MEASUREMENT OF TERRITORIAL CONVERGENCE. AN ANALYSIS IN THE CASE OF ROMANIA

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Abstract
This paper reviews a number of methods and instruments developed for the analysis of economic inequalities and that can be used for examining territorial disparities in Romania. The objective of the paper was to produce an update analysis of the convergence process among Romanian regions in light of a panel of these instruments, specific for the measurement of sigma-convergence. By using EUROSTAT data for 200-2011, several indexes were computed and their evolution is analysed. Romania experienced a process of economic divergence, a process of widening of inequalities between regions and counties. The process is more visible at regions level. Territorial inequalities are explained in a proportion of 71,67%-84,24% by the inter-group component (inter-regions), the intra-group component (intra-regions or among counties) being less important.

Keywords: economic convergence, inequalities, regional convergence

JELCodes: E20, O11, O47

1. Introduction

In the European Union the problem of economic convergence between countries and regions is linked to the main objectives of Union, stated in the Rome Treaty stipulated that “the harmonious development of the economic activities” and “the continuous and balanced expansion”. The Maastricht Treaty includes three economic objectives concerning convergence: (1) harmonious and sustainable development of the economic activities; (2) high level of convergence of the economic performance; (3) economic and social cohesion and solidarity of the member states. Later, in the the Amsterdam Treaty, objectives concerning the real convergence of the economic performance through cohesion were included.

The economic and social cohesion is to be achieved mainly through the promotion of growth-enhancing conditions and the reduction of disparities between the levels of development of EU regions and Member States.

The clarifying elements in the matter of convergence are the overall results of the influence of all factors of convergent growth in each country, determined by means of different factors (usually, computed on long term), which show either the diminution in the inequalities between the set of analysed economies (the evolution of the index concerning the ratio between the level indicators of the economies, dispersion, Gini index, Theil index, etc.), or the crosssection convergence (beta-convergence).

For Romania, as Member State, the European integration process implies not only monitoring the convergence to the EU level, but also its internal convergence aiming to a balanced territorial development.

The main objective of the paper is to offer an overview of the measurement of regional disparities within Romania and to underline some explanatory elements. The paper is divided into three sections besides the introduction. The second section describes the methods and instruments for the measurement of convergence, specifically, sigma-convergence, the third section is dedicated to findings obtained by applying of these methods and instruments to the regional context of Romania and the last section contains the study conclusions.

2. Measurement of economic convergence

Measuring economic convergence presents some complexities. First, there are several definitions of convergence and although coherent, they correspond to different concepts of convergence. One should therefore have a clear view of what is measured when using convergence indices. Second, there is no convergence measure capable of capturing all relevant aspects of a convergence process [13].

2.1. Beta-convergence
Beta-convergence refers to a process in which poor regions grow faster than rich one and therefore catch upon them. The concept of Beta-convergence is directly related to neo-classical growth theory [16] where one key assumption is that factors of production, in particular capital are subject to diminishing return.

When all economies are assumed to converge towards the same steady-state (in terms of GDP per head and growth rate), Beta-convergence is said to be absolute. However, the steady-state may depend on features specific to each economy, in which case convergence will still take place, but not necessarily at the same long-run levels. This will be the case when GDP per head is supposed to depend on a series of determinants such as factor endowment or institutions, which can vary from one economy to the other even in the long-run. Beta-convergence is then said to be conditional [13].

The so called”literature of convergence” comprises a large literature typified by Barro and Sala-i-Martin (1992) and Mankiw et al.(1992), exploring beta-convergence. Many studies have documented beta-convergence in the U.S. Among them, Barro and Sala-i-Martin (1992), Evans and Karras (1996a and 1996b), Sala-i-Martin (1996), and Evans (1997a and 1997b) found statistically significant beta-convergence effects using U.S. state level data.

2.2. Sigma-convergence

Despite the literature's stress on beta-convergence, economists have acknowledged that it is not a sufficient condition for sigma-convergence [3]. Quah (1993) and Friedman (1992) both suggest that sigma-convergence is of greater interest since it speaks directly as to whether the distribution of income across economies is becoming more equitable. Indeed, sigma-convergence simply refers to a reduction of disparities among regions in time. The beta- and sigma-convergence are two concepts closely related. Formally, Beta-convergence is necessary but not sufficient for Sigma-convergence. Economies can converge towards one another but random shocks push them apart or because, in the case of conditional Beta-convergence, economies can converge towards different steady-states.

There are several measures that can be used for sigma-convergence. We will review the following measures and tools: the coefficient of variation, the Lorenz curve, the Gini index, the Atkinson index, the Theil index and the Mean Logarithmic Deviation (MLD).

The coefficient of variation is a normalised measure of dispersion of a probability distribution. It is defined as the ratio of the standard deviation to the mean. It is often reported as a percentage by multiplying the above calculation by 100 which is sometimes referred to as the relative standard deviation (RSD or %RSD). The main disadvantage of this indicator is the sensitivity to changes in the mean, in particular when the mean value is near zero. The coefficient of variation can be calculated with the following formula:

\[ CV = \sqrt{\frac{1}{n} \sum_{i=1}^{n} (y_i - \bar{y})^2} \frac{1}{y} \]

where: n is the number of regions, \( \bar{y} \) is the national average of GDP per capita and \( y_i \) is GDP per capita of the \( i^{th} \) region.

**Figure 1 The Lorenz curve**

![Figure 1 The Lorenz curve](image-url)
**Lorenz curve** represents a probability distribution of statistical values, being associated with income distribution calculation. It is a tool used to analyse territorial differences. On abscisa are marked the cumulated weights of population in the total population, from the lowest to highest, on the ordinate, the corresponding cumulated weights of income in the total income and then, the points corresponding to the peer values are marked, as well. The line passing through all points is the Lorenz curve. The 45 degree line reflects absolutely equal distribution of income. The area A between the line of perfect equality and Lorenz curve represents an aggregate measure of the disparities or the concentration degree. The area underneath the Lorenz curve is B (Figure 1).

The Gini coefficient can be calculated using areas on the Lorenz curve. Gini coefficient is defined as the ratio of surface area A (bounded by the Lorenz curve and the diagonal line) and the entire area below the diagonal line, denoted by A+B, where B is the area under the Lorenz curve. Thus, we may estimate the Gini coefficient, G, as follows:

\[
G = \frac{A}{A + B} \tag{2}
\]

Also, taking into account that the denominator is equivalent to half of the unit, the Gini coefficient is by definition twice of A:

\[
G = 2A \tag{3}
\]

where: A is equal to 0,5 - B.

Gini coefficient can range from 0 (perfect equality) and 1 (perfect inequality). When it is expressed as a percentage, this indicator is called Gini index.

The main characteristic of this indicator is its sensitivity to changes in inequality around the median/mode [13]. There are different ways for expressing the Gini coefficient. For the purpose of the present study we will use the formula proposed by Angus Deaton (1997):

\[
G = \frac{n + 1}{n - 1} - \frac{2}{n(n - 1)} \sum_{i=1}^{n} p_i y_i \tag{4}
\]

where: \( n \) is the number of regions, \( \bar{y} \) is the national average of GDP per capita, \( y_i \) is GDP per capita of the \( i^{th} \) region, \( p_i \) is the rank of the region \( i \) (the poorest region has the rank \( n \) and the richest has the rank 1).

In our case, Gini coefficient is a measure which represents the deviation from a fully egalitarian distribution of GDP per capita values among regions.

In order to analyse the disparities among Romanian counties, we will use the following formula for Gini coefficient:

\[
G = 1 - \sum_{i=1}^{n} \left( \frac{x_i - x_{i-1}}{100} \right) \left( \frac{y_i + y_{i+1}}{200} \right) \tag{5}
\]

where: \( x_i \) are the cumulated weights of population for the county \( i \) in the total population, \( y_i \) are the cumulated weights of GDP for the county \( i \) in the total national GDP and \( n \) is the number of counties (n=42).

The Atkinson index is another popular measure of income inequality. Its distinguishing feature is its ability to emphasise movements in particular segments of the distribution. Specifically, a parameter entering into the computation of the index allows for giving more or less weight to changes in a given portion of the income distribution. This parameter, known as the level of “inequality aversion”, is generally denoted by \( \varepsilon \). The Atkinson index becomes more sensitive to changes at the lower end of the distribution (low income or GDP per head levels) as \( \varepsilon \) approaches 1. Conversely, as the level of inequality aversion falls, that is as \( \varepsilon \) approaches 0, the index becomes more sensitive to changes in the upper end of the income distribution [13]. The formulas for this index [2] are:

\[
A_\varepsilon (y_1, y_2, ..., y_n) = 1 - \left[ \frac{1}{n} \sum_{i=1}^{n} \left( \frac{y_i}{\bar{y}} \right) \right]^{-\frac{1}{\varepsilon}} \quad \text{for} \quad \varepsilon \in (0, 1) \cup (1, \infty) \tag{6}
\]

\[
A_\varepsilon (y_1, y_2, ..., y_n) = 1 - \left( \frac{1}{\bar{y}} \prod_{i=1}^{n} y_i \right) \quad \text{for} \quad \varepsilon = 1 \tag{7}
\]

where: \( \varepsilon (>0) \) is an inequality inversion parameter which captures the distaste or aversion to inequality, a value judgement of the analyst (or social evaluator/policy maker), \( n \) is the number of regions, \( \bar{y} \) is the national average of GDP per capita and \( y_i \) is GDP per capita of the \( i^{th} \) region. In our case, we take the value of 1 for \( \varepsilon \), as reflection of a great concern about inequality in the Romanian society.
The Theil index is a particular case of the Generalised Entropy Index with coefficient 1. One interest of the Theil index compared to the preceding measures is that it corresponds to the sum of average inequality within subgroups and inequality among those subgroups, a property which is referred to as “decomposability”. Formally, if the population is divided into \( m \) subgroups (e.g. Member States), if \( T_{ci} \) is the Theil index for subgroup \( i \) (e.g. reflecting the disparities among regions of Member State \( i \)), \( S_i \) is the share of group \( i \) in global income (e.g. the share of Member State \( i \) in EU GDP) and \( T_r \) the index computed on the basis of the \( m \) groups (e.g. reflecting the disparities among Member State), then the Theil index is

\[
T = \sum_{i=1}^{m} S_i T_{ci} + T_r = T_c + T_r
\]

(8)

In the case of Romania, \( T_{ci} \) is the Theil index for region \( i \), reflecting the disparities among counties of the region \( i \), \( S_i \) is the share of region \( i \) in the national income (the share of region \( i \) in Romanian GDP) and \( T_r \) is the index computed on the basis of the \( m=8 \) Romanian regions. We will use the following formulas [5]:

\[
T_r = \frac{1}{m} \sum_{i=1}^{m} \frac{y_i}{\bar{y}} \log \frac{\bar{y}}{y_i} ; \quad T_{ci} = \frac{1}{n_i} \sum_{j=1}^{n_i} \frac{y_j}{\bar{y}_{ni}} \log \frac{\bar{y}_{ni}}{y_j}
\]

(9)

where: \( m \) is the number of regions, \( y_i \) is GDP per capita of the \( i^{th} \) region, \( \bar{y} \) is the national average GDP per capita, \( n_i \) is the number of counties in the composition of the \( i^{th} \) region, \( y_j \) is GDP per capita of the \( j^{th} \) county and \( \bar{y}_{ni} \) is the average GDP per capita of \( i^{th} \) county.

The mean logarithmic deviation (MLD) is also a member of the generalised entropy family of inequality measures, corresponding to the Generalised Entropy Index with coefficient 0. As for the Theil index, the MLD is decomposable in measures of inequality both within and between groups. However, the MLD is relatively more responsive to changes at the lower end of the distribution [13].

We use the following formula proposed by Cowel (2008):

\[
MLD = 1 \sum_{i=1}^{n} \log \frac{\bar{y}}{y_i}
\]

(10)

\[
MLD = MLD_c + MLD_r
\]

(11)

where: \( n \) is number of regions, \( \bar{y} \) is the national average of GDP per capita and \( y_i \) is GDP per capita of the \( i^{th} \) region, \( MLD_c \) is the intra-region mean logarithmic deviation (among counties) and \( MLD_r \) is the inter-region mean logarithmic deviation (among regions).

3. Main findings

The above methods and instruments were applied to the Romania's case, using EUROSTAT data (regional and county GDP per capita, in PPS, inhabitants -thousand persons per region and county) for 2000-2010.

Coefficient of variation

Figure 2 shows the evolution of the coefficient of variation calculated for Romanian NUTS 2 regions for the period 2000-2010.

As we can see in the figure 2, the convergence continually increased during 2000-2010, with a period of decrease and stagnation during 2001-2004. The year of 2008 brought a maximum of convergence (0,56) followed by a downward trend in 2009 and a return in 2010 at higher level than 2007. From 2004, an upward trend can be identified due to the positive dynamics of regional economies, maintained since 2008, when the effects of economical recession where visible in the increase of regional disparities. This is a different situation from EU, where a significant convergence was found, a continuous decreasing in the variation coefficient from 14.0% in 2000 to 10.4% in 2010 (see [1]).
Figure 2 The coefficient of variation, GDP per capita, Romanian regions (NUTS2)

Source: author's calculations based on EUROSTAT data

The analysis of the coefficient of variation evolution can be completed by examining the economic output differential among the Romanian regions, over the period of 2007-2010, the years of economic crisis.

Table 1 Output differential ($\ln Y_i - \ln \bar{Y}$) among the Romanian regions during the economic recession

<table>
<thead>
<tr>
<th>Region</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nord-Vest</td>
<td>-0.04</td>
<td>-0.11</td>
<td>-0.09</td>
<td>-0.11</td>
</tr>
<tr>
<td>Centru</td>
<td>0.01</td>
<td>-0.05</td>
<td>-0.04</td>
<td>-0.04</td>
</tr>
<tr>
<td>Nord-Est</td>
<td>-0.45</td>
<td>-0.49</td>
<td>-0.48</td>
<td>-0.49</td>
</tr>
<tr>
<td>Sud-Est</td>
<td>-0.21</td>
<td>-0.22</td>
<td>-0.22</td>
<td>-0.19</td>
</tr>
<tr>
<td>Sud - Muntenia</td>
<td>-0.20</td>
<td>-0.19</td>
<td>-0.16</td>
<td>-0.18</td>
</tr>
<tr>
<td>Bucuresti - Ilfov</td>
<td>0.79</td>
<td>0.91</td>
<td>0.86</td>
<td>0.87</td>
</tr>
<tr>
<td>Sud-Vest Oltenia</td>
<td>-0.25</td>
<td>-0.30</td>
<td>-0.28</td>
<td>-0.26</td>
</tr>
<tr>
<td>Vest</td>
<td>0.14</td>
<td>0.09</td>
<td>0.09</td>
<td>0.12</td>
</tr>
</tbody>
</table>

Source: author's calculations based on EUROSTAT data

Note: $Y_i$ is GDP per capita of $i^{th}$ region, $\bar{Y}$ is national average of GDP per capita

The table 1 shows that only two regions (Bucureşti-Ilfov and Vest) were above the national mean of GDP per capita during 2007-2010. Compared to 2007, the wealthiest region, Bucuresti-Ilfov, registered a downturn of convergence to the national average, unlike the region of Vest, where the output differential is diminished, indicating the presence of convergence. The region of Centru has a particular evolution. Before the economical crisis it was above the national average, but during 2008-2010 the economy of this region goes down and the output differential increased. The poorer regions as Nord-Est and Sud-Muntenia converged to the average and the poorest region of Nord-Est is moving continuously to grow its output differential.

The Lorenz curve

In our case, we use the Lorenz curve to expresses the inequality of GDP distribution among the counties of Romania.

Figure 3 Lorenz curve for Romanian counties, 2001

Figure 4 Lorenz curve for Romanian counties, 2010

Source: Source: author's calculations based on EUROSTAT data
By computing data on GDP and population for the 42 counties of Romania, we construct the Lorenz curve. Thus, on abscissa is marked the cumulative share of counties in total Romanian population, from lowest to highest, and on the ordinate the corresponding cumulative share of counties in national GDP, then, the points corresponding to the peer values are marked, as well. The line passing through all points is the Lorenz curve.

As it is shown in the Figure 3 and, respectively Figure 4, there is a clear tendency for divergence among the counties of Romania. The inequalities among counties increased in ten years, we can see an extension of the area bounded by the Lorenz curve and the diagonal line in 2010 compared to 2001.

The Gini coefficient

By using the formula (4), as it is shown in the figure 5, the distribution of wealth among the Romanian regions is relative close to an egalitarian one in all years, during 2000-2010. Disparities among regions declined from 0,20 in 2000 to 0,18 in 2004. An ascending trend in last years (2005-2010) is visible, with a maximum of 0,25 in 2008.

![Figure 5 Gini coefficients (based on regional GDP per capita, in PPS) for Romania](image)

Source: author's calculations based on EUROSTAT data

By using the formula (4) for counties data, over 2000-2010, we obtained the evolution presented in Figure 6.

![Figure 6 Gini coefficients (based on county GDP per capita, in PPS) for Romania](image)

Source: author's calculations based on EUROSTAT data

Compared to regional disparities, in the evolution of inequalities among counties of Romania we can notice a sharp variation in 2001, a decline to a halved level of 2000, followed by a slightly, but ascending trend (Figure 6). The Gini coefficient rose from 0,14, in 2001, to 0,20 in 2010, reflecting a convergence tendency at counties level.

The Atkinson Index

The Atkinson index is computed based on regional GDP per capita values, for the period of 2000-2010 in the Romanian regions. As the figure 7 shows, the index has very low values, between 0,049 to 0,09, similar to the situation in the whole European Union (see [13], p.6)
Figure 7 Atkinson Index (based on regional GDP per capita) in Romania

Source: author's calculations based on EUROSTAT data

The Theil Index

Figure 8 Theil index (based on regional GDP per capita) in Romania

Source: author's calculations based on EUROSTAT data

The value of this index (figure 8) shows a reduction of inequalities among the Romanian regions during 2000-2004 and an increase after, with a maximum of 0,11 in 2008, followed by a stable evolution to 2010. The levels of this index are in line with the results obtained above with other measures.

Figure 9 displays the Theil Index and its decomposition, into its county (Tc) and regional (Tr) components for the Romanian regions (NUTS 2), taking into consideration the levels of GDP per capita for counties and regions, expressed in PPS, from EUROSTAT data base.

The trend of this index is ascending over the period of 2001-2010, with a maximum in 2008, the year when the effects of crisis emerged in the Romanian economy. The ascending trend of this index is explained by the fact that disparities among counties and regions are strongly increasing over the period examined.

Figure 9 Theil Index and its components (based on regional GDP per capita), Romanian regions (NUTS 2)
The ration of Tc/T corresponds to the share of disparities explained by the variation within regions (among counties) (referred to as intra-regions inequalities), while its complement Tr/T measures the share explained by disparities among the regions (referred to as inter-regions inequalities). Table 2 reports these shares for the period of 2000-2010.

### Table 2 Shares of inter- and intra-regional inequalities, 2001-2010

<table>
<thead>
<tr>
<th>Share of Theil Index explained by:</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inter-regions inequalities</td>
<td>80,52%</td>
<td>80,84%</td>
<td>75,95%</td>
<td>79,01%</td>
<td>81,19%</td>
<td>82,90%</td>
<td>84,24%</td>
<td>84,10%</td>
<td>84,16%</td>
<td>79,88%</td>
<td>78,81%</td>
</tr>
<tr>
<td>Intra-regions inequalities</td>
<td>19,48%</td>
<td>19,16%</td>
<td>24,05%</td>
<td>20,99%</td>
<td>18,81%</td>
<td>17,10%</td>
<td>15,76%</td>
<td>15,90%</td>
<td>15,84%</td>
<td>20,12%</td>
<td>21,19%</td>
</tr>
</tbody>
</table>

Source: author's calculations based on EUROSTAT data

The inter-region component of the index clearly decreases over time. In 2000, 80.52% of territorial disparities can be explained by differences among regions counties. By 2010, territorial disparities among regions accounted only for 78.81% of inequalities among regions, suggesting a slight increase of intra-regions components (among counties.)

#### The Mean Logarithmic deviation (MLD)

Figure 10 shows the MLD as well as its county (MLDc) and regional (MLDr) components for the Romanian NUTS 2 regions.

The results are qualitatively similar to those obtained with the Theil index. Regional disparities increased continuously over the period of observation but within regions, territorial inequalities among counties increased only slightly.

### Figure 10 The Mean Logarithmic deviation and its components (based on regional GDP per capita), Romanian regions (NUTS 2)

Source: author's calculations based on EUROSTAT data

The contribution of the intra-group (intra-region) and inter-group (inter-regions) inequalities to global inequalities are reported in Table 3.

### Table 3 Shares of inter- and intra-regional inequalities, 2001-2010

<table>
<thead>
<tr>
<th>Share of MLD Index explained by:</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inter-regions inequalities(Tr)</td>
<td>75,88%</td>
<td>76,11%</td>
<td>71,67%</td>
<td>74,29%</td>
<td>78,3%</td>
<td>77,32%</td>
<td>78,02</td>
<td>77,84%</td>
<td>79,35%</td>
<td>74,27%</td>
<td>75,28%</td>
</tr>
<tr>
<td>Intra-regions inequalities(Tc)</td>
<td>24,12%</td>
<td>21,89%</td>
<td>28,33%</td>
<td>25,71%</td>
<td>21,7%</td>
<td>22,68%</td>
<td>21,98%</td>
<td>22,16%</td>
<td>20,65%</td>
<td>25,73%</td>
<td>24,72%</td>
</tr>
</tbody>
</table>

Source: author's calculations based on EUROSTAT data

As we can see in the Table 3, the territorial disparities are explained rather by the inter-regions inequalities than the intra-regions differences. The evolution of the components is relatively stable; their shares are almost constant over the period of observation.
4. Conclusions and policy implications

The paper tried to highlight the most frequent methods and instruments for measuring economic inequality that can be used for examining the territorial disparities in Romania.

The results obtained with various measures and tools are qualitatively similar. However, the instruments vary significantly in terms of their specificity and qualities. For example, the Gini coefficient is used in most empirical analyses, which allows comparability of results, it is easy to interpret graphically, and depends on the income position as well as income level. The Theil Index and MLD are decomposable by population groups and the Atkinson indices can offer a welfare interpretation, but it depends on the “aversion to inequality” - a value which can be decided in a subjective way by researchers.

The main conclusion of the present study is that, over the last years, Romania experienced a process of economic divergence, a process of widening of inequalities between regions and counties. The process is more visible at regions level. However, a process of increasing inequalities between counties is emphasized by the comparison of the shape of Lorenz curve of 2000 to that of 2010, the area A between the Lorenz curve and diagonal being more extended in 2010.

The level of regional inequalities expressed by Gini coefficient is not high (0.19 to 0.25), over the time of observation(2000-2010), but a clear ascending trend is identified after 2008.

By using the indexes as measure for inequality (Atkinson, Theil, MLD), territorial inequalities are explained in a proportion of 71.67%-84.24% by the inter-group component (inter-regions), the intra-group component(intra-regions or among counties) being less important. This is a relevant finding for policy makers in the decisional process related to division of Romania in regions, according to realistic and relevant criteria for the long run growth. It is very important how counties will be associated in regions in order to result a balanced distribution of wealth and development resources.

As relevance for policy makers, is also, that keeping track of regional disparities and monitoring their evolution is definitely of key importance for the design and management of the new regional policy, for 2014-2020.

5. References