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PART II

ARTICLES

Marta GÖTZ*

POLAND IN THE PERIOD OF ECONOMIC TRANSITION AND GERMANY AFTER REUNIFICATION AN ATTEMPT AT ASSESSING Σ-CONVERGENCE

Abstract: In 2009 and 2010 Poland and Germany are celebrating some important anniversaries – 20 years of the first free elections and the fall of the Berlin Wall. These jubilees inspire research aiming at taking stock of developments having unfolded over this time. Since the economic cohesion is high on the EU agenda, examining international and interregional differences seems an important research task. This article aims at evaluating and comparing σ-convergence (diminishing discrepancies of GDP p.c.) in Poland (1995–2005) and Germany (1992–2006) on three NUTS levels. Preliminary results point to inequalities regularly diminishing in Germany, however, growing in Poland. A tentative reasoning suggests that increasing values of regional differences observed in Poland might be a temporary phenomenon.
Key words: σ-convergence, regional disparities, new economic geography, Nomenclature of Territorial Units for Statistics – NUTS.

1. ECONOMIC CONVERGENCE – SETTING THE SCENE

One of the problems economists have been tackling for decades are levels and reasons of economic welfare differences among countries and within countries among regions. This topic lays in fact at the heart of growth and development theory (Malaga, 2004, pp. 7–10). As pointed out by some authors countless theoretical and empirical studies on welfare and global income distribution throughout decades yield various often contradictory results. As a matter of fact there are few so perplexing concepts as convergence is that can, by applying advanced computer assisted techniques and complex models and simultaneously

* Marta GÖTZ, Instytut Zachodni w Poznaniu, ul. Mostowa 27, 61-845 Poznań, Poland, e-mail: mgoetz@iz.poznan.pl; martagoetz@gmail.com.

respecting all principles of statistical reasoning, lead to so profoundly opposite conclusions (Funke and Strulik, 2000, pp. 363–384; Peseran, 2004, p. 1).[1]

In a nutshell, economic convergence denotes process of gradual catching up. Economic literature offers a multitude of convergence types – distinguishing for instance the real one, nominal one or convergence of business cycles.[2] Besides classifying convergence based on the subject (convergence of GDP p.c., GDP per worker etc.) it can be also categorised by the techniques used (Matkowski and Próchniak, 2004, pp. 5–38; Pronobis, 2007; Magrini, 2004, pp. 2742–2791).

The phenomenon of economic growth convergence of various countries, also called real convergence, is one of the most important conclusions emerging from neoclassical models of economic growth (Matkowski and Próchniak, 2005, pp. 293–320). It is the confirmation of the tendency to equalisation of *per capita* income levels among weakly-developed and highly-developed countries, since as predicted by these models the former ones grow in general faster than the latter ones.

Such reasoning ascertain growth convergence, or more precisely, conditional β-convergence. The convergence is conditional because it takes place when both economies tend to reach the same steady-state. This convergence can be perceived as model's property of reaching steady state – equilibrium state (Malaga, 2004, pp. 7–8). If the less developed economy always grew faster, we would deal with absolute convergence.

There is also a second method of convergence analysis, based on comparing the dispersion of income levels. It is called σ-convergence or sigma type convergence. It appears if income differences between the economies concerned decrease over time. Income differentiation can be measured in many ways: by the variance, standard deviation of real GDP *per capita*, or normalised index – coefficient of variation. β-Convergence is a necessary but not sufficient condition for the existence of σ-convergence.[3] The fact that less developed countries demonstrate a higher growth rate does not guarantee that income differences among them and richer states will be falling.

The main factor causing the occurrence of income level equalisation are decreasing capital revenues as assumed in neoclassical models. Underpinning is the basic economic law of diminishing rate of return. Countries with a lower

[1] Cf. Funke and Strulik (2000) who predict speedy convergence and reaching by Eastern Germany 80% of western levels in 2015, whereas Peseran (2004) claims that despite technology diffusion some intrinsic features may hamper full convergence and become responsible for pertaining differences.

[2] Approach adopted to convergence in this paper draws on growth regression and can be seen as an alternative to concentration indices such as Gini coefficient – cf. Melchior (2008), p. 22.

[3] One of reasons might be migration. European Commission Report stated that it is inappropriate economic policy in less developed countries which impedes closing technological gap and subsequent catching up of living standards. See Jungmittag (2004).

level of economic growth, with relatively smaller amount of capital, demonstrate a higher rate of return on investments. This leads to the increased inflow of foreign investments and in result – higher economic growth.

New Economic Geography's (NEG) models[4] supported by empirical tests stipulate contrary to the neoclassical ones – emergence of divergence processes (Bruelhart and Torstensson, 1996; Bruelhart, 2000; Puga, 2001, p. 11; Garretsen, 2003). They highlight the paramount influence of starting point (i.e. initial conditions – the situation of a given economy in the first year of analysis) on subsequent developments and due to self-reinforcing cumulative processes negate an unconditional catching-up (Martin, 2005, pp. 83–108; Ottaviano and Thisse, 2004, p. 18). Results of empirical research encompassing different countries depend to a great extent on the makeup of the analysed group. Studies on countries with a similar economic growth level (e.g. highly developed) confirm the occurrence of the phenomenon of income levels equalisation, but those including more differentiated countries rather deny existence of such tendency (Próchniak, 2006, pp. 74–92). Recent models of economic growth do not confirm the phenomenon of convergence. The diversity of *per capita* incomes worldwide tended to grow, and the distance dividing the developing countries from the industrially advanced countries did not diminish distinctly (Snowdown and Vane, 2005, pp. 590). β-Convergence observed in 'old' 15 EU member states has not so far implied occurrence of σ-convergence (Tsagkanos *et al.*, 2006). Therefore, discussions on growth convergence and the impact on it of international cooperation and integration are by no means closed. There is still a place for an analysis of the factors that decrease or increase existing differences in the economic growth (that is, create a tendency in the direction of convergence or divergence) and the need for continuing empirical surveys related to different groups of countries. Regions' emancipation and their role in the EU on the one hand, yet as suggested by the Cohesion Reports widening regional disparities along with convergence process at countries level on the other hand call for more detailed analysis.

2. REUNITED GERMANY AND POLAND'S TRANSITION ECONOMY – SOME STYLISED FACTS

To get the full picture of a country's economy one must not limit the description only to basic facts and assessment of fundamental macroindices. Taking into account spatial distribution of economic activity seems to be an important and valuable enrichment of various studies devoted to Poland's and Germany's economy.

[4] New Economic Geography's models with mobility.

Launched in 1989 process of Poland's transformation provided for abandoning centrally planned state economy and moving towards liberal market economy. Accurate assessment of Poland's economy after 20 years proves a very far reaching and complex task.[5] Current values of macroeconomic indicators and their recent developments point to important strengths as well as deficiencies of Poland's economy that must not be ignored. Advantages include first of all impressive GDP growth rate (even in time of economic recession elsewhere in Europe) and low inflation rate.[6] Stressing high GDP dynamic one cannot forget that Poland still belongs to the least developed EU member states. Nevertheless, the gradual process of catching up with richer countries continues. Poland's economy becomes more like its western neighbors as far as ownership structure (privatisation) and sectors contribution to GDP is concerned (growing role of services and decline of agriculture). Foreign trade has been developing vigorously and many multinational enterprises keep flowing to Poland attracted by lower production costs, market potential and other incentives. One of the biggest weaknesses of Poland's economy is situation of public finances. Innovativeness also falls short comparing to other EU countries. Further efforts and reforms seem inevitable. Moreover, judging by long time series of regional data, Poland is characterised by significant and persisting spatial inequalities (Malaga and Kliber, 2007, pp. 31–32). They are culturally, historically and economically rooted and mirror clearly long observed differences between the western – more developed and eastern – poorer part of Poland (Malaga and Kliber, 2007, p. 74).

Shock therapy launched in 1989 by professor L. Balcerowicz – the vice prime minster and finance minister – unleashed the hidden potential of Polish entrepreneurship. Numerous small businesses had been set up – entrepreneurs blossomed. Though painful, the package of reforms introduced in December 1989 allowed Poland to break the chains of state controlled crumbling economy whose days were in fact numbered. Today, 20 years on, the adopted measures aiming at full liberalisation, opening foreign trade, privatisation, setting prices free by market forces etc. are judged mainly positive, although some voices are raised that steps undertaken should have included more social aspects and should have taken into account laid off labour force or fair sale of assets of obsolete state property. Guessing what might have happened if changes had been introduced in a different way – i.e. less as wished by some or more strict as suggested recently by Balcerowicz – is meaningless. Laying these consideration aside, one has to admit reform package launched that time was for Poland a landmark development.

[5] Cf. media debate taking place on the occasion of 20th anniversary of launching the Balcerowicz Plan.

[6] Presented assessment refers to pre-crisis period i.e. they describe general economic situation before financial crisis hit late 2008. See Kalka and Götz (2009).

Germany's reunification offers an unique research laboratory for real convergence studies (Buch, 2007, p. 1). Fall of the Berlin Wall and subsequent unification of previously divided BRD and DDR can be regarded as a special type of EU enlargement and an example of EU integration. Right from the start public opinion and policy makers were optimistic about speedy 'knitting together' of two artificially separated countries. 'Blossoming Landscapes' had been promised. Yet, the catching up process after significant progress in the early 1990s got stuck around 1997. Due to slow and unsatisfactory developments this convergence is being dubbed as 'Godot convergence' (Hall and Ludwig, 2006, pp. 941–953). It highlights a very distant perspective and points to likelihood of bumpy road ahead since possible obstacles decelerating catching up may occur. This scenario warns even that new *Länder* are doomed to repeat the fate of southern Italy – Mezzogiorno. On the eve of 20th anniversary of reunification economic condition of Eastern Germany reveals many contradictions (Ludwig *et al*., 2002, pp. 248–258; Albach, 1998, pp. 1–38, in Czech-Rogosz, 2005). On the one hand, judging by changes of income levels or infrastructure developments profound goals have been achieved. On the other hand, eastern unemployment rate is double of that in Western Germany, export and innovativeness indicators lag significantly behind. Against the background of expectations ignited in the early 1990s, deliveries might be assessed as somewhat mediocre. Though, one has to remember the humble beginnings of DDR economy in united Germany. Obsolete infrastructure, hidden unemployment, dominance of state ownership, and other – shared by so many Eastern and Central Europe economies – deficiencies. Germany's economy continues to be perceived by many as the 'tale of two countries'.

Questions of regional inequalities within EU are often touched upon and discussed in various reports.[7] According to Eurostat figures ratio of GDP p.c. regional differences equals 2.5 : 1 in Poland and 2.2 : 1 in Germany. Against the EU background where regional inequalities range from 1.5 : 1 to 3.9 : 1 Polish and German internal discrepancies are rather modest. Economic cohesion constitutes priority of the EU Funds directed to lagging behind regions. Beneficiaries of this assistance is level NUTS 2.[8] Data retrieved from European statistical office (Eurostat) indicate that over years 1995–2005 income differ-

[7] There are numerous papers examining the role of EU structural and Cohesion Funds in achieving the goals of European regional policy. The results obtained differ profoundly depending on applied methods and/or period covered. See Hagen and Mohl (2008).

[8] NUTS 1 stands for administrative units inhabited by 3 to 7 million people; NUTS 2 – population of 800,000 to 3 million; whereas NUTS 3 – for 180,000 to 800,000. According to this methodology, the following units have been distinguished in Poland – 6 regions NUTS 1, 16 voivodships NUTS 2 and 66 (21) groups of counties NUTS 3; whereas in Germany these are: 16 *Bundesländer* at NUTS 1, 39 *Regierungsbezirke* at NUTS 2 and 429 *Landkreise* at NUTS 3. Altogether in the EU there are 97 NUTS 1 regions, 271 NUTS 2 and 1 303 NUTS 3. See http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-EP-08-001/EN/KS-EP-08-001-EN.PDF, accessed 14 January 2009.

ences at this territorial division level has been systematically growing in Poland and decreasing in Germany (figure 1).

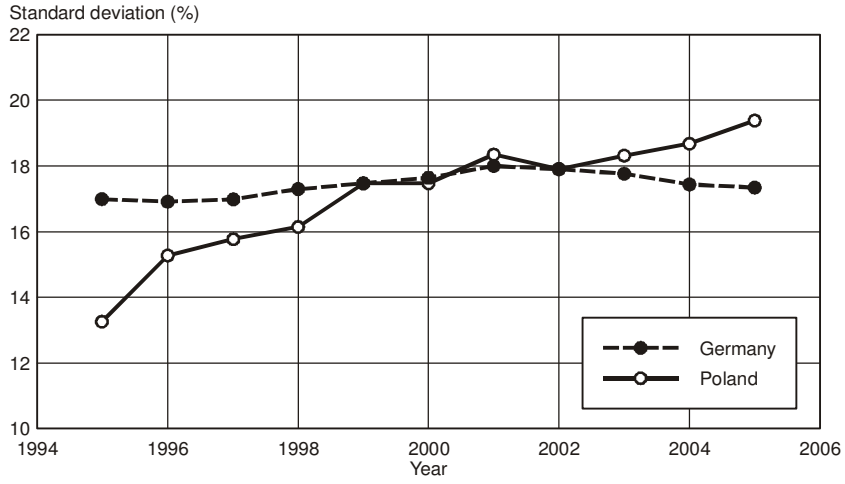

Fig. 1. GDP p.c. differences in Poland and Germany (NUTS 2 level, standard deviation %)
Source: based on Eurostat databases

On average, regional GDP p.c. discrepancies in Germany reached in 1995 17%, in Poland almost 4 percent points less – 13.3%. Though, over time inequalities tended to grow in Poland and remain rather stable in Germany. As the result in 2005 they equalled 17.4% in Germany and 19.4% in Poland.

Examining intra-countries spatial inequalities shall enrich more common general macroeconomic assessments. Studying such territorial makeup of a given state resembles taking bird's view on spatial processes happening on the ground. Moreover, conceptual support for studying regional inequalities comes from the EU cohesion policy stipulating profound role of convergence processes, which – as assumed – shall lead to disparities reduction.

The purpose of this paper is to examine σ-convergence at lower administrative/territorial levels in Germany and Poland over last 20 years. Due to data availability the period taken into account comprises years 1995–2005 in Poland and 1992–2006 in Germany. The aim is to find out whether income differentiation within these two countries, i.e. among their regions, has decreased (Malaga, 2004, p. 171). In order to answer this question changes of standard deviation of GDP p.c. need to be tested.[9] This widely used measure of variability or disper-

[9] More about various measures used for σ-convergence testing see: Próchniak (2006), pp. 74–92.

sion has been selected from other possible variables such as: the variance of a random variable or distribution[10] or coefficient of variation.[11]

To test σ-convergence income dispersion has been analysed by estimating the trend line of standard deviation of GDP *per capita*. σ-Convergence exists if the trend line slopes down, meaning that income dispersion tends to decline. For research purposes data on GDP p.c. at three levels, in two countries has been compiled. These are: 6 regions (NUTS 1 – macroregions), 16 voivodships (administrative region of the first order in Poland) and 66 (21)[12] groups of poviats (administrative regions of second order) in Poland, and 2 regions (former DDR and BRD), 16 *Bundesländer*, 39 *Regierungsbezirke* and 427 *Landkreise* in Germany. The figures were retrieved from German Destatis (*Online Datenbank Genesis – Gemainsame Neue Statistische Informations-System*) and regional base VGRL (*Volkswirtschaftliche Gesamtrechnungen der Länder*) accessible online, and from Eurostat – European Union statistical office. They cover years 1995–2005 in Poland and 1992–2006 in Germany.

3. INTERREGIONAL Σ-CONVERGENCE IN POLAND – THREE LEVELS OF ADMINISTRATIVE UNITS

In the following section an attempt at assessing σ-convergence in Poland throughout years 1995–2005 on three NUTS levels has been undertaken. The idea was to adjust the trend line to the developments observed over years and then diagnose the character of regularities by referring to function's properties and its course. The following four functions have been selected as reference framework: linear function,[13] parabola,[14] power function[15] and the exponential function.[16] To check the significance of parameters of explanatory variables t Student test (whether the slope of a regression line differs significantly from 0) and F test for non linear

[10] The expected (mean) value of the square of the deviation of that variable from its expected value (mean).

[11] Normalised measure of dispersion of a probability distribution, defined as the ratio of the standard deviation to the mean.

[12] Missing data on many poviats reduced the actual number of Polish NUTS 3 regions.

[13] This equation stands for regular equation with one unknown and yield one unique solution, i.e. one value satisfies solution.

[14] Parabolic function is a graphic presentation of second degree equation (power of unknown and value of exponent equal 2. Quadratic function is a non monotonic function, i.e. it does not preserve the given order.

[15] Power function of the form $f(x) = x^a$.

[16] Exponential function is the function e^x , where e is the number (approx. 2.71). The graph is upward-sloping, and increases faster as x increases.

dependencies have been applied. For this purpose the level of statistical certainty has been established at 95% – a typical confidence. To assess the goodness of fit studies often referred to *R*-squared.[17] Level of R^2 has been decisive criteria for selecting particular trend. R^2 stands for how much of developments of dependant variable (standard deviation of GDP p.c.) can be presumably explained by changes of selected independent variables (time in this case).

Presumably, identified interdependencies shall yield scenarios of most possible future developments. Similarly, these calculations have been repeated for Germany. Results obtained allow comparative evaluation of σ-convergence in both countries.

3.1. σ-Convergence at NUTS 1

Analysing σ-convergence among six Polish regions, i.e. looking at GDP p.c. differences at the most aggregated level (NUTS 1) one can notice easily an increasing tendency (figures 2–3). In trying to characterize more precisely the observed relations various functions may be utilised. Among linear trend, parabola, exponential and power functions it is the quadratic function which provides best quality fitting (selection was subject to variables significance – *t* Student and *F* test – and depend on goodness of fit – R^2).

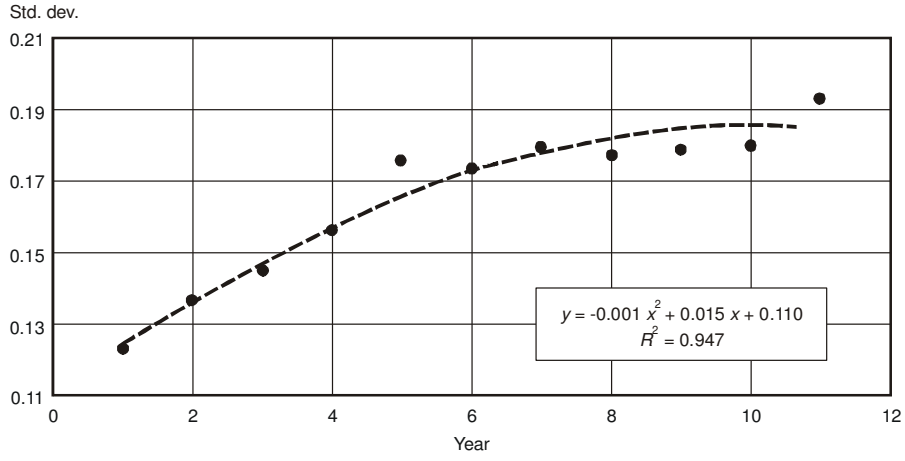

Fig. 2. σ-Convergence at NUTS 1 level (a) – differences of GDP p.c. among Polish regions in years 1995–2005 measured by standard deviation

[17] The least-squares fitting process produces a value – *R*-squared (R^2) – which is the square of the residuals of the data after the fit. It says what fraction of the variance of the data is explained by the fitted trend line.

Adopting such function for further estimations seems to offer more optimistic interpretation. It namely predicts that as time goes by a certain point shall occur when the increasing trend would be reversed and discrepancies among regions start declining. Applying exponential function has similar to parabola quality of fit as measured by R^2. Though, in this case interpretation is rather negative since as the course of trend line predicts discrepancies would continuously grow without any chance of turning point.

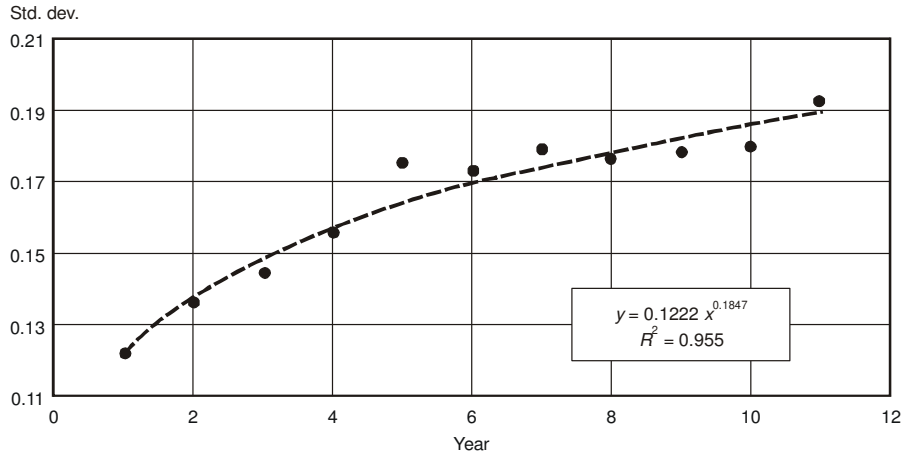

Fig. 3. σ-Convergence at NUTS 1 level (b) – differences of GDP p.c. among Polish regions in years 1995–2005 measured by standard deviation

Estimating significance of parameters values for non-linear function with 2 unknowns – i.e. for exponential, power and parabolic functions one should apply *F* test (Roeske-Słomka and Kudelski, 1998, p. 171). Basic analysis confirms that parameters are statistically significant (calculated *F* values exceed critical values in distribution tables). In other words, it turns out that power function and parabola are best fitted to the observed in reality changes of GDP p.c. differences among six regions. Bearing in mind relatively short time series and limitations attached to simple extrapolating conducted in excel spreadsheet interpretation must be extremely cautious. Due to similar levels of goodness of fit (R^2) parabola and power function seem to equally well depict character of observed relations. Nevertheless, as already mentioned, quadratic non-monotonic function offers much more positive scenario. It refers to present in some of the NEG models interplay of centripetal and centrifugal forces and stipulate that tendency of increasing discrepancies may be reversed in the future.[18] Seen this way, growing differences observed so far are a temporary phenomenon.

[18] Malaga and Kliber (2007) have faced similar dilemma of choosing the right function. Crucial is the underpinning assumption of either perfect and homogenous within a country factor's pro-

3.2. σ-Convergence at NUTS 2

Simple analysis conducted on NUTS 1 level in point 3.1 has been extended to lower territorial level – NUTS 2 (figures 4–5). Examined have been time changes of GDP p.c. differences among 16 voivodship. Selection of best function is based on goodness of fit (R^2) while fully respecting the significance of parameters as measured by t Student and F test. Parameters of all four tested functions proved significant – quadratic function offers the best fit, though has only slightly higher R^2 than the power function.[19]

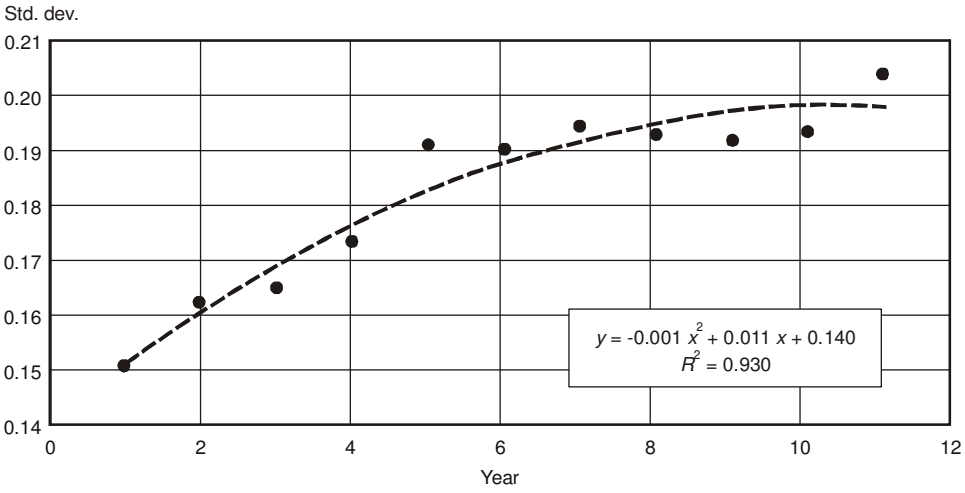

Fig. 4. σ-Convergence at NUTS 2 level (a) – differences in GDP p.c. among 16 voivodships in years 1995–2005 measured by standard deviation

ductivity or contrary – a heterogeneous one varying among voivodships. The first premise is backed by the fact that domestically (in one country) effectiveness of applying the same production factors (e.g. physical capital, labour force) shall be identical. This would hold true if allocation of production factors happened on the same base – i.e. would depend on equal criteria and their flow would not be impeded by any obstacles and would be guided only by profit maximisation. Unfortunately, this seems unreal. More likely proves the assumption of heterogeneous factor's productivity. Models putting forward unequal factor's productivity shall be regarded as more likely and intuitively right. Hence, NEG models with imperfect mobility (non-monotonic relations) seem more real. Malaga and Kliber (2007), p. 80. Similar problems of selecting the best fitting trend can be found also in studies by Melchior (2008), p. 10.

[19] Studies done by Malaga and Kliber (2007, p. 75) revealed that in 1998–2003 regional discrepancies in Poland measured by GDP p.c. slightly though systematically grow.

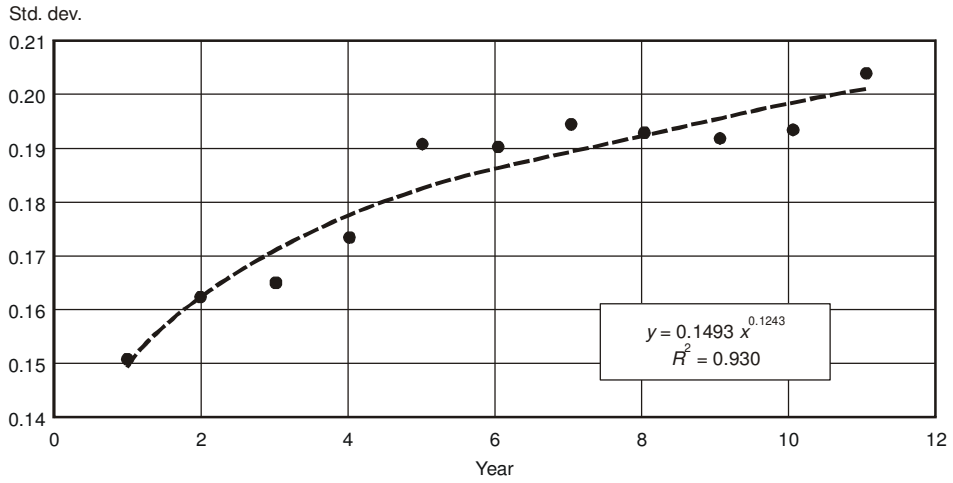

Fig. 5. σ-Convergence at NUTS 2 level (b) – differences in GDP p.c. among 16 voivodships in years 1995–2005 measured by standard deviation

In other words, the ambiguous situation at NUTS 1 level seems to repeat at NUTS 2 where again parabola offers slightly better goodness of fit i.e. reflects better actual relations.

3.3 σ-Convergence at NUTS 3

More precise assessment of σ-convergence within Poland can be provided by extending previous tests at NUTS 1 and 2 to NUTS 3 level – groups of poviats (figure 6). Nevertheless, due to data limitations (missing figures) the cohort in this case has to be reduced from 66 to barely 21.[20] As it was practiced earlier, selection of the right function hinges on goodness of fit and depends on the results of t Student and F test confirming significance of parameters. The latter have been validated for all four functions, thus crucial for choosing were the values of R^2. As it was at more aggregated levels of NUTS 1 and 2, parabola seems to offer best goodness of fit ($R^2 = 0.89$; whereas 0.85 for linear function; 0.83 for power function; 0.84 for exponential).

[20] Cf. problems with data availability at this low territorial division level force Melchior (2008, p. 10) to exclude from her analysis counties.

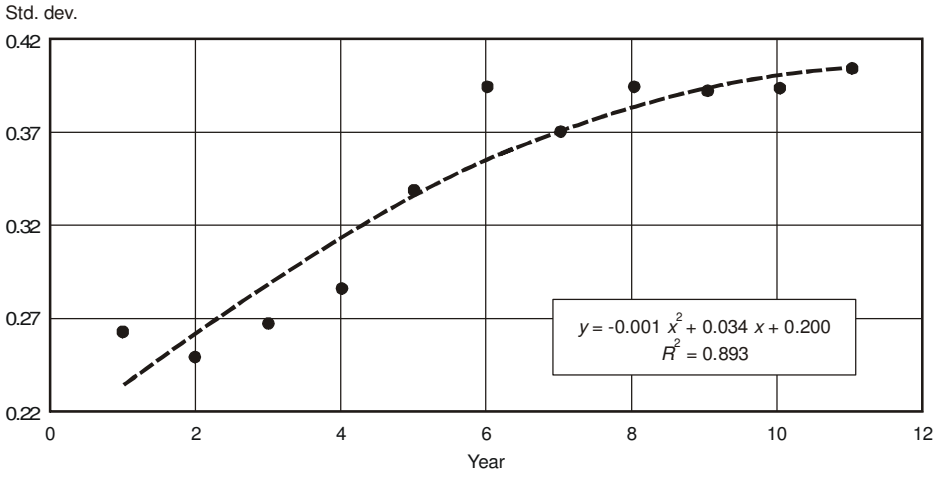

Fig. 6. σ-Convergence at NUTS 3 level – differences in GDP p.c. among group of poviats in years 1995–2005 measured by standard deviation

Very simple simulations based on conducted tests suggest that the turning point (when tendency of growing differences shall come to a halt and discrepancies' decline shall start) would be observed at earliest at the highest territorial division level i.e. among six regions, then among voivodships and finally among the group of poviats.

4. INTERREGIONAL Σ-CONVERGENCE IN GERMANY – THREE LEVELS OF ADMINISTRATIVE UNITS

Distinguishing two parts of Germany (former DDR and BRD) and comparing time changes of GDP p.c. differences between them one can easily notice negative relations i.e. systematically falling discrepancies (figure 7). The figures for the whole period confirm the existence of σ-convergence. However, the differences have been decreasing continuously the fast process in the early 1990s seems to have come to a halt around the 6th year of analysis (in 1997). Application of various trend lines to the observed interdependencies resulted in exponential function being better than linear one, though, worse than quadratic function as far as goodness of fit is concerned. Nevertheless, adapting power function yields best value of R^2.

Applying this function and extrapolating results suggest that it would take more than 100 years to halve the discrepancies registered in 2007.

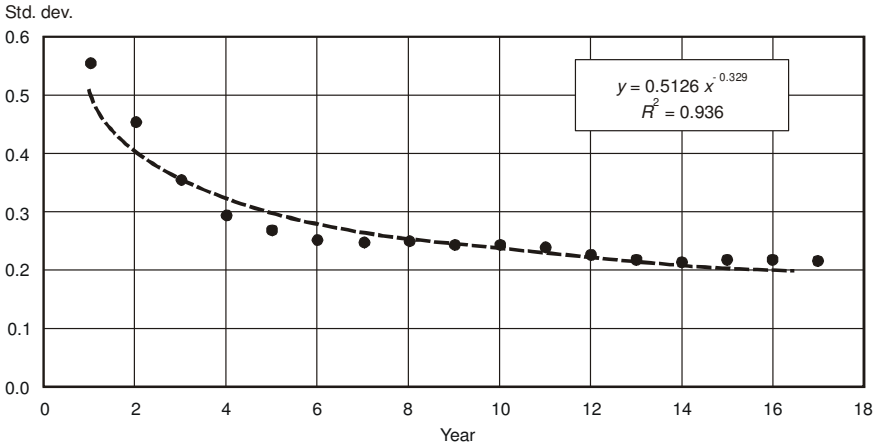

Fig. 7. σ-Convergence between former DDR and BRD in 1991–2007 measured by standard deviation level

4.1. σ-Convergence at NUTS 1

Analogous test can be conducted at a more disaggregated territorial division level. Examining GDP p.c. differences among 16 *Bundesländer* revealed a falling tendency, at though this process (like it was observed for two regions analysis) came to a halt in 1997 (figure 8). Exponential function proves better than linear (as judged by R^2) but worse than parabola. Nevertheless, power function offers best goodness of fit and seems to illustrate best interdependencies observed in reality.

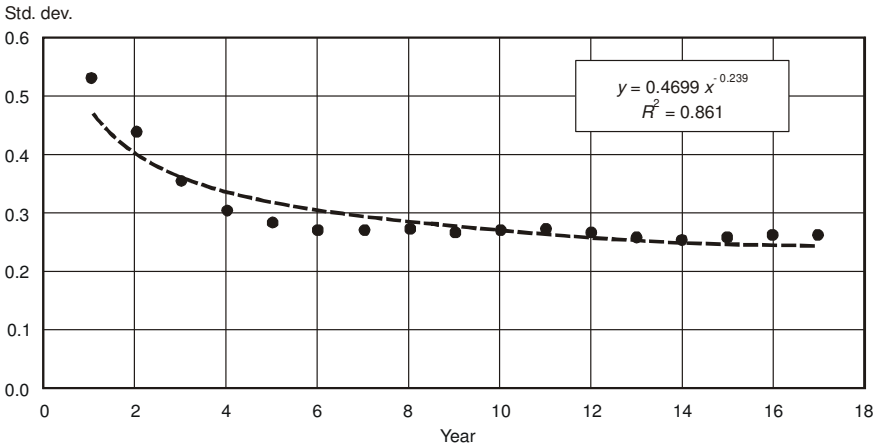

Fig. 8. σ-Convergence at NUTS 1 level – GDP p.c. differences among 16 *Bundesländer* in 1991–2007 measured by standard deviation level

On the 30th anniversary of the reunification differences of GDP p.c. among *Bundesländer* might fall to 0.21 from 0.24 registered in 2007. Simultaneously, the time necessary to halve the discrepancies from 2007 values would be much longer at NUTS 2 level than it might be at two regions level (i.e. differences seem to vanish the more quickly the higher the level of spatial analysis).

4.2. σ-Convergence at NUTS 2

Analysis of *Regierungsbezirke* constitutes a natural extension of research conducted for two regions and 16 *Bundesländer*. While trying to describe precisely the changes of GDP p.c. differences over time and thus possible σ-convergence one can easily apply various functions. The decreasing trend of income discrepancies among *Regierungsbezirke* is clearly visible on figure 9.

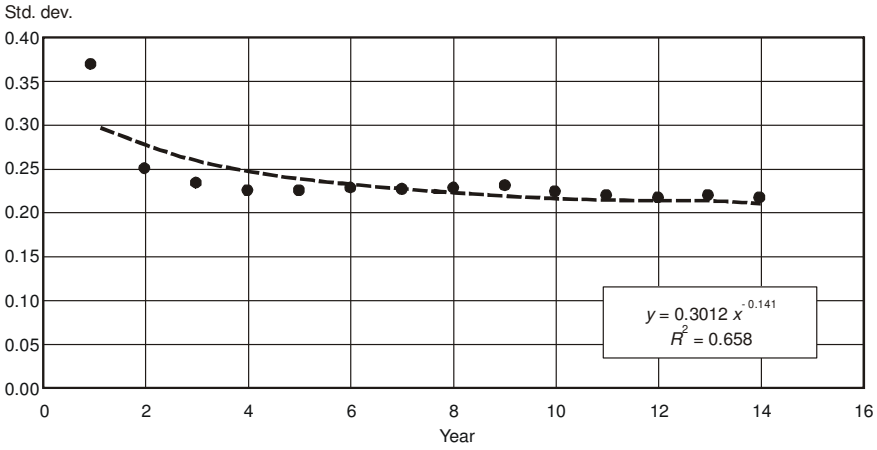

Fig. 9. σ-Convergence at NUTS 2 level – differences of GDP p.c. among *Regierungsbezirke* in 1992–2006 measured by standard deviation level

Significance of parameters tests – t Student for linear trend (satisfied) and F test for the rest 3 functions (condition of F statistics being four times higher than the reference value satisfied only for power function) and goodness of fit test (R^2) indicate that it is the power function that best fit to the observed at NUTS 2 changes of GDP p.c. discrepancies.

4.3. σ-Convergence at NUTS 3

Even more detailed picture of Germany's σ-convergence can be painted while referring to the NUTS 3 level i.e. analysing GDP p.c. differences among *Landkreise*. As it was for highest NUTS levels also in this case power function

of negative slope seems to be the one best fitted while respecting significance of parameters (*t* Student and *F* test) and goodness of fit ($R^2 = 0.67$ whereas 0.37 for linear trend; 0.60 for parabola and 0.39 for exponential function).

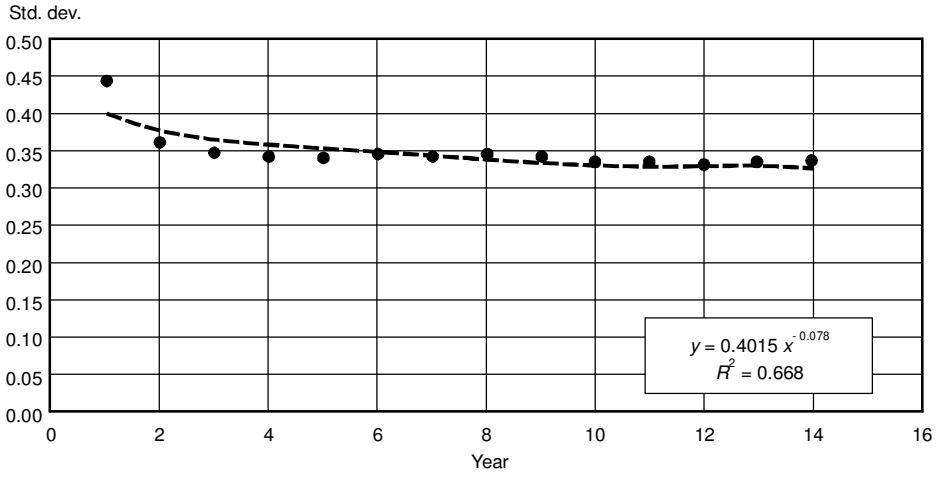

Fig. 10. σ-Convergence at NUTS 3 level – differences in GDP p.c. among *Landkreise* in 1992–2006 measured by standard deviation level

As one can see in figure 10 differences between average income levels among *Landkreise* were falling. Results obtained suggest that fading away of differences takes place the earlier the higher the territorial division level.

5. σ-Convergence – Comparing Poland and Germany Results

Table 1 illustrates the summary of results obtained for analysis of σ-convergence in Poland in 1995–2005 at NUTS 1, 2, 3; and in Germany in years 1991–2007 at four division levels. The shadow cells contain the best fitting equation and subsequent trend lines. Criterion for selection was goodness of fit (R^2) supported by significance of variables parameters (*t* Student and *F* test).

In order to asses σ-convergence in Poland in years 1995–2005 it was necessary to evaluate changes of standard deviation of GDP p.c. over this time at three different levels of administrative and territorial division i.e. among 6 regions, 16 voivodships and 21 groups of poviats.

Results obtained point to systematically growing disparities at all three levels and thus σ-convergence cannot be diagnosed. In fact we observed certain divergence.

Table 1. Economic convergence in Poland and Germany – summary of results obtained (√ – stands for possibility of rejecting the H0 assuming no significance)

Investigated relation	Function type		R^2	Significance of parameters	Interpretation
1	2		3	4	5
POLAND σ-convergence GDP p.c. difference measured by standard deviation among six regions NUTS 1	Linear trend	$y = 0.0061x + 0.1287$	0.86	|7.2| vs. 2.26 √	
	Quadratic function	$y = -0.0007x^2 + 0.0147x + 0.1102$	0.95	47.87 vs. 4.06 √	Non-monotonic relation shall be reversed at some point, exact moment of the turning of relation into the opposite direction – i.e. the start of decline of differences (negative slope) approx. 10–11th year of analysis
	Power function	$y = 0.1222x^{-0.187}$	0.95	82.59 vs. 4.25 √	Continuing decrease of inequalities though weaker as the time passes by
	Exponential function	$y = 0.1299e^{0.0387x}$	0.83	24.97 vs. 4.25 √	
POLAND σ-convergence GDP p.c. difference measured by standard deviation among sixteen voivodships NUTS 2	Linear trend	$y = 0.0047x + 0.1547$	0.84	|6.87| vs. 2.26 √	
	Quadratic function	$y = -0.0005x^2 + 0.0113x + 0.1404$	0.93	24.52 vs. 4.06 √	Point of likely change of function slope – start of falling discrepancies around 12th year of analysis
	Power function	$y = 0.1493x^{-0.1243}$	0.93	58.82 vs. 4.25 √	Systematic though weakening fall of interregional differences
	Exponential function	$y = 0.1554e^{0.0264x}$	0.83	24.65 vs. 4.25 √	

POLAND σ-convergence GDP p.c. difference measured by standard deviation among groups of poviats NUTS 3	Linear trend	$y = 0.0172x + 0.2374$	0.85	|7.1| vs. 2.26 √	
	Quadratic function	$y = -0.0014x^2 + 0.0343x + 0.2004$	0.89	24.82 vs. 4.06 √	Interdependency being reversed at some point – moment when function slope changes approx. in 13th year of analysis
	Power function	$y = 0.2309x^{0.2341}$	0.83	29.93 vs. 4.25 √	
	Exponential function	$y = 0.2439e^{0.053x}$	0.84	23.68 vs. 4.25 √	
GERMANY σ-convergence GDP p.c. difference measured by standard deviation among two regions former DDR and BRD	Linear trend	$y = -0.0144x + 0.4079$	0.59	|–4,7| vs. 2.13 √	
	Quadratic function	$y = 0.022x^2 - 0.0539x + 0.5331$	0.86	34.13 vs. 3.34 √	
	Power function	$y = 0.5126x^{-0.329}$	0.94	131.1 vs. 3.6 √	In the long term fading differences – dispersion decline over time
	Exponential function	$y = 0.4005e^{-0.0447x}$	0.69	13.77 vs. 3.6	
GERMANY σ-convergence GDP p.c. difference measured by standard deviation among 16 *Bundesländer* NUTS 1	Linear trend	$y = -0.0106x + 0.3954$	0.51	|–3.94| vs. 2.13 √	
	Quadratic function	$y = 0.0019x^2 - 0.045x + 0.504$	0.83	26.64 vs. 3.34 √	
	Power function	$y = 0.4699x^{-0.2386}$	0.86	61.4 vs. 3.68 √	In the long run systematic decline of dispersion
	Exponential function	$y = 0.3862e^{-0.0304x}$	0.56	16.3 vs. 3.68 √	

Table 1 (contd.)

1	2	3	4	5	6
GERMANY σ-convergence GDP p.c. difference measured by standard deviation among *Regierungsbezirke* NUTS 2	Linear trend	$y = -0.0055x + 0.2762$	0.34	|–2.5| vs. 2.17 √	
	Quadratic function	$y = 0.0013x^2 - 0.0243x + 0.3265$	0.58	8.4 vs. 3.6	
	Power function	$y = 0.3012x^{-0.1427}$	0.66	17.3 vs. 3.8 √	Fading away discrepancies; in the long run value of differences approaching 0
	Exponential function	$y = 0.2709e^{-0.0201x}$	0.38	9.2 vs. 3.8	
GERMANY σ-convergence GDP p.c. difference measured by standard deviation among *Landkreise* NUTS 3	Linear trend	$y = -0.0042x + 0.3812$	0.37	|–2.6| vs. 2.17 √	
	Quadratic function	$y = 0.0009x^2 - 0.018x + 0.4182$	0.60	9.1 vs. 3.5	
	Power function	$y = 0.4015x^{-0.0777}$	0.67	18 vs. 3.8 √	Fading away discrepancies; in the long run value of differences approaching 0
	Exponential function	$y = 0.3791e^{-0.011x}$	0.39	9.6 vs. 3.8	

The developments taking place over time with respect to GDP p.c. standard deviation seem best described by parabola and power function. Whereas the latter one suggests continuous increase of differences and leaves no hope for σ-convergence, quadratic function being a non monotonic function assumes that turning point emerges at certain moment and decrease of differences shall start bringing about σ-convergence.

Against the background of NEG models without mobility this situation may reflect such a high level of spatial concentration when centrifugal forces start pulling activity out of the agglomeration leading to more equal territorial distribution and subsequently a likely equalization of income levels among regions.

Likewise, examining changes of GDP p.c. discrepancies over time among Germany's two regions, 16 *Bundesländer*, 39 *Regierungsbezirke* and 427 *Landkreise* yields interesting results and conclusions.

Application of linear trend (regression described by one degree equation) confirms σ-convergence at all investigated levels. Reference to this linear function and comparison of the pace of changes i.e. how fast σ-convergence proceeds indicates that inequalities seem to disappear the faster the more aggregated level of analysis – i.e. earlier between 2 regions, 16 *Bundesländer* than among *Regierungsbezirke* and *Landkreise*. Lower values of discrepancies observed at two regions' level (between former DDR and BRD) than those at *Bundesländer's* level seem to confirm the regularity present in the whole EU. Cohesion Reports by the European Commission conducted on a regular basis point to continuously fading differences among Member States but steady or even growing discrepancies among regions. The more aggregate level of territorial division the faster the equalisation process.[21]

However, as measured by R^2 – better goodness of fit has the power function – i.e. its course better reflects the actual changes happening at all four levels. Application of such non linear trend assumes continuous decline of GDP p.c. differences. Though this process as suggested by function property is fading away – drops of differences get smaller with the passage of time. Moreover, income equalisation seems happening earlier at more aggregated levels of investigation (first among *Bundesländer*, later *Regierungsbezirke* and then *Landkreise*).

[21] First Commission Report evaluating progress of cohesion policy stated that starting in 1983 income differences among Member States declined – though discrepancies among regions stayed high. Next reports concluded with similar results. Recently, Commission admitted, in some countries differences among their regions (within states) even rise. See Busch (2006). Various statistical analyses confirm growing interregional income discrepancies. Melchior's studies revealed that out of 36 investigated countries 23 registered increase of domestic regional inequalities, 10 witnessed modest, though ambiguous changes (both slight decreases and offsetting increases) and only 3 states – decline of differences. Moreover, in 2005 64% of international (i.e. among countries) differences could be attributed to and explained by discrepancies at NUTS 3 level.

Interpretation of these results calls for extreme caution, particularly in Poland's case. Besides the fact of very simple statistical calculations, due to limited data availability at lower (more disaggregated) levels, the period covered in this paper refers to years 1995–2005. Since it barely captured one year of Poland in the EU structures, the full effects of membership and associated regional policy funds almost certainly have not been reflected in available statistical data.[22]

6. CONCLUSIONS – POLAND'S FUTURE CON(DI)VERGENCE?

1. Results of studies conducted and discussed in previous sections may suggest the incidence of divergence processes in Poland in years 1995–2005. Not denying a huge progress achieved since the beginning of transformation in Poland 20 years ago, one has to be aware of still existing (as indicated by test conducted even growing) regional disparities. Scenarios of long-term developments for voivodships point to possible further deepening of discrepancies where already prosperous regions would benefit even more and those lagging behind might become poorer. Some forecasts suggest sharpening of existing discrepancies between so called 'Poland A' (western part of country) and 'Poland B' dubbed as 'Eastern Wall' with simultaneously clearly outstanding position of capital city voivodship Mazovia (Fandrejewska and Cieślak-Wróblewska 2009a, b).

2. However, one of the most significant limitations of this analysis is the comparatively short period of observation and very simple techniques used. Hence, the obtained results should be treated cautiously. It is worth continuing research on this subject in the coming years in order to determine if intercountries interregional cohesion may take place.

3. In this respect, the right utilisation of available EU cohesion and structural funds might bridge the interregional gap. Since due to data availability this research covers only one year of Poland's membership in the EU – 2005 – future analysis with updated statistics are inevitable. Hopefully, they would confirm the positive effects of these funds and subsequent regional equalisation (or at least cease of growing discrepancies). So far several studies pointed to such positive and very likely impact the EU Funds should have on Polish regional developments.[23]

4. Not denying the significance of the cohesion aim of EU regional policy and its structural funds one has to be aware that perfectly equal distribution of economic activities in space is neither feasible nor desired. It is first unlikely due to 'putty clay' character of economic activity itself meaning indivisibility, or certain

[22] According to some reports full effects can be expected even a couple of years after completing the project under given EU Fund.

[23] Cf. Malaga and Kościelski (2006, p. 80) comparison of GDP p.c. levels and interregional differences in steady states with and without EU money.

'lumpiness' of plants or production processes (Krugman, 1991, p. 53; 1994, pp. 1–37; Garretsen, 2003). Further to this, it is not favourable in the light of the newest regional growth and development theories assuming existence of clusters, centers of excellences, or poles of growth (Brodzicki and Szultka, 2002; Misala 2003, p. 117). They all presume certain spatial concentration is necessary in order to trigger growth, which subsequently shall spread over neighbouring regions and spill over to nearby area contributing to development of larger territories.

5. Departing from concrete study results, some general reflections drawing on theoretical framework might be worth presenting as well. Specifically, models of New Economic Geography focuse on integration (scale economies) and international trade interplay which in fact can be narrowed down to relation between these two phenomena and localisation.[24] Bruelhart and Torstensson (1998) proved non monotonic interdependency between integration and localisation described by reversed *U* shaped (or Ω shaped) sequence: dispersion – concentration – dispersion. In particular, a bell-shaped curve arises: dispersion of economic activities is predicted when trade costs are either low or high, whereas concentration in one region – at intermediate trade costs levels. In other words, at certain point of continuing integration (falling trade costs, positive externalities) centripetal processes become outweighed by rising centrifugal forces – such as growing congestion, rising prices, rent costs, pollution etc., all of which encourage economic activity to leave the centre and head towards peripheries thus leading to more equal spatial distribution of economic activity.

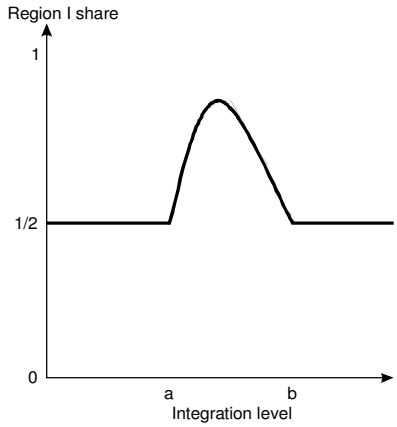

Fig. 11. Integration and localisation interplay in NEG models (without mobility)
Source: based on the literature quoted

[24] Under the notion of 'integration' while analysing single country, one can understand progressing cohesion such as better developed road infrastructure, more frequent migration, commuting, increased flow of goods and services between regions. Alternatively, one can refer to Kuznet's curve assuming reversed *U* shaped interdependency between inequalities (not only spatial) and development level.

Horisontal axis of figure 11 stands for progressing integration, i.e. falling trade costs, whereas vertical one depicts region's share in total country economic activity, thus informing about the concentration level. Perfectly equal distribution between two regions takes place for either very low or very high costs i.e. non integrated or highly integrated economy). Combining the prediction of Ω interdependencies with results obtained for analyzing σ-convergence in Poland as described by non-monotonic parabola function suggests certain overlapping. Bell shaped relation assumed that with progressing integration (with the passage of time) initial dispersion of economic activity in space fades away and gets replaced by growing concentration only to outweigh again once certain threshold has been reached. Process of σ-convergence observed in Poland at three NUTS levels (divergence in fact) suggests that (as predicted by best fitting non monotonic parabola trend) these discrepancies might start falling at certain point – ultimately convergence cannot be ruled out. If it is the case, i.e. indeed higher territorial concentration of economic activity is associated with more income inequalities than we are observing currently the left branch of Ω relationship and left part (upward slope) of σ-convergence on figures 2 and 4. Against the background of results achieved, it would mean that among so many positive processes launched in transition period early 1990s equalisation of interregional income differences would unfortunately be missed and thus absent. Presumably, further integration and cohesion processes (better developed roads, telecommunications etc.) would lead – as predicted by some NEG models[25] – after temporary concentration and spatial inequalities to more equally distributed activity and lower GDP p.c. differences. Along with increasing spatial dispersion interregional income equalisation should take place. Hence, an interesting stream of future research on economic convergence shall be a detailed (almost like case study) analysis of all administrative units, which might allow more accurate assessment of developments taking place over time as far as the particular region's economic position and performance within country is regarded. Further research should thus allow more precise and accurate evaluation of pursued cohesion policy.

Moreover, certain ambiguity arises from the theoretical framework itself. On the one hand, NEG models assume 'path dependency', 'cumulative causation', or 'self-reinforcing processes' (Venables, 1998; Brakman, *et al*., 2001, pp. 59–99). On the other hand, they stress profound importance of 'single events' i.e. unexpected impact of certain developments, which can catapult region into extra league or lead to its gradual decline (Davis and Weinstein, 2002, pp. 1–23).

Bearing in mind above mentioned contradictions and intricacies of both theories as well as practice, future strict monitoring of developments is badly needed.

[25] Models without mobility of production factors, mainly labour force.

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