, apart from others, a result of many state subsidies being conditional to person's registration in labour office files, and the goal of state to stop misusing these subsidies by changing the law. Therefore registry unemployment rate differs among countries.

According to labour force sample survey by ILO methodology, unemployed person is a person who is not employed (see the Section called *Employment Rate*), actively searched for employment within last 4 weeks (or already found an employment that will start within three months), and is able to start working. So for example, persons on maternity leave are not unemployed, because they cannot start to work immediately.

According to [Boeri Scarpetta 1996], in some situations there is positive correlation between employment rate and unemployment rate. Therefore we will focus also on unemployment rate as social cohesion indicator.

Unemployment rate differs from other indicators, in other indicators more means better. With unemployment rate this is different, more means worth. For the purposes of this work we will define unemployment as 100% minus unemployment according to LFS using ILO methodology. This allows consistent measurements of convergence, which is comparable with other indicators.

All other indicators (GDP or employment rate), have clear indication on the development: the higher, the better. Unemployment rate is different: the lower the better. To preserve consistency we will understand unemployment rate as 100% minus unemployment rate from LFS by ILO methodology. This will make coefficients (mainly μ and skewness) consistent.

Results of convergence according to Unemployment rate are in the Section called *Unemployment Rate Convergence* in Chapter 5

Economic Activity Rate

Economic activity rate shows, which part of productive age population is active at labour market. Economically active are those, who are either employed or unemployed. Economically inactive are for example students, people on maternity leave, soldiers of mandatory service (e.g. in Germany), or voluntarily unemployed.

Traditionally, high economic activity rates appear at Nordic countries (see the Section called *Region Nordic Countries* in Chapter 4), lowest economic activity rates are at southern countries (see the Section called *Region South* in Chapter 4) and Hungary.

Results of convergence according to Economic activity rate are in the Section called *Economic Activity Rate Convergence* in Chapter 5

Territorial Cohesion

Territorial cohesion is generally overlapping with both economic and social cohesion. Under the term territorial cohesion, we understand some specific issues of regional development, which are not fully described by economic or social cohesion. According to [Comm2008], in the field of territorial cohesion, the importance of traditional economic centre (region between London, Paris, Milan, Munchen and Hamburg) decreased, mainly due to rising of new centres like Dublin, Madrid, Helsinki, Stockholm, Warsaw, Prague, Bratislava and Budapest. In the national economies, economic growth is concentrating in centres of regions.

There are very few relevant data for territorial cohesion, therefore in this work we will focus only on social and economic cohesion.

Chapter 3. Measurement Methodology

All different metrics of inequality discussed in Chapter 1 result in quantitative measurement of inequality in given year, beta convergence being exception. In the Section called *Trend Estimation* we describe method to measure and test for increase or decrease of a time series. In the Section called *Quantification of Coefficients* we describe equations used to calculate different inequality metrics.

Trend Estimation

In common literature, standard enumeration of sigma convergence uses a chi square test. This test uses sample sigma coefficient at the beginning and end of period and decide whether they are significatly different. Underlying distribution is assumed normal, identical and independent, and so these sigma coefficients are assumed to have chi square distribution. If these assumptions are tested and met, standard test on equality of two sigma coefficients is tested. Null hypothesis is that sigma coefficients are the same, alternative hypothesis is that they are not equal.

Main problem with this testing are assumptions on underlying distribution being normal IID. This assumption allows easy construction of the term "significantly different". Two variables are significantly different if the distance among their estimates is more than a quantil from underlaying distribution. However, the assumptions of IID are very strong and not always met. Results in the Section called *Kurtosis Convergence* in Chapter 5 and the Section called *Skewness Convergence* in Chapter 5 show that kurtosis and skewness of the sample changes over time and is not constantly zero as normal distribution should have.

Therefore in this work we are using test describing whether time series of variance is decreasing or increasing. This is similar to testing whether initial and end value are different, however there are some differences.

There are several ways to identify trend in time series. The easiest way is to see whether elements in time series are in decreasing order, however a slight increase in one year would declare time series non decreasing. Comparison of first and last value in the time series is very sensitive to fluctuations at the ends and can describe U shape curve as decreasing or increasing depending on where U is cut. Another possibility is to take average of the last two or three years, but this would require a larger gap between the ends. Linear estimation of time series allows decent tests of increasing or decreasing linear trends, however non linear trends are not identified and possible underlying non normal distribution of residuals can cause problems.

In this work, we use Spearman's rank correlation coefficient. It was defined by Spearman in 1905 in [Spearman1905]. It is, together with other methods, well described in [Siegel1988]. The main advantages of this estimation are that it is independent from underlying statistical distribution and tests for all possible decreasing trends (linear and non linear). On the top, this estimation is fairly old and well accepted among statisticians.

Equation 3-1. Spearman's rank correlation coefficient

$$\rho = (n\sum(t*c_t)-\sum t\sum c_t)/((\sqrt{(n\sum t^2-(\sum t)^2)}*(\sqrt{(n\sum c_t^2-(\sum c_t)^2)})$$

where time t is integer from 1 and c_t is the order of spread metrics in time t (eg if in year 3 the value of sigma is second smallest, c_t is 2).

The result of this equation is estimate ρ with values between -1 and 1. In our case low values mean convergence, high values mean divergence and values around 0 do not prove either.

Figure 3-1 and Figure 3-2 show distribution of ρ of convergence in different regions (see Chapter 4) and according to different variables (see Chapter 2). As it can be seen, this distribution has three local maximums. Highest one is near 1, two other are near 0 and -0.9. Two local minimums are near 0.5 and -0.5.

Figure 3-1. Histogram of convergence

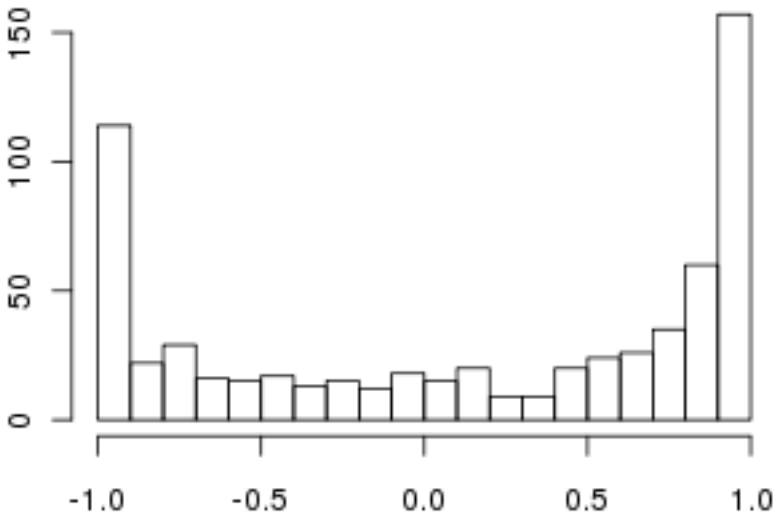
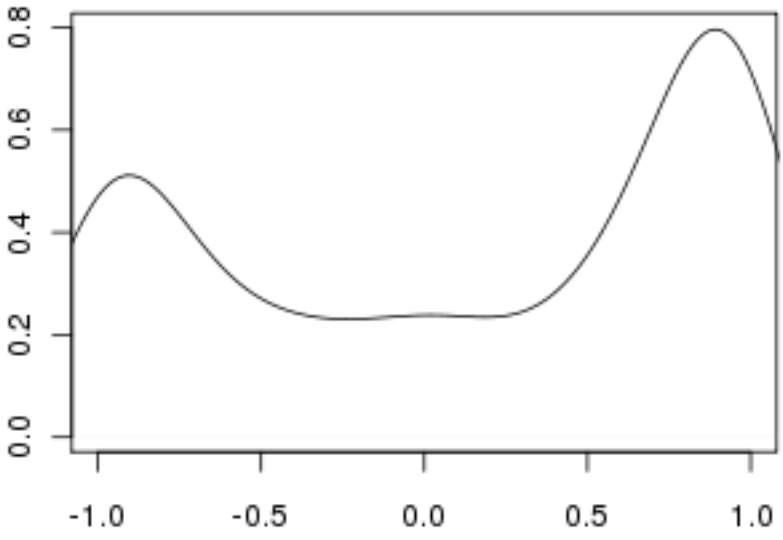


Figure 3-2. Density of convergence



Strong and Weak Convergence

In common literature, standard enumeration of sigma convergence uses a chi square test. This test uses sample sigma coefficient at the beginning and end of period. Underlying distribution is assumed normal, identical and independent, and so these sigma coefficients are assumed to have chi square distribution. If these assumptions are tested and met, standard test on equality of two sigma coefficients is tested. Null hypothesis is that sigma coefficients are the same, alternative hypothesis is that they are not equal.

Main problem with this testing are assumptions on underlying distribution being normal IID. These assumptions are very strong and not always met. Results in the Section called *Kurtosis Convergence* in Chapter 5 show that kurtosis of the sample changes over time and is not constantly zero as normal distribution should have.

Therefore in this work we are using test describing whether time series of variance is decreasing or increasing. This is similar to testing whether initial and end value are different, however there are some differences.

In this work we use the term strong and weak convergence. Strong convergence is convergence that is proven, weak convergence is proven, however at lower significance values. In other words, strong convergence is visible and consistent and weak convergence is less visible and less consistent, however present.

It must be noted that strength of convergence is not tied to speed of convergence but more to its consistency throughout sample period. It is possible, that a region with strong convergence converges slower (in the sense of difference in absolute sigma value in the beginning and end) than region with weak or no convergence.

Due to relatively short time series of around 10 years, it was impossible to calculate breakpoint test or to experiment with convergence in various sub periods. On the other hand, we did experiment with convergence in various sub regions of EU as defined in Chapter 4.

In case of beta convergence, strong convergence occurs correlation coefficient between growth and value has p value smaller than 1%, and weak convergence when smaller than 10%.

In case of other convergences, strong convergence occurs when Spearman r statistic has p value smaller than 1%, weak convergence when smaller than 10%.

Quantification of Coefficients

In this section, there are several measurements of inequality. All of them (except beta) are used to calculate inequality index in a given year. Methodology from the Section called *Trend Estimation* is used to measure convergence or divergence.

Sigma Convergence

Broader discussion of sigma was in the Section called *Sigma Convergence* in Chapter 1

Sigma coefficient is variance of a variable. It can be calculated by :

Equation 3-2. Sigma coefficient

$$\sigma_t = 1/N \sum (Y_{i,t} - \mu_t)^2$$

where μ is average, Y is tested variable in region i and time t.

```
Sigma coefficient in R
n <- length(x)
V <- sqrt((n - 1)*var(x)/n)/mean(x)
```

where x is tested variable.

It case of convergence of regions, sigma coefficient is decreasing over time.

Results of convergence according to sigma are in the Section called *Sigma Convergence* in Chapter 5

Gini Convergence

Broader discussion of Gini was in the Section called *Gini Convergence* in Chapter 1

Its equation is (Yi are incremental):

Equation 3-3. Gini coefficient

$$G_t = 1/N(N+1-2(\sum (Y_{i,t} * (n+1-i))/\sum Y_{i,t}))$$

```
Gini coefficient in R
n <- length(x)
x <- sort(x)
```

```
G <- sum(x*1:n)
G <- 2*G/(n*sum(x))
G - 1 - (1/n)
```

Results of convergence according to Gini are in the Section called *Gini Convergence* in Chapter 5

Entropy Convergence

Broader discussion of entropy was in the Section called *Entropy Convergence* in Chapter 1

Entropy is theoretical term originated at thermodynamics describing randomness of data.

Equation 3-4. Entropy definition

$$e_t=\sum p(Y_{i,t})*\log(p(Y_{i,t}))$$

where p is probability of outcome Y and log is logarithm with base 2, e or 10.

```
Entropy function in R
k <- 0.5
e <- (x/mean(x))^k
e <- mean(e - 1)/(k*(k - 1))
```

Results of convergence according to entropy are in the Section called *Entropy Convergence* in Chapter 5

Theil Convergence

Broader discussion of Theil was in the Section called *Theil Convergence* in Chapter 1

Equation 3-5. Theil definition

$$e_t=(\sum Y_{i,t}*\log(Y_{i,t}/\mu))/(\sum Y_{i,t})$$

where μ is average

```
Theil equation in R
x <- x[!(x == 0)]
Th <- x/mean(x)
Th <- sum(x*log(Th))
Th <- Th/sum(x)
```

Results of convergence according to Theil are in the Section called *Theil Convergence* in Chapter 5

IQR Convergence

Broader discussion of IQR was in the Section called *IQR Convergence* in Chapter 1

Quantile of n per cent is value than n percent are lower that the quantile and the rest of observations is higher. Median is a special quantile of 50 percent. Upper quartile is 75 percent quantile, lower quartile is 25 percent quantile.

Inter quartile range (IQR) used in this analysis is distance between upper and lower quartile.

```
IQR equation in R
stats<-boxplot.stats(data)$stats
return(stats[4]-stats[2]);
```

Results of convergence according to IQR are in the Section called *IQR Convergence* in Chapter 5

Boxplot Convergence

Broader discussion of boxplot was in the Section called *Boxplot Convergence* in Chapter 1

Boxplot coefficient is distance between upper and lower whiskers of box plot. These whiskers are maximum and minimum of sample. If minimum and maximum are outliers, they are excluded. Definition of outlier is based on distance from respective quartile, which should not be more than 1.5 times inter quartile range.

```
Boxplot equation in R
stats<-boxplot.stats(data)$stats
return(stats[5]-stats[1]);
```

Results of convergence according to boxplot are in the Section called *Boxplot Convergence* in Chapter 5

μ Convergence

Broader discussion of μ was in the Section called μ *Convergence* in Chapter 1

Several possibilities of nonparametric methods can be used. One of them is percentage of observations far away from center. It is necessary to define what is center and what is far away.

Possible measurements of centers of a sample are mean, modus and median. Mean is well used however it is very sensible to outliers. Modus is the most common value in sample. Median is the value that is in the middle, meaning that half of the values is higher than median and half of the values is lower that the median.

Distance from the centre can be measured by absolute or by relative value. Absolute value can be considered five percentual points from the center. Relative value can be ten percent of center from the center.

μ coefficient used in this work is percentage of regions outside 10% margin (on the negative side) around median of sample.

```
μ function in R
return(signif2(length(data[data < 0.9*median(data)])/length(data)))
```

Results of convergence according to μ are in the Section called μ *Convergence* in Chapter 5

$\varkappa$ Convergence

Broader discussion of $\varkappa$ was in the Section called $\varkappa$ *Convergence* in Chapter 1

Convergence $\varkappa$ is very similar to μ coefficient, however it considers observations less than 75% of median, not 90%.

```
ϰ function in R
return(signif2(length(data[data < 0.75*mean(data)])/length(data)))
```

Results of convergence according to $\varkappa$ are in the Section called $\varkappa$ *Convergence* in Chapter 5

Skewness Convergence

Broader discussion of skewness was in the Section called *Skewness Convergence* in Chapter 1

Skewness is the third moment of random distribution. Skewness is by definition independent from variance and sigma. It can be calculated by:

Equation 3-6. Skewness

$$\gamma_t = \sqrt{N} \sum (Y_{i,t} - \mu_t)^3 / (\sum (Y_{i,t} - \mu_t)^2)^{3/2}$$

where $Y_{i,t}$ is value of variable in region i and time t, μ_t is mean in time t

Normal definition has by definition kurtosis equal to zero. However as the Section called *Kurtosis Convergence* in Chapter 5 shows, kurtosis of variables changes over time.

```
Skewness function in R
skewness = -1*sum((x-mean(x))^3/sqrt(var(x))^3)/length(x))
```

Results of convergence according to skewness are in the Section called *Skewness Convergence* in Chapter 5

Kurtosis Convergence

Broader discussion of kurtosis was in the Section called *Kurtosis Convergence* in Chapter 1

Kurtosis is the fourth moment of random distribution. Kurtosis is by definition independent from variance and sigma. Skewness and kurtosis can be calculated by:

Equation 3-7. Kurtosis

$$\gamma_t = N\sum(Y_{i,t}-\mu_t)^4/(\sum(Y_{i,t}-\mu_t)^2)^2 - 3$$

where $Y_{i,t}$ is value of variable in region i and time t, μ_t is mean in time t

Normal definition has by definition kurtosis equal to zero. However as the Section called *Kurtosis Convergence* in Chapter 5 shows, kurtosis of variables changes over time.

```
Kurtosis function in R
kurtosis = sum((x-mean(x))^4/var(x)^2)/length(x) - 3
```

Results of convergence according to kurtosis are in the Section called *Kurtosis Convergence* in Chapter 5

Beta Convergence

Broader discussion of beta was in the Section called *Beta Convergence* in Chapter 1

Most of the authors calculate beta convergence using methodology of econometrics or spatial econometrics. Main problems of econometric modeling is many assumptions that are attached to the model. Usual assumptions are normality of residual, independence of residuals, and same variance of residuals in all observations.

Coefficient of beta convergence is solution to econometric model :

Equation 3-8. Beta coefficient

$$\ln(Y_{i,t}/Y_{i,t-1}) = a + \beta * Y_{i,t-1} + u_{i,t}$$

where β is computed beta coefficient, $Y_{i,t}$ is studied variable in region i and time t, a is intercept and u in random variable.

Experiments with econometric models during this work failed. Main problem was very low R^2 statistics, which only in rare cases reached 10%. Other problem was non-normality of the residuals which indicated doubts about reliability of the results.

Other main problem with beta convergence in standard terms is that its strength is in different sense than strength of sigma convergence as described in the Section called *Strong and Weak Convergence*. Beta strength would mean speed of convergence whilst sigma strength means consistency of convergence. Therefore these two parameters could not have been compared.

In order to avoid these problems in this work, we are using beta convergence as correlation coefficient between value of variable and its growth. Since all variables are in percents, it is not necessary to calculate growth rate, but just growth as difference between current and future value.

The correlation coefficient is calculated using Spearman's correlation test:

Equation 3-9. Spearman's rank correlation coefficient

$$\rho = (n\sum(g_{t,i}*c_{t,i})-\sum t\sum c_{t,i})/((\sqrt{(n\sum g_{t,i}^{2}-(\sum g_{t,i})^{2})}*(\sqrt{(n\sum c_{t,i}^{2}-(\sum c_{t,i})^{2})})$$

where $g_{t,i}$ is order of the growth of the variable, and $c_{t,i}$ is the order of variable in time t and NUTS region i. This coefficient is analogous to trend estimation in the Section called *Trend Estimation*.

If p value of correlation is smaller than 1%, we consider convergence strong, if it is smaller than 10% and greater than 1% we consider convergence weak. Otherwise there is no convergence.

Results of convergence according to beta are in the Section called *Beta Convergence* in Chapter 5

Beta2 Convergence

Beta2 convergence is analogous to beta convergence. The only difference is that Beta2 is correlation between logarithm of growth and the value instead of correlation between growth and value (without logarithms).

Beta3 Convergence

Beta3 convergence is analogous to beta and beta2 convergence. The only difference is that Beta2 is correlation between growth rate and logarithm of the value instead of correlation between growth and value (without logarithms).

Software and Data Used for Calculations

A vast majority of data used at this work were obtained from Eurostat, the statistical office of European union. ([Eurostat]). Over 700 thousand individual variables were studied, which included time series as well as stationary data. These variable allocated into several hundred of regions accounted into circa 100 million observations. Due to speed processing of data, they were stored in a SQL database ([MySQL]).

Maps were generated using Gisco - Geographic Information System of the European Commission ([Gisco]), and its NUTS regions geodata set copyrighted by EuroGeographics for the administrative boundaries.

As statistical software R ([R-project]) was used. A brief summary of R spatial functions is in [Bivand2002]. R is an implementation of the S language, as is S-Plus, and often able to execute the same interpreted code; it was initially written by Ross Ihaka and Robert Gentleman ([Ihaka1996]). R follows most of the Brown and Blue Books ([Becker1988] and [Chambers1992]), and also implements parts of the Green Book ([Chambers1998]). R is associated with the Omegahat project: it is here that much progress on inter-operation is being made, for instance embedding R in Perl, Python, Java, PostgreSQL or Gnumeric. R is available as Free Software under the terms of the Free Software Foundation's GNU General Public License in source code form.

R is currently maintained by The R Foundation for Statistical Computing, based at Vienna Technical University and Vienna Economic University. A great part of classes and methods used at this work are maintained by Norwegian School of Economics and Business Administration in Bergen. A brief description of classes is in [Ripley2001].

Chapter 4. Selected Regions of Europe

Europe, or European union, is divided into 27 countries. However, these countries are nowhere near being similar in sizes and in their degree of homogeneity. Due to these reasons the Nomenclature of Territorial Units for Statistics (NUTS) was developed by European parliament and commission in cooperation with Eurostat [NUTS].

Since NUTS is a three-level hierarchical classification, it subdivides each country into a whole number of NUTS 1 regions, each of which is in turn subdivided into a whole number of NUTS 2 regions and so on.

At the regional level (without taking the municipalities into account), the administrative structure of each country generally comprises two main regional levels (Länder and Kreise in Germany, régions and départements in France, Comunidades autonomas and provincias in Spain, regioni and provincie in Italy, etc.). Several countries have no NUTS 1 level regions, so this region is the same as country. This is the case of all smaller countries, Slovakia being one of them.

The thresholds for NUTS 1 region is minimum 3 and maximum 7 million inhabitants, NUTS 2 between 800 thousand and 3 million, and NUTS 3 between 150 and 800 thousand inhabitants. Countries smaller than mentioned thresholds stay as separate NUTS regions even though they are very small. NUTS 3 regions are hierarchically divided into LAU regions.

The structure of NUTS regions is developing. For example, during the last years, Denmark and Slovenia got split from one into more NUTS 2 regions. Scotland, Eastern Germany and Western Sweden regions also changed. This leads to inconsistencies in time series, however the statistical offices usually recalculate historical values for new regions.

One of the questions is, whether convergence occurs within EU, and if not, whether it occurs within some subregions of EU. In order to test this, we constructed and tested convergence in several artificial regions. Some of these regions have same currency (monetary union), some are single large countries which have their own cohesion policy (France and Germany), some have the same language (islands of UK and Ireland), some are geographically separate (north, south). Each of this sub region has a common point, which suggest that convergence should occur more, than in case of very heterogenous European Union. As we can see from the rest of this chapter, this is not always the case. Several authors (eg [Evans1996], [Workie2006]) concluded their works with findings that convergence occurs if regions are sufficiently similar and if they are closely cooperating.

In order to deal with outliers, several NUTS regions had to be removed from the sample. French Départments d'outrie mer (regions of far sea) are very special regions of EU. They include Guadeloupe, Martinique, Guyane and Réunion. These regions are outliers in both geographical and economical sense. Therefore we removed these regions from our sample. Other geographically separate regions are Spanish Ceuta and Mellila in north Africa, Spanish Canary islands, Portuguese Azores islands and Madeira. These regions are not as economical outliers as the French regions are and they are relatively close to Europe mainland. Therefore we include them in the analysis. Greenland, even though is closely connected to Denmark, is not part of EU. Several islands in the arctic sea are part of Norway, which again is not part of EU. Similar approach was used by [Terrasi2002].

Other special regions are metropolitan regions. They are described in the Section called *Region Agglomerations*. These regions are economical outliers and show very different development of all indicators. Therefore these regions are excluded from other analysis. Excluding them made statistics of convergence more reliable, which has implications on metropolitan regions having different convergence than non-metropolitan ones. [Brauninger2005] had similar findings.

Region Agglomerations

Region agglomerations includes regions Brussels, Prague, Vienna, Stuttgart, Tübingen, Oberbayern, Berlin, Bremen, Hamburg, Darmstadt, Hannover, Düsseldorf, Köln, Leipzig, Hovedstaden, Comunidad de Madrid, Île de France, Kozep-Magyarorszag, Lombardia, Provincia Autonoma Bolzano/Bozen, Lazio, Luxembourg, Groningen, Utrecht, Noord-Holland, Lisboa, Stockholm, Bratislava region, London and Berkshire, Buckinghamshire and Oxfordshire. Together there are 31 NUTS2 regions. There are 93 964 848 inhabitants in agglomerations, total area is 171 249 square km. The share of production of EU production is 29,52 %.

Main metropolitan regions of EU are within this region. Metropolitan region are characterised by high labour productivity, high production in services, high share of employees with university degree (however this differs from country to country). As a consequence, there are low unemployment rates and high employment rates.

The choice of metropolitan regions among NUTS2 regions is relatively hard. Whilst some regions are ease choice (like Bratislava region, London, Ile de France), some metropolitan areas are not separate NUTS2 regions. These include cities of Warsaw, Barcelona, Marseille, Lyon or Munchen. These cities are a part of larger NUTS2 regions, where rural surrounding change the statistics of the region as a whole. If the NUTS2 region is relatively small, it is included in this analysis.

Even though there are only 31 NUTS2 regions, these metropolitan regions produce almost 30% of EU's GDP in PPS.

These metropolitan regions were excluded from analysis of convergence in other regions of EU. Excluding them greatly improved convergence significance in all terms. This was mainly visible in GDP convergence, where agglomerations have high GDP growth even with already high GDP levels.

Figure 4-1 shows location of region of agglomerations in Europe.

Figure 4-1. Region of agglomerations

Table 4-1. Region Agglomerations, Basic Indicators in 2007

variable	mean	variance	min	max
GDP per capita in PPS of EU average	153.6	50.2	89	334
Employment rate	59.5	6.1	49.7	75.8
Economic activity rate	63.3	5.1	53.5	78.8

variable	mean	variance	min	max
Share of employees with university degree	33.4	9.7	11.8	55.3
Value added in services	55.6	9.1	28.7	73.1
Unemployment rate	93.1	4.0	82.8	97.6
Disposable income	124.4	22.6	73.43	172.87

Above table shows basic indicators of region of agglomerations. Mean is average value of individual indicator, variance is variance of sample, min and max are minimal and maximal value. Actual convergence indicators are in the Section called *Region Agglomerations* in Chapter 5.

Region Mediterreanean

Region mediterreanean includes regions South (ES), East (ES), Meditereanean coast (FR), Islands (IT), Liguria, Toscana, Lazio, Campania, Puglia, Calabria, Molise, Abruzzo, Marche, Emilia-Romagna, Veneto, Friuli-Venezia Giulia, Western Slovenia, Anatoliki Makedonia, Thraki, Kentriki Makedonia, Thessalia, Kentriki Ellada, Attiki, Nisia Aigaiou, Kriti, Cyprus and Malta. Together there are 39 NUTS2 regions. There are 85 653 430 inhabitants in mediterreanean, total area is 414 772 square km. The share of production of EU production is 17,71 %. There are no metropolitan regions in the area.

This region is part of EU, which lays around the Mediterreanean sea. There are parts of seven EU countries in this region. Cyprus and Malta are whole in, from Greece and Slovenia, majority is in this region, and parts of Spain, France and Italy.

Overall, there are only several metropolitan and industrial regions, Lazio in Italy and Catalunia in Spain. Other regions with big cities (like Marseille and Genova) are bigger NUTS2 regions where the whole region cannot be characterised as agglomeration.

During the history, Mediterreanean region had a great advantage of the sea as a relatively easy and fast way of traveling and transporting goods. After the introduction of trains, highways and airplanes, this advantage has diminished.

Another common similarity in these regions, is possibility for tourism. This is extremely visible in France, Greece and Spain, but less visible in Italy and Slovenia.

The Euro - Mediterranean Partnership ([EuroMed]) was started in 1995 by the Barcelona meeting. This partnership includes EU and 10 governments from wider Mediterranean region (north Africa and middle east). After the introductory meeting, the EuroMed has not reached its anticipations. The middle east peace process did not show substantial progress. However, several cultural exchanges occurred and the economic basket can be considered as a success ([EuroMed2]).

In 2008, French president Nicolas Sarkozy showed the aim of creating Union for the Mediterranean ([MedUnion]). This was a reaction to stopping of EU enlargement (mainly Turkey). It is supposed to be separate from EU, including Meditarranean countries regardless of EU membership. This movement is new and the main criticism is duplication of EuroMed, as main EU external policy in region. Also, this movement was started in 2008, which is two year after latest available data used in this work.

Figure 4-2 shows location of region of mediterreanean in Europe.

Figure 4-2. Region of mediterreanean

Table 4-2. Region Mediterreanean, Basic Indicators in 2007

variable	mean	variance	min	max
GDP per capita in PPS of EU average	89.8	20.5	60	128
Employment rate	50.5	6.2	38.9	66.3
Economic activity rate	54.2	5.9	43.4	68.5
Share of employees with university degree	22.3	6.4	14	37
Value added in services	47.3	7.9	30	61.7
Unemployment rate	91.6	3.7	79.7	97.1
Disposable income	99.9	18.2	59.79	140.58

Above table shows basic indicators of region of mediterreanean. Mean is average value of individual indicator, variance is variance of sample, min and max are minimal and maximal value. Actual convergence indicators are in the Section called *Region Mediterreanean* in Chapter 5.

Region Baltic

Region Baltic includes regions Estonia, Latvia, Lithuania, Warminsko-Mazurskie, Pomorskie, Zachodniopomorskie, Mecklenburg-Vorpommern, Schleswig-Holstein, Syddanmark, Sjælland, Hovedstaden, Småland med öarna,

Sydsverige, East Sweden, North Sweden, Pohjois-Suomi, Länsi-Suomi, Etelä-Suomi and Åland. Together there are 22 NUTS2 regions. There are 32 404 811 inhabitants in Baltic, total area is 899 683 square km. The share of production of EU production is 6,46 %. Metropolitan regions in the area are Hovedstaden and Stockholm. These metropolitan regions are excluded from the analysis. Excluding them made convergence more visible.

Baltic region include NUTS2 regions bordering to the Baltic sea. This region includes both post socialistic countries (East Germany, Poland, Lithuania, Latvia, Estonia) and relatively old members of EU (Denmark, Sweden, Finland). There are two metropolitan regions (Stockholm, Copenhagen).

This region is connected to Nordic countries (see the Section called *Region Nordic Countries*). Compared to Nordic countries, there are very few formal agreements. Several are connected to polution in the Baltic sea (1974 and 1992 Helsinki Conventions). There is Baltic Sea Trade Union Network ([Batsun]), Baltic University Network ([BUP], a network of almost 200 universities from larger Baltic region, including Slovakia), a cooperation since 1992 Vision and Strategies around the Baltic Sea 2010 ([Vasab]).

However larger cooperation and free markets started after all countries entered EU in 2004. For programmic period 2007-2013, the final version Operational Programme for the Baltic Sea Region Programme 2007-2013 was approved by the European Commission (DG Regio and DG Aidco) on the 21 December 2007 ([BalticSea]). The area for the programme includes, apart from Baltic region as described here, Norway, parts of Russia, Belarus, and whole Poland, Sweden, Denmark and Finland.

Figure 4-3 shows location of region of Baltic in Europe.

Figure 4-3. Region of Baltic

Table 4-3. Region Baltic, Basic Indicators in 2007

variable	mean	variance	min	max
GDP per capita in PPS of EU average	98.6	33.7	41	165

variable	mean	variance	min	max
Employment rate	62.0	7.6	48.2	75.8
Economic activity rate	65.6	6.9	53.7	78.8
Share of employees with university degree	31.1	6.4	20.4	44.1
Value added in services	44.4	8.1	31.8	58.3
Unemployment rate	92.9	3.2	82.6	96.5
Disposable income	87.2	22.3	47.72	121.89

Above table shows basic indicators of region of Baltic. Mean is average value of individual indicator, variance is variance of sample, min and max are minimal and maximal value. Actual convergence indicators are in the Section called *Region Baltic* in Chapter 5.

Region European Union

Region European Union includes countries Latvia, Lithuania, Estonia, Slovakia, Czech republic, Hungary, Slovenia, Poland, Malta, Cyprus, Romania, Bulgaria, Spain, Portugal, Italy, Greece, France, Germany, Luxembourg, Netherlands, Belgium, Ireland, Denmark, Sweden, United Kingdom, Finland and Austria. Together there are 267 NUTS2 regions. There are 493 442 464 inhabitants in European Union, total area is 3 406 211 square km. The share of production of EU production is 106 %.

European union project was started as European Coal and Steel Community proposed by Robert Schuman. In 1957 custom union of European Economic Community was established. In 1993 the Maastricht treaty went into force and it introduced the term European Union and single market in EU.

EU is a single market that guarantees free movement of people, goods, services and capital. People are allowed to live and work in other member countries. Since 1999 also non-economically active people have freedom to move to another country. Free movement of goods and services means foreign trade with minimum restrictions ([EUmarket]).

However, several exceptions from single market exists. Most visible are closed labour markets to people from several member countries.

Table 4-4. Region European Union, Basic Indicators in 2007

variable	mean	variance	min	max
GDP per capita in PPS of EU average	97.0	37.1	26	334
Employment rate	56.4	6.0	38.9	75.8
Economic activity rate	59.9	5.5	43.4	78.8
Share of employees with university degree	26.9	8.8	8.7	55.3
Value added in services	45.3	8.1	28.7	73.1
Unemployment rate	93.0	3.3	79.7	97.9
Disposable income	100.0	30.0	24.99	172.87

Above table shows basic indicators of region of European Union. Mean is average value of individual indicator, variance is variance of sample, min and max are minimal and maximal value. Actual convergence indicators are in the Section called *Region European Union* in Chapter 5.

Region Visegrad Countries

Region Visegrad countries includes countries Slovakia, Czech republic, Hungary and Poland. Together there are 32 NUTS2 regions. There are 59 204 906 inhabitants in Visegrad countries, total area is 211 463 square km. The share of production of EU production is 7,04 %. Metropolitan regions in the area are Prague, Kozep-Magyarorszag and Bratislava region. These metropolitan regions are excluded from the analysis. Excluding them made convergence more visible.

The Visegrad group originated as Visegrad three on 15 February 1991 at north Hungarian town of Visegrad where the presidents of the ČSFR (Václav Havel), Hungary (Árpád Göncz), and Poland (Lech Walesa) signed a declaration on close co-operation between these three countries. After the 1993 split of ČSFR into Czech and Slovak republics, Visegrad group had four members. History of other meetings are at [SummitsV4].

On 21st December 1992, these four countries signed Central European Free Trade Agreement ([CEFTA]). This agreement was in 1996 joined by Slovenia, 1997 by Romania, 1999 by Bulgaria and 2003 by Croatia. In 2006 and 2007 Macedonia, Bosnia and Herzegovina, Moldova, Serbia, Montenegro, Albania and UNMIK (Kosovo) joined this agreement. Contries entering EU left this agreement when entering EU.

All of Visegrad countries have similar history in socialistic economy and all of them were relatively well developed in the former eastern block. Several facts indicate that this region is relatively homogenous and interconnected: trade among these countries was very intense, Czech Republic and Slovakia were one country until 1993, Czech, Slovak and Polish languages are very similar, there is a large Hungarian minority in Slovakia.

Figure 4-4 shows location of region of Visegrad countries in Europe.

Figure 4-4. Region of Visegrad countries

Table 4-5. Region Visegrad Countries, Basic Indicators in 2007

variable	mean	variance	min	max

variable	mean	variance	min	max
GDP per capita in PPS of EU average	53.8	12.6	37	87
Employment rate	54.3	4.6	45.3	62
Economic activity rate	58.8	4.3	50.1	64.3
Share of employees with university degree	19.2	5.0	8.7	32.9
Value added in services	39.0	6.1	29.7	58.3
Unemployment rate	91.0	2.9	84.7	96.6
Disposable income	55.7	8.1	43.55	73.1

Above table shows basic indicators of region of Visegrad countries. Mean is average value of individual indicator, variance is variance of sample, min and max are minimal and maximal value. Actual convergence indicators are in the Section called *Region Visegrad Countries* in Chapter 5.

Region Nordic Countries

Region Nordic countries includes countries Denmark, Finland and Sweden. Together there are 16 NUTS2 regions. There are 16 282 443 inhabitants in Nordic countries, total area is 813 511 square km. The share of production of EU production is 3,94 %. Metropolitan regions in the area are Hovedstaden and Stockholm. These metropolitan regions are excluded from the analysis. Excluding them made convergence more visible.

Nording or Scandinavian countries had a long common history. From 16th to 18th century, majority of the land was under Denmark-Norway (personal union) and Sweden. In 19th century, Norway came into personal union with Sweden and Finland became a part of Russia. In 1905, the union between Sweden and Norway was dissolved. In 1917, Finland became separate from Russia. In 1944, Iceland became separate from Denmark ([NordicCountries]).

In 1952, the Nordic Council was formed ([Norden]). It has its headquarters in Copenhagen and members are Norway, Denmark, Sweden, Iceland, Finland (since 1956), and associate members of Åland, Faore Islands and Greenland. This treaty allowed citizens of given countries travel without passport, just using a national ID card (eg driving license). Common Nordic labour market was signed on 6th March 1982 and took effect on 1st August 1983. Since 1987 there is in place Convention concluded by Sweden, Denmark, Finland, Iceland and Norway on Nordic citizens' right to use their own language in another Nordic country. This for example allows a Swede to use Swedish in Denmark when communicating with tax office. Since 2004, there is also the Royal League with futball teams from Denmark, Norway and Sweden.

The Northern Dimension ([NorthDim]), is an EU External Relations programme. It includes Nordic countries, Baltic countries, northern Poland and parts of Russia and Bielarussia. This movement signifies Commissions view of the north as a common region.

This region of Nordic countries is closely connected to region of Baltic sea (see the Section called *Region Baltic*.

Figure 4-5 shows location of region of Nordic countries in Europe.

Figure 4-5. Region of Nordic countries

Table 4-6. Region Nordic Countries, Basic Indicators in 2007

variable	mean	variance	min	max
GDP per capita in PPS of EU average	111.2	13.7	89	143
Employment rate	64.2	6.6	50.4	73.5
Economic activity rate	67.1	6.6	55.5	76.1
Share of employees with university degree	33.2	5.3	25	44.1
Value added in services	40.1	6.4	31.8	55.8
Unemployment rate	93.9	2.0	89	96.7
Disposable income	95.5	6.2	86.02	104.06

Above table shows basic indicators of region of Nordic countries. Mean is average value of individual indicator, variance is variance of sample, min and max are minimal and maximal value. Actual convergence indicators are in the Section called *Region Nordic Countries* in Chapter 5.

Region South

Region South includes countries Cyprus, Malta, Spain, Portugal, Italy and Greece. Together there are 57 NUTS2 regions. There are 102 190 016 inhabitants in South, total area is 473 977 square km. The share of production of EU

production is 20,59 %. Metropolitan regions in the area are Comunidad de Madrid, Lombardia, Provincia Autonoma Bolzano/Bozen, Lazio and Lisboa. These metropolitan regions are excluded from the analysis. Excluding them made convergence more visible.

As was mentioned above, this region includes six countries. Spain and Italy are the biggest countries with great internal differences, Portugal and Greece are smaller countries, Cyprus and Malta are the smallest countries in EU (together with Luxembourg). Italy was founding member of the European Economic Community, Greece joined in 1981, Spain and Portugal in 1986, Cyprus and Malta in 2004.

None of these six countries went through a period of planned economy. Spain was under non-democratic Franco rule until 1975. After this, Spain became a standard democracy with king Juan Carlos. Portugal had similar democratic development as Spain. After the revolution in 1910, Portugal ended monarchy and proclaimed a republic. After 16 years of chaotic struggle for parliamentary democracy, military action put António de Oliveira Salazar as head of Estado Novo (new republic). This authoritative regime lasted until 1974 when it was ended by revolution. A standard parliamentary with president was established. Greece also experienced several turbulences in the last hundred years. 19th century was characterised by many changes in the state. Greece was ruled by governor, then Bavarian duke, then Danish prince, and finally own king Constantine I (which was son of the Danish prince and a Grand Duchess of Russia). This changing period was ended by WW1 and following war against Turkey with massive population exchange of about 1.5 million Greeks. During the WW2, Greece was surrendered by German troops and after WW2 the civil war started. Tension lasted for 30 years. In 1974 last of the dictatorships collapsed when Turkey invaded Cyprus. In 1975 Greece finally became standard parliamentary republic. Cyprus, with its strategic position near Suez Canal, was under British rule. In 1960 Cyprus gained independence by agreement among United Kingdom, Greece and Turkey. After several years of violence and changes, in 1974 Turkey invaded the island and captured northern part. After this, Cyprus is de facto two countries: Republic of Cyprus and Turkish controlled norther part. UN buffer zone and UK bases also exist on the island. Italy was united in 1861 under Kingdome of Italy by Guiseppe Garibaldi. Italy was characterised by drastic differences between industrial north and not developed south. These differences caused problems throughout the 20ties century. In WW1 Italy fought with allies (after one year being neutral but with formal agreement with the Triple Alliance), however after the end of the war economy collapsed. This lead to dictatorship and fascism before and during WW2. In 1946, Italy became a republic. Marshall plan helped to start the economy in the 1950ties and 1960th, followed by conflicts in the 1970ties and 1980th. After 50th, there was an average of one government per year. Malta had the easiest history. It was under British rule until 1964. After then it was a parliamentary democracy, with president after 1974.

As it can be seen, all of southern countries experience very moving time in the last century. However after the 1980th, all of the economies are stable and democratic. However several problematic regions exist here, mainly Basque in Spain, Sicily and Napoli in Italy and part of Cyprus.

Figure 4-6 shows location of region of South in Europe.

Figure 4-6. Region of South

Table 4-7. Region South, Basic Indicators in 2007

variable	mean	variance	min	max
GDP per capita in PPS of EU average	90.8	21.4	60	137
Employment rate	52.1	6.4	38.9	67.4
Economic activity rate	55.7	6.2	43.4	70.9
Share of employees with university degree	23.0	9.1	9	49.2
Value added in services	44.9	8.0	30	61.7
Unemployment rate	92.2	3.5	79.7	97.1
Disposable income	99.1	19.9	59.79	140.58

Above table shows basic indicators of region of South. Mean is average value of individual indicator, variance is variance of sample, min and max are minimal and maximal value. Actual convergence indicators are in the Section called *Region South* in Chapter 5.

Region Benelux

Region Benelux includes countries Luxembourg, Netherlands and Belgium. Together there are 19 NUTS2 regions. There are 21 534 023 inhabitants in Benelux, total area is 63 392 square km. The share of production of EU production

is 5,32 %. Metropolitan regions in the area are Brussels, Luxembourg (Grand-Duché), Groningen, Utrecht and Noord-Holland. These metropolitan regions are excluded from the analysis. Excluding them made convergence more visible.

As was mentioned, this region consists of two larger countries and one smaller. Belgium and Luxembourg entered economic and monetary union BLEU on 22nd December 1922, [BLEU].

Benelux was created by Benelux Customs Union signature in 1944, and went into force in 1948. In 1960, it was replaced by Benelux Economic Union. This union was signed on 3rd February 1958 in the Haague. See [Benelux] for more information.

Since these countries make an economic union, it can be assumed that convergence will occur.

Figure 4-7 shows location of region of Benelux in Europe.

Figure 4-7. Region of Benelux

Table 4-8. Region Benelux, Basic Indicators in 2007

variable	mean	variance	min	max
GDP per capita in PPS of EU average	108.3	18.9	75	137
Employment rate	57.7	5.2	47	67.8
Economic activity rate	60.2	4.4	52.4	70.2
Share of employees with university degree	34.5	6.8	23.7	53.6
Value added in services	47.0	6.7	36.1	64.9
Unemployment rate	94.9	2.9	87.2	97.9

variable	mean	variance	min	max
Disposable income	108.6	10.8	97.28	136.5

Above table shows basic indicators of region of Benelux. Mean is average value of individual indicator, variance is variance of sample, min and max are minimal and maximal value. Actual convergence indicators are in the Section called *Region Benelux* in Chapter 5.

Region British Isles

Region British Isles includes countries United Kingdom and Ireland. Together there are 36 NUTS2 regions. There are 55 389 226 inhabitants in British Isles, total area is 227 842 square km. The share of production of EU production is 12,67 %. Metropolitan regions in the area are Inner London, Outer London and Berkshire, Buckinghamshire and Oxfordshire. These metropolitan regions are excluded from the analysis. Excluding them made convergence more visible.

The regions of British Isles had a long common history. For the latter part, from 1801 to 1922, they formed The United Kingdom of Great Britain and Ireland. On 6th December 1922 Ireland separated from the United Kingdom. In 1927 by the Royal and Parliamentary Titles Act 1927 the name of UK was United Kingdom of Great Britain and Northern Ireland, in recognition of the fact that all of Ireland except the North-East had seceded to form a separate dominion (then Irish Free State, now Republic of Ireland).

Even after the split in two countries, there were close connections. Ireland and UK made a free travel area ever since 1922. UK embassies act as Irish consulate where necessary. The British-Irish Council and the British-Irish Inter-Parliamentary Body exist since 1999 and 1990, however with very few formal power. Both of the countries are EU members since 1973.

Figure 4-8 shows location of region of British Isles in Europe.

Figure 4-8. Region of British Isles

Table 4-9. Region British Isles, Basic Indicators in 2007

variable	mean	variance	min	max
GDP per capita in PPS of EU average	103.1	19.8	73	166
Employment rate	59.7	3.1	52.9	64.6
Economic activity rate	61.8	3.0	54.9	66.4
Share of employees with university degree	33.2	3.8	26.2	40.7
Value added in services	47.8	6.2	35.9	59.5
Unemployment rate	95.0	1.2	91.9	96.7
Disposable income	115.4	11.8	98.61	148.37

Above table shows basic indicators of region of British Isles. Mean is average value of individual indicator, variance is variance of sample, min and max are minimal and maximal value. Actual convergence indicators are in the Section called *Region British Isles* in Chapter 5.

Region NMS8

Region NMS8 includes countries Latvia, Lithuania, Estonia, Slovakia, Czech republic, Hungary, Slovenia and Poland. Together there are 37 NUTS2 regions. There are 68 223 876 inhabitants in NMS8, total area is 406 913 square km. The share of production of EU production is 8,32 %. Metropolitan regions in the area are Prague, Kozep-Magyarorszag and Bratislava region. These metropolitan regions are excluded from the analysis. Excluding them made convergence more visible.

These countries entered EU on 1st May 2004. This was according to the Treaty of Accession 2003 ([Comm2003]) signed on 16th of April 2003 in Athens under Greek presidency ([GR2003]).

In this work, Cyprus and Malta are excluded from the analysis, since they have very different starting points and history than the other eight countries. This region also includes Visegrad countries (see the Section called *Region Visegrad Countries* for more details).

The remaining eight countries share a common history of centrally planned economy, and transformation. Some of the regions were successful (Slovenia, capital cities) while others were less successfull.

Figure 4-9 shows location of region of NMS8 in Europe.

Figure 4-9. Region of NMS8

Table 4-10. Region Nms8, Basic Indicators in 2007

variable	mean	variance	min	max
GDP per capita in PPS of EU average	56.4	15.1	37	107
Employment rate	55.2	4.8	45.3	62.7
Economic activity rate	59.5	4.3	50.1	65.3
Share of employees with university degree	20.3	6.2	8.7	36.5
Value added in services	40.2	6.7	29.7	58.3
Unemployment rate	91.6	3.1	84.7	96.6
Disposable income	57.3	10.4	43.55	91.32

Above table shows basic indicators of region of NMS8. Mean is average value of individual indicator, variance is variance of sample, min and max are minimal and maximal value. Actual convergence indicators are in the Section called *Region NMS8* in Chapter 5.

Region European Monetary Union

Region European monetary union includes countries Spain, Portugal, Italy, Greece, France, Germany, Luxembourg, Netherlands, Belgium, Ireland, Austria and Finland. Together there are 138 NUTS2 regions. There are 238 740 649

inhabitants in European monetary union, total area is 1 845 517 square km. The share of production of EU production is 51,31 %. Metropolitan regions in the area are Vienna, Brussels, Stuttgart, Tübingen, Oberbayern, Berlin, Bremen, Hamburg, Darmstadt, Hannover, Düsseldorf, Köln, Leipzig, Comunidad de Madrid, Île de France, Lombardia, Provincia Autonoma Bolzano/Bozen, Lazio, Luxembourg (Grand-Duché), Groningen, Utrecht, Noord-Holland and Lisboa. These metropolitan regions are excluded from the analysis. Excluding them made convergence more visible.

European Monetary Union process started on 19th November 1969 in Den Haag by the Heads of State or Government of the member countries of the EEC which stated "it is essential that the Heads of State or Government affirm their determination to pursue the construction of a genuine Community, i.e. to buttress the customs union by establishing an economic and monetary union in the years ahead" ([Comm1969]).

In 1999, 11 countries entered monetary union. In 2001 they were joined by Greece. Final adoption of Euro coins and notes was on 1st January 2002 ([EMUhistory], [CommEuro]). Recently (2007 to 2009) Slovenia, Malta, Cyprus and Slovakia adopted Euro, however data used in this work end in 2007, so no possitve effects of common market could be visible in these countries. Therefore only 12 countries regions will be addressed as EMU.

Figure 4-10 shows location of region of European monetary union in Europe.

Figure 4-10. Region of European monetary union

Table 4-11. Region European Monetary Union, Basic Indicators in 2007

variable	mean	variance	min	max
GDP per capita in PPS of EU average	99.1	20.5	60	166
Employment rate	54.6	5.5	38.9	67.8
Economic activity rate	58.2	5.0	43.4	70.9

variable	mean	variance	min	max
Share of employees with university degree	26.2	8.3	9	53.6
Value added in services	44.7	6.5	30	64.9
Unemployment rate	92.6	3.4	79.7	97.9
Disposable income	109.2	17.8	59.79	140.58

Above table shows basic indicators of region of European monetary union. Mean is average value of individual indicator, variance is variance of sample, min and max are minimal and maximal value. Actual convergence indicators are in the Section called *Region European Monetary Union* in Chapter 5.

Region France

Region France includes France. Together there are 21 NUTS2 regions. There are 50 196 684 inhabitants in France, total area is 531 953 square km. The share of production of EU production is 10,33 %. There are no metropolitan regions in the area.

The French Republic (République française) was the founding member of the European Coal and Steel Community (ECSC) which was first proposed by the then French foreign minister Robert Schuman and French economic theorist Jean Monnet in 1950 and established by the Treaty of Paris in 1951. However, history of France after WW2 was not so straightforward. In 1946 the Fourth republic replaced the German run Vichy France. The Fourth Republic faced struggles with post war ruined economy and disappearing status of colonial power. Due to this, there was a new prime minister every year. After this period, Charles de Gaulle, WW2 hero, stepped out with movement for new constitution with strong president. This constitution was ratified by referendum in 1958 and so the Fifth Republic was created. Charles de Gaulle was voted as the first president and remained in the office for 10 years. Government became more stable and average prime minister stayed in position for 3 years.

France, once a colonial power, retains some geographically distant regions as part of the Republic and are part of EU. These are outer sea departments (Départements d'outre mer) which include Guadeloupe, Martinique, Guyane and Réunion. Out of these regions, Guyane with rocket base for space shuttles is the most important. These outer departments are technically part of the European union, however their characteristics are similar to those of Latin America or Oceania. Due to these reasons, these departments were excluded from convergence analysis.

The French government is very centralised. First decentralisation rules started in the eighties, a further step was done in 2004 ([MAE2006]). So for the vast majority of discussed period, the government was centralised with centralised spacial and cohesion policy.

As it can be seen, France has basic conditions for convergence: it is a single market, with no barriers on labour market, there is common language, region is relatively large, there is no focus on just one sector or region, and it is standard democratic country. As the table below prooves, there is convergence in France.

Figure 4-11 shows location of region of France in Europe.

Figure 4-11. Region of France

Table 4-12. Region France, Basic Indicators in 2007

variable	mean	variance	min	max
GDP per capita in PPS of EU average	93.9	6.5	85	110
Employment rate	54.2	3.1	46	58.8
Economic activity rate	58.0	2.8	50.9	61.8
Share of employees with university degree	26.8	3.6	20.7	34
Value added in services	46.4	3.4	38.9	53.3
Unemployment rate	92.0	1.8	88.5	94.3
Disposable income	116.5	5.2	104.42	123.22

Above table shows basic indicators of region of France. Mean is average value of individual indicator, variance is variance of sample, min and max are minimal and maximal value. Actual convergence indicators are in the Section called *Region France* in Chapter 5.

Region Germany

Region Germany includes Germany. Together there are 28 NUTS2 regions. There are 49 795 201 inhabitants in Germany, total area is 284 517 square km. The share of production of EU production is 10,98 %. Metropolitan regions

in the area are Stuttgart, Tübingen, Oberbayern, Berlin, Bremen, Hamburg, Darmstadt, Hannover, Düsseldorf, Köln and Leipzig. These metropolitan regions are excluded from the analysis. Excluding them made convergence more visible.

Federal Republic of Germany (Bundesrepublik Deutschland) was after WW2 divided into four military occupation zones. In 1949 Federal Republic of Germany (aka West Germany) and German Democratic Republic (aka East Germany) were established. Since these two countries represented opposite sides of the cold war, economic exchange did not occur in a larger scope. This was made better in the 70th. Berlin Wall was built in 1961. Berlin retained special status not being legally part of West Germany, tax benefits and encouragement of investors caused lead to high economic growth of the city isolated in East Germany.

In 1990, Germany was reunified after Two Plus Four Treaty, when the four occupying powers renounced their post WW2 rights. Major dispute was about Germany's presence in NATO, which was solved by changed status of NATO by London Declaration. The basics of the treaty were that east Germany would become part of west Germany in exchange for Berlin as capital and post war borders becoming final. Soviet troops withdrew eastern part of Germany in 1994. In 1994 the process of relocation the capital from Bonn to Berlin as stated by unification treaty was started. This relocation was completed in 1999 when parliament had its first meeting in Berlin. However many government offices still remain in Bonn.

On 1st July 1990, both Germanies entered economic and monetary union. Eastgerman Mark was exchanged for German Mark at rate of 1:1 for the first 4000 marks, and 2:1 for larger amounts. This exchange rate was more political decision and is in question how this caused subsequent negative development in eastern part of Germany. German Mark was one of the most stable currencies in Europe after WW2, with very low inflation rates (as opposition to hyperinflation between the wars).

Since part of Germany was planned economy and part was social market economy, reunification caused growth of disparities. The shock therapy of opening the markets caused subsequent problems in eastern part of Germany.

Figure 4-12 shows location of region of Germany in Europe.

Figure 4-12. Region of Germany

Table 4-13. Region Germany, Basic Indicators in 2007

variable	mean	variance	min	max
GDP per capita in PPS of EU average	103.3	15.8	76	132
Employment rate	55.6	3.3	50.5	61.6
Economic activity rate	60.6	2.1	54.8	64.3
Share of employees with university degree	26.3	4.7	18.2	37.4
Value added in services	42.8	3.1	36.8	50.5
Unemployment rate	91.3	3.7	82.6	95.7
Disposable income	120.7	11.2	100.16	136.41

Above table shows basic indicators of region of Germany. Mean is average value of individual indicator, variance is variance of sample, min and max are minimal and maximal value. Actual convergence indicators are in the Section called *Region Germany* in Chapter 5.

Region Southwest

Region southwest includes countries France, Spain and Portugal. Together there are 45 NUTS2 regions. There are 96 423 601 inhabitants in southwest, total area is 621 136 square km. The share of production of EU production is 19,70 %. Metropolitan regions in the area are Comunidad de Madrid, Île de France and Lisboa. These metropolitan regions are excluded from the analysis. Excluding them made convergence more visible.

This region represents three old EU countries, France being founding member, Spain and Portugal entering in 1986. France is economically strong, whilst Spain and Portugal have worse indicators in all terms. Short history of these countries is described at the Section called *Region France* and the Section called *Region South*. All of the countries have relatively high regional differences.

Since all three countries were in EU for a long time, we can expect EU cohesion policy to have full effect. This should also be forced by then state of EU, where Spain and Portugal were among the poorest countries in EU. Therefore volume of cohesion policy budget pouring into this countries was wery high. Also these countries are close to each other, with similar languages, active international trade and few border barriers.

Figure 4-13 shows location of region of southwest in Europe.

Figure 4-13. Region of southwest

Table 4-14. Region Southwest, Basic Indicators in 2007

variable	mean	variance	min	max
GDP per capita in PPS of EU average	94.1	15.5	60	137
Employment rate	54.9	4.6	44.1	67.4
Economic activity rate	59.0	4.0	50.9	70.9
Share of employees with university degree	27.5	8.2	9	49.2
Value added in services	44.3	6.8	30.7	61.7
Unemployment rate	91.7	3.1	79.7	95.7
Disposable income	106.0	17.5	66.19	137.28

Above table shows basic indicators of region of southwest. Mean is average value of individual indicator, variance is variance of sample, min and max are minimal and maximal value. Actual convergence indicators are in the Section called *Region Southwest* in Chapter 5.

Summary of Regions

Below, there is summary of state of regions used in this work. It can be seen, that regions are not homogenous a show wide differences in average values of discussed indicators. Tables show average values and variances for year 2007.

Table 4-15. Economic Cohesion Indicators

Region	nuts regions	GDP per capita in PPS of EU average	Disposable income	Value added in services
agglomerations	31	154.7 (variance 47.8)	127.3 (variance 24.9)	54.6 (variance 8.1)
mediterreanean	39	92.1 (variance 22.1)	98.7 (variance 21.1)	47.1 (variance 7.6)
Baltic	22	94.4 (variance 37.7)	80.4 (variance 27.5)	43.6 (variance 7.8)
European Union	267	96.9 (variance 38.8)	100.1 (variance 32.3)	44.1 (variance 8.0)
Visegrad countries	32	49.5 (variance 11.4)	49.6 (variance 7.6)	38.8 (variance 5.5)
Nordic countries	16	111.7 (variance 15.5)	90.9 (variance 8.5)	39.7 (variance 6.2)
South	57	91.5 (variance 22.9)	97.5 (variance 22.4)	44.6 (variance 8.0)
Benelux	19	109.6 (variance 16.7)	110.0 (variance 13.2)	45.1 (variance 6.1)
British Isles	36	105.2 (variance 17.8)	117.5 (variance 13.7)	44.7 (variance 6.5)
NMS8	37	50.9 (variance 13.9)	49.8 (variance 10.4)	39.6 (variance 6.0)
European monetary union	138	100.7 (variance 21.3)	107.9 (variance 19.9)	43.7 (variance 6.6)
France	21	98.6 (variance 7.8)	111.3 (variance 7.5)	44.5 (variance 4.0)
Germany	28	105.9 (variance 17.5)	123.7 (variance 11.5)	41.8 (variance 3.0)
southwest	45	93.2 (variance 15.7)	100.7 (variance 17.0)	43.1 (variance 6.7)

Highest GDP per capita in PPS of EU average was in agglomerations and lowest was in Visegrad countries. Highest Disposable income was in agglomerations and lowest was in Visegrad countries. Highest Value added in services was in agglomerations and lowest was in Visegrad countries.

Table 4-16. Social Cohesion Indicators

Region	nuts regions	Employment rate	Unemployment rate	Economic activity rate
agglomerations	31	58.1 (variance 6.4)	92.9 (variance 4.1)	62.0 (variance 5.5)
mediterreanean	39	48.7 (variance 6.0)	89.6 (variance 5.1)	53.2 (variance 5.5)
Baltic	22	59.6 (variance 7.9)	89.7 (variance 5.7)	65.0 (variance 5.9)
European Union	267	55.0 (variance 6.4)	91.7 (variance 4.7)	59.0 (variance 5.7)
Visegrad countries	32	53.2 (variance 4.9)	87.3 (variance 6.0)	59.6 (variance 4.7)
Nordic countries	16	63.0 (variance 6.5)	92.4 (variance 2.8)	66.7 (variance 6.0)
South	57	50.3 (variance 6.4)	90.4 (variance 4.9)	54.4 (variance 5.7)
Benelux	19	56.4 (variance 5.3)	94.5 (variance 3.0)	59.0 (variance 4.5)
British Isles	36	58.8 (variance 3.5)	95.0 (variance 1.4)	61.0 (variance 3.2)
NMS8	37	53.7 (variance 4.9)	87.6 (variance 5.9)	60.0 (variance 4.6)
European monetary union	138	53.1 (variance 5.9)	91.6 (variance 4.5)	57.1 (variance 5.1)
France	21	53.0 (variance 4.7)	90.9 (variance 2.8)	57.3 (variance 4.3)
Germany	28	54.1 (variance 3.4)	91.2 (variance 4.2)	59.1 (variance 2.6)
southwest	45	53.0 (variance 5.7)	90.4 (variance 4.0)	57.4 (variance 4.9)

Highest Employment rate was in Nordic countries and lowest was in mediterreanean and majority of the regions are below EU average. Highest Unemployment rate was in British Isles and lowest was in Visegrad countries and majority of the regions are below EU average. Highest Economic activity rate was in Nordic countries and lowest was in mediterreanean.

Chapter 5. Results

Quantification Methods

Methods used for quantification of convergence were described in Chapter 1 and in the Section called *Quantification of Coefficients* in Chapter 3. They include well used methods, like beta and sigma convergence, as well as not widely used methods like IQR and kurtosis convergence. As it can be seen from below comparisons, these methods sometimes show independent and statistically irrelevant results.

The terms strong and weak convergence were introduced in the Section called *Strong and Weak Convergence* in Chapter 3. These convergences do not describe absolute change in discussed parameters, rather than consistency of decrease or increase. Non parametric rank test is used to test existence of increase, therefore its results are not affected by underlying probabilistic distribution. Importance of this is shown in the Section called *Kurtosis Convergence*, where kurtosis changed in almost half of cases. This puts normality of variable into question.

Beta Convergence

Below is a summary of vergence in various regions (see Chapter 4) and according to various indicators (as defined in Chapter 2). Beta coefficient was described in the Section called *Beta Convergence* in Chapter 1 and the Section called *Beta Convergence* in Chapter 3.

Overall, beta showed strong convergence in 5 cases and weak convergence in 4 in cases. On the other hand, strong divergence according to beta was in 31 cases and weak divergence in 12 cases. Remaining 32 cases showed no signs of convergence or divergence. Below table shows convergence and divergence according to beta. 1 means strong convergence, 0.6 means weak convergence (as defined in the Section called *Strong and Weak Convergence* in Chapter 3), negative values show divergence.

Table 5-1. Economic Cohesion According to Beta

Region	GDP per capita in PPS of EU average	Disposable income	Value added in services
Baltic	0.6		-0.6
Benelux	-1		0
Germany	1		0
European monetary union	0.6		-1
European Union	1		-1
France	0		0
South	0		-1
mediterreanean	0		-0.6
agglomerations	0		-1
NMS8	-1		-1
British Isles	-1		0
Nordic countries	0		-0.6
southwest	0		-1
Visegrad countries	-1		-1

Above table gives a summary of vergence, as quantified by beta. At GDP per capita in PPS of EU average, there are 2 regions with strong convergence and there are 4 regions with strong divergence. At Disposable income, there are no regions with strong convergence and there are no regions with strong divergence. At Value added in services, there are no regions with strong convergence and there are 7 regions with strong divergence.

Table 5-2. Social Cohesion According to Beta

Region	Employment rate	Unemployment rate	Economic activity rate
Baltic	0	0	-0.6
Benelux	-0.6	0.6	-0.6
Germany	-1	0	-0.6
European monetary union	0	-1	-1
European Union	0	0	0
France	0	0	-0.6
South	0	-0.6	-1
mediterreanean	-1	-0.6	-1
agglomerations	0	0	0
NMS8	-1	1	-1
British Isles	-0.6	0.6	-1
Nordic countries	0	0	-0.6
southwest	0.6	0	0
Visegrad countries	-1	1	-1

Above table gives a summary of vergence, as quantified by beta. At Employment rate, there are no regions with strong convergence and there are 4 regions with strong divergence. At Unemployment rate, there are 2 regions with strong convergence and there is one region with strong divergence. At Economic activity rate, there are no regions with strong convergence and there are 6 regions with strong divergence.

Sigma Convergence

Below is a summary of vergence in various regions (see Chapter 4) and according to various indicators (as defined in Chapter 2). Sigma coefficient was described in the Section called *Sigma Convergence* in Chapter 1 and the Section called *Sigma Convergence* in Chapter 3.

Overall, sigma showed strong convergence in 30 cases and weak convergence in 10 in cases. On the other hand, strong divergence according to sigma was in 8 cases and weak divergence in 2 cases. Remaining 34 cases showed no signs of convergence or divergence. Below table shows convergence and divergence according to sigma. 1 means strong convergence, 0.6 means weak convergence (as defined in the Section called *Strong and Weak Convergence* in Chapter 3), negative values show divergence.

Table 5-3. Economic Cohesion According to Sigma

Region	GDP per capita in PPS of EU average	Disposable income	Value added in services
Baltic	1	1	0
Benelux	-1	1	0
Germany	1	0.6	0.6
European monetary union	1	1	0.6
European Union	1	0	0.6
France	1	0.6	1
South	1	1	-0.6
mediterreanean	1	1	-0.6
agglomerations	-1	0	-1
NMS8	0	0	-1

Region	GDP per capita in PPS of EU average	Disposable income	Value added in services
British Isles	-1	0	0.6
Nordic countries	0	0	0
southwest	1	0	0
Visegrad countries	0	0	-1

Above table gives a summary of vergence, as quantified by sigma. At GDP per capita in PPS of EU average, there are 8 regions with strong convergence and there are 3 regions with strong divergence. At Disposable income, there are 5 regions with strong convergence and there are no regions with strong divergence. At Value added in services, there is just one region with strong convergence (however, 4 regions have weak convergence) and there are 3 regions with strong divergence.

Table 5-4. Social Cohesion According to Sigma

Region	Employment rate	Unemployment rate	Economic activity rate
Baltic	0	0	0
Benelux	0	0	0
Germany	0	0	1
European monetary union	1	1	0
European Union	1	1	1
France	1	1	1
South	1	1	-1
mediterreanean	0	1	0
agglomerations	0	0	0.6
NMS8	0	0	1
British Isles	0.6	0	1
Nordic countries	0	0.6	-0.6
southwest	1	0	1
Visegrad countries	0	0	1

Above table gives a summary of vergence, as quantified by sigma. At Employment rate, there are 5 regions with strong convergence and there are no regions with strong divergence. At Unemployment rate, there are 5 regions with strong convergence and there are no regions with strong divergence. At Economic activity rate, there are 7 regions with strong convergence and there is one region with strong divergence.

Gini Convergence

Below is a summary of vergence in various regions (see Chapter 4) and according to various indicators (as defined in Chapter 2). Gini coefficient was described in the Section called *Gini Convergence* in Chapter 1 and the Section called *Gini Convergence* in Chapter 3.

Overall, Gini showed strong convergence in 27 cases and weak convergence in 8 in cases. On the other hand, strong divergence according to Gini was in 9 cases and weak divergence in 4 cases. Remaining 36 cases showed no signs of convergence or divergence. Below table shows convergence and divergence according to Gini. 1 means strong convergence, 0.6 means weak convergence (as defined in the Section called *Strong and Weak Convergence* in Chapter 3), negative values show divergence.

Table 5-5. Economic Cohesion According to Gini

Region	GDP per capita in PPS of EU average	Disposable income	Value added in services
Baltic	1	1	-1
Benelux	-1	0.6	0
Germany	1	0.6	0
European monetary union	1	1	0
European Union	1	0	0
France	1	0.6	1
South	1	1	-0.6
mediterreanean	0.6	1	-0.6
agglomerations	0	0	-1
NMS8	0	0.6	-1
British Isles	-1	0	0
Nordic countries	0	0	-1
southwest	1	0.6	-0.6
Visegrad countries	0	0	-1

Above table gives a summary of vergence, as quantified by Gini. At GDP per capita in PPS of EU average, there are 7 regions with strong convergence and there are 2 regions with strong divergence. At Disposable income, there are 4 regions with strong convergence (however, 5 regions have weak convergence) and there are no regions with strong divergence. At Value added in services, there is just one region with strong convergence and there are 5 regions with strong divergence.

Table 5-6. Social Cohesion According to Gini

Region	Employment rate	Unemployment rate	Economic activity rate
Baltic	0	0	0
Benelux	0	0	0
Germany	0	0	1
European monetary union	1	1	1
European Union	1	1	1
France	1	1	1
South	1	1	-1
mediterreanean	0	1	-0.6
agglomerations	0	0	1
NMS8	0	0	0
British Isles	1	0	0.6
Nordic countries	0	0.6	-0.6
southwest	1	0.6	1
Visegrad countries	0	0	0

Above table gives a summary of vergence, as quantified by Gini. At Employment rate, there are 6 regions with strong convergence and there are no regions with strong divergence. At Unemployment rate, there are 5 regions with strong convergence and there are no regions with strong divergence. At Economic activity rate, there are 6 regions with strong convergence and there is one region with strong divergence.

Entropy Convergence

Below is a summary of vergence in various regions (see Chapter 4) and according to various indicators (as defined in Chapter 2). Entropy coefficient was described in the Section called *Entropy Convergence* in Chapter 1 and the Section called *Entropy Convergence* in Chapter 3.

Overall, entropy showed strong convergence in 30 cases and weak convergence in 8 in cases. On the other hand, strong divergence according to entropy was in 8 cases and weak divergence in 4 cases. Remaining 34 cases showed no signs of convergence or divergence. Below table shows convergence and divergence according to entropy. 1 means strong convergence, 0.6 means weak convergence (as defined in the Section called *Strong and Weak Convergence* in Chapter 3), negative values show divergence.

Table 5-7. Economic Cohesion According to Entropy

Region	GDP per capita in PPS of EU average	Disposable income	Value added in services
Baltic	1	1	0
Benelux	-1	1	0
Germany	1	0.6	0.6
European monetary union	1	1	0
European Union	1	0	0
France	1	0.6	1
South	1	1	-0.6
mediterreanean	1	1	-0.6
agglomerations	-1	1	-1
NMS8	0	0.6	-1
British Isles	-1	0	0.6
Nordic countries	0	0	-0.6
southwest	1	0	-0.6
Visegrad countries	0	0	-1

Above table gives a summary of vergence, as quantified by entropy. At GDP per capita in PPS of EU average, there are 8 regions with strong convergence and there are 3 regions with strong divergence. At Disposable income, there are 6 regions with strong convergence and there are no regions with strong divergence. At Value added in services, there is just one region with strong convergence and there are 3 regions with strong divergence.

Table 5-8. Social Cohesion According to Entropy

Region	Employment rate	Unemployment rate	Economic activity rate
Baltic	0	0	0
Benelux	0	0	0
Germany	0	0	1
European monetary union	1	1	0
European Union	1	1	1
France	1	1	1
South	1	1	-1
mediterreanean	0	1	0
agglomerations	0	0	0.6
NMS8	0	0	1
British Isles	0.6	0	1

Region	Employment rate	Unemployment rate	Economic activity rate
Nordic countries	0	0.6	-0.6
southwest	1	0	1
Visegrad countries	0	0	1

Above table gives a summary of vergence, as quantified by entropy. At Employment rate, there are 5 regions with strong convergence and there are no regions with strong divergence. At Unemployment rate, there are 5 regions with strong convergence and there are no regions with strong divergence. At Economic activity rate, there are 7 regions with strong convergence and there is one region with strong divergence.

Theil Convergence

Below is a summary of vergence in various regions (see Chapter 4) and according to various indicators (as defined in Chapter 2). Theil coefficient was described in the Section called *Theil Convergence* in Chapter 1 and the Section called *Theil Convergence* in Chapter 3.

Overall, Theil showed strong convergence in 30 cases and weak convergence in 9 in cases. On the other hand, strong divergence according to Theil was in 8 cases and weak divergence in 3 cases. Remaining 34 cases showed no signs of convergence or divergence. Below table shows convergence and divergence according to Theil. 1 means strong convergence, 0.6 means weak convergence (as defined in the Section called *Strong and Weak Convergence* in Chapter 3), negative values show divergence.

Table 5-9. Economic Cohesion According to Theil

Region	GDP per capita in PPS of EU average	Disposable income	Value added in services
Baltic	1	1	0
Benelux	-1	1	0
Germany	1	0.6	0.6
European monetary union	1	1	0
European Union	1	0	0.6
France	1	0.6	1
South	1	1	-0.6
mediterreanean	1	1	-0.6
agglomerations	-1	0.6	-1
NMS8	0	0	-1
British Isles	-1	0	0.6
Nordic countries	0	0	-0.6
southwest	1	0	0
Visegrad countries	0	0	-1

Above table gives a summary of vergence, as quantified by Theil. At GDP per capita in PPS of EU average, there are 8 regions with strong convergence and there are 3 regions with strong divergence. At Disposable income, there are 5 regions with strong convergence and there are no regions with strong divergence. At Value added in services, there is just one region with strong convergence and there are 3 regions with strong divergence.

Table 5-10. Social Cohesion According to Theil

Region	Employment rate	Unemployment rate	Economic activity rate
Baltic	0	0	0
Benelux	0	0	0

Region	Employment rate	Unemployment rate	Economic activity rate
Germany	0	0	1
European monetary union	1	1	0
European Union	1	1	1
France	1	1	1
South	1	1	-1
mediterreanean	0	1	0
agglomerations	0	0	0.6
NMS8	0	0	1
British Isles	0.6	0	1
Nordic countries	0	0.6	-0.6
southwest	1	0	1
Visegrad countries	0	0	1

Above table gives a summary of vergence, as quantified by Theil. At Employment rate, there are 5 regions with strong convergence and there are no regions with strong divergence. At Unemployment rate, there are 5 regions with strong convergence and there are no regions with strong divergence. At Economic activity rate, there are 7 regions with strong convergence and there is one region with strong divergence.

IQR Convergence

Below is a summary of vergence in various regions (see Chapter 4) and according to various indicators (as defined in Chapter 2). IQR coefficient was described in the Section called *IQR Convergence* in Chapter 1 and the Section called *IQR Convergence* in Chapter 3.

Overall, IQR showed strong convergence in 13 cases and weak convergence in 14 in cases. On the other hand, strong divergence according to IQR was in 13 cases and weak divergence in 9 cases. Remaining 35 cases showed no signs of convergence or divergence. Below table shows convergence and divergence according to IQR. 1 means strong convergence, 0.6 means weak convergence (as defined in the Section called *Strong and Weak Convergence* in Chapter 3), negative values show divergence.

Table 5-11. Economic Cohesion According to IQR

Region	GDP per capita in PPS of EU average	Disposable income	Value added in services
Baltic	1	0	-1
Benelux	-1	0	-0.6
Germany	0.6	0.6	-1
European monetary union	1	1	-0.6
European Union	1	0	-1
France	0	0	0.6
South	0	-0.6	0
mediterreanean	0	-1	-0.6
agglomerations	0	0.6	0
NMS8	0	0.6	-0.6
British Isles	-0.6	-1	0
Nordic countries	0	0	-1
southwest	1	0	-1
Visegrad countries	0	0	-0.6

Above table gives a summary of vergence, as quantified by IQR. At GDP per capita in PPS of EU average, there are 4 regions with strong convergence and there is one region with strong divergence. At Disposable income, there is just one region with strong convergence and there are 2 regions with strong divergence. At Value added in services, there are no regions with strong convergence and there are 5 regions with strong divergence.

Table 5-12. Social Cohesion According to IQR

Region	Employment rate	Unemployment rate	Economic activity rate
Baltic	0	0	0
Benelux	0	0	0
Germany	0	-1	0
European monetary union	0	1	0.6
European Union	0	1	1
France	1	1	0
South	0	1	-0.6
mediterreanean	0	0.6	0
agglomerations	0	0.6	0.6
NMS8	0	0	-0.6
British Isles	1	0.6	0.6
Nordic countries	0	0.6	-0.6
southwest	0.6	1	1
Visegrad countries	0	0	-0.6

Above table gives a summary of vergence, as quantified by IQR. At Employment rate, there are 2 regions with strong convergence and there are no regions with strong divergence. At Unemployment rate, there are 5 regions with strong convergence and there is one region with strong divergence. At Economic activity rate, there are 2 regions with strong convergence and there are no regions with strong divergence.

Boxplot Convergence

Below is a summary of vergence in various regions (see Chapter 4) and according to various indicators (as defined in Chapter 2). Boxplot coefficient was described in the Section called *Boxplot Convergence* in Chapter 1 and the Section called *Boxplot Convergence* in Chapter 3.

Overall, boxplot showed strong convergence in 20 cases and weak convergence in 6 in cases. On the other hand, strong divergence according to boxplot was in 11 cases and weak divergence in 12 cases. Remaining 35 cases showed no signs of convergence or divergence. Below table shows convergence and divergence according to boxplot. 1 means strong convergence, 0.6 means weak convergence (as defined in the Section called *Strong and Weak Convergence* in Chapter 3), negative values show divergence.

Table 5-13. Economic Cohesion According to Boxplot

Region	GDP per capita in PPS of EU average	Disposable income	Value added in services
Baltic	1	1	-0.6
Benelux	-1	0	-0.6
Germany	1	1	-0.6
European monetary union	1	1	-0.6
European Union	0.6	-0.6	-0.6
France	0.6	0	0

Region	GDP per capita in PPS of EU average	Disposable income	Value added in services
South	1	0	-0.6
mediterreanean	1	-0.6	-0.6
agglomerations	0.6	0	0
NMS8	0	1	-1
British Isles	0	0	0
Nordic countries	0	0	-1
southwest	0.6	-1	-1
Visegrad countries	-1	-1	0

Above table gives a summary of vergence, as quantified by boxplot. At GDP per capita in PPS of EU average, there are 5 regions with strong convergence and there are 2 regions with strong divergence. At Disposable income, there are 4 regions with strong convergence and there are 2 regions with strong divergence. At Value added in services, there are no regions with strong convergence and there are 3 regions with strong divergence.

Table 5-14. Social Cohesion According to Boxplot

Region	Employment rate	Unemployment rate	Economic activity rate
Baltic	0	0.6	0
Benelux	0	0	0
Germany	0	-1	0
European monetary union	0	1	0
European Union	1	1	1
France	1	0.6	1
South	0	1	-1
mediterreanean	0	1	-0.6
agglomerations	0	0.6	1
NMS8	-0.6	0	0
British Isles	1	0	1
Nordic countries	-0.6	0	-1
southwest	1	1	1
Visegrad countries	0	0	0

Above table gives a summary of vergence, as quantified by boxplot. At Employment rate, there are 4 regions with strong convergence and there are no regions with strong divergence. At Unemployment rate, there are 5 regions with strong convergence and there is one region with strong divergence. At Economic activity rate, there are 5 regions with strong convergence and there are 2 regions with strong divergence.

μ Convergence

Below is a summary of vergence in various regions (see Chapter 4) and according to various indicators (as defined in Chapter 2). μ coefficient was described in the Section called *μ Convergence* in Chapter 1 and the Section called *μ Convergence* in Chapter 3.

Overall, μ showed strong convergence in 14 cases and weak convergence in 12 in cases. On the other hand, strong divergence according to μ was in 10 cases and weak divergence in 9 cases. Remaining 39 cases showed no signs of convergence or divergence. Below table shows convergence and divergence according to μ. 1 means strong convergence, 0.6 means weak convergence (as defined in the Section called *Strong and Weak Convergence* in Chapter 3), negative values show divergence.

Table 5-15. Economic Cohesion According to μ

Region	GDP per capita in PPS of EU average	Disposable income	Value added in services
Baltic	1	1	-1
Benelux	-0.6	1	0
Germany	0	0	0
European monetary union	1	0	-1
European Union	1	0	-1
France	0	0	0
South	-0.6	0	-1
mediterreanean	0	-0.6	-0.6
agglomerations	0	0	-0.6
NMS8	-0.6	0	-0.6
British Isles	-0.6	0.6	0
Nordic countries	1	0.6	-1
southwest	1	1	-1
Visegrad countries	0	-1	-0.6

Above table gives a summary of vergence, as quantified by μ. At GDP per capita in PPS of EU average, there are 5 regions with strong convergence and there are no regions with strong divergence. At Disposable income, there are 3 regions with strong convergence and there is one region with strong divergence. At Value added in services, there are no regions with strong convergence and there are 6 regions with strong divergence.

Table 5-16. Social Cohesion According to μ

Region	Employment rate	Unemployment rate	Economic activity rate
Baltic	0	0	0
Benelux	0	0	0
Germany	0	0.6	0
European monetary union	1	1	0.6
European Union	0.6	0.6	1
France	0.6	0.6	0
South	1	1	0
mediterreanean	1	0.6	0
agglomerations	0	0	1
NMS8	0	0	0
British Isles	0	0	0
Nordic countries	0.6	0	0.6
southwest	1	0	1
Visegrad countries	0	0.6	0.6

Above table gives a summary of vergence, as quantified by μ. At Employment rate, there are 4 regions with strong convergence and there are no regions with strong divergence. At Unemployment rate, there are 2 regions with strong convergence (however, 5 regions have weak convergence) and there are no regions with strong divergence. At Economic activity rate, there are 3 regions with strong convergence and there are no regions with strong divergence.

$\varkappa$ Convergence

Below is a summary of vergence in various regions (see Chapter 4) and according to various indicators (as defined in Chapter 2). $\varkappa$ coefficient was described in the Section called *$\varkappa$ Convergence* in Chapter 1 and the Section called *$\varkappa$ Convergence* in Chapter 3.

Overall, $\varkappa$ showed strong convergence in cases and weak convergence in in cases. On the other hand, strong divergence according to $\varkappa$ was in cases and weak divergence in cases. Remaining cases showed no signs of convergence or divergence. Below table shows convergence and divergence according to $\varkappa$. 1 means strong convergence, 0.6 means weak convergence (as defined in the Section called *Strong and Weak Convergence* in Chapter 3), negative values show divergence.

Table 5-17. Economic Cohesion According to $\varkappa$

Region	GDP per capita in PPS of EU average	Disposable income	Value added in services
Baltic	0.6	0.6	-1
Benelux	-1	0	0
Germany	1	0	0
European monetary union	1	1	-1
European Union	0.6	0	-1
France	0	0	0
South	0	1	-0.6
mediterreanean	0	1	-1
agglomerations	0	0	0
NMS8	0	1	-1
British Isles	0	0.6	0
Nordic countries	0	0	0
southwest	0.6	0	0
Visegrad countries	0	0	0

Above table gives a summary of vergence, as quantified by $\varkappa$. At GDP per capita in PPS of EU average, there are 2 regions with strong convergence and there is one region with strong divergence. At Disposable income, there are 4 regions with strong convergence and there are no regions with strong divergence. At Value added in services, there are no regions with strong convergence and there are 5 regions with strong divergence.

Table 5-18. Social Cohesion According to $\varkappa$

Region	Employment rate	Unemployment rate	Economic activity rate
Baltic	0	0	0
Benelux	0	0	0
Germany	0	0	0
European monetary union	0	0	0
European Union	1	0	-0.6
France	1	0	0.6
South	0	0	0
mediterreanean	1	0	0.6
agglomerations	0	0	0
NMS8	0	0	0
British Isles	0	0	0

Region	Employment rate	Unemployment rate	Economic activity rate
Nordic countries	0	0	0
southwest	1	0	0.6
Visegrad countries	0	0	0

Above table gives a summary of vergence, as quantified by $\varkappa$. At Employment rate, there are 4 regions with strong convergence and there are no regions with strong divergence. At Unemployment rate, there are no regions with strong convergence and there are no regions with strong divergence. At Economic activity rate, there are no regions with strong convergence and there are no regions with strong divergence.

Skewness Convergence

Below is a summary of vergence in various regions (see Chapter 4) and according to various indicators (as defined in Chapter 2). Skewness coefficient was described in the Section called *Skewness Convergence* in Chapter 1 and the Section called *Skewness Convergence* in Chapter 3.

Overall, skewness showed strong convergence in cases and weak convergence in in cases. On the other hand, strong divergence according to skewness was in cases and weak divergence in cases. Remaining cases showed no signs of convergence or divergence. Below table shows convergence and divergence according to skewness. 1 means strong convergence, 0.6 means weak convergence (as defined in the Section called *Strong and Weak Convergence* in Chapter 3), negative values show divergence.

Table 5-19. Economic Cohesion According to Skewness

Region	GDP per capita in PPS of EU average	Disposable income	Value added in services
Baltic	0.6	-1	-1
Benelux	-1	0	0
Germany	1	0	0
European monetary union	0.6	-1	-1
European Union	1	-0.6	-1
France	0	0.6	-1
South	-1	-1	-1
mediterreanean	-1	-1	-1
agglomerations	1	1	0
NMS8	0	0.6	0
British Isles	1	0.6	-0.6
Nordic countries	0.6	0	-1
southwest	1	-0.6	-1
Visegrad countries	0	0	0.6

Above table gives a summary of vergence, as quantified by skewness. At GDP per capita in PPS of EU average, there are 5 regions with strong convergence and there are 3 regions with strong divergence. At Disposable income, there is just one region with strong convergence and there are 4 regions with strong divergence. At Value added in services, there are no regions with strong convergence and there are 8 regions with strong divergence.

Table 5-20. Social Cohesion According to Skewness

Region	Employment rate	Unemployment rate	Economic activity rate
Baltic	-0.6	-0.6	0
Benelux	0	0	0

Region	Employment rate	Unemployment rate	Economic activity rate
Germany	0	1	0
European monetary union	0	0.6	-0.6
European Union	0	0	0
France	0.6	0	0
South	-1	0	-1
mediterreanean	0.6	0	0
agglomerations	0	0	0
NMS8	0	0	1
British Isles	0	0	-0.6
Nordic countries	0.6	0	0.6
southwest	0	-1	0.6
Visegrad countries	0	0	1

Above table gives a summary of vergence, as quantified by skewness. At Employment rate, there are no regions with strong convergence and there is one region with strong divergence. At Unemployment rate, there is just one region with strong convergence and there is one region with strong divergence. At Economic activity rate, there are 2 regions with strong convergence and there is one region with strong divergence.

Kurtosis Convergence

Below is a summary of vergence in various regions (see Chapter 4) and according to various indicators (as defined in Chapter 2). Kurtosis coefficient was described in the Section called *Kurtosis Convergence* in Chapter 1 and the Section called *Kurtosis Convergence* in Chapter 3.

Overall, kurtosis showed strong convergence in 15 cases and weak convergence in 6 in cases. On the other hand, strong divergence according to kurtosis was in 12 cases and weak divergence in 7 cases. Remaining 44 cases showed no signs of convergence or divergence. Below table shows convergence and divergence according to kurtosis. 1 means strong convergence, 0.6 means weak convergence (as defined in the Section called *Strong and Weak Convergence* in Chapter 3), negative values show divergence.

Table 5-21. Economic Cohesion According to Kurtosis

Region	GDP per capita in PPS of EU average	Disposable income	Value added in services
Baltic	-1	0	1
Benelux	1	0	-1
Germany	0	-0.6	0
European monetary union	-1	-0.6	1
European Union	-1	0	1
France	0.6	1	0
South	1	1	1
mediterreanean	1	1	1
agglomerations	-1	1	0
NMS8	-0.6	-1	0
British Isles	-1	1	1
Nordic countries	-1	0	1
southwest	-1	-1	1
Visegrad countries	-1	0	-0.6

Above table gives a summary of vergence, as quantified by kurtosis. At GDP per capita in PPS of EU average, there are 3 regions with strong convergence and there are 8 regions with strong divergence. At Disposable income, there are 5 regions with strong convergence and there are 2 regions with strong divergence. At Value added in services, there are 8 regions with strong convergence and there is one region with strong divergence.

Table 5-22. Social Cohesion According to Kurtosis

Region	Employment rate	Unemployment rate	Economic activity rate
Baltic	0	0	0
Benelux	0	0	0
Germany	0	1	0
European monetary union	0	0	0
European Union	0	0	0
France	0.6	0	0
South	0.6	-0.6	0.6
mediterreanean	0	-0.6	0
agglomerations	0	0	0
NMS8	0	0	0.6
British Isles	0	-0.6	0
Nordic countries	0	0	1
southwest	0	-0.6	0
Visegrad countries	0	0	0.6

Above table gives a summary of vergence, as quantified by kurtosis. At Employment rate, there are no regions with strong convergence and there are no regions with strong divergence. At Unemployment rate, there is just one region with strong convergence and there are no regions with strong divergence. At Economic activity rate, there is just one region with strong convergence and there are no regions with strong divergence.

Convergence Summary

Table 5-23. Comparison of Metrics

metric	strong conv	weak conv	noconv	weak div	strong div
Theil	30	9	34	3	8
entropy	30	8	34	4	8
sigma	30	10	34	2	8
Gini	27	8	36	4	9
boxplot	20	6	35	12	11
kurtosis	15	6	44	7	12
μ	14	12	39	9	10
IQR	13	14	35	9	13
beta	5	4	32	12	31
beta3	5	4	32	12	31
beta2	5	4	32	12	31

The most optimistic are Theil, entropy and sigma, the most pesimistic are beta, beta3 and beta2. kurtosis usually shows neither convergence nor divergence.

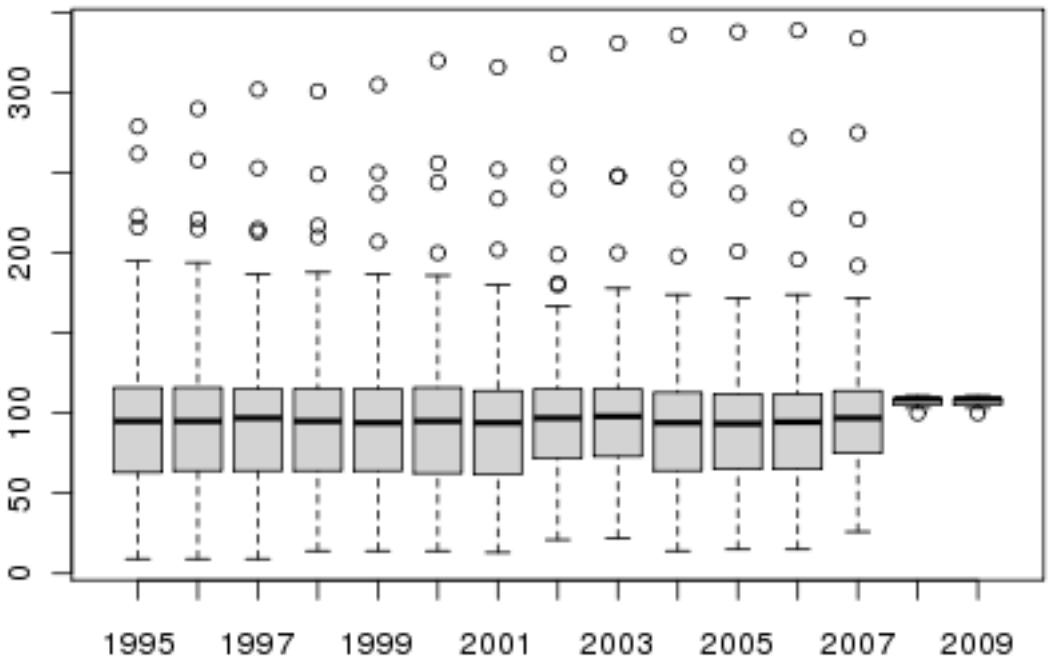
Coefficients of Cohesion

In this work, we use seven coefficients to measure economic and social cohesion. These were described in Chapter 2. These seven coefficients represent various aspects of social and economic cohesion.

GDP Per Capita in PPS of EU Average Convergence

GDP per capita in PPS of EU average convergence is described in the Section called *Gross Domestic Product* in Chapter 2.

Figure 5-1. GDP per capita in PPS of EU average Box and Whisker plot



Outliers are represented by circles outside whiskers. Common outliers above the average are Inner London (317), Brussels (248), Luxembourg (Grand-Duché) (246), Hamburg (204), Vienna (187), Southern and Eastern (161), North Eastern Scotland (159), Åland (149), Prov. Antwerpen (148) and País Vasco (130). Regions well below the average are Norte (60), Centro (P) (64) and Itä-Suomi (85).

Map in Figure 5-2 shows values of GDP per capita in PPS of EU average in European NUTS regions. Darker colours mean lower values, lighter colours mean higher values. White colour is missing value or region outside of EU.

Figure 5-2. Map of GDP per capita in PPS of EU average distribution

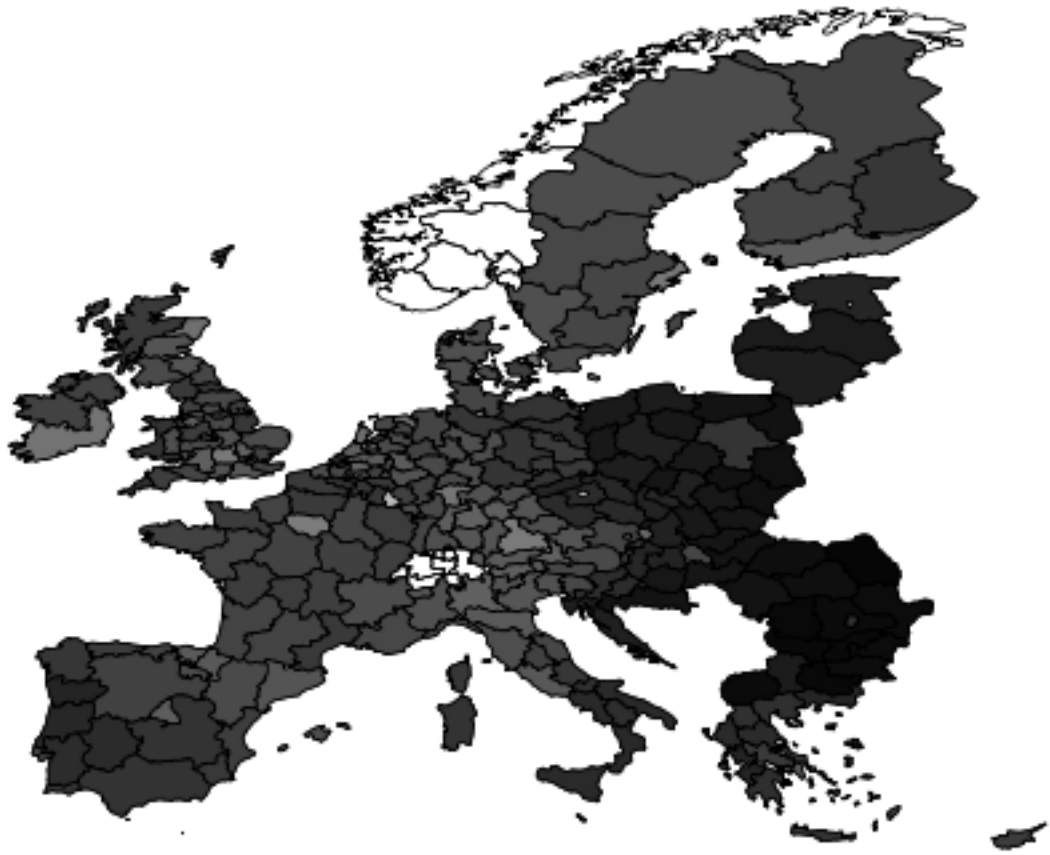


Table 5-24. GDP Per Capita in PPS of EU Average, Basic Indicators

year	mean	variance	count	min	max
year 1995	91.0	42.5	297	9	279
year 1996	90.9	42.2	297	9	290
year 1997	91.2	42.0	293	9	302
year 1998	91.6	40.6	297	14	301
year 1999	91.3	41.3	297	14	305
year 2000	91.5	41.8	303	14	320
year 2001	90.1	41.4	301	13	316
year 2002	95.7	38.8	277	21	324
year 2003	95.8	38.4	277	22	331
year 2004	90.7	40.6	303	14	336
year 2005	91.1	40.1	308	15	338
year 2006	91.4	39.7	308	15	339
year 2007	96.2	36.8	282	26	334
year 2008	107.0	4.0	7	100	111
year 2009	107.0	4.0	7	100	111

Where variance is the spread of variable, mean is arithmetic average, count is number of regions in sample, min and max are minimum and maximum value in sample.

Table 5-25. Convergence of GDP Per Capita in PPS of EU Average

Region	sigma	IQR	μ	kurtosis	beta
Baltic	1	1	1	-1	0.6
Benelux	-1	-1	-0.6	1	-1
Germany	1	0.6	0	0	1
European monetary union	1	1	1	-1	0.6
European Union	1	1	1	-1	1
France	1	0	0	0.6	0
South	1	0	-0.6	1	0
mediterreanean	1	0	0	1	0
agglomerations	-1	0	0	-1	0
NMS8	0	0	-0.6	-0.6	-1
British Isles	-1	-0.6	-0.6	-1	-1
Nordic countries	0	0	1	-1	0
southwest	1	1	1	-1	0
Visegrad countries	0	0	0	-1	-1

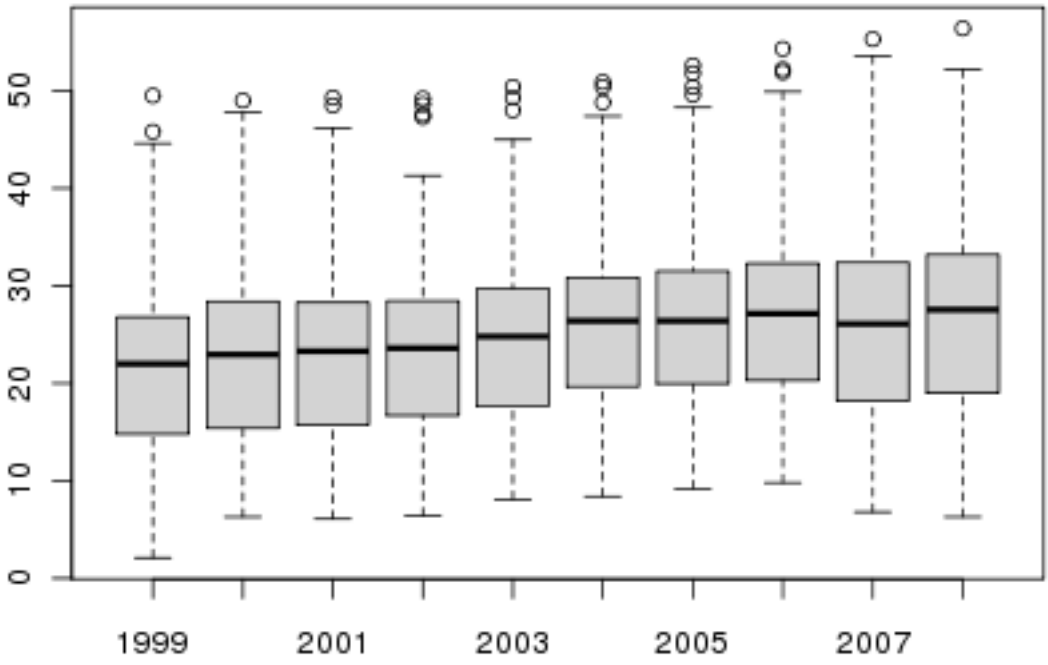
where 1 means strong convergence, 0.6 means weak convergence, negative value mean divergence, as described in the Section called *Strong and Weak Convergence* in Chapter 3.

GDP per capita in PPS of EU average does not behave significantly different than other measurements of cohesion, removing it did not significantly change correlations.

Share of Employees with University Degree Convergence

Share of employees with university degree convergence is described in the Section called *Percentage of Working Population with University Degree* in Chapter 2.

Figure 5-3. Share of employees with university degree Box and Whisker plot



Outliers are represented by circles outside whiskers. Common outliers above the average are Inner London (51), Brussels (50), Prov. Brabant Wallon (50), País Vasco (45), Lithuania (39), Dresden (38) and Eesti (35). Regions well below the average are Região Autónoma da Madeira (6), Algarve (7), Região Autónoma dos Açores (8), Norte (9), Centro (P) (9) and Alentejo (9).

Map in Figure 5-4 shows values of Share of employees with university degree in European NUTS regions. Darker colours mean lower values, lighter colours mean higher values. White colour is missing value or region outside of EU.

Figure 5-4. Map of Share of employees with university degree distribution

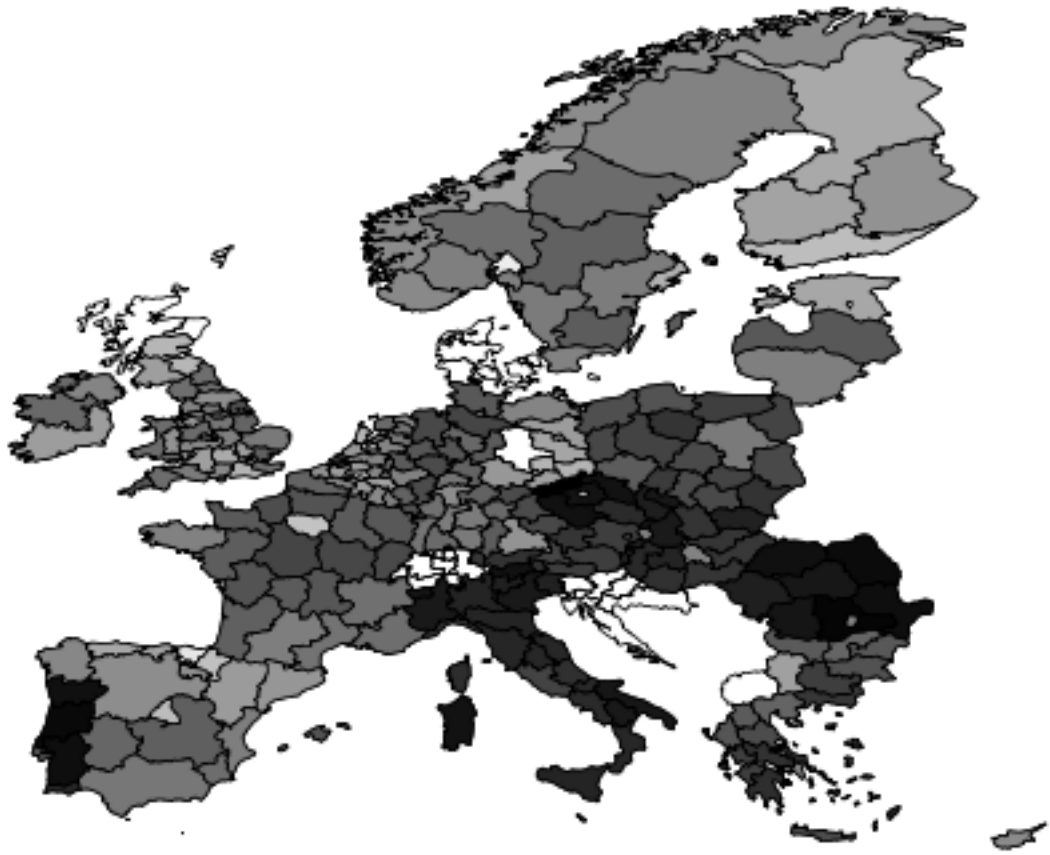


Table 5-26. Share of Employees with University Degree, Basic Indicators

year	mean	variance	count	min	max
year 1999	21.0	9.2	255	2.1	49.5
year 2000	22.4	8.9	260	6.3	49
year 2001	23.0	8.4	260	6.1	49.3
year 2002	23.3	8.4	263	6.4	49.2
year 2003	24.3	8.5	269	8.1	50.4
year 2004	25.7	8.5	271	8.4	50.9
year 2005	26.2	8.6	271	9.2	52.6
year 2006	26.6	8.6	270	9.8	54.3
year 2007	25.8	9.4	302	6.8	55.3
year 2008	26.7	9.4	306	6.3	56.4

Where variance is the spread of variable, mean is arithmetic average, count is number of regions in sample, min and max are minimum and maximum value in sample.

Table 5-27. Convergence of Share of Employees with University Degree

Region	sigma	IQR	μ	kurtosis	beta
Baltic	1	0	0	0	0
Benelux	1	0.6	0.6	-1	1
Germany	0	-1	-1	0.6	-1

Region	sigma	IQR	μ	kurtosis	beta
European monetary union	1	-1	0	0	-1
European Union	1	0	0	0	-1
France	0	-1	0	0	0
South	1	0.6	0	-1	-1
mediterreanean	1	0.6	0	0	-1
agglomerations	1	0	1	0	0
NMS8	0	-1	0	1	-1
British Isles	0.6	0	0.6	0	0
Nordic countries	0	0	0	-0.6	0
southwest	1	-1	0	0	-1
Visegrad countries	-1	-1	-1	-1	-1

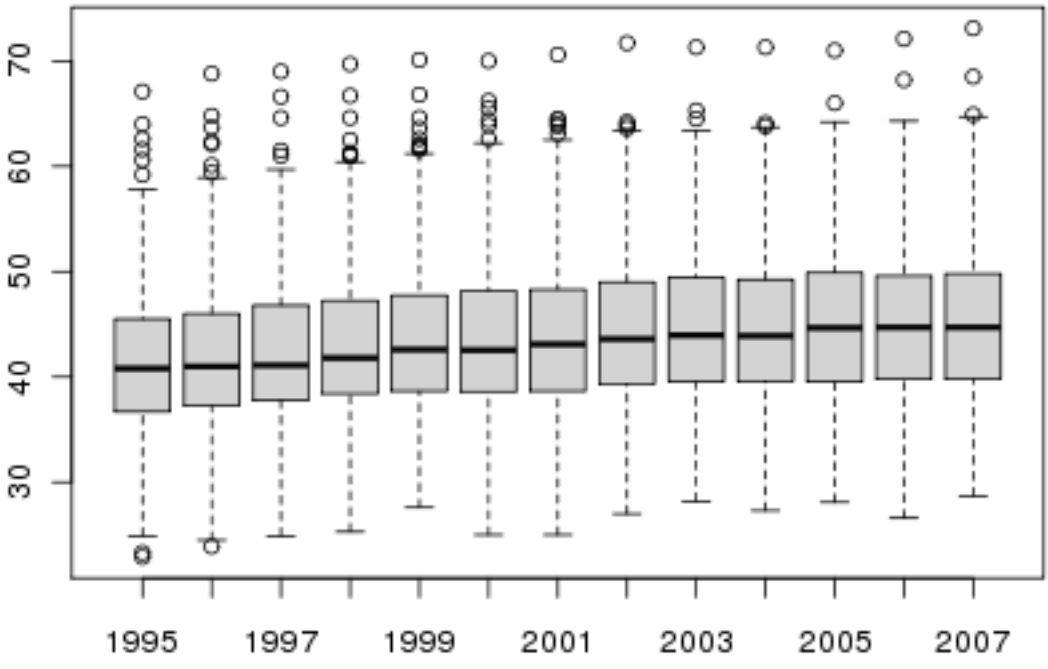
where 1 means strong convergence, 0.6 means weak convergence, negative value mean divergence, as described in the Section called *Strong and Weak Convergence* in Chapter 3.

Removing Share of employees with university degree from analysis positively changes correlation between metrics in several cases. More specifically between Gini and beta to 0.52 (by 0.174), between sigma and beta to 0.421 (by 0.169), between Theil and beta to 0.465 (by 0.164), between entropy and beta to 0.467 (by 0.158), between Gini and boxplot to 0.719 (by 0.089), between sigma and boxplot to 0.591 (by 0.082), between boxplot and Theil to 0.619 (by 0.075), between $\varkappa$ and beta to 0.403 (by 0.073) and between entropy and boxplot to 0.63 (by 0.071).

Value Added in Services Convergence

Value added in services convergence is described in the Section called *Value Added in Services* in Chapter 2.

Figure 5-5. Value added in services Box and Whisker plot



Outliers are represented by circles outside whiskers. Common outliers above the average are Inner London (70), Notio Aigaio (65), Luxembourg (Grand-Duché) (64), Illes Balears (64), Prague (63), Brussels (62), Prov. Vlaams-Brabant

(61), Attiki (61), Surrey, East and West Sussex (60) and Ionia Nisia (59). Regions well below the average are Border, Midland and Western (27), Sterea Ellada (28), Groningen (30) and Braunschweig (35).

Map in Figure 5-6 shows values of Value added in services in European NUTS regions. Darker colours mean lower values, lighter colours mean higher values. White colour is missing value or region outside of EU.

Figure 5-6. Map of Value added in services distribution

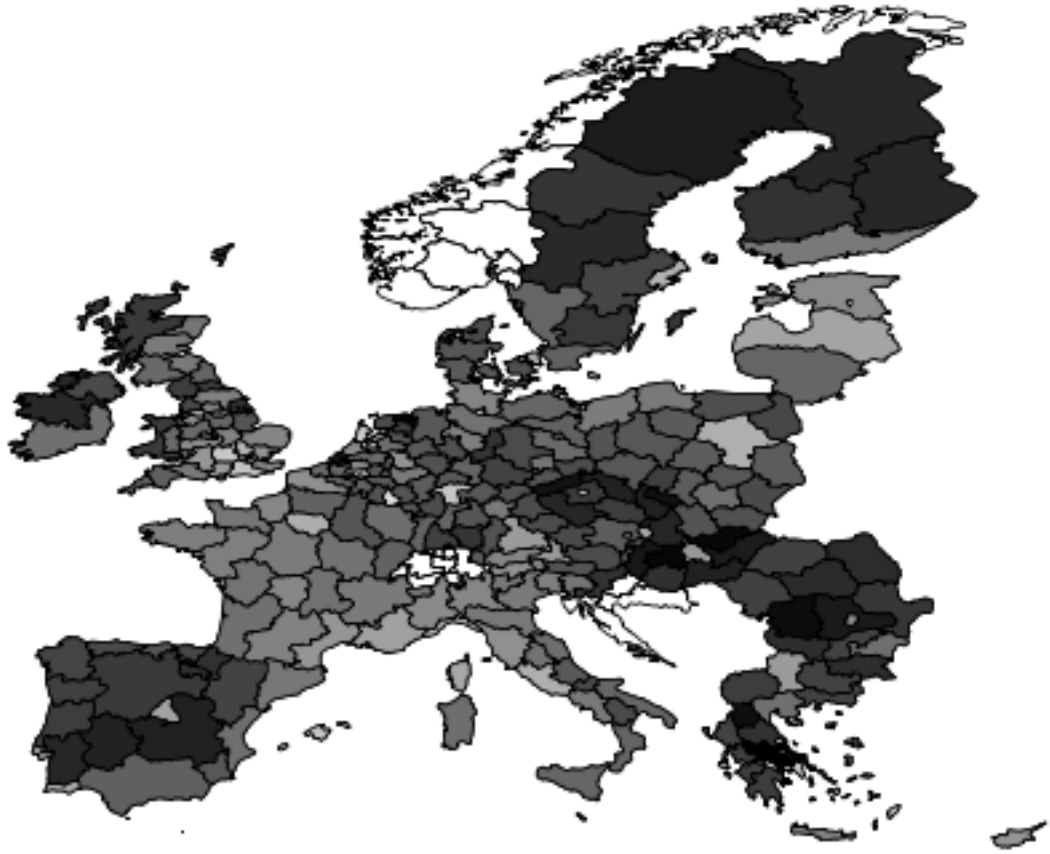


Table 5-28. Value Added in Services, Basic Indicators

year	mean	variance	count	min	max
year 1995	41.8	7.8	230	22.9	67.1
year 1996	42.3	7.6	271	23.9	68.8
year 1997	42.8	7.7	268	24.9	69
year 1998	43.4	7.7	271	25.3	69.7
year 1999	43.9	7.7	271	27.6	70.1
year 2000	43.9	8.0	272	25	70
year 2001	44.2	8.0	272	25	70.6
year 2002	44.7	7.8	272	27	71.7
year 2003	44.9	7.9	272	28.2	71.3
year 2004	44.8	8.0	272	27.3	71.3
year 2005	45.3	7.9	272	28.1	71
year 2006	45.2	8.0	272	26.6	72.1
year 2007	45.3	8.0	272	28.7	73.1

Where variance is the spread of variable, mean is arithmetic average, count is number of regions in sample, min and

max are minimum and maximum value in sample.

Table 5-29. Convergence of Value Added in Services

Region	sigma	IQR	μ	kurtosis	beta
Baltic	0	-1	-1	1	-0.6
Benelux	0	-0.6	0	-1	0
Germany	0.6	-1	0	0	0
European monetary union	0.6	-0.6	-1	1	-1
European Union	0.6	-1	-1	1	-1
France	1	0.6	0	0	0
South	-0.6	0	-1	1	-1
mediterreanean	-0.6	-0.6	-0.6	1	-0.6
agglomerations	-1	0	-0.6	0	-1
NMS8	-1	-0.6	-0.6	0	-1
British Isles	0.6	0	0	1	0
Nordic countries	0	-1	-1	1	-0.6
southwest	0	-1	-1	1	-1
Visegrad countries	-1	-0.6	-0.6	-0.6	-1

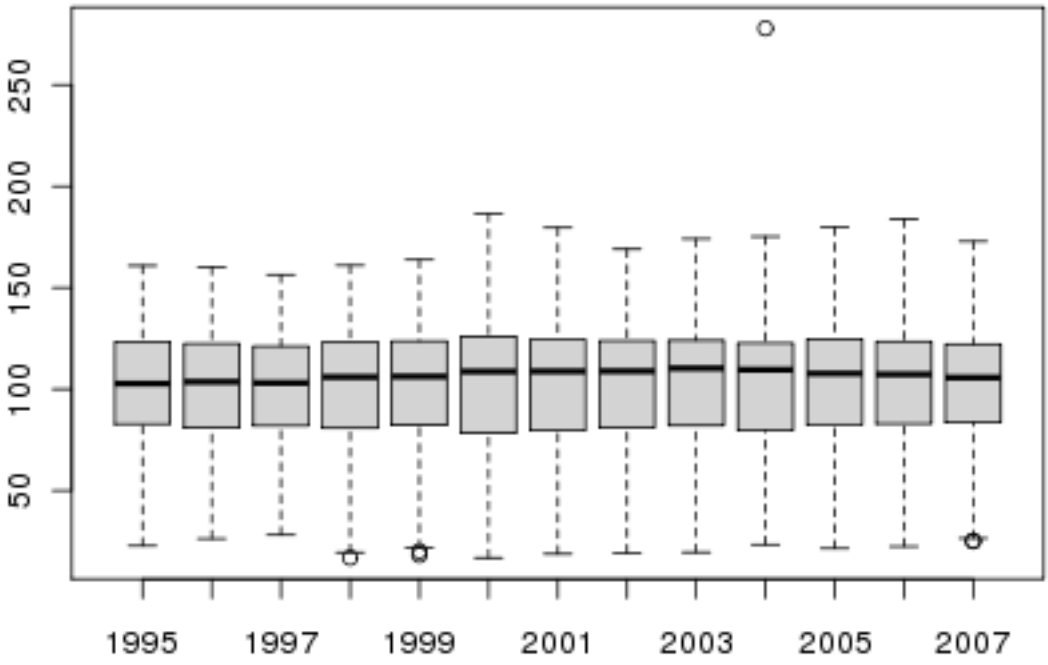
where 1 means strong convergence, 0.6 means weak convergence, negative value mean divergence, as described in the Section called *Strong and Weak Convergence* in Chapter 3.

Value added in services does not behave significantly different than other measurements of cohesion, removing it did not significantly change correlations.

Disposable Income Convergence

Disposable income convergence is described in the Section called *Disposable Income* in Chapter 2.

Figure 5-7. Disposable income Box and Whisker plot



Outliers are represented by circles outside whiskers. Common outliers above the average are Emilia-Romagna (158), Prov. Vlaams-Brabant (142), Prov. Brabant Wallon (137), Western Slovenia (88) and Eastern Slovenia (77). Regions well below the average are Nord - Pas-de-Calais (97) and Corse (101).

Map in Figure 5-8 shows values of Disposable income in European NUTS regions. Darker colours mean lower values, lighter colours mean higher values. White colour is missing value or region outside of EU.

Figure 5-8. Map of Disposable income distribution

Table 5-30. Disposable Income, Basic Indicators

year	mean	variance	count	min	max
year 1995	100.0	30.9	232	22.77	160.86
year 1996	100.0	30.4	236	26.31	160.3
year 1997	100.0	29.2	232	28.13	156.43
year 1998	100.0	32.4	244	16.89	160.99
year 1999	100.0	32.0	244	18.25	163.79
year 2000	100.0	35.2	266	16.85	186.53
year 2001	100.0	34.7	257	18.8	179.59
year 2002	100.0	33.7	259	19.3	169.03
year 2003	100.0	33.8	259	19.58	174.1
year 2004	100.0	34.5	266	23.42	277.82
year 2005	100.0	32.6	264	21.47	179.85
year 2006	100.0	31.8	264	22.44	183.78
year 2007	100.0	30.0	264	24.99	172.87

Where variance is the spread of variable, mean is arithmetic average, count is number of regions in sample, min and max are minimum and maximum value in sample.

Table 5-31. Convergence of Disposable Income

Region	sigma	IQR	μ	kurtosis	beta

Region	sigma	IQR	μ	kurtosis	beta
Baltic	1	0	1	0	
Benelux	1	0	1	0	
Germany	0.6	0.6	0	-0.6	
European monetary union	1	1	0	-0.6	
European Union	0	0	0	0	
France	0.6	0	0	1	
South	1	-0.6	0	1	
mediterreanean	1	-1	-0.6	1	
agglomerations	0	0.6	0	1	
NMS8	0	0.6	0	-1	
British Isles	0	-1	0.6	1	
Nordic countries	0	0	0.6	0	
southwest	0	0	1	-1	
Visegrad countries	0	0	-1	0	

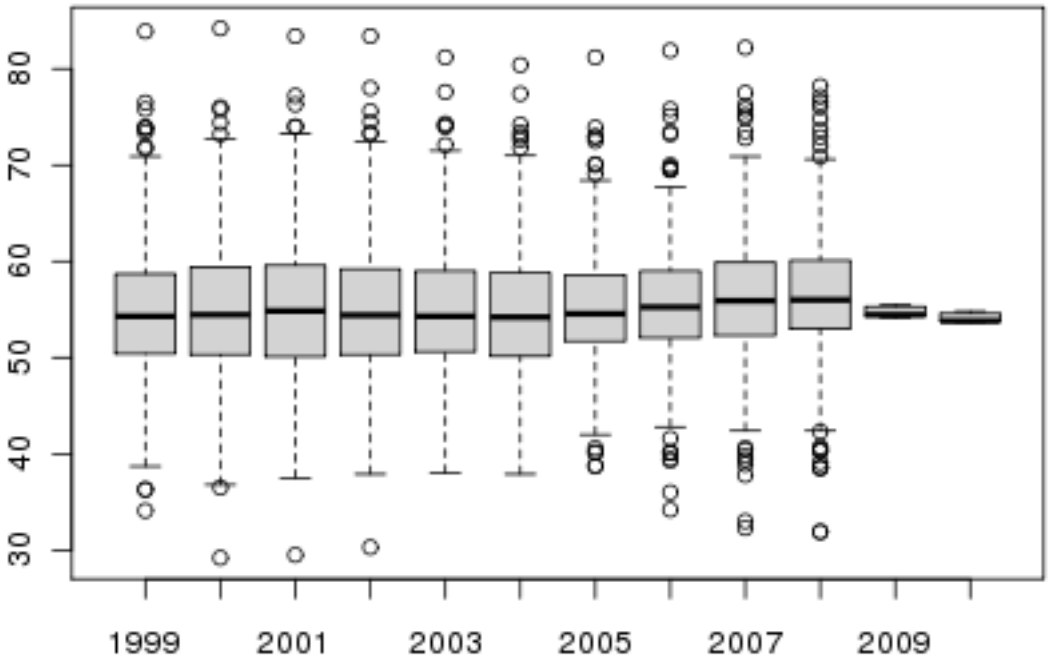
where 1 means strong convergence, 0.6 means weak convergence, negative value mean divergence, as described in the Section called *Strong and Weak Convergence* in Chapter 3.

Removing Disposable income from analysis positively changes correlation between metrics in several cases. More specifically between IQR and μ to 0.64 (by 0.098), between μ and $\varkappa$ to 0.521 (by 0.094), between IQR and $\varkappa$ to 0.499 (by 0.083), between IQR and Theil to 0.602 (by 0.078), between Gini and IQR to 0.717 (by 0.077), between Gini and μ to 0.639 (by 0.077), between sigma and IQR to 0.552 (by 0.076), between entropy and IQR to 0.616 (by 0.074) and between entropy and μ to 0.604 (by 0.072).

Employment Rate Convergence

Employment rate convergence is described in the Section called *Employment Rate* in Chapter 2.

Figure 5-9. Employment rate Box and Whisker plot



Outliers are represented by circles outside whiskers. Common outliers above the average are Stockholm (77), Västsverige (73), Flevoland (68), Centro (P) (68) and Cyprus (65). Regions well below the average are Corse (34), Sicilia (38), Calabria (38), Campania (39) and Puglia (40).

Map in Figure 5-10 shows values of Employment rate in European NUTS regions. Darker colours mean lower values, lighter colours mean higher values. White colour is missing value or region outside of EU.

Figure 5-10. Map of Employment rate distribution

Table 5-32. Employment Rate, Basic Indicators

year	mean	variance	count	min	max
year 1999	54.8	7.7	253	34.1	83.9
year 2000	55.0	7.7	254	29.2	84.2
year 2001	55.3	7.8	270	29.5	83.4
year 2002	55.1	7.5	273	30.3	83.4
year 2003	55.0	7.1	280	38	81.2
year 2004	54.9	6.9	282	37.9	80.4
year 2005	55.3	6.6	270	38.7	81.2
year 2006	55.4	6.8	296	34.2	81.9
year 2007	56.1	7.3	321	32.3	82.2
year 2008	56.2	7.2	310	31.9	78.2

Where variance is the spread of variable, mean is arithmetic average, count is number of regions in sample, min and max are minimum and maximum value in sample.

Table 5-33. Convergence of Employment Rate

Region	sigma	IQR	μ	kurtosis	beta
Baltic	0	0	0	0	0
Benelux	0	0	0	0	-0.6
Germany	0	0	0	0	-1

Region	sigma	IQR	μ	kurtosis	beta
European monetary union	1	0	1	0	0
European Union	1	0	0.6	0	0
France	1	1	0.6	0.6	0
South	1	0	1	0.6	0
mediterreanean	0	0	1	0	-1
agglomerations	0	0	0	0	0
NMS8	0	0	0	0	-1
British Isles	0.6	1	0	0	-0.6
Nordic countries	0	0	0.6	0	0
southwest	1	0.6	1	0	0.6
Visegrad countries	0	0	0	0	-1

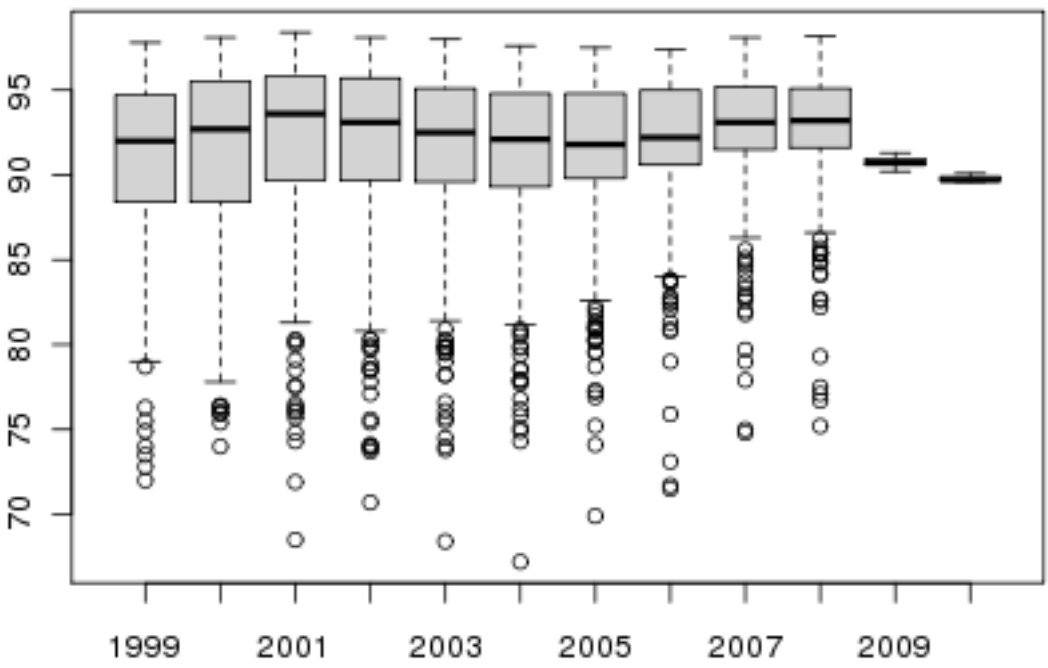
where 1 means strong convergence, 0.6 means weak convergence, negative value mean divergence, as described in the Section called *Strong and Weak Convergence* in Chapter 3.

Employment rate does not behave significantly different than other measurements of cohesion, removing it did not significantly change correlations.

Unemployment Rate Convergence

Unemployment rate convergence is described in the Section called *Unemployment Rate* in Chapter 2.

Figure 5-11. Unemployment rate Box and Whisker plot



Outliers are represented by circles outside whiskers. Common outliers above the average are . Regions well below the average are Calabria (75), Dolnoslaskie (75), Zachodniopomorskie (76), Warminsko-Mazurskie (76), Lubuskie (77), Corse (78), Campania (78), Eastern Slovakia (78), Ciudad Autónoma de Ceuta (78) and Sicilia (79).

Map in Figure 5-12 shows values of Unemployment rate in European NUTS regions. Darker colours mean lower values, lighter colours mean higher values. White colour is missing value or region outside of EU.

Figure 5-12. Map of Unemployment rate distribution

Table 5-34. Unemployment Rate, Basic Indicators

year	mean	variance	count	min	max
year 1999	90.9	5.1	253	72	97.8
year 2000	91.3	5.3	255	74	98.1
year 2001	91.7	5.7	258	68.5	98.4
year 2002	91.4	5.7	261	70.7	98.1
year 2003	91.2	5.4	270	68.4	98
year 2004	90.9	5.3	272	67.2	97.6
year 2005	91.2	5.0	268	69.9	97.5
year 2006	91.9	4.4	294	71.5	97.4
year 2007	92.8	3.8	319	74.8	98.1
year 2008	92.8	3.7	308	75.2	98.2

Where variance is the spread of variable, mean is arithmetic average, count is number of regions in sample, min and max are minimum and maximum value in sample.

Table 5-35. Convergence of Unemployment Rate

Region	sigma	IQR	μ	kurtosis	beta
Baltic	0	0	0	0	0

Region	sigma	IQR	μ	kurtosis	beta
Benelux	0	0	0	0	0.6
Germany	0	-1	0.6	1	0
European monetary union	1	1	1	0	-1
European Union	1	1	0.6	0	0
France	1	1	0.6	0	0
South	1	1	1	-0.6	-0.6
mediterreanean	1	0.6	0.6	-0.6	-0.6
agglomerations	0	0.6	0	0	0
NMS8	0	0	0	0	1
British Isles	0	0.6	0	-0.6	0.6
Nordic countries	0.6	0.6	0	0	0
southwest	0	1	0	-0.6	0
Visegrad countries	0	0	0.6	0	1

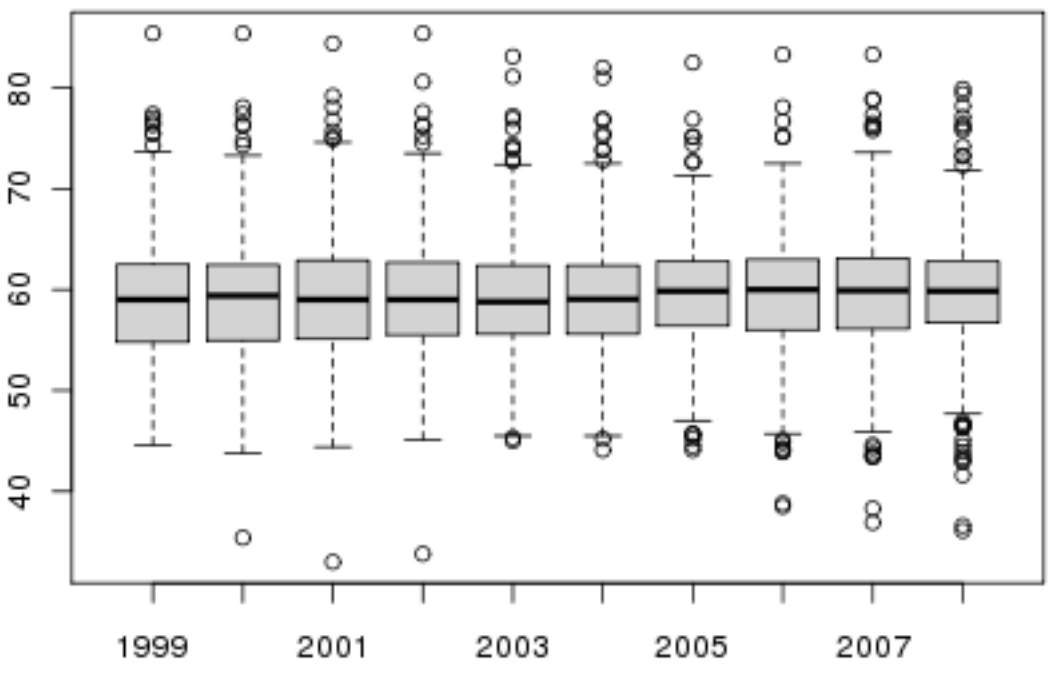
where 1 means strong convergence, 0.6 means weak convergence, negative value mean divergence, as described in the Section called *Strong and Weak Convergence* in Chapter 3.

Removing Unemployment rate from analysis positively changes correlation between metrics in several cases. More specifically between entropy and beta to 0.405 (by 0.096), between Gini and beta to 0.438 (by 0.092), between μ and beta to 0.555 (by 0.083), between boxplot and beta to 0.631 (by 0.071), between boxplot and $\varkappa$ to 0.408 (by 0.065), between IQR and $\varkappa$ to 0.481 (by 0.065), between Gini and $\varkappa$ to 0.579 (by 0.053), between entropy and $\varkappa$ to 0.561 (by 0.048) and between Theil and $\varkappa$ to 0.529 (by 0.045).

Economic Activity Rate Convergence

Economic activity rate convergence is described in the Section called *Economic Activity Rate* in Chapter 2.

Figure 5-13. Economic activity rate Box and Whisker plot



Outliers are represented by circles outside whiskers. Common outliers above the average are Stockholm (80), Västsverige (76), Småland med öarna (75), Östra Mellansverige (73), Flevoland (71), Centro (P) (70) and Cyprus (67). Regions well below the average are Corse (39), Sicilia (44), Calabria (44), Campania (44), Puglia (44), Molise (46), Basilicata (47), Eszak-Magyarorszag (48), Eszak-Alfold (48) and Del-Dunantul (50).

Map in Figure 5-14 shows values of Economic activity rate in European NUTS regions. Darker colours mean lower values, lighter colours mean higher values. White colour is missing value or region outside of EU.

Figure 5-14. Map of Economic activity rate distribution

Table 5-36. Economic Activity Rate, Basic Indicators

year	mean	variance	count	min	max
year 1999	59.1	6.7	257	44.6	85.4
year 2000	59.1	6.7	259	35.4	85.4
year 2001	59.2	6.9	270	33	84.4
year 2002	59.2	6.5	273	33.8	85.4
year 2003	59.3	6.1	280	45	83.1
year 2004	59.4	6.0	282	44.1	82
year 2005	59.6	5.6	270	44.1	82.5
year 2006	59.4	6.3	296	38.5	83.3
year 2007	59.6	6.7	321	36.9	83.3
year 2008	59.7	6.5	310	36.1	79.9

Where variance is the spread of variable, mean is arithmetic average, count is number of regions in sample, min and max are minimum and maximum value in sample.

Table 5-37. Convergence of Economic Activity Rate

Region	sigma	IQR	μ	kurtosis	beta
Baltic	0	0	0	0	-0.6
Benelux	0	0	0	0	-0.6
Germany	1	0	0	0	-0.6
European monetary union	0	0.6	0.6	0	-1
European Union	1	1	1	0	0
France	1	0	0	0	-0.6
South	-1	-0.6	0	0.6	-1
mediterreanean	0	0	0	0	-1
agglomerations	0.6	0.6	1	0	0
NMS8	1	-0.6	0	0.6	-1
British Isles	1	0.6	0	0	-1
Nordic countries	-0.6	-0.6	0.6	1	-0.6
southwest	1	1	1	0	0
Visegrad countries	1	-0.6	0.6	0.6	-1

where 1 means strong convergence, 0.6 means weak convergence, negative value mean divergence, as described in the Section called *Strong and Weak Convergence* in Chapter 3.

Removing Economic activity rate from analysis positively changes correlation between metrics in several cases. More specifically between entropy and $\varkappa$ to 0.581 (by 0.068), between Theil and $\varkappa$ to 0.551 (by 0.067), between μ and $\varkappa$ to 0.491 (by 0.064), between Gini and $\varkappa$ to 0.589 (by 0.063), between IQR and $\varkappa$ to 0.474 (by 0.058) and between sigma and $\varkappa$ to 0.48 (by 0.053).

Regions

Convergence is measured in several regions of Europe. These regions were described in Chapter 4.

In each region we will briefly describe convergence or divergence according to several chosen parametres. In most of the regions it is visible, that these parameters do not have common development. Therefore we include analysis which briefly shows whether removing this region from analysis changes correlation between metrics.

Region Agglomerations

Region agglomerations was closely described in the Section called *Region Agglomerations* in Chapter 4.

Table 5-38. Convergence in Agglomerations

variable	sigma	IQR	μ	kurtosis	beta
GDP per capita in PPS of EU average	-1	0	0	-1	0
Employment rate	0	0	0	0	0
Economic activity rate	0.6	0.6	1	0	0

variable	sigma	IQR	μ	kurtosis	beta
Share of employees with university degree	1	0	1	0	0
Value added in services	-1	0	-0.6	0	-1
Unemployment rate	0	0.6	0	0	0
Disposable income	0	0.6	0	1	

The above table shows summary of regions convergence and divergence in agglomerations. Out of 66 observations, 8 show strong convergence, 11 show strong divergence and 39 show neither convergence nor divergence. In economic cohesion, overall divergence occurs, however it is not proven by all parametres. Neither overall convergence nor divergence was proven in social cohesion, overall cohesion and discussed cohesion. In the field of GDP per capita in PPS of EU average there is weak divergence (proven by the development of sigma and kurtosis). In the field of Employment rate there is neither convergence, nor divergence. In the field of Economic activity rate there is weak convergence (proven by the development of sigma, IQR and μ). In the field of Share of employees with university degree there is weak convergence (proven by the development of sigma and μ). In the field of Value added in services there is weak divergence (proven by the development of sigma, μ and beta). In the field of Unemployment rate there is neither convergence, nor divergence. In the field of Disposable income there is strong divergence (proven by the development of IQR and kurtosis).

Removing agglomerations from analysis positively changes correlation between metrics in several cases. More specifically between sigma and boxplot to 0.565 (by 0.056), between entropy and boxplot to 0.615 (by 0.056), between boxplot and Theil to 0.598 (by 0.054), between Gini and boxplot to 0.678 (by 0.048), between μ and skewness to 0.414 (by 0.048), between μ and beta to 0.514 (by 0.042), between Gini and IQR to 0.68 (by 0.04), between IQR and μ to 0.58 (by 0.038) and between sigma and IQR to 0.514 (by 0.038).

Region Mediterreanean

Region mediterreanean was closely described in the Section called *Region Mediterreanean* in Chapter 4.

Table 5-39. Convergence in Mediterreanean

variable	sigma	IQR	μ	kurtosis	beta
GDP per capita in PPS of EU average	1	0	0	1	0
Employment rate	0	0	1	0	-1
Economic activity rate	0	0	0	0	-1
Share of employees with university degree	1	0.6	0	0	-1
Value added in services	-0.6	-0.6	-0.6	1	-0.6
Unemployment rate	1	0.6	0.6	-0.6	-0.6
Disposable income	1	-1	-0.6	1	

The above table shows summary of regions convergence and divergence in mediterreanean. Out of 66 observations, 11 show strong convergence, 9 show strong divergence and 22 show neither convergence nor divergence. Neither overall convergence nor divergence was proven in economic cohesion, social cohesion, overall cohesion and discussed cohesion. In the field of GDP per capita in PPS of EU average there is weak convergence (proven by the development of sigma and kurtosis). In the field of Employment rate there is neither convergence, nor divergence. In the field of Economic activity rate there is neither convergence, nor divergence. In the field of Share of employees with university degree there is neither convergence, nor divergence. In the field of Value added in services there is weak divergence (proven by the development of sigma, IQR, μ, kurtosis and beta). In the field of Unemployment rate there is neither convergence, nor divergence. In the field of Disposable income there is strong divergence (proven by the development of sigma, IQR, μ and kurtosis).

Removing mediterreanean from analysis positively changes correlation between metrics in several cases. More specifically between $\varkappa$ and beta to 0.448 (by 0.118), between boxplot and $\varkappa$ to 0.413 (by 0.07), between Theil and μ to 0.574 (by 0.057), between sigma and μ to 0.537 (by 0.056), between entropy and μ to 0.587 (by 0.055), between Gini and μ to 0.616 (by 0.054), between IQR and $\varkappa$ to 0.468 (by 0.052) and between μ and $\varkappa$ to 0.468 (by 0.041).

Region Baltic

Region Baltic was closely described in the Section called *Region Baltic* in Chapter 4.

Table 5-40. Convergence in Baltic

variable	sigma	IQR	μ	kurtosis	beta
GDP per capita in PPS of EU average	1	1	1	-1	0.6
Employment rate	0	0	0	0	0
Economic activity rate	0	0	0	0	-0.6
Share of employees with university degree	1	0	0	0	0
Value added in services	0	-1	-1	1	-0.6
Unemployment rate	0	0	0	0	0
Disposable income	1	0	1	0	

The above table shows summary of regions convergence and divergence in Baltic. Out of 66 observations, 15 show strong convergence, 3 show strong divergence and 39 show neither convergence nor divergence. Neither overall convergence nor divergence was proven in economic cohesion, social cohesion, overall cohesion and discussed cohesion. In the field of GDP per capita in PPS of EU average there is weak convergence (proven by the development of sigma, IQR, μ, kurtosis and beta). In the field of Employment rate there is neither convergence, nor divergence. In the field of Economic activity rate there is neither convergence, nor divergence. In the field of Share of employees with university degree there is neither convergence, nor divergence. In the field of Value added in services there is weak divergence (proven by the development of IQR, μ, kurtosis and beta). In the field of Unemployment rate there is neither convergence, nor divergence. In the field of Disposable income there is strong divergence (proven by the development of sigma and μ).

Baltic does not behave significantly different than other regions, removing it did not significantly change correlations.

Region European Union

Region European Union was closely described in the Section called *Region European Union* in Chapter 4.

Table 5-41. Convergence in European Union

variable	sigma	IQR	μ	kurtosis	beta
GDP per capita in PPS of EU average	1	1	1	-1	1
Employment rate	1	0	0.6	0	0
Economic activity rate	1	1	1	0	0
Share of employees with university degree	1	0	0	0	-1
Value added in services	0.6	-1	-1	1	-1
Unemployment rate	1	1	0.6	0	0
Disposable income	0	0	0	0	

The above table shows summary of regions convergence and divergence in European Union. Out of 66 observations, 27 show strong convergence, 9 show strong divergence and 24 show neither convergence nor divergence. Neither overall convergence nor divergence was proven in economic cohesion. In social cohesion, overall cohesion and discussed cohesion, overall convergence occurs, however it is not proven by all parametres. In the field of GDP per capita in PPS of EU average there is weak convergence (proven by the development of sigma, IQR, μ, kurtosis and beta). In the field of Employment rate there is weak convergence (proven by the development of sigma and μ). In the field of Economic activity rate there is weak convergence (proven by the development of sigma, IQR and μ). In the field of Share of employees with university degree there is neither convergence, nor divergence. In the field of Value added in services there is weak divergence (proven by the development of sigma, IQR, μ, kurtosis and beta). In the field of Unemployment rate there is weak convergence (proven by the development of sigma, IQR and μ). In the field of Disposable income there is strong divergence (proven by the development of).

European Union does not behave significantly different than other regions, removing it did not significantly change correlations.

Region Visegrad Countries

Region Visegrad countries was closely described in the Section called *Region Visegrad Countries* in Chapter 4.

Table 5-42. Convergence in Visegrad Countries

variable	sigma	IQR	μ	kurtosis	beta
GDP per capita in PPS of EU average	0	0	0	-1	-1
Employment rate	0	0	0	0	-1
Economic activity rate	1	-0.6	0.6	0.6	-1

variable	sigma	IQR	μ	kurtosis	beta
Share of employees with university degree	-1	-1	-1	-1	-1
Value added in services	-1	-0.6	-0.6	-0.6	-1
Unemployment rate	0	0	0.6	0	1
Disposable income	0	0	-1	0	

The above table shows summary of regions convergence and divergence in Visegrad countries. Out of 66 observations, 3 show strong convergence, 32 show strong divergence and 25 show neither convergence nor divergence. In economic cohesion and overall cohesion, overall divergence occurs, however it is not proven by all parametres. Neither overall convergence nor divergence was proven in social cohesion and discussed cohesion. In the field of GDP per capita in PPS of EU average there is weak divergence (proven by the development of kurtosis and beta). In the field of Employment rate there is neither convergence, nor divergence. In the field of Economic activity rate there is neither convergence, nor divergence. In the field of Share of employees with university degree there is strong divergence (proven by the development of sigma, IQR, μ, kurtosis and beta). In the field of Value added in services there is strong divergence (proven by the development of sigma, IQR, μ, kurtosis and beta). In the field of Unemployment rate there is weak convergence (proven by the development of μ and beta). In the field of Disposable income there is strong divergence (proven by the development of μ).

Visegrad countries does not behave significantly different than other regions, removing it did not significantly change correlations.

Region Nordic Countries

Region Nordic countries was closely described in the Section called *Region Nordic Countries* in Chapter 4.

Table 5-43. Convergence in Nordic Countries

variable	sigma	IQR	μ	kurtosis	beta
GDP per capita in PPS of EU average	0	0	1	-1	0
Employment rate	0	0	0.6	0	0
Economic activity rate	-0.6	-0.6	0.6	1	-0.6
Share of employees with university degree	0	0	0	-0.6	0
Value added in services	0	-1	-1	1	-0.6
Unemployment rate	0.6	0.6	0	0	0
Disposable income	0	0	0.6	0	

The above table shows summary of regions convergence and divergence in Nordic countries. Out of 66 observations, 3 show strong convergence, 5 show strong divergence and 48 show neither convergence nor divergence. Neither overall convergence nor divergence was proven in economic cohesion, social cohesion, overall cohesion and discussed

cohesion. In the field of GDP per capita in PPS of EU average there is neither convergence, nor divergence. In the field of Employment rate there is neither convergence, nor divergence. In the field of Economic activity rate there is neither convergence, nor divergence. In the field of Share of employees with university degree there is neither convergence, nor divergence. In the field of Value added in services there is weak divergence (proven by the development of IQR, μ, kurtosis and beta). In the field of Unemployment rate there is neither convergence, nor divergence. In the field of Disposable income there is strong divergence (proven by the development of μ).

Removing Nordic countries from analysis positively changes correlation between metrics in several cases. More specifically between sigma and μ to 0.528 (by 0.047), between Gini and μ to 0.604 (by 0.042), between Theil and μ to 0.559 (by 0.042) and between entropy and μ to 0.572 (by 0.04).

Region South

Region South was closely described in the Section called *Region South* in Chapter 4.

Table 5-44. Convergence in South

variable	sigma	IQR	μ	kurtosis	beta
GDP per capita in PPS of EU average	1	0	-0.6	1	0
Employment rate	1	0	1	0.6	0
Economic activity rate	-1	-0.6	0	0.6	-1
Share of employees with university degree	1	0.6	0	-1	-1
Value added in services	-0.6	0	-1	1	-1
Unemployment rate	1	1	1	-0.6	-0.6
Disposable income	1	-0.6	0	1	

The above table shows summary of regions convergence and divergence in South. Out of 66 observations, 17 show strong convergence, 17 show strong divergence and 12 show neither convergence nor divergence. Neither overall convergence nor divergence was proven in economic cohesion, social cohesion and overall cohesion. In discussed cohesion, overall convergence occurs, however it is not proven by all parametres. In the field of GDP per capita in PPS of EU average there is weak convergence (proven by the development of sigma, μ and kurtosis). In the field of Employment rate there is weak convergence (proven by the development of sigma, μ and kurtosis). In the field of Economic activity rate there is weak divergence (proven by the development of sigma, IQR, kurtosis and beta). In the field of Share of employees with university degree there is neither convergence, nor divergence. In the field of Value added in services there is weak divergence (proven by the development of sigma, μ, kurtosis and beta). In the field of Unemployment rate there is weak convergence (proven by the development of sigma, IQR, μ, kurtosis and beta). In the field of Disposable income there is strong divergence (proven by the development of sigma, IQR and kurtosis).

Removing South from analysis positively changes correlation between metrics in several cases. More specifically between Gini and μ to 0.6 (by 0.038), between IQR and beta to 0.544 (by 0.035), between entropy and μ to 0.565 (by 0.033), between entropy and $\varkappa$ to 0.545 (by 0.032), between sigma and $\varkappa$ to 0.458 (by 0.031) and between Theil and μ to 0.548 (by 0.031).

Region Benelux

Region Benelux was closely described in the Section called *Region Benelux* in Chapter 4.

Table 5-45. Convergence in Benelux

variable	sigma	IQR	μ	kurtosis	beta
GDP per capita in PPS of EU average	-1	-1	-0.6	1	-1
Employment rate	0	0	0	0	-0.6
Economic activity rate	0	0	0	0	-0.6
Share of employees with university degree	1	0.6	0.6	-1	1
Value added in services	0	-0.6	0	-1	0
Unemployment rate	0	0	0	0	0.6
Disposable income	1	0	1	0	

The above table shows summary of regions convergence and divergence in Benelux. Out of 66 observations, 8 show strong convergence, 11 show strong divergence and 33 show neither convergence nor divergence. In economic cohesion and discussed cohesion, overall divergence occurs, however it is not proven by all parametres. Neither overall convergence nor divergence was proven in social cohesion and overall cohesion. In the field of GDP per capita in PPS of EU average there is weak divergence (proven by the development of sigma, IQR, μ, kurtosis and beta). In the field of Employment rate there is neither convergence, nor divergence. In the field of Economic activity rate there is neither convergence, nor divergence. In the field of Share of employees with university degree there is weak convergence (proven by the development of sigma, IQR, μ, kurtosis and beta). In the field of Value added in services there is weak divergence (proven by the development of IQR and kurtosis). In the field of Unemployment rate there is neither convergence, nor divergence. In the field of Disposable income there is strong divergence (proven by the development of sigma and μ).

Benelux does not behave significantly different than other regions, removing it did not significantly change correlations.

Region British Isles

Region British Isles was closely described in the Section called *Region British Isles* in Chapter 4.

Table 5-46. Convergence in British Isles

variable	sigma	IQR	μ	kurtosis	beta
GDP per capita in PPS of EU average	-1	-0.6	-0.6	-1	-1
Employment rate	0.6	1	0	0	-0.6
Economic activity rate	1	0.6	0	0	-1

variable	sigma	IQR	μ	kurtosis	beta
Share of employees with university degree	0.6	0	0.6	0	0
Value added in services	0.6	0	0	1	0
Unemployment rate	0	0.6	0	-0.6	0.6
Disposable income	0	-1	0.6	1	

The above table shows summary of regions convergence and divergence in British Isles. Out of 66 observations, 9 show strong convergence, 11 show strong divergence and 22 show neither convergence nor divergence. Neither overall convergence nor divergence was proven in economic cohesion, social cohesion and overall cohesion. In discussed cohesion, overall divergence occurs, however it is not proven by all parametres. In the field of GDP per capita in PPS of EU average there is strong divergence (proven by the development of sigma, IQR, μ, kurtosis and beta). In the field of Employment rate there is neither convergence, nor divergence. In the field of Economic activity rate there is neither convergence, nor divergence. In the field of Share of employees with university degree there is neither convergence, nor divergence. In the field of Value added in services there is weak convergence (proven by the development of sigma and kurtosis). In the field of Unemployment rate there is neither convergence, nor divergence. In the field of Disposable income there is strong divergence (proven by the development of IQR, μ and kurtosis).

Removing British Isles from analysis significantly positively changes correlation between metrics in one case: between IQR and $\varkappa$ to 0.466 (by 0.05) and between boxplot and beta to 0.596 (by 0.036).

Region NMS8

Region NMS8 was closely described in the Section called *Region NMS8* in Chapter 4.

Table 5-47. Convergence in NMS8

variable	sigma	IQR	μ	kurtosis	beta
GDP per capita in PPS of EU average	0	0	-0.6	-0.6	-1
Employment rate	0	0	0	0	-1
Economic activity rate	1	-0.6	0	0.6	-1
Share of employees with university degree	0	-1	0	1	-1
Value added in services	-1	-0.6	-0.6	0	-1
Unemployment rate	0	0	0	0	1
Disposable income	0	0.6	0	-1	

The above table shows summary of regions convergence and divergence in NMS8. Out of 66 observations, 4 show strong convergence, 26 show strong divergence and 29 show neither convergence nor divergence. In economic cohesion and discussed cohesion, overall divergence occurs, however it is not proven by all parametres. Neither overall convergence nor divergence was proven in social cohesion and overall cohesion. In the field of GDP per capita in

PPS of EU average there is weak divergence (proven by the development of μ, kurtosis and beta). In the field of Employment rate there is neither convergence, nor divergence. In the field of Economic activity rate there is neither convergence, nor divergence. In the field of Share of employees with university degree there is neither convergence, nor divergence. In the field of Value added in services there is weak divergence (proven by the development of sigma, IQR, μ and beta). In the field of Unemployment rate there is neither convergence, nor divergence. In the field of Disposable income there is strong divergence (proven by the development of IQR and kurtosis).

NMS8 does not behave significantly different than other regions, removing it did not significantly change correlations.

Region European Monetary Union

Region European monetary union was closely described in the Section called *Region European Monetary Union* in Chapter 4.

Table 5-48. Convergence in European Monetary Union

variable	sigma	IQR	μ	kurtosis	beta
GDP per capita in PPS of EU average	1	1	1	-1	0.6
Employment rate	1	0	1	0	0
Economic activity rate	0	0.6	0.6	0	-1
Share of employees with university degree	1	-1	0	0	-1
Value added in services	0.6	-0.6	-1	1	-1
Unemployment rate	1	1	1	0	-1
Disposable income	1	1	0	-0.6	

The above table shows summary of regions convergence and divergence in European monetary union. Out of 66 observations, 25 show strong convergence, 12 show strong divergence and 17 show neither convergence nor divergence. Neither overall convergence nor divergence was proven in economic cohesion and overall cohesion. In social cohesion and discussed cohesion, overall convergence occurs, however it is not proven by all parametres. In the field of GDP per capita in PPS of EU average there is weak convergence (proven by the development of sigma, IQR, μ, kurtosis and beta). In the field of Employment rate there is weak convergence (proven by the development of sigma and μ). In the field of Economic activity rate there is neither convergence, nor divergence. In the field of Share of employees with university degree there is neither convergence, nor divergence. In the field of Value added in services there is neither convergence, nor divergence. In the field of Unemployment rate there is weak convergence (proven by the development of sigma, IQR, μ and beta). In the field of Disposable income there is strong divergence (proven by the development of sigma, IQR and kurtosis).

European monetary union does not behave significantly different than other regions, removing it did not significantly change correlations.

Region France

Region France was closely described in the Section called *Region France* in Chapter 4.

Table 5-49. Convergence in France

variable	sigma	IQR	μ	kurtosis	beta
GDP per capita in PPS of EU average	1	0	0	0.6	0
Employment rate	1	1	0.6	0.6	0
Economic activity rate	1	0	0	0	-0.6
Share of employees with university degree	0	-1	0	0	0
Value added in services	1	0.6	0	0	0
Unemployment rate	1	1	0.6	0	0
Disposable income	0.6	0	0	1	

The above table shows summary of regions convergence and divergence in France. Out of 66 observations, 26 show strong convergence, 2 show strong divergence and 28 show neither convergence nor divergence. In economic cohesion, social cohesion, overall cohesion and discussed cohesion, overall convergence occurs, however it is not proven by all parametres. In the field of GDP per capita in PPS of EU average there is weak convergence (proven by the development of sigma and kurtosis). In the field of Employment rate there is weak convergence (proven by the development of sigma, IQR, μ and kurtosis). In the field of Economic activity rate there is neither convergence, nor divergence. In the field of Share of employees with university degree there is neither convergence, nor divergence. In the field of Value added in services there is weak convergence (proven by the development of sigma and IQR). In the field of Unemployment rate there is weak convergence (proven by the development of sigma, IQR and μ). In the field of Disposable income there is strong divergence (proven by the development of sigma and kurtosis).

Removing France from analysis significantly positively changes correlation between metrics in one case: between boxplot and beta to 0.604 (by 0.044) and between IQR and beta to 0.541 (by 0.032).

Region Germany

Region Germany was closely described in the Section called *Region Germany* in Chapter 4.

Table 5-50. Convergence in Germany

variable	sigma	IQR	μ	kurtosis	beta
GDP per capita in PPS of EU average	1	0.6	0	0	1
Employment rate	0	0	0	0	-1
Economic activity rate	1	0	0	0	-0.6
Share of employees with university degree	0	-1	-1	0.6	-1
Value added in services	0.6	-1	0	0	0

variable	sigma	IQR	μ	kurtosis	beta
Unemployment rate	0	-1	0.6	1	0
Disposable income	0.6	0.6	0	-0.6	

The above table shows summary of regions convergence and divergence in Germany. Out of 66 observations, 13 show strong convergence, 13 show strong divergence and 30 show neither convergence nor divergence. Neither overall convergence nor divergence was proven in economic cohesion, social cohesion, overall cohesion and discussed cohesion. In the field of GDP per capita in PPS of EU average there is weak convergence (proven by the development of sigma, IQR and beta). In the field of Employment rate there is neither convergence, nor divergence. In the field of Economic activity rate there is neither convergence, nor divergence. In the field of Share of employees with university degree there is weak divergence (proven by the development of IQR, μ, kurtosis and beta). In the field of Value added in services there is neither convergence, nor divergence. In the field of Unemployment rate there is neither convergence, nor divergence. In the field of Disposable income there is strong divergence (proven by the development of sigma, IQR and kurtosis).

Removing Germany from analysis positively changes correlation between metrics in several cases. More specifically between IQR and μ to 0.583 (by 0.041), between boxplot and μ to 0.528 (by 0.041), between μ and $\varkappa$ to 0.464 (by 0.037) and between IQR and beta to 0.54 (by 0.031).

Region Southwest

Region southwest was closely described in the Section called *Region Southwest* in Chapter 4.

Table 5-51. Convergence in Southwest

variable	sigma	IQR	μ	kurtosis	beta
GDP per capita in PPS of EU average	1	1	1	-1	0
Employment rate	1	0.6	1	0	0.6
Economic activity rate	1	1	1	0	0
Share of employees with university degree	1	-1	0	0	-1
Value added in services	0	-1	-1	1	-1
Unemployment rate	0	1	0	-0.6	0
Disposable income	0	0	1	-1	

The above table shows summary of regions convergence and divergence in southwest. Out of 66 observations, 25 show strong convergence, 11 show strong divergence and 19 show neither convergence nor divergence. Neither overall convergence nor divergence was proven in economic cohesion and overall cohesion. In social cohesion and discussed cohesion, overall convergence occurs, however it is not proven by all parametres. In the field of GDP per capita in PPS of EU average there is weak convergence (proven by the development of sigma, IQR, μ and kurtosis). In the field of Employment rate there is weak convergence (proven by the development of sigma, IQR, μ and beta). In the field of Economic activity rate there is weak convergence (proven by the development of sigma, IQR and μ). In the field of Share of employees with university degree there is neither convergence, nor divergence. In the field of Value added in services there is weak divergence (proven by the development of IQR, μ, kurtosis and beta). In the field of

Unemployment rate there is neither convergence, nor divergence. In the field of Disposable income there is strong divergence (proven by the development of μ and kurtosis).

southwest does not behave significantly different than other regions, removing it did not significantly change correlations.

Chapter 6. Discussion of Results

Comparisons of Coefficients

As it can be seen from results in Chapter 5, coefficients used in this work sometimes show similar results and sometimes no. Below, there are several tables describing where the differences occur. Each table says, that in how many regions the different metrics showed very different or slightly different results.

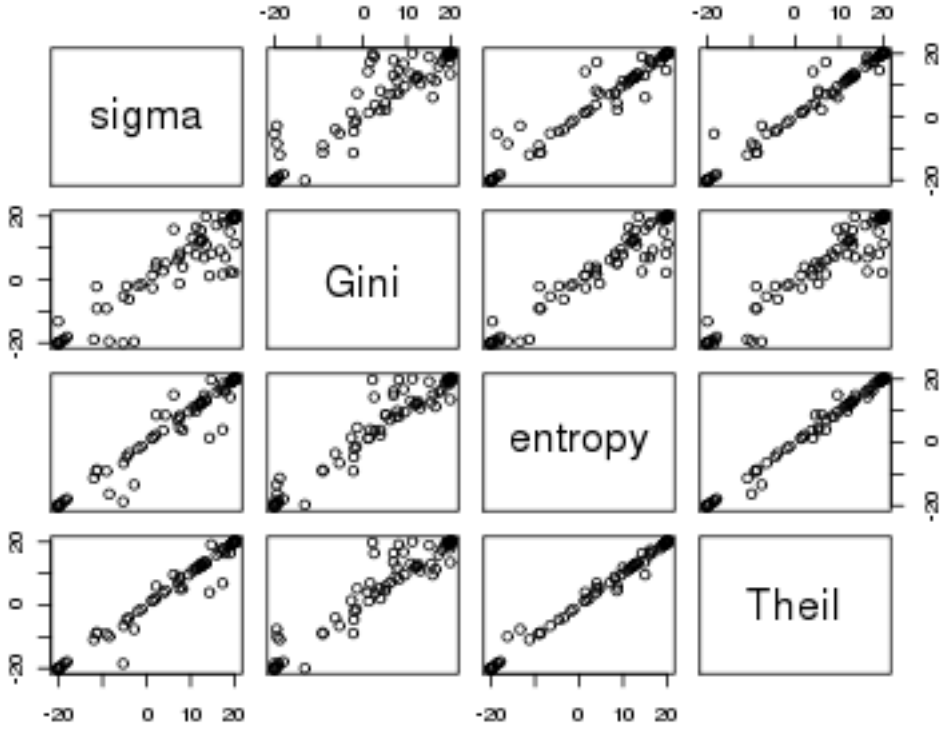
Extremely big difference occurs when one of the metrics shows strong convergence but the other shows strong divergence. Very big difference is when one metrics shows strong convergence and the other weak divergence. Big difference indicates that one metrics indicated strong convergence and the other metrics did not indicate neither divergence nor convergence. Medium difference is when one metrics shows weak convergence and the other no convergence and small difference when the two metrics show strong and weak convergence. Ideally, there is no difference, with metrics showing same convergence.

Comparison of Sigmas

This section includes comparison of sigma (see the Section called *Sigma Convergence* in Chapter 1 and the Section called *Sigma Convergence* in Chapter 3), Gini (see the Section called *Gini Convergence* in Chapter 1 and the Section called *Gini Convergence* in Chapter 3), entropy (see the Section called *Entropy Convergence* in Chapter 1 and the Section called *Entropy Convergence* in Chapter 3) and Theil (see the Section called *Theil Convergence* in Chapter 1 and the Section called *Theil Convergence* in Chapter 3).

Figure 6-1 visually shows common points of sigma, Gini, entropy and Theil. The metrics behave similarly, if all observations represented by circles are around the main diagonal. If the observations are in upper left or lower right corner, metrics show extremely different results.

Figure 6-1. differences between metrics, logfunc sigmas



Correlation coefficient between Gini and sigma is 0.925, which means rather common development of these two parametres. Total correlation of 0.925 can be increased to 0.934 removing NMS8 or to 0.939 removing Economic activity rate. The highest correlation if achieved at 0.946 removing Economic activity rate and European Union.

Correlation coefficient between entropy and sigma is 0.978, which means rather common development of these two parametres.

Correlation coefficient between entropy and Gini is 0.949, which means rather common development of these two parametres. Total correlation of 0.949 can be increased to 0.957 removing Visegrad countries or to 0.969 removing Economic activity rate. The highest correlation if achieved at 0.973 removing Economic activity rate and European Union.

Correlation coefficient between Theil and sigma is 0.986, which means rather common development of these two parametres.

Correlation coefficient between Theil and Gini is 0.947, which means rather common development of these two parametres. Total correlation of 0.945 can be increased to 0.953 removing Visegrad countries or to 0.964 removing Economic activity rate. The highest correlation if achieved at 0.97 removing Economic activity rate and European Union.

Correlation coefficient between Theil and entropy is 0.997. This high correlation coefficient means that Theil and entropy behave almost exactly the same.

As it can be seen from above analysis, all of the metrics show very similar results. Gini coefficient showed the most different results, but the correlation coefficient to other metrics was around 95% and it showed the same results in convergence terms. Correlation coefficients of other metrics were around 99%.

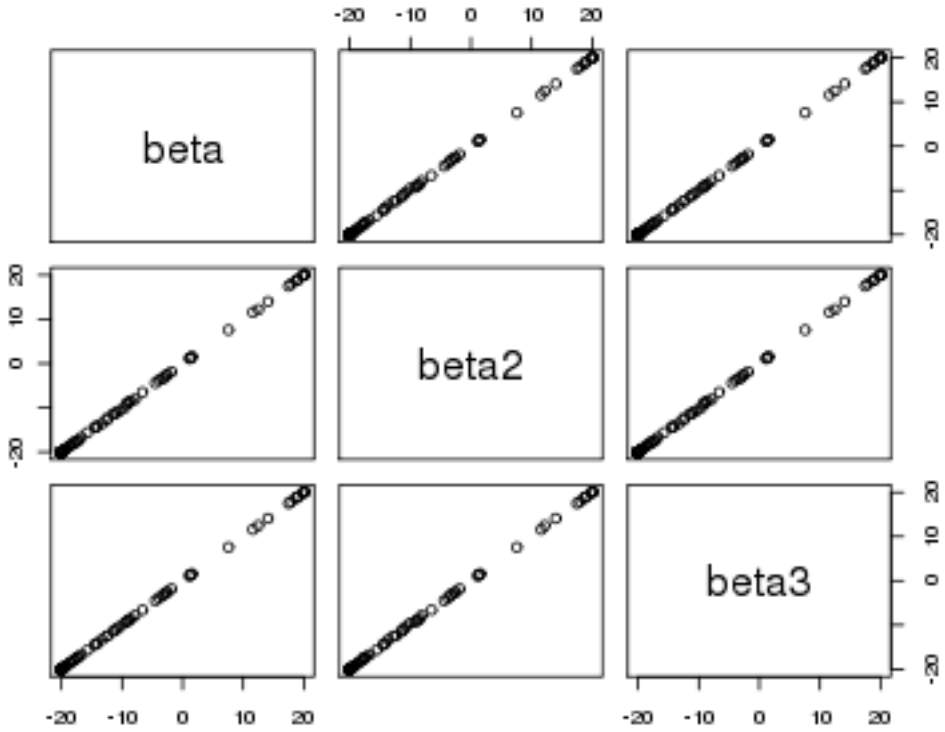
Due to common behaviour of sigma, Theil, Gini and entropy coefficients, only sigma coefficient is used for further analysis.

Comparison of Betas

This section includes comparison of beta (see the Section called *Beta Convergence* in Chapter 1 and the Section called *Beta Convergence* in Chapter 3), beta2 (see Beta coefficient and the Section called *Beta2 Convergence* in Chapter 3) and beta3 (see Beta coefficient and the Section called *Beta3 Convergence* in Chapter 3).

Figure 6-2 visually shows common points of beta, beta2 and beta3. The metrics behave similarly, if all observations represented by circles are around the main diagonal. If the observations are in upper left or lower right corner, metrics show extremely different results.

Figure 6-2. differences between metrics, logfunc betas



Correlation coefficient between beta2 and beta is 0.998. This high correlation coefficient means that beta2 and beta behave almost exactly the same.

Correlation coefficient between beta3 and beta is 1. This high correlation coefficient means that beta3 and beta behave almost exactly the same.

Correlation coefficient between beta3 and beta2 is 0.998. This high correlation coefficient means that beta3 and beta2 behave almost exactly the same.

As it can be seen various beta coefficients behave the same. This is caused by methodology, which does not make use of econom tric methods, but rather nonparametric ones. Therefore this approach is not fully comparable with other papers in this field. In the work, there are 3 beta coefficients: non logarithm beta, logarithm of growth as beta2 and logarithm of value beta3. We will use beta (non logarithm version) for further analysis.

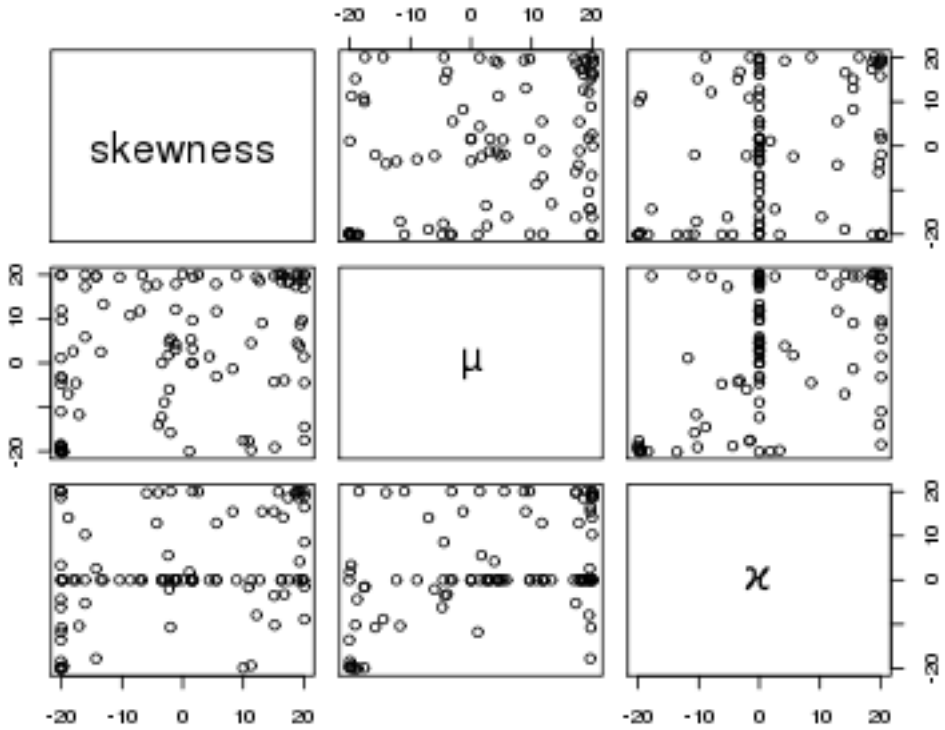
Comparison of Biased

This section includes comparison of skewness (see the Section called *Skewness Convergence* in Chapter 1 and the Section called *Skewness Convergence* in Chapter 3), μ (see the Section called μ *Convergence* in Chapter 1 and the

Section called μ *Convergence* in Chapter 3) and $\varkappa$ (see the Section called $\varkappa$ *Convergence* in Chapter 1 and the Section called $\varkappa$ *Convergence* in Chapter 3).

Figure 6-3 visually shows common points of skewness, μ and $\varkappa$. The metrics behave similarly, if all observations represented by circles are around the main diagonal. If the observations are in upper left or lower right corner, metrics show extremely different results.

Figure 6-3. differences between metrics, logfunc biased



Correlation coefficient between μ and skewness is 0.366, which means that no connection can be proven. Total correlation of 0.366 can be increased to 0.414 removing agglomerations or to 0.403 removing Disposable income. The highest correlation if achieved at 0.449 removing Employment rate and agglomerations. Removing several regions and variables, the correlation coefficient can increase. For example, by removing Employment rate in agglomerations to 0.449 (by 0.083), removing Share of employees with university degree in agglomerations to 0.448 (by 0.082), removing Disposable income in British Isles to 0.447 (by 0.081), removing Unemployment rate in agglomerations to 0.444 (by 0.078), removing Disposable income in agglomerations to 0.438 (by 0.072), removing Disposable income in Visegrad countries to 0.437 (by 0.071) and removing Employment rate in Visegrad countries to 0.434 (by 0.068).

Correlation coefficient between $\varkappa$ and skewness is 0.283, which means that no connection can be proven. Total correlation of 0.283 can be increased to 0.325 removing Visegrad countries or to 0.398 removing Disposable income. The highest correlation if achieved at 0.457 removing Disposable income and Visegrad countries. Removing several regions and variables, the correlation coefficient can increase. For example, by removing Disposable income in Visegrad countries to 0.457 (by 0.174), removing Disposable income in agglomerations to 0.452 (by 0.169), removing Disposable income in British Isles to 0.45 (by 0.167), removing Disposable income in NMS8 to 0.43 (by 0.147), removing Disposable income in Germany to 0.414 (by 0.131), removing Disposable income in Nordic countries to 0.399 (by 0.116) and removing Disposable income in European monetary union to 0.386 (by 0.103).

Correlation coefficient between $\varkappa$ and μ is 0.427, which means that no connection can be proven. Total correlation of 0.427 can be increased to 0.468 removing mediterreanean or to 0.521 removing Disposable income. The highest correlation if achieved at 0.573 removing Disposable income and Germany. Removing several regions and variables,

the correlation coefficient can increase. For example, by removing Disposable income in Germany to 0.573 (by 0.146), removing Disposable income in European Union to 0.542 (by 0.115), removing Disposable income in South to 0.538 (by 0.111), removing Disposable income in mediterreanean to 0.535 (by 0.108), removing Disposable income in Nordic countries to 0.534 (by 0.107), removing Economic activity rate in mediterreanean to 0.533 (by 0.106) and removing Disposable income in agglomerations to 0.532 (by 0.105).

Most of the measurements in this work are symmetric: positive or negative change equally affects convergence measurement. Metrics metioned in this part distinguish between changes on the positive and negative end. Skewness describes asymetry of distribution. Other two methods count number of regions below a treshold. If this number is decreasing, convergence occurs.

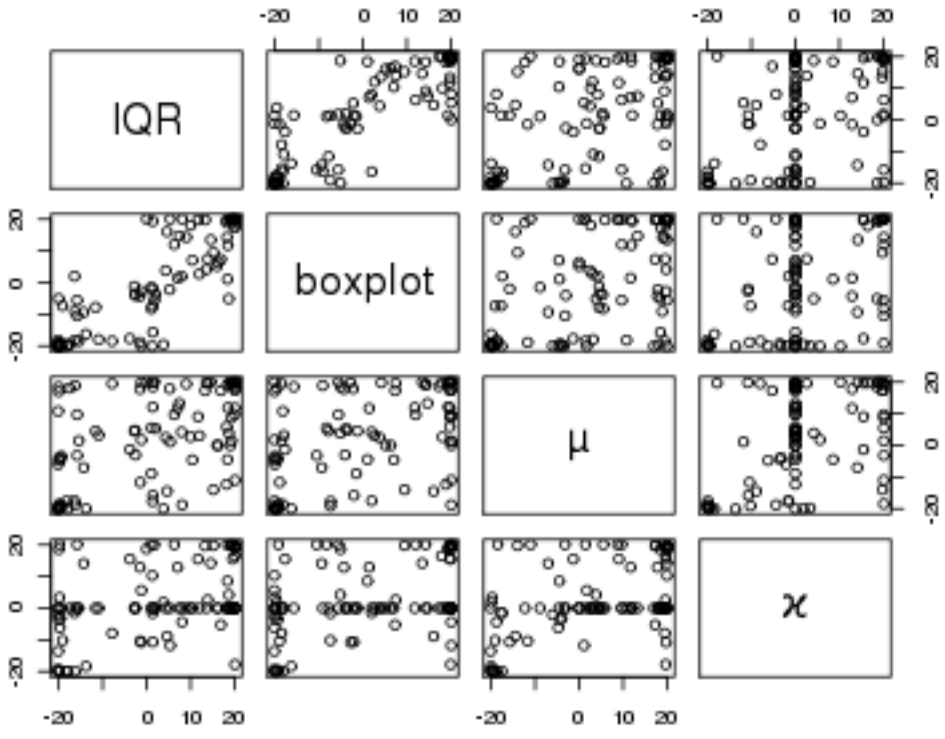
As it can be seen from the graphs, these metrics do not behave in very similarly. Even though there are signs of positive correlation, this does not occur often. $\varkappa$ relatively often show neither convergence nor divergence when μ has signs of convergence. $\varkappa$ convergence is usually weaker measurement than μ. Skewness shows very weak but positive correlation with the other two.

Comparison of Difference

This section includes comparison of IQR (see the Section called *IQR Convergence* in Chapter 1 and the Section called *IQR Convergence* in Chapter 3), boxplot (see the Section called *Boxplot Convergence* in Chapter 1 and the Section called *Boxplot Convergence* in Chapter 3), μ (see the Section called μ *Convergence* in Chapter 1 and the Section called μ *Convergence* in Chapter 3) and $\varkappa$ (see the Section called $\varkappa$ *Convergence* in Chapter 1 and the Section called $\varkappa$ *Convergence* in Chapter 3).

Figure 6-4 visually shows common points of IQR, boxplot, μ and $\varkappa$. The metrics behave similarly, if all observations represented by circles are around the main diagonal. If the observations are in upper left or lower right corner, metrics show extremely different results.

Figure 6-4. differences between metrics, logfunc difference



Correlation coefficient between boxplot and IQR is 0.856, which means rather common development of these two parametres. Total correlation of 0.857 can be increased to 0.872 removing Baltic or to 0.889 removing Disposable income. The highest correlation if achieved at 0.904 removing GDP per capita in PPS of EU average and Baltic.

Correlation coefficient between μ and IQR is 0.543, which means that no connection can be proven. Total correlation of 0.542 can be increased to 0.583 removing Germany or to 0.64 removing Disposable income. The highest correlation if achieved at 0.684 removing Disposable income and Germany. Removing several regions and variables, the correlation coefficient can increase. For example, by removing Disposable income in Germany to 0.684 (by 0.142), removing Disposable income in agglomerations to 0.676 (by 0.134), removing Disposable income in Nordic countries to 0.658 (by 0.116), removing Disposable income in South to 0.656 (by 0.114), removing Disposable income in mediterreanean to 0.654 (by 0.112), removing Disposable income in British Isles to 0.651 (by 0.109) and removing Disposable income in Visegrad countries to 0.645 (by 0.103).

Correlation coefficient between μ and boxplot is 0.487, which means that no connection can be proven. Total correlation of 0.487 can be increased to 0.528 removing Germany or to 0.545 removing Disposable income. The highest correlation if achieved at 0.591 removing Disposable income and agglomerations. Removing several regions and variables, the correlation coefficient can increase. For example, by removing Disposable income in agglomerations to 0.591 (by 0.104), removing Disposable income in Germany to 0.581 (by 0.094), removing Disposable income in South to 0.577 (by 0.09), removing Disposable income in mediterreanean to 0.572 (by 0.085), removing Disposable income in Nordic countries to 0.565 (by 0.078), removing Disposable income in British Isles to 0.558 (by 0.071) and removing GDP per capita in PPS of EU average in agglomerations to 0.556 (by 0.069).

Correlation coefficient between $\varkappa$ and IQR is 0.417, which means that no connection can be proven. Total correlation of 0.416 can be increased to 0.468 removing mediterreanean or to 0.499 removing Disposable income. The highest correlation if achieved at 0.535 removing Disposable income and European Union. Removing several regions and variables, the correlation coefficient can increase. For example, by removing Disposable income in European Union to 0.535 (by 0.119), removing Unemployment rate in mediterreanean to 0.534 (by 0.118), removing Unemployment rate in British Isles to 0.532 (by 0.116), removing Economic activity rate in British Isles to 0.529 (by 0.113), removing Disposable income in Germany to 0.528 (by 0.112), removing Disposable income in British Isles to 0.528 (by 0.112) and removing Economic activity rate in mediterreanean to 0.524 (by 0.108).

Correlation coefficient between $\varkappa$ and boxplot is 0.346, which means that no connection can be proven. Total correlation of 0.343 can be increased to 0.413 removing mediterreanean or to 0.408 removing Unemployment rate. The highest correlation if achieved at 0.478 removing Unemployment rate and mediterreanean. Removing several regions and variables, the correlation coefficient can increase. For example, by removing Unemployment rate in mediterreanean to 0.478 (by 0.135), removing Unemployment rate in South to 0.459 (by 0.116), removing Economic activity rate in mediterreanean to 0.455 (by 0.112), removing Disposable income in mediterreanean to 0.445 (by 0.102), removing Unemployment rate in British Isles to 0.437 (by 0.094), removing Unemployment rate in agglomerations to 0.435 (by 0.092) and removing Economic activity rate in South to 0.435 (by 0.092).

Correlation coefficient between $\varkappa$ and μ is 0.427, which means that no connection can be proven. Total correlation of 0.427 can be increased to 0.468 removing mediterreanean or to 0.521 removing Disposable income. The highest correlation if achieved at 0.573 removing Disposable income and Germany. Removing several regions and variables, the correlation coefficient can increase. For example, by removing Disposable income in Germany to 0.573 (by 0.146), removing Disposable income in European Union to 0.542 (by 0.115), removing Disposable income in South to 0.538 (by 0.111), removing Disposable income in mediterreanean to 0.535 (by 0.108), removing Disposable income in Nordic countries to 0.534 (by 0.107), removing Economic activity rate in mediterreanean to 0.533 (by 0.106) and removing Disposable income in agglomerations to 0.532 (by 0.105).

Since Inter quartile range, boxplot and μ convergence behave very similarly, this is despite very different construction of parameters. IQR convergence studies distance between upper and lower quartile, boxplot convergence studies distance between maximum and minimum value. μ convergence studies number of regions outlying more than 10% from median. These coefficients show correlation of around 60 to 80%. This is relatively low however all three parameters show the same results in terms of convergence enumeration. Due to this common development we will use IQR convergence for further analysis.

Kurtosis convergence, on the other hand, showed different results. Correlation coefficients to IQR, boxplot and μ convergences is negative. These negative values are quite low, around 20 to 40%. These values show that kurtosis

and IQR convergence usually do not occur simultaneously. Kurtosis and IQR showed the same results only in 6 cases however different results in 20 cases.

Comparison of Beta Sigma and Kurtosis

This section includes comparison of beta (see the Section called *Beta Convergence* in Chapter 1 and the Section called *Beta Convergence* in Chapter 3), sigma (see the Section called *Sigma Convergence* in Chapter 1 and the Section called *Sigma Convergence* in Chapter 3) and kurtosis (see the Section called *Kurtosis Convergence* in Chapter 1 and the Section called *Kurtosis Convergence* in Chapter 3).

Figure 6-5 visually shows common points of beta, sigma and kurtosis. The metrics behave similarly, if all observations represented by circles are around the main diagonal. If the observations are in upper left or lower right corner, metrics show extremely different results.

Figure 6-5. differences between metrics, logfunc beta sigma and kurtosis

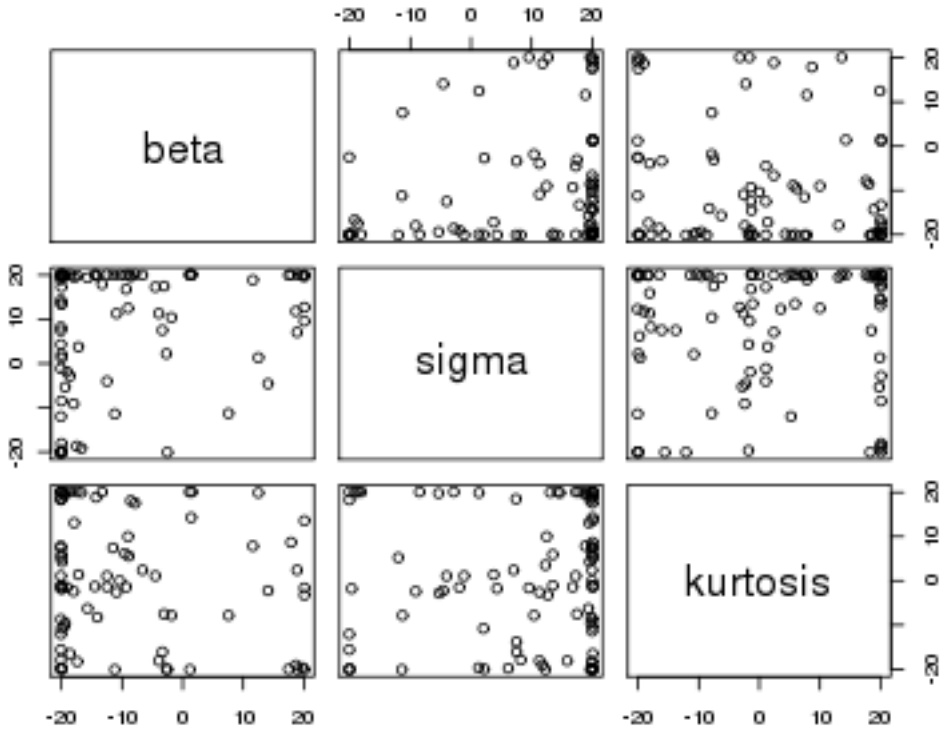


Table 6-1. Differences Between Metrics, Beta Sigma and Kurtosis

coefficient	coefficient	extremely big difference	very big difference	big difference	medium difference	small difference	no difference
sigma	beta	9	1	29	12	4	23
sigma	kurtosis	7	1	35	10	10	28

Correlation coefficient between sigma and beta is 0.249, which means that no connection can be proven. Total correlation of 0.252 can be increased to 0.294 removing European monetary union or to 0.421 removing Share of employees with university degree. The highest correlation if achieved at 0.479 removing Share of employees with university degree and agglomerations. Removing several regions and variables, the correlation coefficient can increase. For ex-

ample, by removing Share of employees with university degree in agglomerations to 0.479 (by 0.227), removing Share of employees with university degree in European monetary union to 0.452 (by 0.2), removing Share of employees with university degree in European Union to 0.442 (by 0.19), removing Share of employees with university degree in Nordic countries to 0.439 (by 0.187), removing Share of employees with university degree in British Isles to 0.429 (by 0.177), removing Share of employees with university degree in Germany to 0.423 (by 0.171) and removing Share of employees with university degree in Benelux to 0.417 (by 0.165).

Correlation coefficient between kurtosis and beta is -0.18, which means that no connection can be proven. Total correlation of -0.18 can be increased to -0.136 removing European Union or to -0.143 removing Value added in services. The highest correlation if achieved at -0.0989 removing Value added in services and Benelux.

Correlation coefficient between kurtosis and sigma is 0.0926, which means that no connection can be proven. Total correlation of 0.091 can be increased to 0.146 removing European monetary union or to 0.156 removing Value added in services. The highest correlation if achieved at 0.224 removing Value added in services and European monetary union.

Comparison of All

This section includes comparison of sigma (see the Section called *Sigma Convergence* in Chapter 1 and the Section called *Sigma Convergence* in Chapter 3), IQR (see the Section called *IQR Convergence* in Chapter 1 and the Section called *IQR Convergence* in Chapter 3), μ (see the Section called μ *Convergence* in Chapter 1 and the Section called μ *Convergence* in Chapter 3) and kurtosis (see the Section called *Kurtosis Convergence* in Chapter 1 and the Section called *Kurtosis Convergence* in Chapter 3).

Figure 6-6 visually shows common points of sigma, IQR, μ and kurtosis. The metrics behave similarly, if all observations represented by circles are around the main diagonal. If the observations are in upper left or lower right corner, metrics show extremely different results.

Figure 6-6. differences between metrics, logfunc all

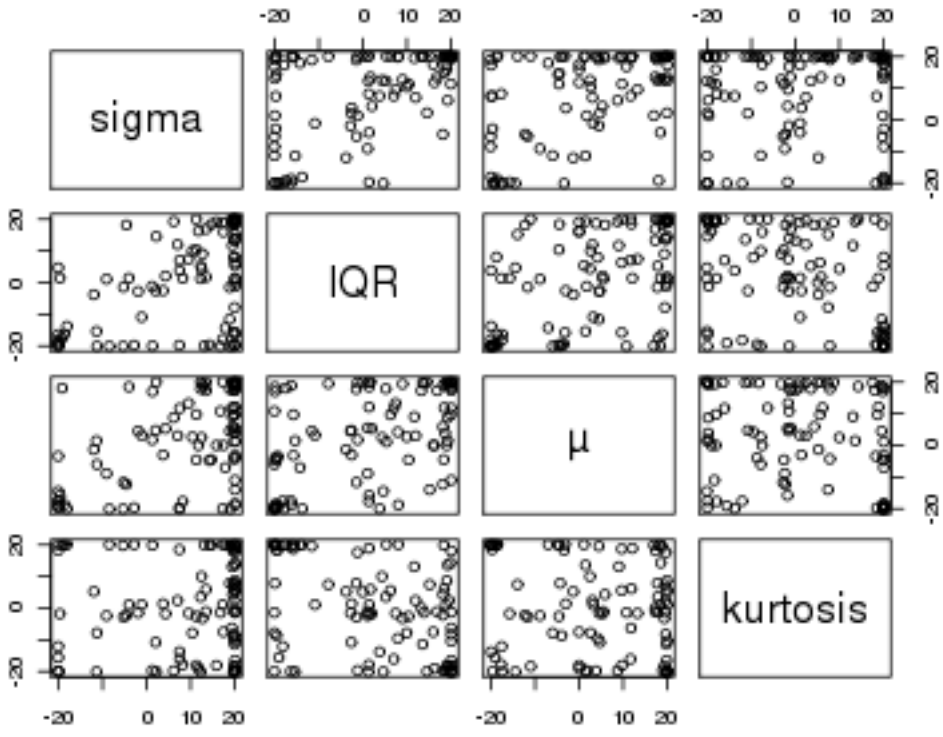


Table 6-2. Differences Between Metrics, All

coefficient	coefficient	extremely big difference	very big difference	big difference	medium difference	small difference	no difference
sigma	kurtosis	7	1	35	10	10	28
sigma	IQR	3	1	24	10	13	42
sigma	μ	0	1	26	13	14	40

Correlation coefficient between IQR and sigma is 0.477, which means that no connection can be proven. Total correlation of 0.476 can be increased to 0.514 removing agglomerations or to 0.552 removing Disposable income. The highest correlation if achieved at 0.594 removing Disposable income and agglomerations. Removing several regions and variables, the correlation coefficient can increase. For example, by removing Disposable income in agglomerations to 0.594 (by 0.118), removing Disposable income in European monetary union to 0.576 (by 0.1), removing Disposable income in European Union to 0.565 (by 0.089), removing Disposable income in Visegrad countries to 0.556 (by 0.08), removing Disposable income in British Isles to 0.555 (by 0.079), removing Disposable income in NMS8 to 0.555 (by 0.079) and removing Share of employees with university degree in agglomerations to 0.552 (by 0.076).

Correlation coefficient between μ and sigma is 0.48, which means that no connection can be proven. Total correlation of 0.481 can be increased to 0.537 removing mediterreanean or to 0.546 removing Disposable income. The highest correlation if achieved at 0.602 removing Disposable income and Nordic countries. Removing several regions and variables, the correlation coefficient can increase. For example, by removing Disposable income in Nordic countries to 0.602 (by 0.121), removing Disposable income in mediterreanean to 0.583 (by 0.102), removing Share of employees with university degree in Nordic countries to 0.573 (by 0.092), removing Disposable income in Germany to 0.571 (by 0.09), removing Share of employees with university degree in mediterreanean to 0.564 (by 0.083), removing Disposable income in European Union to 0.559 (by 0.078) and removing Disposable income in South to 0.559 (by 0.078).

Correlation coefficient between μ and IQR is 0.543, which means that no connection can be proven. Total correlation of 0.542 can be increased to 0.583 removing Germany or to 0.64 removing Disposable income. The highest correlation if achieved at 0.684 removing Disposable income and Germany. Removing several regions and variables, the correlation coefficient can increase. For example, by removing Disposable income in Germany to 0.684 (by 0.142), removing Disposable income in agglomerations to 0.676 (by 0.134), removing Disposable income in Nordic countries to 0.658 (by 0.116), removing Disposable income in South to 0.656 (by 0.114), removing Disposable income in mediterreanean to 0.654 (by 0.112), removing Disposable income in British Isles to 0.651 (by 0.109) and removing Disposable income in Visegrad countries to 0.645 (by 0.103).

Correlation coefficient between kurtosis and sigma is 0.0926, which means that no connection can be proven. Total correlation of 0.091 can be increased to 0.146 removing European monetary union or to 0.156 removing Value added in services. The highest correlation if achieved at 0.224 removing Value added in services and European monetary union.

Correlation coefficient between kurtosis and IQR is -0.444, which means that no connection can be proven. Total correlation of -0.444 can be increased to -0.406 removing South or to -0.407 removing Disposable income. The highest correlation if achieved at -0.369 removing Disposable income and South.

Correlation coefficient between kurtosis and μ is -0.261, which means that no connection can be proven. Total correlation of -0.26 can be increased to -0.204 removing southwest or to -0.138 removing Value added in services. The highest correlation if achieved at -0.081 removing Value added in services and mediterreanean.

In this section, there are only metrics that show significantly different results. Maximum correlation coefficient is only 54% (between μ and inter quartile range), minimum coefficient is -44% (between IQR and kurtosis).

Positive correlation is between mentioned IQR and μ (54%), μ and sigma (48%) and sigma and IQR (48%). Negative correlation was between kurtosis and IQR (-44%) and μ and kurtosis (-26%). Kurtosis and sigma are independent (correlation of 9%). All of these analysis show that each of these metrics describes different aspect of convergence.

The above analysis show that it is necessary to study all of the four metrics to quantify all ways of convergence and divergence.

Differences Between Variables

Table 6-3. Differences Between Variables

variable	extremely big difference	very big difference	big difference	medium difference	small difference	no difference
Disposable income	1	3	23	13	5	30
Value added in services	2	1	43	17	27	34
Economic activity rate	10	2	43	22	10	36
Share of employees with university degree	27	0	55	16	5	36
GDP per capita in PPS of EU average	15	0	48	7	18	50
Unemployment rate	4	1	30	30	7	54
Employment rate	0	3	48	9	16	63

As it can be seen, highest extremely big differences are in Share of employees with university degree and GDP per capita in PPS of EU average, however highest very big differences are in Disposable income and Employment rate. Smallest differences are in Employment rate and Unemployment rate.

Summary

We described several measurements of convergence. Some of these measurements showed different results, however some have similar development.

We are able to show several convergence clubs. Different interpretations of sigma coefficients have very similar behaviour (see the Section called *Comparison of Sigmas* for more details). Also, various mutations of beta coefficient were identical (see the Section called *Comparison of Betas* for further details). IQR convergence, boxplot convergence and μ convergence show similar behaviour. Even though correlation coefficient is not very high, in all cases it is positive and above 60%. Also, there is no case of one metric showing different kind of convergence than another one. See the Section called *Comparison of Difference* for more details.

On the other hand, several coefficients showed statistically independent results. This was the case of sigma and kurtosis. These two coefficients are by definition independent and empirical correlation coefficient of 5% proves this. Various authors worked on connection between beta and sigma coefficients. They showed that beta convergence is a necessary condition for sigma convergence ([Higgins2007]). These authors used very different methods to calculate beta coefficient and to enumerate sigma convergence. In this work, the methodology is very different. An empirical result of this work is positive however statistically insignificant correlation between sigma and beta convergence. See the Section called *Comparison of Beta Sigma and Kurtosis* for further details.

Summary of Convergence

Table 6-4. Summary of convergence

Region	GDP				Disposable income				Employment rate			
	σ	μ	IQR	γ	σ	μ	IQR	γ	σ	μ	IQR	γ
European Union	++	++	++	--					++	+		
EMU	++	++	++	--	++		++	-	++	++		
Nordic countries		++		--		+				+		
South	++	-		++	++		-	++	++	++		+
British Isles	--	-	-	--		+	--	++	+		++	
NMS8		-		-			+	--				
Visegrad countries				--		--						
agglomerations	--			--			+	++				
Germany	++		+		+		+	-				
Benelux	--	-	--	++	++	++						

In table, σ was described in the Section called *Sigma Convergence* in Chapter 3, μ was described in the Section called μ *Convergence* in Chapter 3, IQR was described in the Section called *IQR Convergence* in Chapter 3, γ was described in the Section called *Kurtosis Convergence* in Chapter 3 and variables were described in Chapter 2. ++ means strong convergence, + weak one, -- is strong divergence, - is weak one.

Below table compares metrics and coefficients by number of regions where convergence or divergence occurs. Sign + describes number of region with strong convergence, - number of regions with weak convergence.

Table 6-5. Comparison of Metrics

variable	sigma	Gini	Theil	IQR	boxplot	μ	$\varkappa$	skew-ness	kurtosis
GDP	+8 -3	+7 -2	+8 -3	+4 -1	+5 -2	+5 -0	+2 -1	+5 -3	+3 -8
Employ-ment rate	+5 -0	+6 -0	+5 -0	+2 -0	+4 -0	+4 -0	+4 -0	+0 -1	+0 -0
Economic activity rate	+7 -1	+6 -1	+7 -1	+2 -0	+5 -2	+3 -0	+0 -0	+2 -1	+1 -0
Share of employees with university degree	+8 -1	+7 -1	+8 -1	+0 -6	+0 -5	+1 -2	+4 -0	+0 -2	+1 -3
Value added in services	+1 -3	+1 -5	+1 -3	+0 -5	+0 -3	+0 -6	+0 -5	+0 -8	+8 -1
Unem-ployment rate	+5 -0	+5 -0	+5 -0	+5 -1	+5 -1	+2 -0	+0 -0	+1 -1	+1 -0
Disposable income	+5 -0	+4 -0	+5 -0	+1 -2	+4 -2	+3 -1	+4 -0	+1 -4	+5 -2

Chapter 7. Conclusions

This work studied convergence in several subregions of EU according to several metrics and several variables describing social and economic cohesion.

Substantial difference from other works is different methodology of convergence enumeration. Whilst most other works compare initial and ending values of sigma coefficient to see whether they are statistically significantly different, in this work we test time series of sigma coefficients for decreasing trend. This method has advantage of no assumptions on underlying distribution and usage of the same method on all metrics.

One of the results of the work is the empirical proof that sigma convergence, entropy convergence, Theil convergence and Gini convergence behave similarly and it is irrelevant which of these metrics is used. All of these metrics take into account all observations. The disadvantage is that it is always possible to decrease this metric, so convergence would be never ending.

Beta convergence in common literature is tested by solving a linear econometric or spatial econometric model, where beta coefficient is linear trend between variable and its growth. In this work we tested for correlation between variable and its growth. This test has again advantages of no dependence on underlying distribution. This methodology is very different from standard methodology, therefore comparison with other papers is not possible. Several logarithmised and non logarithmised versions of beta convergences behaved very similarly. Only slight connection between beta and sigma convergence was shown. This could be in apparent conflict with other papers, however completely different methodology is used in this work than other papers.

Inter quartile range convergence and boxplot convergence are different types of convergence. This convergence shows distance where majority of regions is located. The advantage of this metric is in ignoring outliers and actual distribution of regions around center. This makes IQR and boxplot convergence robust against extreme outliers on positive or negative side.

μ convergence is number of regions far away from median on the negative side. This allows for controlling only for negative outliers. Therefore changes on the positive side or around the center do not affect convergence in this metric. As a result of this, it is a very effective measure of convergence. Therefore it is used by European commission as criterion for regions to qualify into goal 1.

Kurtosis is the fourth moment of variable distribution. It describes how is sigma composed. If kurtosis is increasing, more of the variance is obtained from extreme values. If the kutrosis is low, more of the variance is from regions around the mean. Hence if kurtosis is decreasing, we consider regions converging. Kurtosis convergence empirically proved its theoretical ground and is independent from sigma coefficient. It is also independent from all other convergence types.

Overall four convergence clubs appear: sigma convergence, μ convergence, IQR convergence and kurtosis convergence. All of these describe different types of convergence and cannot be substituted by each other.

Seven variables describing social and economic cohesion were discussed. Economic cohesion was represented by Gross domestic product per capita in purchasing power parities and by disposable income as variables used in most of the papers. Even though GDP per capita has methodological problems (mainly commuting residents and different price levels), it is statistically well collected. Its possible successor, GNP, is not yet available on regional level. Other variable was value added in services as a portion of total value added in region. This variable represents structure of region's production. Percentage of workers with university degree describes quality of workforce which is connected to production in region.

Social cohesion was described by various rates from labour force sample survey. Unemployment rate according to ILO definition is very visible and discussed by media and politicians. Employment rate shows percentage of people active at labour market. Economic activity rate describes portion of inhabitants willing to be active at labour market. Each of these indicators of cohesion describes different part of economy. Even though employment rate, unemployment rate and economic activity rate are by definition connected, they do not always share the same characteristics.

In this work, several subregions of European union were studied. These regions were chosen to be either known subregions with specific cooperation (like whole EU, European monetary union or Benelux), larger countries (Germany and France), geographically close countries (Nordic countries, Visegrad countries, British isles, South, Southwest), countries with similar history (Visegrad countries or New member states from 2004), or artificial regions with similar

behaviour (agglomerations) or geographically connected (Mediterreanean or Baltic regions). Overall there are fourteen different subregions. Convergence and divergence according to each of the six indicators and each of the eleven metrics was tested.

Convergence of regions with excluded metropolitan regions was a lot more visible than convergence with metropolitan regions included. This is in accordance with several regional theories of metropolitan regions behaving differently.

Due to very different behaviour of each of the four metrics clubs, it is not possible to draw simple conclusions about fact whether convergence occurs.

Appendix A. Spatial Econometrics

While forecasting and analysing regional variables, several problem occur. The main problem is that regions are connected and that development in them is not independent from each other and is correlated. Spatial econometrics tackles this problem.

Spatial econometrics, as opposed to standard econometrics, assumes that regions depend on each other, as opposed to periods. This dependence is described by distance matrix or weight matrix W.

In common literature (e.g. [Johnstone1997]) there are two ways of dependence. Either random component in neighbouring regions effects dependent variable in given region, or dependent variable in neighbouring region effects its value in given region, or a possible combination of both effects.

Correlation among parametres describe fixed effects and random effects models. If the parametres of intercept are correlated with independent variables, it is fixed effects model. If they are uncorrelated it is random effects model. Difference between this models is technical and affects choice of algorithm used to calculate unbiased, consistend and effective estimates.

In spatial error model random component in neighbouring regions affects dependent variable in given region

Equation A-1. Spatial error

$$Y_t = Y_t * \beta + \mu + \phi_t \phi_t = \sigma * W * \phi_t + u_t$$

where: μ - intercept, ϕ - spatially correlated random component, u - IID random component

In spatial lag model dependent variable in neighbouring region affects its value in given region.

Equation A-2. Spatial lag

$$Y_t = Y_t * \beta + \mu + u_t + Y_t * \sigma * W$$

where: μ - intercept, u - IID random component

Distances Among Regions

In order to produce weight matrix for econometric modeling, distance matrix has to be computed. Due to the fact, that regions are not points, there are several possibilities on how to compute distance matrix.

Latter sections describe several approaches to constructing distance matrix. Distances among regions are not in kilometres, rather they represent a distance of general terms (the bigger distance, the more far away regions are). This is especially the case in neighbour matrix, where 1 means regions are not neighbours, while 0 means they are neighbours.

Easiest option to produce distance matrix is by neighbour matrix. In such matrix, two regions are of distance 0 if they are neighbours, otherwise their distance is 1.

Table A-1. Neighbouring Matrix Example

from	to	distance
Bratislava region	Bratislava region	0
Bratislava region	Western Slovakia	0
Bratislava region	Vienna	1
Bratislava region	Düsseldorf	1
Bratislava region	Prague	1
Bratislava region	Berlin	1

Other commonly used distance definition is as distance from centre of region to centre of other region. Centres

of regions are calculated as geographical centres, which do not neccessarily represent business centres of regions. However in most smaller regions, geographical centre is close to business centre.

Table A-2. Distance Between Centres of Regions Example

from	to	distance
Bratislava region	Bratislava region	0
Bratislava region	Western Slovakia	0.9
Bratislava region	Vienna	0.8
Bratislava region	Düsseldorf	11.04
Bratislava region	Prague	3.23
Bratislava region	Berlin	5.64

One possibility to compute distance matrix is as distance between two closest points of regions. Distance between two regions is defined as distance between two points from those regions, which are closest to each other.

As a consequence, distance between neighboring regions is zero, distance from region to itself is zero.

Table A-3. Distance of Closest Points from Regions Example

from	to	distance
Bratislava region	Bratislava region	0
Bratislava region	Western Slovakia	0
Bratislava region	Vienna	0.31
Bratislava region	Düsseldorf	9.95
Bratislava region	Prague	2.69
Bratislava region	Berlin	5.03

Appendix B. NUTS regions in Europe

Table B-1. Austria: Nuts Regions Data from Year 2005

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Disposable income	Employment rate	Unemployment rate	Economic activity rate
AT	Austria	124	20.8	47.9	155.9	56.9	94.8	59.4
AT1	East Austria	131	23.2	52.3	137.5	55.6	93.3	58.9
AT11	Burgenland	84	15	41.2	127.08	54	94	56.8
AT12	Niederösterreich	100	19.8	43.5	134.55	57	95.7	59.1
AT13	Vienna	169	28	58.3	137.94	54.5	90.9	59.1
AT2	South Austria	106	19.7	41.3	127.08	54.8	95.7	56.7
AT21	Kärnten	105	19.7	42.2	124.68	53.7	95.2	55.9
AT22	Steiermark	107	19.8	40.9	125.56	55.2	95.9	57.1
AT3	West Austria	127	18.7	45.8	132.65	59.7	96.1	61.6
AT31	Oberösterreich	121	18.2	40.5	130.25	58.3	96	60.3
AT32	Salzburg	138	21.1	53.8	132.53	61.8	96.8	63.3
AT33	Tirol	129	17.9	50.5	128.61	60.3	96.5	61.9
AT34	Vorarlberg	129	18.6	43.6	134.27	60.9	94.7	63.6

Table B-2. Belgium: Nuts Regions Data from Year 2005

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Disposable income	Employment rate	Unemployment rate	Economic activity rate
BE	Belgium	120	38.1	51.6	134.71	52.4	91.6	56.4
BE1	Brussels	237	52.6	62.3	110.06	49.6	83.7	58.1
BE2	VLAAMS GEWEST	119	36.6	50.7	122.19	54.7	94.6	57.2
BE21	Prov. Antwerpen	142	36	51.5	118.82	53.2	93.8	56.4
BE22	Prov. Limburg (B)	96	31.8	43	109.89	52.5	92.9	55.8

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Disposable income	Employment rate	Unemployment rate	Economic activity rate
BE23	Prov. Oost-Vlaanderen	106	35.7	45.5	120.51	55.9	95.1	58
BE24	Prov. Vlaams-Brabant	125	45.3	64.2	137.38	58.5	95.6	60.5
BE25	Prov. West-Vlaanderen	111	33.5	45.9	114.88	53.5	95.3	55.6
BE3	RÉGION WALLONNE	86	36.7	45.4	104.62	49.1	88.2	54.4
BE31	Prov. Brabant Wallon	116	51.8	52.7	129.9	54.5	91	58.9
BE32	Prov. Hainaut	79	32	44.7	97.64	46	86	51.8
BE33	Prov. Liège	88	37.5	43.6	101.61	48.9	88.1	54.5
BE34	Prov. Luxembourg (B)	82	32.5	41.9	99.38	53.6	92.1	57
BE35	Prov. Namur	83	36	44.9	102.79	52.1	89.6	56.6

Table B-3. Bulgaria: Nuts Regions Data from Year 2005

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Disposable income	Employment rate	Unemployment rate	Economic activity rate
BG	Bulgaria	34	27.2	45.4	31.27	49	89.9	53.8
BG3	North and east Bulgaria	29	24.4	39.4	24.69	46.2	88.8	51.3
BG31	Severozapaden	26	24.5	35.9	21.47	40.6	87.4	45.6
BG32	Severen tsentralen	27	26.4	39.2	25.33	45.4	87.5	51.1
BG33	Severoiztochen	30	24.1	46.7	23.98	50.2	87.9	56.2

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Disposable income	Employment rate	Unemployment rate	Economic activity rate
BG34	Yugoiztochen	32	23.2	35.9	26.27	48.4	91.7	52.2
BG4	Southwest and central Bulgaria	40	29.9	50.1	29.09	52.1	91.1	56.5
BG41	Yugozapaden	51	36.5	54.2	32.07	54.8	92.4	58.9
BG42	Yuzhen tsentralen	26	19.7	39.2	24.09	48.3	89	53.3

Table B-4. Cyprus: Nuts Regions Data from Year 2005

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Disposable income	Employment rate	Unemployment rate	Economic activity rate
CY	Cyprus	91	32.8	53.1		64.3	94.7	67.1

Table B-5. Czech Republic: Nuts Regions Data from Year 2005

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Disposable income	Employment rate	Unemployment rate	Economic activity rate
CZ01	Prague	159	30.1	63.5	84.7	65.2	96.5	67.3
CZ02	Central Czechia	70	12.4	38	66.58	60.9	94.8	63.9
CZ03	Jihozapad	70	12.1	34.5	61.69	61.6	94.9	64.4
CZ04	Northwest Czechia	60	9.2	31.3	55.56	57.6	86.5	65.4
CZ05	Severovychod	64	12.2	33.8	59.91	60.2	94.4	63.1
CZ06	Jihovychod	68	16.4	38.3	60.46	59	92.3	63
CZ07	Stredni Morava	59	14.3	33.6	57.66	57.6	90.3	62.9
CZ08	Moravskoslezsko	64	13.3	31.1	57.04	55.6	86.1	63.2

Table B-6. Germany: Nuts Regions Data from Year 2005

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Dispos-able income	Employ-ment rate	Unem-ployment rate	Economic activity rate
DE	Germany	117	28.9	47.1	153.67	53.9	88.9	60.3
DE1	Baden-Würtenberg	129	29.6	41.7	143.45	58.9	93	62.9
DE11	Stuttgart	138	30.2	42.6	146.42	58.6	92.8	62.8
DE12	Karlsruhe	133	30.3	45.1	138.79	57.4	92.5	61.7
DE13	Freiburg	114	27.3	38.9	137.84	60	93.6	63.6
DE14	Tübingen	123	29.9	37.1	138.57	60.4	93.3	64.3
DE2	BAYERN	138	27.8	47.8	139.42	58.2	93	62.1
DE21	Oberbayern	170	34.3	54.1	151.4	60.2	94.2	63.5
DE22	Niederbay-ern	115	21.4	40.7	123.78	59.5	93.6	63.2
DE23	Oberpfalz	121	22	41.1	123.85	58.2	93.5	61.8
DE24	Oberfranken	113	22	41.9	129.29	54.9	89.8	60.4
DE25	Mittel-franken	135	27	48.7	136.35	55.8	91.4	60.7
DE26	Unter-franken	119	25.8	42.9	129	57.1	91.8	61.4
DE27	Schwaben	122	24.8	41.8	134.31	57.7	93.5	61.4
DE3	Berlin	100	42.4	49.1	110.58	50.8	80.8	62.5
DE4	BRAN-DENBURG	82	36.6	45.4	110.77	51.8	81.9	62.8
DE41	Brandenburg - Nordost	76	35.8	44.4	107.53	51	80.2	63
DE42	Brandenburg - Südwest	88	37.2	46.1	110.58	52.4	83.3	62.6
DE5	Bremen	161	26.9	53.8	147.13	47	83.5	56.1
DE6	Hamburg	201	30.1	63.6	171.13	55.1	89.6	61.2
DE7	HESSEN	143	31	56.2	135.67	55.6	91.6	60.4
DE71	Darmstadt	162	33.1	61.3	138.93	56.3	91.9	61
DE72	Gießen	108	29.1	43	125.85	56.2	91.1	61
DE73	Kassel	115	26	45.1	124.78	53	90.7	58.1
DE8	MECKLENBURG-VORPOMMERN	81	31.7	45.3	105.02	49	78.7	62.3

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Disposable income	Employment rate	Unemployment rate	Economic activity rate
DE9	NIEDERSACHSEN	103	23.5	44.3	126.62	52.8	89.6	58.5
DE91	Braunschweig	112	24.9	36.8	123.24	50.2	88.5	56.2
DE92	Hannover	115	26.9	49.4	128.36	52.9	89.6	58.6
DE93	Lüneburg	84	20.9	47.2	130.68	53.2	90.3	58.5
DE94	Weser-Ems	101	21.5	42.9	118.77	54.3	89.9	60.1
DEA	NORDRHEINWESTFALEN	116	25.5	47.2	138.95	52.2	89.6	57.8
DEA1	Düsseldorf	130	24.6	52.7	139.66	51.5	89.4	57.3
DEA2	Köln	120	31.3	48.6	137.36	53.5	90.6	58.7
DEA3	Münster	98	23.8	43	129.47	52.6	90.6	57.6
DEA4	Detmold	111	23.9	41.8	140.63	54.4	89.9	60.1
DEA5	Arnsberg	108	21.9	41.8	136.04	50	87.9	56.4
DEB	RHEINLANDPFALZ	103	25.7	42.2	127.72	54.4	91.3	59.2
DEB1	Koblenz	98	22.2	43.8	125.28	53.6	91.3	58.2
DEB2	Trier	97	25.8	42.2	122.93	54.9	92.7	58.8
DEB3	Rheinhessen-Pfalz	107	28.3	41.1	127.13	54.9	90.8	60.1
DEC	SAARLAND	114	23.2	42.3	128.92	49.5	89.2	54.9
DED	SACHSEN	86	38.6	43.3	109.78	48.9	81.3	60
DED1	Chemnitz	81	36.4	42.6	108.26	48.6	82.2	59.2
DED2	Dresden	89	39.9	40.9	108.88	49.4	81.7	60.2
DED3	Leipzig	87	39.8	48	107.16	48.8	79.5	60.7
DEE	SACHSENANHALT	82	31	40.8	105.18	48.3	79.7	60.3
DEF	SCHLESWIGHOLSTEIN	103	24.2	50.3	126.56	54.6	89.8	60.3
DEG	THÜRINGEN	82	34.9	39.2	106.41	50.7	82.9	61

Table B-7. Denmark: Nuts Regions Data from Year 2005

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Disposable income	Employment rate	Unemployment rate	Economic activity rate
DK	Denmark	124	36.8	46.1	107.58	62.5	95.2	65.3
DK01	Hoved-staden	157		57.1	94.7			
DK02	Sjælland	94		41.6	90.37			
DK03	Syddanmark	113		43.3	88.46			
DK04	Midtjylland	116		42.5	89.41			
DK05	Nordjylland	110		40.7	88.34			

Table B-8. Estonia: Nuts Regions Data from Year 2005

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Disposable income	Employment rate	Unemployment rate	Economic activity rate
EE	Estonia	62	37.7	51.5	54.53	59.3	92.1	63.8

Table B-9. Spain: Nuts Regions Data from Year 2005

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Disposable income	Employment rate	Unemployment rate	Economic activity rate
ES	Spain	102	33.9	46.2	122.62	53.6	90.8	58.1
ES1	NOROESTE	87	34.1	40.3	99.07	48.4	90.2	52.9
ES11	Galicia	83	32.2	39.7	92.87	49.3	90.1	53.9
ES12	Principado de Asturias	90	37.6	40.2	104.37	44.7	89.8	49
ES13	Cantabria	100	36.7	42.6	108.29	51.7	91.5	55.9
ES2	NORESTE	122	42.7	38.9	127.39	55.2	93.4	58.4
ES21	País Vasco	129	48.3	39.8	133.17	54.8	92.7	58.4
ES22	Comunidad Foral de Navarra	128	41.9	36.3	132.01	58.2	94.4	61.1
ES23	La Rioja	110	33.4	36	111.67	56.9	93.8	60
ES24	Aragón	109	35.6	39.3	113.06	54	94.2	56.9

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Disposable income	Employment rate	Unemployment rate	Economic activity rate
ES3	Comunidad de Madrid	133	41.2	55.6	126.62	60.3	93.2	63.9
ES4	CENTRO (E)	85	29.3	35.9	94.08	48.7	89.8	53.4
ES41	Castilla y León	97	33.2	37.8	103.77	49.3	91.3	53.3
ES42	Castilla-La Mancha	80	25.3	33.7	85.66	50.1	90.8	54.3
ES43	Extremadura	69	26.5	33.8	79.69	44.8	84.2	52
ES5	East (ES)	110	32.3	48.8	110.91	57	92.4	60.9
ES51	Cataluña	121	34.7	48.2	118.43	58.1	93	61.6
ES52	Comunidad Valenciana	94	30.6	46.7	94.86	54.9	91.2	59.2
ES53	Illes Balears	114	23.3	61.3	113.36	59.6	92.8	63.3
ES6	South (ES)	80	29.2	43.8	84.47	49.1	87	55.3
ES61	Andalucía	79	29.4	44.3	82.71	48.2	86.2	54.8
ES62	Región de Murcia	86	27.8	42.7	84.34	54.4	92	58.3
ES63	Ciudad Autónoma de Ceuta	92	31.4	31.5	105.1	50.4	80.3	59.8
ES64	Ciudad Autónoma de Melilla	91	37.9	31.6	104.16	48.6	86	54
ES7	CANARIAS	92	29.6	57	92.77	55	88.3	61.1

Table B-10. Finland: Nuts Regions Data from Year 2005

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Disposable income	Employment rate	Unemployment rate	Economic activity rate
FI	Finland	114	39	43.1	106.94	58.3	91.6	62.5
FI1	MANNER-SUOMI	114	39.1	43	91.47	58.3	91.6	62.5
FI13	Itä-Suomi	85	34	34.7	82.05	50.8	88.3	56.3

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Dispos-able income	Employ-ment rate	Unem-ployment rate	Economic activity rate
FI18	Etelä-Suomi	132	41.4	48.5	96.6	61.8	93.1	65.5
FI19	Länsi-Suomi	102	37	36.5	85.77	56.1	91.2	60.4
FI1A	Pohjois-Suomi	98	38	34.7	81.63	56.2	88.9	61.6
FI2	Åland	147	26.1	59	108.6	54.4		56

Table B-11. France: Nuts Regions Data from Year 2005

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Dispos-able income	Employ-ment rate	Unem-ployment rate	Economic activity rate
FR	France	111	28.8	51.5	142.33	55.2	90.7	59.9
FR1	Île de France	172	42.4	57.3	149.61	61.5	91	66.9
FR2	BASSIN PARISIEN	96	22.6	47.3	118.46	55.6	91.6	59.6
FR21	Champagne-Ardenne	101	24.7	42.4	112.3	56	89.9	61.2
FR22	Picardie	88	23.3	44.6	115.46	55.4	89.4	60.6
FR23	Haute-Normandie	100	22.3	50.6	117.5	57.5	92.1	61.6
FR24	Centre	98	21	48.8	120.11	56.7	92.9	60
FR25	Basse-Normandie	91	24.5	48	113	53.7	92.1	57.4
FR26	Bourgogne	96	21.2	47.3	119.39	53.2	92.6	56.6
FR3	NORD - PAS-DE-CALAIS	88	26	52.2	103.01	52.9	86.8	59.2
FR4	EST	96	25.5	45.6	119.48	56.5	91.5	60.7
FR41	Lorraine	91	24.2	46.6	113.89	54.8	89.7	59.9
FR42	Alsace	104	29.1	44.9	122.71	60	93	63.5

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Dispos-able income	Employ-ment rate	Unem-ployment rate	Economic activity rate
FR43	Franche-Comté	95	21.8	44.6	117.93	54.2	92.7	57.7
FR5	OUEST	98	26.9	49	115.32	54.4	92.4	58.1
FR51	Pays de la Loire	100	25.1	49.4	113.84	56.6	92.6	60.3
FR52	Bretagne	98	31.2	49.3	113.57	52.9	93	56.2
FR53	Poitou-Charentes	92	23.3	47.4	113.59	52.8	91.2	56.9
FR6	SUD-OUEST	99	27.6	48.6	118.17	53.8	92.8	57.4
FR61	Aquitaine	100	25.5	46.9	117.23	52.4	92.5	56.1
FR62	Midi-Pyrénées	100	30.6	49.9	114.88	55.3	92.9	59
FR63	Limousin	91	24.7	50.8	119.45	53.9	93.6	56.6
FR7	CENTRE-EST	108	27.4	48.4	123.57	56.8	92	61
FR71	Rhône-Alpes	111	28.2	48.6	122.34	57.5	91.8	61.8
FR72	Auvergne	93	23.8	47.1	119.44	53.9	92.6	57.4
FR8	Meditere-anean coast (FR)	98	27.9	54.7	116.44	48.7	89	53.9
FR81	Languedoc-Roussillon	87	28.7	53.4	107.85	47.6	87.9	53.3
FR82	Provence-Alpes-Côte d'Azur	105	28	55.2	119.11	49.5	89.6	54.5
FR83	Corse	85	16.9	56.4	103.61	44.5	89.1	49.3
FR9	DÉPARTE-MENTS D'OUTRE-MER	67		45.9	71.45	44.9	73.9	58
FR91	Guadeloupe	70		49.4		45.1	74.1	58.6
FR92	Martinique	76		48.1		46.6	81.3	56
FR93	Guyane	53		39.4		49.8	75.2	63.5
FR94	Réunion	65		43.8		43	69.9	57.9

Table B-12. Greece: Nuts Regions Data from Year 2005

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Disposable income	Employment rate	Unemployment rate	Economic activity rate
GR	Greece	92	25.1	52	114.12	51.6	90.2	56.2
GR1	VOREIA ELLADA	71	24	42.2	88.14	49.6	88.6	54.9
GR11	Anatoliki Makedonia, Thraki	62	18.5	39.4	82.68	49.1	88.1	54.4
GR12	Kentriki Makedonia	74	26.3	46.9	89.6	49.9	88.9	55.1
GR13	Dytiki Makedonia	76	24.7	30.6	89.07	44	82	52
GR14	Thessalia	69	22.2	36.3	82.43	51.2	90.5	56
GR2	Kentriki Ellada	73	18.7	37.6	79.64	49.5	89.9	53.9
GR21	Ipeiros	68	23.7	39.3	81.14	47	88.5	52
GR22	Ionia Nisia	74	14.7	57.8	56.56	52	91.5	56
GR23	Dytiki Ellada	60	19.9	38.8	74.54	48.9	89.4	53.9
GR24	Sterea Ellada	88	17.7	28.1	94.45	48.5	89.1	53
GR25	Peloponnisos	75	17.1	38.4	75.12	51.4	91.3	55.3
GR3	Attiki	125	30.8	61.8	119.98	54	91.2	58.4
GR4	Nisia Aigaiou, Kriti	82	20.3	53.5	88.5	54.1	91.8	58
GR41	Voreio Aigaio	66	22.1	48.1	83.89	44.5	89.8	47.9
GR42	Notio Aigaio	93	15.5	62.4	93.13	53.6	90.7	58.6
GR43	Kriti	81	22.1	49.9	85.4	57.6	92.9	61.3

Table B-13. Hungary: Nuts Regions Data from Year 2005

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Disposable income	Employment rate	Unemployment rate	Economic activity rate
HU	Hungary	63	21.8	42.1	69.17	51	92.8	54.3
HU1	Kozep-Magyarorszag	103	31.3	53.7	84.81	56.2	94.9	58.8

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Disposable income	Employment rate	Unemployment rate	Economic activity rate
HU2	DUNANTUL	55	16.2	32	52.92	52.5	93.1	55.8
HU21	Kozep-Dunantul	59	15.3	29.2	54.17	54.5	93.7	57.7
HU22	Nyugat-Dunantul	63	16.1	32.2	54.61	54.7	94.1	57.7
HU23	Del-Dunantul	44	17.6	36.1	47.38	47.9	91.2	51.7
HU3	ALFOLD ES ESZAK	41	18.4	32	44	46.1	90.8	49.9
HU31	Eszak-Magyarorszag	41	18.3	29.4	44.1	44.4	89.4	48.7
HU32	Eszak-Alfold	40	18.7	32.8	41.47	46	91	49.6
HU33	Del-Alfold	43	18.2	33.7	44.87	47.7	91.9	51.3

Table B-14. Ireland: Nuts Regions Data from Year 2005

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Disposable income	Employment rate	Unemployment rate	Economic activity rate
IE	Ireland	144	33.7	44.8	128.8	61.8	95.7	64.1
IE01	Border, Midland and Western	98	27	35	98.52	60	95.6	62.2
IE02	Southern and Eastern	161	35.9	47	114.29	62.5	95.7	64.7

Table B-15. Italy: Nuts Regions Data from Year 2005

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Disposable income	Employment rate	Unemployment rate	Economic activity rate
IT	Italy	105	15.5	50	134.08	48	92.3	51.2

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Dispos-able income	Employ-ment rate	Unem-ployment rate	Economic activity rate
ITC	NORD-OVEST	128	15	51.5	135.76	52.2	95.6	54.1
ITC1	Piemonte	116	13.5	51.4	130.17	50.5	95.3	52.4
ITC2	Valle d'Aosta/Vallée d'Aoste	124	12.8	47.6	131.61	54.1	96.8	55.6
ITC3	Liguria	107	17.9	58.7	125.92	45.8	94.2	48.2
ITC4	Lombardia	138	15.3	50.7	136.88	54	95.9	55.9
ITD	NORD-EST	125	14.3	48.7	132.73	53.3	96	55.1
ITD1	Provincia Autonoma Bolzano/Bozen	135	12.2	52.5	137.52	59.3	97.2	60.6
ITD2	Provincia Autonoma Trento	122	14.6	48.3	119.23	54.3	96.4	56
ITD3	Veneto	124	13.5	48.6	125.06	53.3	95.8	55.2
ITD4	Friuli-Venezia Giulia	117	14.8	49.5	126.63	49.5	95.9	51.4
ITD5	Emilia-Romagna	128	15.3	48.3	139.24	53.5	96.2	55.4
ITE	CENTRO (I)	118	18	53.9	125.37	49.9	93.6	52.7
ITE1	Toscana	114	15.7	52.3	126.28	50.2	94.7	52.6
ITE2	Umbria	97	15.9	47.5	115.29	48.1	93.9	50.6
ITE3	Marche	105	15.9	46.7	118.32	50.7	95.3	52.7
ITE4	Lazio	127	20.6	57.5	124.62	49.8	92.3	53.1
ITF	SUD	69	15.4	45.9	83.52	40.6	86.2	45.7
ITF1	Abruzzo	85	17.4	43.1	94.32	47.2	92.1	50.6
ITF2	Molise	76	16.2	40.8	86.05	42	89.9	45.7
ITF3	Campania	67	16.3	48.5	80.32	40.2	85.1	45.7
ITF4	Puglia	68	13.1	45.3	81.72	38.8	85.4	44.1
ITF5	Basilicata	73	13.4	40.8	86.19	42.3	87.7	47
ITF6	Calabria	67	15.9	45	79.88	40.1	85.6	45.2
ITG	Islands (IT)	71	14.4	45.7	84.31	40.3	84.7	45.9
ITG1	Sicilia	68	15.3	45.3	80.76	38.7	83.8	44.5
ITG2	Sardegna	80	12.3	46.6	90.27	44.7	87.1	50.1

Table B-16. Lithuania: Nuts Regions Data from Year 2005

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Disposable income	Employment rate	Unemployment rate	Economic activity rate
LT	Lithuania	53	30.8	45.2	61.13	58.9	91.7	63.8

Table B-17. Luxembourg: Nuts Regions Data from Year 2005

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Disposable income	Employment rate	Unemployment rate	Economic activity rate
LU	Luxembourg	255	31.1	66		57.7	95.5	60

Table B-18. Latvia: Nuts Regions Data from Year 2005

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Disposable income	Employment rate	Unemployment rate	Economic activity rate
LV	Latvia	49	24.1	55.6	51.85	57.1	91.1	62.3

Table B-19. Malta: Nuts Regions Data from Year 2005

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Disposable income	Employment rate	Unemployment rate	Economic activity rate
MT	Malta	78	16.9	49.4		46.1	92.7	48.4

Table B-20. Netherlands: Nuts Regions Data from Year 2005

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Disposable income	Employment rate	Unemployment rate	Economic activity rate
NL	Netherlands	131	34	49.7	125.02	61.3	95.3	63.9
NL1	NOORD-NEDERLAND	124	30	35.2	97.65	58.6	94.3	61.6
NL11	Groningen	161	33.7	29.3	91.71	58.2	93.4	61.9
NL12	Friesland	106	27.3	40.8	97.15	59.4	95.1	61.8
NL13	Drenthe	103	29.1	38.5	100.49	58.1	94.3	61.1

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Disposable income	Employment rate	Unemployment rate	Economic activity rate
NL2	OOST-NEDERLAND	109	30.9	46	102.99	61.5	95.2	64.1
NL21	Overijssel	112	29.8	42.2	98.22	60.2	95.1	62.8
NL22	Gelderland	109	31.6	46.6	104.72	61.3	95.7	63.6
NL23	Flevoland	96	30.2	55.5	94.36	67.2	93.4	71.2
NL3	WEST-NEDERLAND	144	37.8	56.3	111.07	62.4	95.3	64.9
NL31	Utrecht	158	43.7	60.4	115.88	65.2	96.2	67.3
NL32	Noord-Holland	154	40.3	62.2	111.92	62.7	95.1	65.6
NL33	Zuid-Holland	135	35	51.6	105.96	61.7	95.1	64.3
NL34	Zeeland	117	24.7	36.2	105.32	57.5	96.7	59.2
NL4	ZUID-NEDERLAND	127	30.8	45.7	106.35	60	95.6	62.4
NL41	Noord-Brabant	132	31.9	46.3	105.34	61.5	96.1	63.7
NL42	Limburg (NL)	116	28.3	44.3	103.75	56.9	94.6	59.8

Table B-21. Poland: Nuts Regions Data from Year 2005

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Disposable income	Employment rate	Unemployment rate	Economic activity rate
PL	Poland	51	22.6	46.8	61.17	50.4	82.3	59.4
PL1	CENTRALNY	70	27.1	54.5	62.16	51.6	84.3	59.8
PL11	Lodzkie	47	21.8	43.8	52.21	50	82.6	59.1
PL12	Mazowieckie	81	30	57.6	65.81	52.5	85.2	60.1
PL2	POLUDNIOWY	51	22	44.7	54.07	49.5	82.6	57.9

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Dispos-able income	Employ-ment rate	Unem-ployment rate	Economic activity rate
PL21	Malopolskie	44	21.6	46.7	46.27	53.6	84.7	61.3
PL22	Slaskie	55	22.3	43.6	58.19	46.8	81	55.8
PL3	WSCHODNI	36	20.2	41.9	42.45	52.8	84.1	60.8
PL31	Lubelskie	35	21.7	43.6	41.67	54.5	85.7	62
PL32	Pod-karpackie	35	17.8	40.6	39.34	52.5	83.3	60.5
PL33	Swi-etokrzyskie	38	20.8	42.8	44.57	49.8	81	59.2
PL34	Podlaskie	38	20.7	40.1	43.64	53.6	85.6	61.1
PL4	POLNOCNO-ZACHODNI	51	21.2	44.2	53.38	50.3	81.1	60
PL41	Wielkopol-skie	55	20.6	42.7	54.22	52.3	82.8	60.7
PL42	Zachod-niopo-morskie	48	22.7	49	52.46	47	77.3	58.8
PL43	Lubuskie	46	21.2	42.3	47.59	49.5	80.9	59.5
PL5	POLUDNIOWO-ZACHODNI	50	23.4	41.9	51.2	48.2	78.6	59.2
PL51	Dol-noslaskie	53	24.8	42.8	53.03	47.5	77.2	59.4
PL52	Opolskie	43	19.3	38.8	43.42	50.2	83.1	58.8
PL6	POL-NOCNY	46	20.5	45.1	48.33	48.6	80.3	58.4
PL61	Kujawsko-Pomorskie	45	18.1	43.4	48.67	49.9	80.2	59.8
PL62	Warminsko-Mazurskie	39	20	41.2	44.11	47.7	79.6	58.1
PL63	Pomorskie	50	23.3	48.4	48.97	48	81.1	57.2

Table B-22. Portugal: Nuts Regions Data from Year 2005

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Dispos-able income	Employ-ment rate	Unem-ployment rate	Economic activity rate
PT	Portugal	77	15	45.8	95.24	61.2	92.4	65.5
PT1	CONTI-NENTE	77	15.2	45.8	81.45	61.2	92.2	65.7
PT11	Norte	61	11.9	38.8	67.46	60.9	91.2	66
PT15	Algarve	81	15.9	56.5	86.92	59	93.8	62.3
PT16	Centro (P)	65	10.7	38.4	73.76	67.2	94.8	70.2
PT17	Lisboa	109	24.1	55.7	103.63	58.8	91.4	63.7
PT18	Alentejo	71	11.5	34.5	75.19	54.3	90.9	58.9
PT2	Região Autónoma dos AÇORES	68	9.6	38.5	78.22	57.8		59.5
PT3	Região Autónoma da MADEIRA	97	12.4	53.7	85.51	63.4	95.5	66

Table B-23. Romania: Nuts Regions Data from Year 2005

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Dispos-able income	Employ-ment rate	Unem-ployment rate	Economic activity rate
RO	Romania	35	14.1	39.5	36.35	55.7	92.8	59
RO1	Macroregiunea unu	34	12.5	37.2	30.09			
RO11	Nord-Vest	33	11.9	39	29.8			
RO12	Centru	34	13.1	35.4	29.5			
RO2	Macroregiunea doi	26	11.2	36.4	26.49			
RO21	Nord-Est	23	11	35.5	24.29			
RO22	Sud-Est	30	11.5	37.4	28.5			
RO3	Macroregiunea trei	48	19.2	45.3	37.62			
RO31	Sud - Muntenia	29	10	32.5	27.17			
RO32	Bucuresti - Ilfov	77	31.5	52.7	52			

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Disposable income	Employment rate	Unemployment rate	Economic activity rate
RO4	Macroregiunea patru	33	13.5	35.1	31.16			
RO41	Sud-Vest Oltenia	27	12.8	30.3	27.69			
RO42	Vest	39	14.4	39	34.35			

Table B-24. Sweden: Nuts Regions Data from Year 2005

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Disposable income	Employment rate	Unemployment rate	Economic activity rate
SE	Sweden	120	31.5	45.7	120.22	70.4	92.5	74.5
SE1	East Sweden	139	35.6	52.1	110.4			
SE11	Stockholm	167	39.4	58.2	117.09			
SE12	Östra Mellansverige	103	30.3	39.7	98.58			
SE2	South Sweden	110	29.5	43.5	100			
SE21	Småland med öarna	103	24.9	37.6	94.97			
SE22	Sydsverige	107	31.4	44.5	99.34			
SE23	Västsverige	115	30.1	45.1	99.61			
SE3	North Sweden	108	27.8	34.8	94.96			
SE31	Norra Mellansverige	105	25.7	35	93.25			
SE32	Mellersta Norrland	111	27.5	37.1	97.89			
SE33	Övre Norrland	111	31.4	32.8	91.07			

Table B-25. Slovenia: Nuts Regions Data from Year 2005

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Disposable income	Employment rate	Unemployment rate	Economic activity rate
SI	Slovenia	88	23.9	42.9	100.24	59.3	93.5	62.7

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Disposable income	Employment rate	Unemployment rate	Economic activity rate
SI01	Eastern Slovenia	73		36.6	79.46	58.1	92.4	61.9
SI02	Western Slovenia	105		47.8	90.67	60.8	94.8	63.6

Table B-26. Slovakia: Nuts Regions Data from Year 2005

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Disposable income	Employment rate	Unemployment rate	Economic activity rate
SK	Slovakia	60	17.5	43.5	64.88	55.7	83.7	65.1
SK01	Bratislava region	147	31.1	56.6	89.55	66.6	94.7	69.9
SK02	Western Slovakia	57	13.6	34.5	52.83	57.5	87.5	64.7
SK03	Central Slovakia	46	18.1	42.2	51.24	53.3	80.4	64.6
SK04	Eastern Slovakia	43	14.9	41.7	46.8	51	76.9	63.9

Table B-27. United Kingdom: Nuts Regions Data from Year 2005

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Disposable income	Employment rate	Unemployment rate	Economic activity rate
UK	United Kingdom	122	33	52.2	153.9	60.2	95.2	62.3
UKC	NORTH EAST	95	28.1	42.4	111.72	54.4	93.9	56.6
UKC1	Tees Valley and Durham	84	28.3	38.6	108.87	54.7	94	56.9
UKC2	Northumberland and Tyne and Wear	105	27.9	45	111.18	54.1	93.8	56.4
UKD	NORTH WEST	105	30.8	49.7	119.83	58.4	95.4	60.2
UKD1	Cumbria	87	28	38.4	124.61	61.5	96.2	62.8
UKD2	Cheshire	133	34	51.7	136.58	61.8	96.7	63.5
UKD3	Greater Manchester	112	30.6	56	114.62	59.4	95.1	61.4

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Dispos-able income	Employ-ment rate	Unem-ployment rate	Economic activity rate
UKD4	Lancashire	97	31.5	40	113.57	56.9	95.7	58.6
UKD5	Merseyside	86	28.7	47.7	113.61	54.2	94.3	56.2
UKE	YORK-SHIRE AND THE HUMBER	104	28.2	47.4	119.36	59.1	95.3	61
UKE1	East Riding and North Lincolnshire	96	22.8	36.3	114.72	56.9	94.6	59
UKE2	North Yorkshire	106	33.5	49.7	136.58	60.9	97.1	62.1
UKE3	South Yorkshire	93	25.2	46.9	112.32	57.8	94.5	59.9
UKE4	West Yorkshire	112	30.1	50.8	115.25	60.3	95.3	62
UKF	EAST MID-LANDS	109	29.6	47	122.75	61.1	95.7	63
UKF1	Derbyshire and Notting-hamshire	108	29.5	45.3	117.49	59.5	95.7	61.3
UKF2	Leicester-shire, Rutland and Northamp-tonshire	119	30.9	50.3	125.59	64.1	95.4	66.2
UKF3	Lincolnshire	85	26.3	42.2	120.67	58.9	96.3	60.5
UKG	WEST MID-LANDS	105	28.9	49	118.91	59.5	95.3	61.5
UKG1	Hereford-shire, Worcester-shire and Warwick-shire	107	32.2	51.5	135.96	62.9	97.4	64.1

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Dispos-able income	Employ-ment rate	Unem-ployment rate	Economic activity rate
UKG2	Shropshire and Stafford-shire	92	27.4	45.8	119.32	60.2	96.3	61.9
UKG3	West Midlands	112	28	49.4	106.98	57.3	93.6	59.9
UKH	EAST OF ENGLAND	116	30.4	53.9	140.01	62.1	96	63.9
UKH1	East Anglia	111	29.8	50.4	128.09	60.7	95.9	62.5
UKH2	Bedford-shire and Hertford-shire	138	36	58.6	149.71	64.3	96.2	66.1
UKH3	Essex	101	25.5	52.8	140.04	62	96.2	63.7
UKI	London	201	42.5	66.7	163.36	62.3	93	65.7
UKI1	Inner London	338	50.4	71	179.85	61.6	92.2	65.4
UKI2	Outer London	111	37.8	58.3	148.78	62.8	93.6	65.8
UKJ	SOUTH EAST	131	35.5	58.3	147.78	63.3	96.2	65.1
UKJ1	Berkshire, Bucking-hamshire and Oxfordshire	167	38.1	61.7	153.02	68.3	96.5	69.9
UKJ2	Surrey, East and West Sussex	126	39.7	61.1	157.61	60.7	96.2	62.5
UKJ3	Hampshire and Isle of Wight	120	32.3	54.1	132.45	62.7	96	64.3
UKJ4	Kent	103	28.5	50.8	131.72	61.9	95.8	63.8
UKK	SOUTH WEST	112	31.9	50.1	130.49	60.5	96.4	62
UKK1	Gloucester-shire, Wiltshire and North Somerset	135	36.2	53.4	133.18	65	96.5	66.5
UKK2	Dorset and Somerset	103	30.1	48.6	133.09	56.2	96.4	57.9

Region	Region	GDP per capita in PPS of EU average	Share of employees with university degree	Value added in services	Dispos-able income	Employ-ment rate	Unem-ployment rate	Economic activity rate
UKK3	Cornwall and Isles of Scilly	76	24	44.2	115.01	55.8	96.6	57.1
UKK4	Devon	93	27.7	44.3	121	58.4	96.1	59.9
UKL	WALES	92	30.2	41.7	116.22	55.8	95.5	57.5
UKL1	West Wales and The Valleys	79	27.6	38.1	111.51	53.4	94.9	55.1
UKL2	East Wales	116	34.2	46	119.94	60.2	96.4	61.7
UKM	SCOT-LAND	116	37.5	46.6	124.95	59.4	94.7	61.7
UKM2	Eastern Scotland	121	40.1	48.7	128.32	61.2	94.9	63.4
UKM3	South Western Scotland	109	36.1	45.8	117.75	57	93.7	59.7
UKM5	North Eastern Scotland	156		47.7	139.11	63.4	96.1	65
UKM6	Highlands and Islands	88		37.8	112.75	59	96.1	60.9
UKN	NORTH-ERN IRELAND	98	31.6	40.6	115.02	57.8	95.3	59.9

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