OLSZTYN ECONOMIC JOURNAL
Abbrev.: Olszt. Econ. J., 2013, 8(1)

INCOME DISTRIBUTION AND REGIONAL CONVERGENCE IN POLAND AND THE EUROPEAN UNION

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K e y w o r d s: analysis of regional convergence, income distribution, kernel density estimation.

A b s t r a c t

The main aim of this paper is to analyze regional convergence in the period 1995–2007 in Poland and European Union. Main hypothesis is statement that convergence (understood as reducing income disparities) perceived from system wide perspective is not identical with diminishing income disparity among inhabitants of regions in particular countries, even though broad range of EU cohesion policy means were applied.

The analysis was carried out in several steps. Initially, the authors referred to the classical convergence hypotheses (unconditional β convergence) within the EU-27, then the same assumptions were examined taking into account population – weighted indicators. However, the main aim of research undertaken in this study was to investigate the regional (within – country) distribution of income for the selected years. The results allows to state that despite growing mean income in the analyzed systems (EU-27 and Poland) and strong support by EU funding, one can observe increased disparities between regions.

ROZKŁAD DOCHODÓW I REGIONALNA KOWERGENCJA W POLSCE I UNII EUROPEJSKIEJ

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S ł o w a k l u c z o w e: analiza konwergencji regionalnej, rozkład dochodów, jądrowa estymacja gęstości.

Abstrakt

Podstawowym celem artykułu była empiryczna analiza procesu regionalnej konwergencji w Polsce oraz Unii Europejskiej w latach 1995–2007. Główną hipotezę stanowi stwierdzenie, że konwergencja (rozumiana jako zmniejszanie różnic w dochodach) postrzegana z perspektywy całego systemu ekonomicznego nie może być utożsamiona z zanikiem zróżnicowania poziomu dochodu mieszkańców regionów poszczególnych państw i to mimo zastosowania wielu instrumentów europejskiej polityki spójności.

Badanie przeprowadzono w kilku etapach. Początkowo odniesiono się do klasycznej hipotezy bezwarunkowej β konwergencji w skali UE-27, a następnie uwzględniono wskaźniki dochodu ważonego rozmiarami populacji. Najważniejszą częścią analizy było przeprowadzenie dla wybranych lat estymacji gęstości regionalnego (wewnętrznego) rozkładu dochodu. Uzyskane wyniki uzasadniają wniosek, że mimo rosnącego przeciętnego dochodu (zarówno w UE-27, jak i w Polsce), można zauważyć pogłębiający się dysparytet zamożności regionalnej.

Introduction

The main aim of regional convergence analysis conducted in this paper is to compare situation between Poland and enlarged EU. Subject of the article is important due to a couple of reasons. First and most important of them are still discussed cost and results of transition, especially when validity of term "Poland A" and "Poland B" is considered. In the above-presented division first group is to be a synonym of well-developed modern area, while so called "Poland B" represent poor, underdeveloped "eastern wall". One can find opinions that this kind of order stems from removal of regional issues from main areas of interest by policy makers founding basement for Polish transition (*Stanisław Gomułka i transformacja*... 2010). Administrative reform implemented in 1999 enforced more detailed and complex view on scale and form of regional divergence which should result in improvement of regional policy.

Another important reason for analysis of domestic convergence is a need to develop suitable regional policy that can face challenges stemming from Polish membership in the EU, especially at the stage of development and implementation of new budget perspective. Honest and objective research is very important and useful tool for supporting EU cohesion policy. Issues of domestic incomes disparity are not only Polish problem but also refer to other EU countries such as Italy, Spain, or Netherlands, where strong regional divergence has significant influence on the whole economic situation. Similar problem concerned also new EU members, for instance Hungary, Romania and Slovenia, where insufficient "integration effect" was observed (KALIORIAS, PETRAKOS 2010), thus one can consider scientific analysis of this phenomenon reasonable.

For the purpose of the research presented in the paper two attitudes towards convergence were employed. First, theoretical, which is presented in

the next part of the article, refers to the idea of convergence linked with neoclassical growth model. Core of second look are institutional and practical dimensions referring to the EU cohesion policy, which is aimed at diminishing differences in socio-economic development between various regions.

Such policy became very important after 1993 when Maastricht Treaty, establishing European Union, was put into the force. Treaty regulations introduced convergence criterions, actually called nominal. Meeting these criterions determined adoption of common currency in EU. Simultaneously a support tool for achieving this goal – Cohesion Fund was implemented in the EU legal instruments. Main objective of the fund was to reduce development differences in particular countries in order to help meeting nominal convergence criterions[1].

Another milestone in the history of regional policy was EU enlargement in 2004. It imposed broad and deep changes in financial and legal framework of this policy. Such situation stemmed from the fact that for the first time in the history of EU so many less developed (in comparison to earlier enlargement) countries entered community.

One has to underline that since 1988 EU cohesion policy has based on long term expenditure programming periods. Simultaneously, funds allocation guidelines, which impose spending in regions with below average EU income, suggest presence of formal linkages between economic convergence and EU structural policy (GŁODOWSKA 2012). This resulted in growing importance of regional policy in the global EU spending. In the financial perspective 1989–1993 regional policy accounted for 20% of budget while in programming period 2007–2013 such share increased to 36%. Financial plan ending 2013 is the first which allows all new members to obtain financing from three support tools: Cohesion Fund, European Regional Development Fund and European Social Fund. Considering scale and importance of this policy one can ask about results and efficiency of its instruments.

Economic convergence and neoclassical growth model

In the second half of 80-ties of XX century one could observe a return to research on economic growth. The main reason boosting this change was statement that long run economic development is much strongly affected by economic growth factors than by countercyclical policy (monetary and fiscal) and business cycles. One of the backbones theories of economic growth was

[1] Detailed rules of the Fund activity are defined in Council Regulation (EC) No 1164/94 of 16 May 1994 establishing a Cohesion Fund (OJ L 130, 25.5.1994).

convergence. Research on convergence was aimed at answering questions whether we were witnessing growing divergence of welfare between countries or whether diminishing divergence followed increase of welfare.

The biggest development of research on economic convergence took place in 90-ties of the XX century. The guide point of reference for modern convergence, interpreted as heading of group of economies towards common steady state, (which is characterized by comparable welfare and growth rate) is publication of BAUMOL (1986). One has to remember that Baumol was inspired by ABRAMOVITZ (1986). Abramovitz on the basis of long run observations for the period 1870–1979 found significant changes in the labor productivity for selected OECD economies. He also claimed that productivity level heads towards common steady state. Very similar conclusions were achieved by Baumol for identical period and comparable set of developed economies (OECD countries). Abramovitz and Baumol findings were questioned by DE LONG (1988). Author stated that convergence hypothesis is strictly linked with arbitrary choice of economies, and expanding this set makes results unclear. Baumol together with Wolff responded to his criticism (BAUMOL, WOLFF 1988). One has to say that listed above publications are milestones of research on convergence understood as process implied by economic growth and diminishing return on capital[2].

Analysis of convergence was aimed at answering question whether modern economies are heading towards common steady state and simultaneously one can expect worldwide wealth convergence. In the literature most popular are classical β and σ convergence hypotheses[3]. First assumes negative relationship between economic growth rate and initial welfare level (usually GDP *per capita*). Sigma convergence assumes diminishing dispersion in the group of countries. Contrary to convergence one can observe σ divergence

Problem of welfare distribution is one of the most commonly discussed issues both by scientists and politicians. Presented results suggest two dimensional divergence[4]: Poor countries developed more slowly than well developed (β divergence), moreover cross economy *per capita* income dispersion was rising (σ divergence). Additionaly QUAH (1996, 1997) presented a model of world economy heading towards bimodal income distribution with two sets of countries: poor (Asia, Africa, South America) and rich (OECD). However

[2] The most important research on convergence can be found in Sala-i-Martina (2002), De La Fuente (1997) and considered to be most often cited ISLAM (2003). Also Polish authors have some valuable publications see: NOWAK (2006) or MALAGA (2004) and PRÓCHNIAK and RAPACKI (2010).

[3] Terms of β and σ convergence (divergence) were introduced by SALA-I-MARTIN in his Ph. D. thesis from 1990 while idea became widely spread by works of Barro (SALA-I-MARTIN 1992).

[4] Due to a lack of consistent, trustworthy data analyses are not conducted for periods earlier than first half of XIX century.

repetition of this research proved that results are not robust to changes of analyzed sets of countries (KREMER et al. 2001).

Research on classical convergence usually bases on research in which, one country equals to one observation (country is treated as analytical unit). In case of searching for growth factors such attitude is fully reasonable because development may stem from many factors such as institutions, education or economic policy influencing growth rate. However if one wants to find out whether poor countries develop faster than the rich ones such attitude has some drawbacks- population of the whole world and sets of both rich and poor countries has to be considered. In case of poor, fast developing country with small population reasoning should be different than this applied to unit with significant share of population.

Presented above drawback can be partially smoothed by using population-weighted data. After such adjustment one can assume that bimodal income distribution doesn't exist (JONES 1997). Moreover, the use of population weighted data allows one to assume that both β, and σ divergence hypotheses should be rejected, and even income of poor countries was growing faster that this of rich, resulting in diminishing income differences (SCHULTZ 1998). Using single country as analytical unit β convergence cannot be observed. After applying population weighted analysis negative relationship between initial welfare and later growth rate is fully confirmed, due to the fact that high population countries (China, India, Indonesia) were in the group of poor and fast growing countries (SALA-I-MARTIN 2006).

The use of *per capita* income weighted by population doesn't allow to assess income distribution and welfare disparities within the country. Such situation stems from the assumption that all citizens have income equal to mean. One can state that such attitude eliminates possibility to analyze convergence from citizen's perspective. As a result idea aimed at finding rising or diminishing income disparities on the basis of empirical income distributions was developed.

References to population weighted GDP and domestic income distribution can be found in: SCHULTZ (1998), SQUIRE, DENINGER (1996), BHALLA (2002), QUAH (2002), SALA-I-MARTIN (2006). However one has to consider that all listed authors based on highly aggregated data (continent, world), putting aside regional or within country analysis. Also transition issues are almost omitted. There are minor exemptions: for example research conducted by FISCHER and STIRBÖCK (2006) which covered 256 EU regions and suggested presence of regional level convergence clubs. Also BATTISTI and DI VAIO (2008) analyzed regional convergence in the EU, however they did not achieve clear results.

Starting from the first half of 90-ties of XX century one can observe consensus that convergence is phenomenon of conditional character which

implies that it can be observed in the selected group of countries. Examples of such sets are OECD countries or EU members (BAUMOL 1986, MANKIW et al. 1992). Typical in-club analysis treated each economy as analytical unit omitting within country distribution.

Such situation boosted authors of this paper to combine both presented attitudes. Set of analyzed countries was reduced to EU members. On the other hand both classical convergence and population-weighted hypotheses were verified. Additionally income distribution within whole EU was analyzed. For this purpose each member of EU-27 was defined as a set of regions. The last aim of the paper was to assess regional convergence in Poland and compare it to EU-wide experience.

Referring to institutional attitude towards convergence one can notify that European cohesion policy tools should stimulate diminishing of income disparities between regions, and therefore boost real convergence. Such hypothesis stems from the fact that all three instruments of EU regional policy: Cohesion Fund, European Regional Development Fund and European Social Fund present convergence as their main objective[5]. Such hierarchy of targets allows to ask about efficiency of regional policy.

Method for Testing β Convergence Hypothesis

Convergence phenomenon is strictly linked with neoclassicał growth theory. In this case convergence is understood as positive correlation between initial distance from steady state and later speed of heading towards it. Let y^* be GDP per capita in steady state, while $y(t)$ represents product per capita at time t. Speed of convergence can be estimated using formula:

$$\dot{y}/y = \beta^*[\ln(y^*) - \ln(y(t))] \tag{1}$$

where:
β^* – convergence speed describing pace of heading towards y^*.

Solution of differential equation (1) is given by:

$$\text{in}(y(t)) = (1 - e^{-\beta t}) \ln(y^*) + e^{-\beta t} \ln (y(0)) \tag{2}$$

where:
$y(0)$ – initial value of per capita product in given region at initial time.

[5] European Commission (2008) notify that this priority is to be understood as reducing gap between GDP per capita in the regions benefiting from EU policy and EU average

Equation (2) can be transformed into pace of production per capita formula:

$$(1/t)[\ln(y(t)) - \ln(y(0))] = (1 - e^{-\beta t})/t] \ln(y^*) - [(1 - e^{-\beta t})/t] \ln(y(0)) \quad (3)$$

Above presented relationship was estimated using regression (4), which created a basis for unconditional β-convergence hypothesis verification.

$$(1/t)[\ln(y(t) - \ln(y(0))] = b_0 + b_1 \ln(y(0)) + \varepsilon_t \quad (4)$$

where:
$y(t)$ – GDP per capita in given region in last year;
$y(0)$ – GDP per capita in given region in initial year;
b_j – estimated parameters (where $j = 0; 1$);
ε_t – error term with normal distribution, fixed variance and null expected value.
Heading towards steady state requires b_1 values to be negative.

One has to notify that thanks to equality $b_1 = -(1 - e^{-\beta t})/t$ empirical value of β coefficient can be found. β describes pace of heading towards steady state in case of set of economies/regions:

$$\beta = -\ln(1 + b_1 t)/t \quad (5)$$

Research on β convergence is commonly followed by verification of σ-convergence hypothesis. In this case one has to find dispersion of GDP per capita. For this purpose most often standard deviation (s) is employed, however it is a measure of absolute dispersion. Other commonly adopted tool is coefficient of variation (Vx), which allows to obtain relative dispersion. In the paper authors resigned of this method in favour of estimation of regional income distribution for EU and then for Poland. Simplifying one can assume that diminishing dispersion of GDP per capita around mean value (or median) will imply σ convergence. More details of this method were presented in the further part of the article

Complying with presented assumptions authors attempted to verify classical β convergence hypothesis for EU-27 economies. Both indicators, these not directly referring to population and those population weighted were employed simultaneously. The main source of quantitative data was European Commission (*Eurostat*) database. GDP per capita values in Euro were in 2000 constant prices.

Regions were separated on the basis of common, legally binding taxonomic benchmark. (NUTS – *Nomenclature d'Unites Territoriales Statistiques*)[6].

[6] See: Regulation (EC) No 1059/2003 of the European Parliament and of the Council of 26 May 2003 on the establishment of a common classification of territorial units for statistics (NUTS). For

NUTS as classically defined statistical classification has hierarchical construction with three levels: NUTS 1, NUTS 2 and NUTS 3[7]. Each tier consists of administrative units of average size with limits for each level. If there are no NUTS compliant units in the country, than existing structure has to be tailored by merging smaller and neighboring units into bigger ones. As a result NUTS units cannot be treated as real administrative departments in spite of the fact that main aim of NUTS developers was to achieve high level of comparability.

Analysis of regional convergence conducted on the basis of NUTS 2 units is followed by per capita dispersion estimations. Lower and upper limits of population for this tier are 800 thousand and 3 million people respectably. In case of Poland such classification is similar to voivodships, but for example for UK it's not compliant with any existing classification of administrative districts[8].

Due to many events and processes observed at the beginning of 90-ties of previous century (transition of majority of 2004 EU entrants, geopolitical changes such as reunification of Germany, independence of former the USSR republics; technical revolution-internet; and integration within EU) and changes in the methodology of national accounts (standard ESA 1995), further analysis covers period 1995–2007. Only in case of Romania data was collected for years 1997–2007. Such attitude allows to omit transition shock which usually deforms results of empirical findings.

Results of Testing Classical β Convergence Hypotheses for EU-27 and Poland: Cross Regional Attitude

Classical β convergence hypothesis was verified in two ways. First attitude assumes that every analyzed region has the same importance so its influence on the whole situation is not different than other regions. In the another method such assumption was repealed and NUTS 2 population criterion was employed. In this case one can consider that importance of each region depends on its population. As a result region with bigger population has stronger influence on estimations and region with small population has weaker.

Poland corresponding document is Rozporządzenie Rady Ministrów z 14 listopada 2007 r. w sprawie wprowadzenia Nomenklatury Jednostek Terytorialnych do Celów Statystycznych (NTS), DzU nr 214, poz. 1572.

[7] More detailed levels called *Local Administrative Units* (LAU) are not subject to regulation no. 1059/2003. For example in Poland LAU 1 are poviats while LAU 2 gminas. Due to this fact Poland is not obliged to transfer to Eurostat LAU complaint data.

[8] List of NUTS 2 is appendix to Regulation no. 1059/2003.

Results of convergence estimation (4) together with diagnostics statistics are presented in Table 1. Additionally estimated relationship is presented on Figure 1. Influence of each region on estimation results is presented by bubble. In the first attitude which assumes each region to have identical importance all "bubbles" have one diameter.

Table 1

Estimated β convergence results for regions in EU-27 and Poland for the period 1995–2007

Country	Convergence hypothesis	b_0	b_1	R^2	$p(F)$	β
EU-27	β non weighted	0.084 (0.013)	–0.006 (0.001)	0.076	0.000	0.65%
	β weighted	0.078 (0.003)	–0.006 (0.000)	0.057	0.000	0.59%
Poland	β non weighted	–0.081 (0.100)	0.018 (0.013)	0.124	0.182	–1.75%
	β weighted	–0.151 (0.020)	0.027 (0.002)	0.231	0.000	–2.63%

Explanations: Standard errors in (parenthesis).
Source: own calculation.

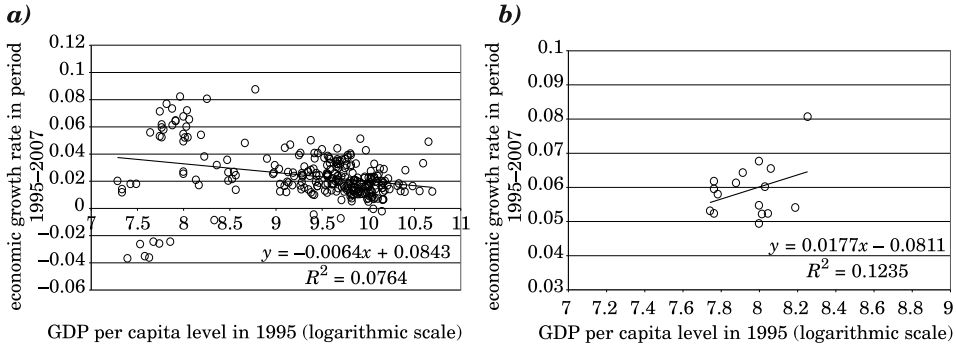

Fig. 1. Non weighted β convergence EU-27 and Polish regions in the period 1995–2007: *a* – EU-27, *b* – Poland

Source: own calculation.

On the basis of conducted analysis one can say that:

– For EU-27 sample one can observe negative slope while in case of Poland slope is positive. This allows to state that EU-27 regions were heading towards steady state at rate 0,65% yearly while in Poland there was divergence -1,75% per year (see-results from table 1).

– b_1 is statistically significant with significance level at 1% for EU-27, while insignificant for Poland;

– R squared for EU-27 and Poland are 7,6% and 12,4% respectably, which implies that differences in the production growth rate are poorly explained by initial GDP per capita level;

– F statistic significance allows to reject hypothesis assuming lack of joint influence of explanatory variables on explained variable only in case of EU-27 regions (with 99% confidence).

In the second attitude towards β convergence assumption of equal weight of each region was lifted In the analysis conducted for UE-27 regions and Poland for the period 1995–2007 importance of each region depended on its population. Estimated results are presented in rows No. 3 and 5 in Table 1 and on Figure 2. Complying with above accepted rule each region is depicted by circle, however in this case their importance is proportional to population.

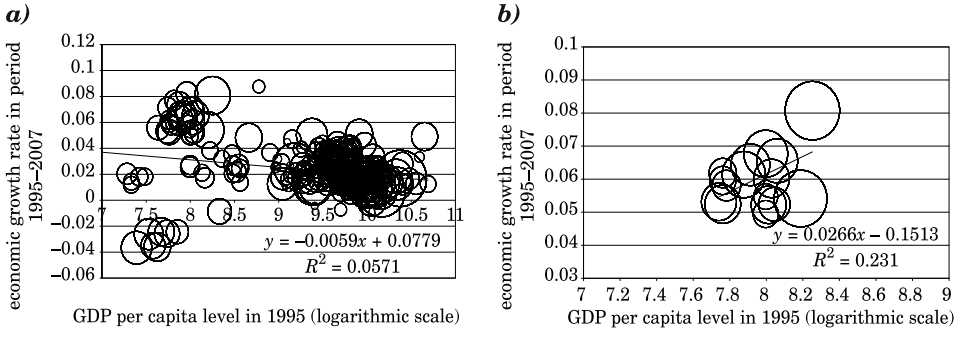

Fig. 2. βconvergence (population weighted) EU-27 and Polish regions in the period 1995–2007: a – EU-27, b – Poland

Source: own calculation.

One the basis of analysis one can state that applying population weighting does not have strong statistical influence on the situation in EU countries while in case of Poland such influence can be found. As a result for Poland divergence with rate of 2.63% can be observed together with statistically significant b_1 coefficient and relatively high R-squared (almost 25%). According to these findings one can state that $^1/_4$ of changes in the growth rate can be explained by initial per capita GDP level. One has also to notify that F statistics level allowed to reject hypothesis assuming lack of joint influence of explanatory variables on explained variable (with over 99% confidence).

Within-Country Regional Income Distribution

Following recently presented remarks, convergence of all types will be used for cross-country analysis, assuming that each country is a separate element of the set. Alternative solution is to analyze within country income distribution, preferably per capita. Due to the assumed analytical targets authors decided to

use also regional cross-section. This allows considering population's size and repeals strict assumption of identity between each citizen income and country average[9]. However one has to notify that such attitude sets equality between citizen's of region income and mean per capita income observed in the analyzed unit.

Authors of the paper attempted to recreate cross regional income distribution for UE – 27 and Poland. Achieving such goal required two prior choices. First was to present criterion of regional division. Second: choice of econometric method for estimation of income distribution.

According to earlier remarks regions were identified on the basis of NUTS classification, and NUTS 2 class was employed. Data about population of each region was gained from Eurostat. Period of analysis was analogous and covered years 1995–2007, but in this case individual years were separated: 1995, 1999, 2003, 2007.

Defining subject of analysis was bit more complicated. As it was said before main task was to depict within country and regional per capita income. Due to the requirement for intertemporal comparison of GDP (always denominated in Euro), 2000 constant prices were used[10]. Having data about real GDP in the country and region one can calculate share of each region (in %) in GDP. Such share was defined as u. Simultaneously data about real GDP per capita in NUTS 2 cross section was obtained, (dividing real GDP in each region by its NUTS-2 population). Next step was combining both information. As a result each observation of per capita GDP in year i was given weight obtained by dividing country's GDP and regional GDP for year i. Such weight was noted u. Finally data series for each country and year i with real GDP *per capita* for NUTS 2 unit, weighted by u was created.

Having so prepared data an attempt to assess continuous (or at least *quasi*-continuous) per capita income distribution was made. Then parametric methods requiring a priori assumed probability distribution of analyzed random variable, (in this case per capita income) were used. This can be for example normal distribution, χ^2 or other known distribution of continuous variable. Then one can asses value of crucial parameters. Disadvantage of such attitude is arbitrary choice of distribution, which can be far from empirical results for sample.

Different attitude is employed by non-parametric. In this case on can build histogram which is the simplest non parametric representation of distribution

[9] Having information about domestic income distribution one can aggregate data to set region or worldwide scale. This allows to compare achieved results with "traditional" convergence estimations. See: Bhalla (2002) or Bourguignon, Morrison (2002).

[10] For this purpose a GDP deflator was used (year 2000 = 100). One has to consider that such attitude doesn't consider regional price differences, but this drawback cannot be eliminated due to a lack of regional GDP deflators.

for population. However using histogram has also drawbacks such as arbitrary size of intervals and inability to obtain algebraic form of histogram as continuous function. As a result probability density function cannot be integrated[11].

Non-parametric methods can be kernel density estimators. This idea assumes finding probability distribution in the neighborhood of every point (value) in the sample and simultaneously finding the best possible algebraic form of distribution for population on the basis of sample distribution which analytical form is not known.

Formal framework of this method can be found in SILVERMAN (1992). Let X be economic random variable with unknown probability distribution f. After some experiments (research) one will obtain data about n- element sample form X. Than finding estimator f is possible (approximation from sample). Denote $K(x)$ as the kernel. The kernel must meet conditios:
– domain and codomain of $K(x)$ is a set of real numbers (R),
– $K(x) \geq 0$ for every $x \in R$,
– $\int_{-\infty}^{\infty} K(x)\, dx = 0$,
– $K(-x) = K(x)$ for every $x \in R$.

Function $f1(x)$ is called kernel density f, when:

$$f_1(x) = \frac{1}{nh} \sum_{i=1}^{n} K(\frac{x - x_i}{h}) \tag{6}$$

Numerator in the brackets (6) identifies neighborhood of point (value) from sample, while h is a smoothing parameter of $f_1(x)$ function graph.

Assessment of "kernels' quality" $K(x)$ usually refers to *Mean Integrated Square Error* – MISE, which represents integral of mean square error for the whole set R. *Mean Square Error* – MSE is expected value of squared error value, which is difference between actual and estimated value. Optimal kernel $K(x)$, considering minimalization of MISE is function proposed by EPANECZNIKOV (1969):

$$K(x) = \begin{cases} \frac{3}{4}(1 - x^2), & |x| < 1 \\ 0, & |x| \geq 1 \end{cases} \tag{7}$$

The above presented function $K(x)$ was widely used in the research, which allowed to obtain continuous probability density function for the sample, without assuming a priori its form.

[11] As a result continuous cumulative distribution function for the population cannot be found.

Chosen (h) parameter influences shape of estimated probability distribution graph. Too high h value results in excessive smoothing of graph, while too low results in to boldly exposed local extremes. Both situations do not comply with real properties of analyzed populations. Due to this fact researcher is usually forced for arbitrary choice of this parameter value. Commonly accepted in the literature (SALA-I-MARTIN 2006, WÓJCIK 2004) method for simplified estimation of h, authors used formula given by:

$$h = 0.9 \frac{s}{\sqrt[5]{n}} \tag{8}$$

Regional Per Capita Income Distribution for EU-27 and Poland

According to above presented procedure, income distribution for samples (defined in compliance with NUTS 2) was used to depict income distribution in the analyzed general population. Estimated probability density functions are presented on Figure 3.

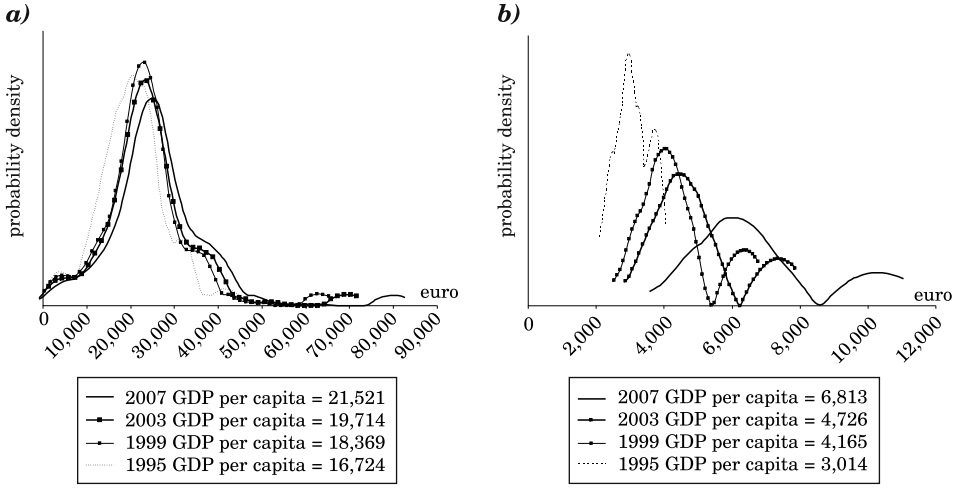

Fig. 3. Regional per capita income distribution for EU-27 and Poland: *a* – EU-27, *b* – Poland
Source: own calculation.

Apart from graphic presentation authors calculated also descriptive indicators showing kurtosis, asymmetry, and dynamic of income changes in population's fractions. Corresponding data is presented in table 2 and 3.

Table 2

Selected properties of regional per capita income distribution

Country	Coefficient of variation				Kurtosis coefficient			
	1995	1999	2003	2007	1995	1999	2003	2007
Poland	14.17	9.69	10.94	10.74	0.28	-0.54	-0.47	-0.67
EU-27	23.59	18.52	18.55	19.14	0.06	0.08	-0.01	0.09

Explanatory note: coefficient of variation (in %): is half of interquartile range divided by median; kurtosis – $(Q_3 + Q_1 - 2\text{Me})/2Q$, where Q_3 – 3rd quartile; Q_1 – 1st quartile; Me – median; Q – interquartile range.
Source: own calculation.

Table 3

Dynamics of chosen deciles of regional per capita income

Country	AI D9 /AI D1				Dynamics AI D1 for year 2007 (AI D1 z 1995 = 100)	Dynamics AI D9 for year 2007 (AI D9 z 1995 = 100)
	1995	1999	2003	2007		
Poland	1.63	1.98	2.02	2.15	216.06	284.33
EU-27	2.28	2.60	3.04	2.76	112.92	136.64

AI D9 – per capita income for 9th decile; AI D1 – per capita income for 1st decile.
Source: own calculation.

On the basis of presented results one can state that economic growth (in this case: increase of real GDP per capita) was followed by increase of mode for every distribution, which can be proved by rightwards movement of extremes. This suggests increase of welfare in the analyzed regions assuming that they are represented by the highest percentage of population.

Probability density functions of European regional GDP per capita have second peak right to the mean. This is even more clearly visible in case of Polish NUTS 2 units. In this case one can state that bimodal distribution are observed. Such situation allows to divide Polish regions into two subsets, one with income clearly below country's average and another, richer. This confirms strong regional divergence in the analyzed economic systems, and implies that assumption about diminishing disparities cannot be verified positively – σ convergence hypothesis should be rejected.

All obtained empirical distributions suggest growing rightwards kurtosis over time. This implies that growth of mean income is followed by rising number of regions which GDP per capita is below country average. As a result one can state that economic growth of particular system is pulled by the few richest NUTS 2 units. This is another condition suggesting rejection of assumption about diminishing regional income disparities.

Volatility of income distribution was also presented as relationship between income per capita observed in the richest and poorest deciles[12] of

[12] For the purpose of presented analysis it was assumed the 1st decile is value of GPD per capita observed in 10% poorest NUTS 2 regions. The 9th decile refers to GDP per capita observed in 10% richest NUTS 2 units respectably.

populations in every analyzed period. Increase of this indicator was observed in all economies, which implies that GDP per capita grew faster in rich regions. This statement can be confirmed by dynamics of real GDP for 1st and 9th deciles of NUTS 2 population. Growth rate for 9th decile was every time higher than similar indicator calculated for 1st decile.

Conclusions

Referring to assumptions of European cohesion policy one can state that achieved results suggest negative trends especially in case of Poland. Regression analysis show that β convergence was not observed in Poland – even adverse trend was found. Poor regions developed slower than the rich ones. This may imply impoverishing large part of society living in the poorer part of Poland. Empirical findings for European regions are not so clear. Negative relationship between initial level of GDP and subsequent growth rate was observed, however with very low goodness – to – fit ratios.

Auxiliary analysis of regional income distribution showed rough income growth. Despite of growing income in the population (both for EU-27 and Poland), one can observe increased disparities between regions. More noticeable bimodality is followed by asymmetry of distribution, which implies growing number of regions with income below mean. Such situation may lead specific "double heterogenity". The income disparities between old and new members will be followed by strong intra-country regional divergence (CAVENAILLIE, DUBOIS 2010)

Above mentioned process questions effectiveness of cohesion policy aimed at smoothing differences in the economic development of regions. This issue becomes more important during crisis that hit Europe. Policy makers will support poor countries less willingly, mainly due to the large public debt. During negotiations on new budget perspective there will be many voices criticizing sense of supporting activities aimed at removing differences in the regional development. It also seems that results presented in the paper are good basis for further analysis aimed at identifying influence of regional convergence on migration within enlarged EU or differences between entrepreneurship in various regions.

Translated by BARTOSZ GODZISZEWSKI

Accepted for print 6.11.2012

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