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THE REGIONAL UNEVENNESS OF ECONOMIC DEVELOPMENT IN UKRAINE AND THE EU: MODELS OF ANALYSIS

S. Prokopovych
N. Chernova

Nowadays countries and regions are under socioeconomic threats of different origin. One of the most crucial ones is notable regional unevenness of development, which leads to aggravation of social tension in society, a decline in the level of social security. Threats of this kind are not only inherent in individual member countries but interregional associations as well, such as the European Union. This leads to a reluctance of donor countries to spend an increasingly greater share of their income on supporting the acceptor countries' development. The regional unevenness problem has been studied by many scientists. However, the structure of unevenness has not been researched fully enough. Economic and mathematical models have been constructed to analyze the economic development regional unevenness. Macroeconomic and mesoeconomic systems have been researched. The macrolevel is presented by the European Union (EU) and its member countries. The mesolevel is presented by Ukraine and its regions. Gross domestic product per capita (for the EU) and gross regional product per capita (for Ukraine) have been selected as key indicators of the unevenness development.

The proposed models are based on the cumulative growth theory assumptions and variance analysis methods. The models make it possible to position separate territories within the system of coordinates "development level – unevenness level"; select the centers of economic growth, problem regions and groups of regions with homogeneous nature of changes in the economic development; carry out a comparative analysis of the unevenness trends at the macro- and mesolevels.

Keywords: *theory of cumulative growth, model, analysis, standard deviation, gross regional product, gross domestic product, regional unevenness.*

РЕГІОНАЛЬНА НЕРІВНОМІРНІСТЬ ЕКОНОМІЧНОГО РОЗВИТКУ В УКРАЇНІ ТА ЄС: МОДЕЛІ АНАЛІЗУ

Прокопович С. В.
Чернова Н. Л.

У цей час країни й регіони є об'єктами впливу соціально-економічних загроз, що мають різне походження. Однією з найбільш важливих із них є істотна регіональна нерівномірність економічного розвитку, яка призводить до загострення соціальної напруженості в суспільстві, зниження рівня соціальної безпеки. Такі загрози притаманні не тільки окремим країнам, а й міжрегіональним об'єднанням, таким як Європейський Союз. Це призводить до небажання країн-донорів витрачати все більшу частину свого доходу на підтримку розвитку країн-акцепторів. Проблему регіональної нерівномірності було вивчено багатьма вченими. Проте структуру нерівномірності не досліджено досить повно. Для аналізу регіональної нерівномірності економічного розвитку побудовано економіко-математичні моделі. Досліджено системи макро- та мезорівнів. Макрорівень презентовано Європейським Союзом та його країнами-членами. Мезорівень презентовано Україною та її регіонами. Валовий внутрішній продукт на душу населення (для ЄС) і валовий регіональний продукт на душу населення (для України) було обрано ключовими індикаторами нерівномірності розвитку.

Пропоновані моделі засновано на припущеннях теорії кумулятивного зростання та методах дисперсійного аналізу. Застосування запропонованих моделей дозволяє позиціонувати окремі території в системі координат "рівень розвитку – рівень нерівномірності"; виділяти центри економічного зростання, проблемні регіони та групи регіонів з однорідним характером змін в економічному розвитку; здійснювати порівняльний аналіз тенденцій нерівномірності економічних систем на макро- і мезорівнях.

Ключові слова: *теорія кумулятивного зростання, модель, аналіз, середньоквадратичне відхилення, валовий регіональний продукт, валовий внутрішній продукт, регіональна нерівномірність.*

РЕГИОНАЛЬНАЯ НЕРАВНОМЕРНОСТЬ ЭКОНОМИЧЕСКОГО РАЗВИТИЯ В УКРАИНЕ И ЕС: МОДЕЛИ АНАЛИЗА

Прокопович С. В.
Чернова Н. Л.

В настоящее время страны и регионы подвергаются социально-экономическим угрозам, которые имеют различное происхождение. Одной из наиболее важных из них является существенная региональная неравномерность экономического развития, которая приводит к обострению социальной напряженности в обществе, снижению уровня социальной безопасности. Такие угрозы присущи не только отдельным странам, но и межрегиональным объединениям, таким как Европейский Союз. Это приводит к нежеланию стран-доноров тратить все большую часть своего дохода на поддержание развития стран-акцепторов. Проблема региональной неравномерности была изучена многими учеными. Тем не менее, структура неравномерности не исследована достаточно полно. Для анализа региональной неравномерности экономического развития построены экономико-математические модели. Исследованы системы макро- и мезоуровней. Макроуровень представлен Европейским Союзом и его странами-членами. Мезоуровень представлен Украиной и ее регионами. Валовой внутренний продукт на душу населения (для ЕС) и валовой региональный продукт на душу населения (для Украины) были выбраны в качестве ключевых индикаторов неравномерности развития.

Предлагаемые модели основаны на предположениях теории кумулятивного роста и методах дисперсионного анализа. Применение предложенных моделей позволяет позиционировать отдельные территории в системе координат "уровень развития – уровень неравномерности"; выделять центры экономического роста, проблемные регионы и группы регионов с однородным характером изменений в экономическом развитии; осуществлять сравнительный анализ тенденций неравномерности экономических систем на макро- и мезоуровнях.

Ключевые слова: *теория кумулятивного роста, модель, анализ, среднеквадратическое отклонение, валовой региональный продукт, валовой внутренний продукт, региональная неравномерность.*

The current stage of development of economic systems is accompanied by the expansion of crises of various origins. So Ukraine is faced with the problem of a significant differentiation of development levels of individual regions and territories, which is one of the main causes of acute social tension, falling social security. Problems of this nature are not confined to individual countries, but they are peculiar to interregional associations, such as the European Union. This leads to a reluctance of donor countries to spend an increasingly greater share of their income on supporting an adequate development level of acceptor countries.

The problem of uneven development of territories has been studied by many domestic and foreign scientists.

The theory of cumulative growth, which is a synthesis of neo-Keynesian, institutional, economic and geographical models can be accentuated. These models are based on the use of scale and specialization effects whose synergy can lead to a new qualitative transformation in the system. This trend in the of theoretical approaches to the study of regional economic growth is based on the concept of "mutual and cumulative conditionality" of the Swedish scientist G. Myrdal [1, p. 565–575]. Specialization and economies of scale may eventually lead to the growth and strengthening of certain benefits of a region – the growth pole on the background of decline in other regions. A similar theory of "backward and forward linkages" introduced by A. Hirschman confirms an irregular mode of a country's economic growth. This is caused by uneven localization of economic development resources. At the same time, this theory supports the "unbalanced growth", which can give an impetus to mobilization of potential reserves for the benefit of the territorial development [2].

The concept of "growth poles" was put forward by the French economist F. Perroux, who proved that economic growth is activated at some points or poles of growth and with a variable intensity it is distributed through various channels [3, p. 60–65]. In other words, the regional growth does not ensure convergence of the levels of economic development of the territories, although some equalization is possible through the development channels of distribution of "increase effects".

The theory of "growth poles" was further developed in the publications of P. Pottier, J. R. Lasuén, J. Friedman, T. Hägerstrand [3–5].

The content of foreign theories of regional economic growth and development has been most comprehensively analyzed in the paper by Yu. Gadzhiev [6, p. 49–52].

There are publication of domestic scientists dealing with specific aspects of uneven regional development. Thus, V. Yermachenko has been exploring unevenness as a factor of tourist flows in Ukraine [7, p. 98]. E. Rayevnyeva and O. Krupa [8, p. 54–64] examined the uneven economic development of regions in terms of their investment potential. Regions are divided into homogeneous groups in the system of axes "investment potential – investment risk" estimated by the standard deviation.

Various economic and mathematical methods and models are widely used to solve problems of estimation, analysis and forecasting of regional differentiation.

M. Malkina has conducted a study of factors of interregional divergence of real incomes of the Russian Federation population on the basis of the Gini coefficient, Theil's entropy measure, Atkinson index and other indicators [9, p. 113–115].

T. Klebanova, L. Guryanova, S. Svetunkov, O. Sergienko in their works analyzed the unevenness development of regions based on convergence models, simulation, scenario modelling and mathematics of complex numbers [10; 11; 12, p. 269–277; 13, p. 408–421; 14, p. 471–479]. The papers of Ukrainian scientists have rejected the hypothesis of convergence of regional development processes in Ukraine [15, p. 29–32].

In most of the studies the uneven development of territories was determined for each time (year) separately, the unevenness structure has not been investigated.

The research aims to build models of evaluation and analysis of regional unevenness of economic development in Ukraine and the European Union. This will help highlight the centres of economic growth, problem areas, carry out a comparative analysis of the unevenness structure.

In this study, the authors propose to carry out analysis at the meso- and macrolevels. The mesolevel is represented by a separate region of Ukraine, with a separate EU country being a macrolevel object.

The objects of study are 24 regions of Ukraine, except for the temporarily occupied territory of the Autonomous Republic of Crimea, and 31 European Union countries. The research period is limited to the years from 2000 to 2013. Thus, the study period does not only include the years of relative economic stability but the financial crisis of 2007 – 2008 and the years of overcoming its consequences. This allows the authors to explore the phenomenon of uneven economic development over a long period and under different conditions.

The following objectives were set in accordance with the goal of the study:

- to identify the key indicators that will help assess the level of economic development of the territories;
- to build assessment and analysis models of the regional unevenness level;
- to select the centres of economic growth, the problem regions, and groups of regions with homogeneous nature of changes in economic development;
- to make a comparative analysis of the unevenness structure at macro- and mesolevels.

The analysis of the publications has shown that indicators which are most frequently used for regional development assessment and analysis can be divided into three groups: economic, social and political. The level of regional development is determined by comparing regional indicators (development indicators) with the national average, or with those of other regions (sometimes with other countries' indicators) [16, p. 321].

The main economic indicators are the gross domestic product (GDP), the gross regional product (GRP), the gross national product (GNP), the gross value added (GVA) or the national income (ND) per capita. The level of economic development is also characterized by indicators of the branch structure (production in industry, production in construction, production in agriculture), financial indicators (general and sector levels of investment, including per capita), indicators of scientific and technical progress (turnover from innovations, total R&D expenditure) and others. It is also crucial to take into account indicators of institutional changes (change of the form of ownership, restructuring, etc.).

Within this paper the authors suggest to use GRP per capita for regions of Ukraine and GDP per capita for EU countries.

The assessment model of regional unevenness is proposed to be build according to the algorithm shown below (Fig. 1).

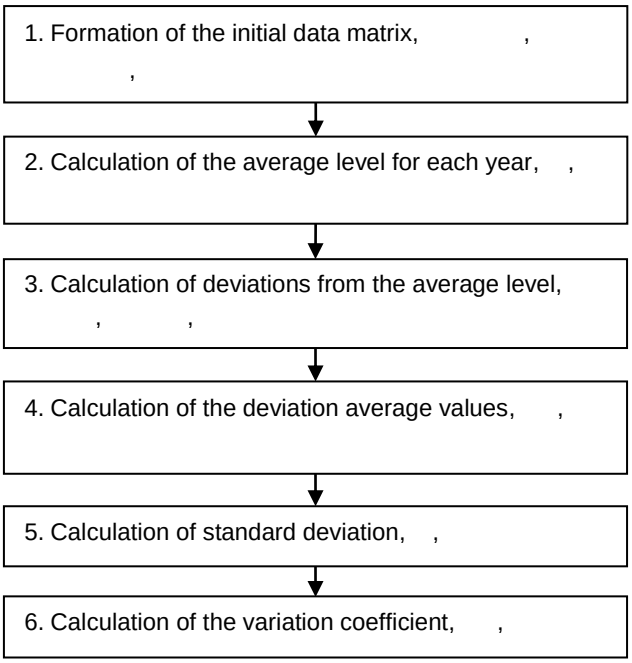

Fig. 1. **The algorithm for constructing the assessment model of regional unevenness of economic development**

Let us consider the stages of the algorithm in more detail.

Firstly, the initial data matrix $Y = y_{tj}$ is formed, where y_{tj} is the value of GRP per capita (UAH) or GDP per capita (EUR) in the year t, ($t = 1, T$) in the region j, ($j = 1, n$).

Secondly, the average level of development of territories is calculated for each year as an average GRP or GDP value according to the formula:

$$y_t = \frac{\sum_{j=1}^{n} y_{tj}}{n}, \qquad t = 1, T.$$

Thus, a general indicator is got to characterize a typical level of regions' development per unit of a homogeneous whole in each year.

Thirdly, the deviation of GRP from the average level is calculated for each region:

$$\Delta y_{tj} = y_{tj} - y_t, \qquad t = 1, T, j = 1, n.$$

Fourthly, the average deviation for each region is determined:

$$\Delta y_j = \frac{\sum_{t=1}^{T} \Delta y_{tj}}{T}, \qquad j = 1, n.$$

Fifthly, the standard deviation (SD) is calculated. It is the best dispersion indicator.

$$\sigma_j = \frac{\sum_{t=1}^{T} \Delta y_{tj} - \Delta y_j^{\,2}}{T-1}, \qquad j = 1, n\,.$$

Sixthly, the value of the variation coefficient (or relative standard deviation) is determined. The coefficient of variation (VC) is determined as a ratio of the standard deviation to the mean. It shows the extent of variability in relation to the mean of the values:

$$VC_j = \frac{\sigma_j}{\Delta y_j} \cdot 100\,\%, \qquad j = 1, n.$$

The proposed algorithm was applied to the regions of Ukraine and the European Union. The initial data sets were formed according to the open access information of the State Statistics Service of Ukraine and the European Statistical Committee [17; 18].

Let's consider the results. Fig. 2 and Fig. 3 show the dynamics of the average values of GRP and GDP per capita in Ukraine and the EU, respectively. Additionally, the median was calculated. It shows the number separating the higher half of a data sample from the lower half.

According to Fig. 2 and Fig. 3 the median values are lower than the average ones. This shows the uneven distributions of values and a strong shift towards smaller values.

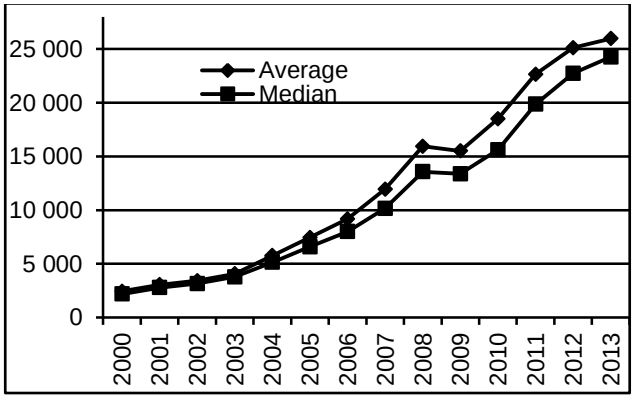

Fig. 2. **The dynamics of the GRP per capita average and median values in Ukraine**

The flat segment of the graph of average values of GRP is the consequences of the financial crisis of 2008 – 2009 years for Ukraine (Fig. 2). During the same period the EU trend changed the direction (Fig. 3).

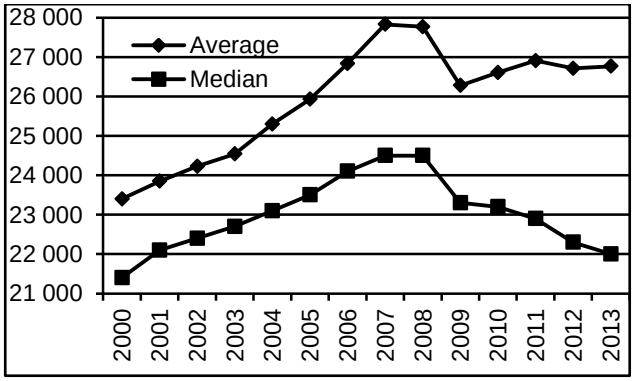

Fig. 3. **The dynamics of the GRP per capita average and median values in the EU**

The results of calculating the deviations of average values from the average level were obtained for the period of 2000 – 2013. In Ukraine, positive average deviations were found in the following regions: Dnipropetrovsk, Donetsk, Poltava, Kyiv, Zaporizhzhia, Kharkiv, Odesa, Luhansk and Mykolaiv. These are industrial regions with a strong transport infrastructure. In the EU, positive average deviations were found in the following countries: Italy, Iceland, Germany, Ireland, Sweden, Switzerland, Norway, Luxembourg, the United Kingdom, France, Belgium, Finland, Austria, the Netherlands and Denmark.

The indicator SD gives a convenient way to demonstrate disparities in the level of economic development of individual regions, as well as make interregional comparisons. In Ukraine, the highest values of standard deviation are demonstrated by the following regions: Donetsk, Poltava, Kyiv, Dnipropetrovsk, Zakarpattia, Chernivtsi and Ternopil. In the EU the highest values of standard deviation are shown by Italy, Iceland, Germany, Ireland, Sweden, Switzerland, Norway, Luxembourg, Slovakia, Portugal, Greece, Cyprus, Spain.

The calculated values of the VC (variation coefficient) in the period of 2000 – 2013 for Ukraine are presented in Table 1.

Table 1

The coefficients of variation for the period of 2000 – 2013

Region	VC	Region	VC
1. Zaporizhzhia	54,44	13. Poltava	75.25
2. Cherkasy	58,38	14. Kherson	75.94
3. Donetsk	64,32	15. Zakarpattia	76.83
4. Zhytomyr	65.07	16. Lviv	78.12
5. Odesa	65.64	17. Dnipropetrovsk	80.04
6. Ternopil	67.71	18. Volyn	81.38
7. Kharkiv	69.62	19. Sumy	82.54
8. Khmelnytsk	71.44	20. Ivano-Frankivsk	83.51
9. Kirovohrad	71.61	21. Rivne	86.58
10. Vinnytsia	72.92	22. Mykolaiv	99.13
11. Chernivtsi	74.07	23. Kyiv	108.52
12. Chernihiv	75.17	24. Luhansk	152.24

The values of variation are very high, thus it is 108.5 % for the Kyiv region, 152.2 % for Luhansk, 99.1 % for Mykolaiv, while for the other regions this value varies from 54 % to 87 %. This indicates a significant level of spread of GRP per capita in Ukraine and the lack of uniformity and a constant trajectory of economic development of regions.

A model of the regional unevenness analysis has been built on the basis of the graphical method. The average deviation of GRP or GDP per capita of the average level ($\Delta y_j, j = 1, n$) and standard deviation ($\sigma_j, j = 1, n$) have been used as initial indicators.

The initial set of indicators was formed according to the following assumptions. If the average values of the deviations are positive, then the level of development can be considered high (or at least above aver-

age). Negative values indicate that the level of development is below average.

The standard deviation may be interpreted as a measure of balance, a measure of evenness of development. High values (above a certain threshold) indicate the imbalance of the territory development. Low values demonstrate a balanced, steady development.

When calculations of $\overline{\Delta y_j}$ and σ_j are made, each region (or country) may be presented as a point in two-dimensional space. The obtained set of points should be divided into four relatively homogenous groups (quadrants) with the following characteristics:

Quadrant I – a positive average value and a high standard deviation.

Quadrant II – a positive average value and a low average deviation.

Quadrant III – a negative average and a low average deviation.

Quadrant IV – a negative average and a high average deviation.

The application of the proposed model to the EU is analyzed in Fig. 4.

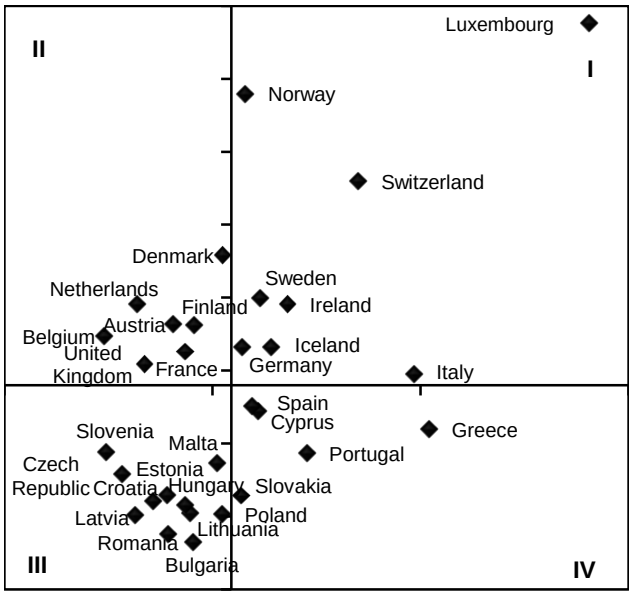

Fig. 4. **Analysis of the application of the unevenness model to the EU**

The average values of both indexes for each quadrant are presented in Fig. 5.

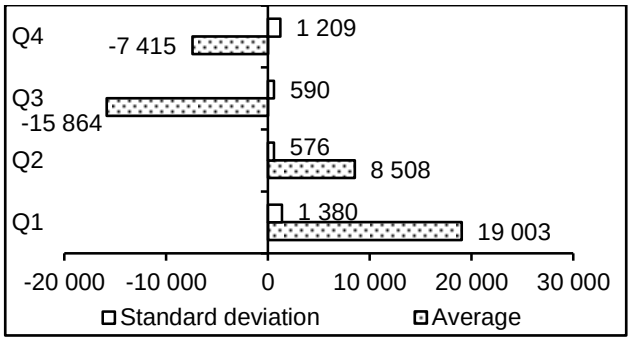

Fig. 5. **The average values for the quadrants**

Let's analyze the obtained results. The values of deviation are almost the same for quadrant I and quadrant III (-19 003 and -15 864 respectively). These values indicate a significant difference between the GDP of these countries from the EU average level. However, if members of the first quadrant may be described as leaders (positive deviation), the third quadrant consists of outsiders (negative deviation). Similar considerations are also valid for the couple "quadrant II – quadrant IV". Their values of deviation are almost identical too and only differ in the sign.

The second and the third quadrants consist of countries which have inverse vectors of development according to their means. But they may be characterized as stable ones according to their variances (576 for quadrant II and 590 for quadrant III). Quadrant I and quadrant IV are unstable zones, because of relatively high variances. Additionally, the values of instability are equal, but opposite, as in the case with the third and second quadrants.

When comparing situations in the third and fourth quadrants you can see that the average value of $\overline{\Delta y_j}$ for quadrant III is almost two times higher than for quadrant IV. As the variances in quadrant III are less, its situation may be characterized as consistently negative.

Let's consider the situation in each quadrant.

The first quadrant consists of the following countries: Italy, Iceland, Germany, Ireland, Sweden, Switzerland, Norway and Luxembourg. The situation within the quadrant is shown in Fig. 6 and Fig. 7.

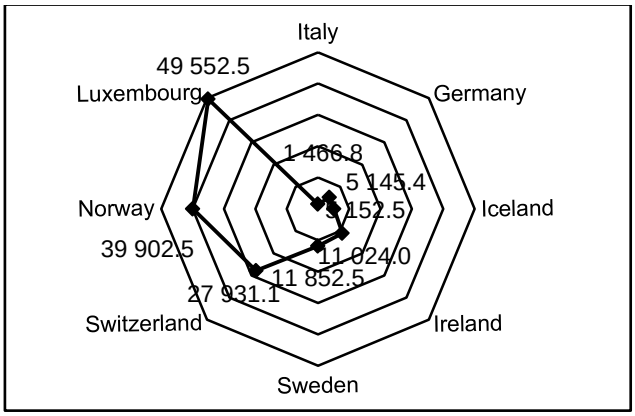

Fig. 6. **Average deviation $\overline{\Delta y_j}$ in quadrant I**

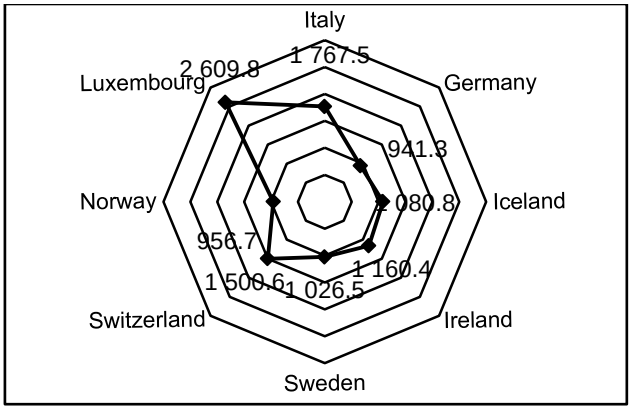

Fig. 7. **Standard deviation σ_j in quadrant I**

According to Fig. 6, such countries as Luxembourg, Norway and Sweden have demonstrated maximum values of Δy_j. This means their GDP levels consistently greatly exceeded the average EU level. The highest variance was calculated for Luxembourg. Other countries have lower variances. But their values are high compared with those from quadrant II and quadrant III.

For the majority of countries (except Italy, Sweden and Switzerland) the dynamics of Δy_{tj} indexes can be described adequately by polynomial functions. Sweden and Switzerland have demonstrated upward linear trends while Italy has shown a downward linear trend.

For most countries you can see an increase in the values of Δy_{tj} compared with 2000 level (by 19.07 % for Ireland, by 25.34 % for Sweden, by 4.27 % for Norway, by 11.61 % for Switzerland, by 9.47 % for Luxemburg, anomalous growth of 72 % was demonstrated by Iceland). Italy has shown a negative growth of approximately 135 %. As it is situated very close to the x-axis in Fig. 4, this country may change its quadrant in the near future.

The second quadrant includes the following countries: the United Kingdom, France, Belgium, Finland, Austria, the Netherlands and Denmark.

The situation within the quadrant is shown in Fig. 8 and Fig. 9.

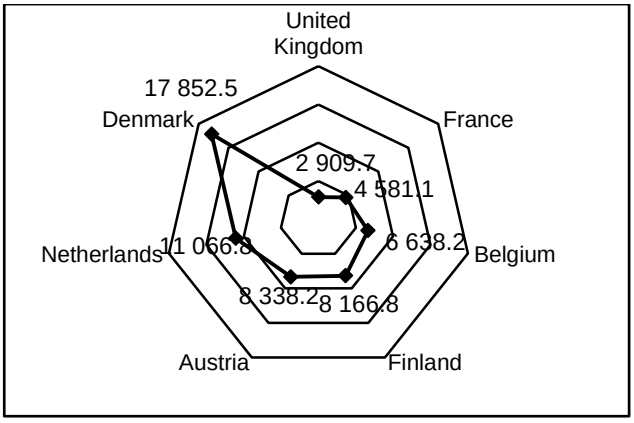

Fig. 8. **Average deviation Δy_j in quadrant II**

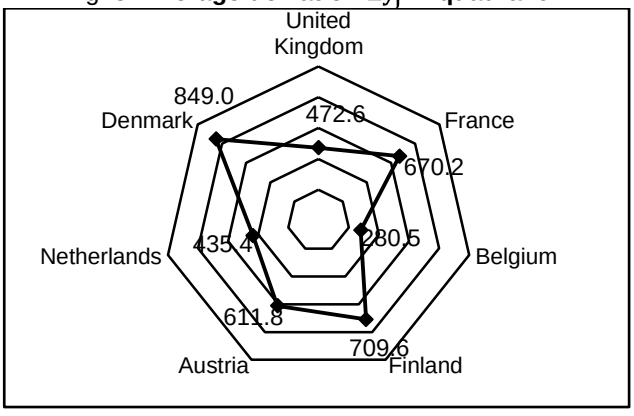

Fig. 9. **Standard deviation σ_j in quadrant III**

A leading position in this quadrant belongs to Denmark. This country has the highest values of Δy_j and σ_j and demonstrates a great potential.

The United Kingdom has the lowest value of the Δy_j index. Its position in Fig. 4 is very close to the x-axis, its Δy_{tj} values are always the lowest (Fig. 10). That is why it may change the quadrant.

A positive growth of Δy_{tj} compared with the level in 2000 is only presented by the United Kingdom (4.67 %), Finland (8.95 %) and Austria (12.48 %) (Fig. 10). Other members of the quadrant have negative growth values. The highest negative growth of 22.18 % is demonstrated by France. For Denmark it is 11.51 %, for Netherlands it makes 4.95 %, for Belgium it is 3.78 %.

All participants of the quadrant have shown high standard deviations. All series can only be adequately presented by polynomial functions. Thus, forecasting values may fluctuate and show either increase or decrease.

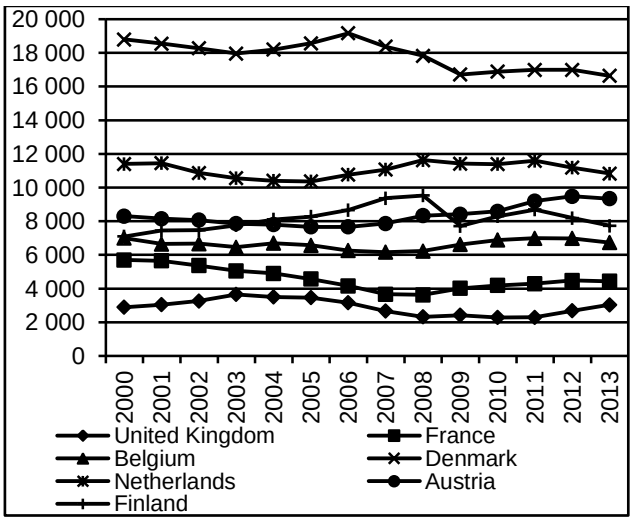

Fig. 10. **The dynamics of Δy_{tj} in quadrant II**

The third quadrant consists of Bulgaria, Romania, Latvia, Poland, Lithuania, Hungary, Croatia, Estonia, the Czech Republic, Malta and Slovenia. The results are shown in Fig. 11 and Fig. 12.

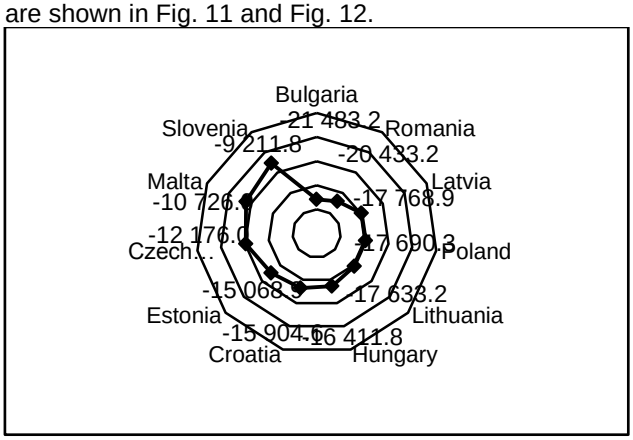

Fig. 11. **The average deviation Δy_j in quadrant III**

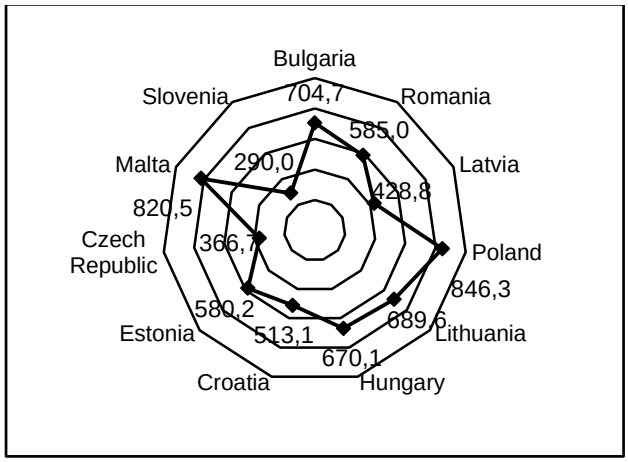

Fig. 12. **The standard deviation σ_j in quadrant III**

Bulgaria and Romania have the highest values of Δy_j. A relatively better situation is with Slovenia (-9 211.8), Malta (-10 726) and the Czech Republic (-12 176).

The analyzed quadrant consists of members which demonstrate high standard deviations. However, Slovenia is an exception among those countries with a relatively low value (Fig. 12).

The situation with dynamics has worsened for Bulgaria (by -4.73 %), Croatia (by -7.56 %), Hungary (by -7.551 %), Malta (by -1.71 %), Romania (by -1.58 %), Slovenia (by -2.81 %) and Croatia (by -7.56 %) (Fig. 13).

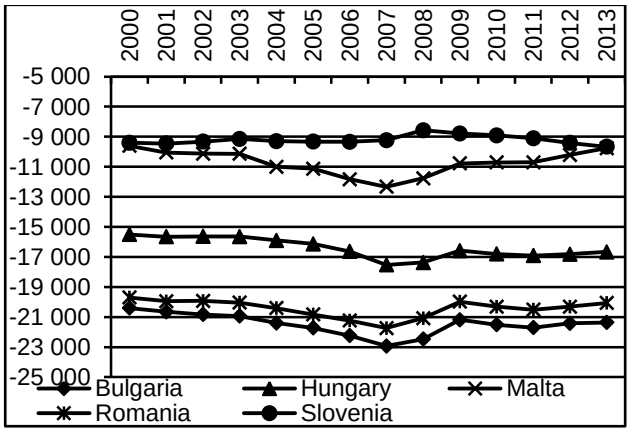

Fig. 13. **The worsened dynamics of Δy_{tj} in quadrant III**

The dynamics of Δy_{tj} is perfectly described by polynomial functions (Fig. 13) and has the same fluctuations. Visual analysis makes it possible to track a similar deterioration trend until 2007. Then all lines except Slovenia tend to grow. Actually, Slovenia has demonstrated a return to the 2000 level. This situation was not probably due to real improvements within the country. The reason is in its stable position against deterioration in other countries.

A relative growth of Δy_{tj} is shown by the rest of the quadrant members. The highest levels of growth are in Lithuania (12.28 %), Estonia (11.62 %) and Latvia (7.89 %). In the Czech Republic and Poland those levels are 4.35 % and 1.97 %, respectively. All trends may be described as polynomial functions only.

Quadrant IV consists of Slovakia, Portugal, Greece, Cyprus and Spain.

These countries show the GDP lowest levels. The high levels of standard deviations give reason to assume an unstable position of these countries (Table 2).

Table 2

Characteristics of quadrant IV

Index	Slovakia	Portugal	Greece	Cyprus	Spain
Average deviation	-15 162	-9 340.3	-6 068.9	-3 568.9	-2 933.2
Standard deviation	939.513	1 253.86	1 842.24	1 019.64	991.626

The levels of Δy_{tj} have demonstrated a dramatic fall for the majority of countries. The series are adequately described by linear functions for Spain, Cyprus and Portugal. As for Greece the best variant is a polynomial function. The greatest reductions in Δy_{tj} against the 2000 level have been demonstrated by Spain (-138.23 %) and Cyprus (-112.15 %). A better situation is for Greece (-71.80 %) and Portugal (-49.51 %).

Slovakia has shown a linear upward trend. Its relative growth of Δy_{tj} equals approximately 13 %. But the absolute value of Δy_{tj} still remains the worst (-13 564.5 in 2013).

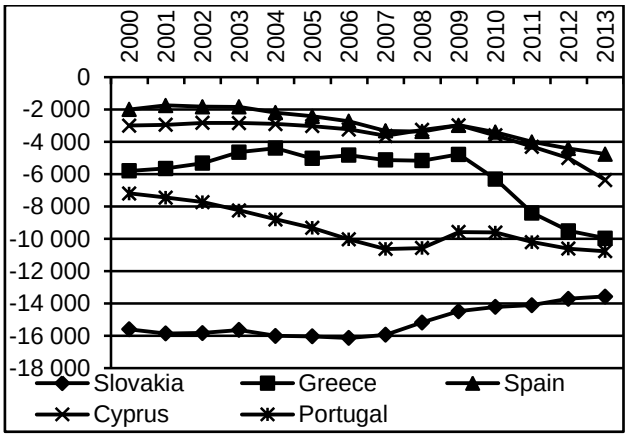

Fig. 14. **The dynamics of Δy_{tj} in quadrant IV**

The application of the proposed model to Ukraine is analyzed in Fig. 15.

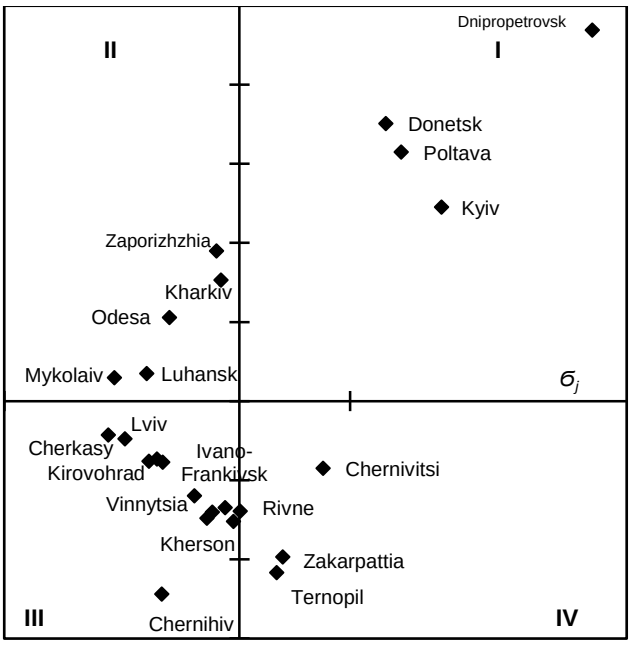

Fig. 15. **The application of the regional unevenness model to Ukraine**

Consider the characteristics of the regions, placed in each of the quadrants.

Donetsk, Poltava, Kyiv, and Dnipropetrovsk regions are in quadrant I. These regions are not only characterized by significantly higher levels of development in the researched period but also by a high level of deviation from the national average, high dynamic changes (Fig. 16 shows the dynamics of the levels of deviations from the average GRP per capita values). But these changes are with a "+" sign and have a stable trajectory. These regions are leading industrial regions, which produce "growth impulses". The advantages of these regions may eventually increase.

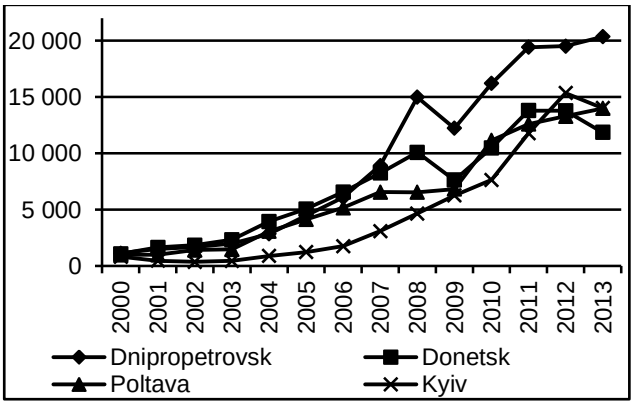

Fig. 16. **The dynamics of average annual value deviations for regions in quadrant I**

Mykolaiv, Luhansk, Odesa, Zaporizhzhia and Kharkiv regions are in quadrant II. These are the regions with the value of GDP that is above average and balanced development. These are industrial regions with a developed transport infrastructure, bordering the regions-leaders. Due to this they have growth potential. Fig. 17 shows the dynamics of the levels of GRP per capita deviations from the average data.

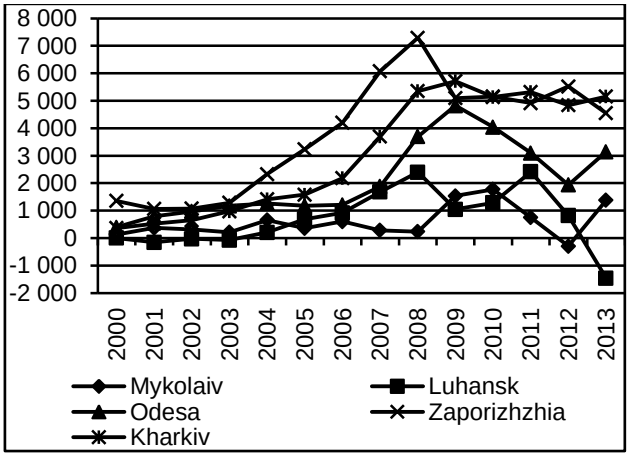

Fig. 17. **The dynamics of average annual value deviations for regions in quadrant II**

The trajectory of economic development has been stable for these regions until 2008 – 2009. The positive deviations indicate that these regions have a certain potential for development. However, a small measure of deviation indicates the need for additional resources to enable these regions to go to the group of the leading regions. This is especially true of the Kharkiv region and Zaporizhzhia region which are stable ones with a growth potential.

Vinnytsia, Volyn, Zhytomyr, Ivano-Frankivsk, Kirovohrad, Lviv, Sumy, Kherson, Khmelnytskyi, Cherkasy and Chernihiv regions belong to quadrant III. These are the regions with lower-middle and low standard deviation levels. For these regions the degree of deviation is insignificant, but these deviations show a negative dynamics (Fig. 18).

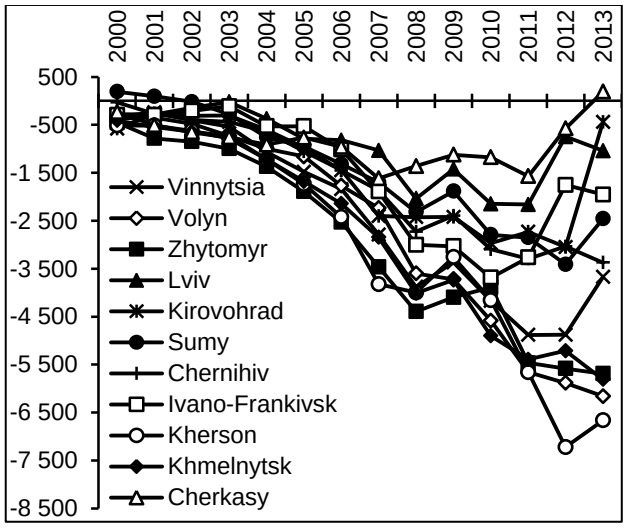

Fig. 18. **The dynamics of average annual value deviations for regions in quadrant III**

Ternopil, Zakarpattia, Rivne and Chernivtsi are in quadrant IV. These are the regions with the lowest

level of economic development and a negative dynamics (Fig. 19).

Potentially, these regions are a threat to the economic security of the country. These regions are outsiders.

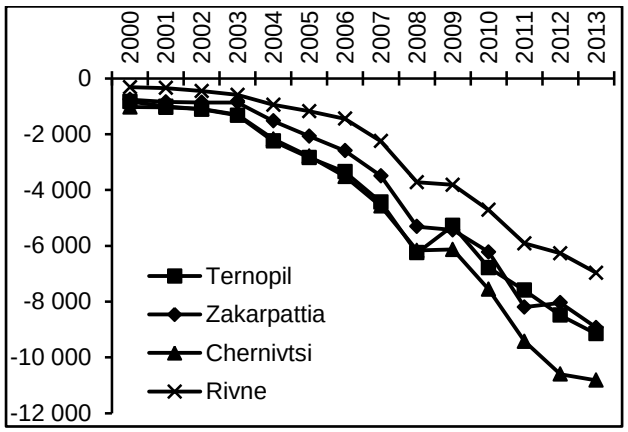

Fig. 19. **The dynamics of average annual value deviations for regions in quadrant IV**

According to the retrospective analysis conducted for Rivne only, it had been situated within quadrant III until 2012. However, its declining trend dropped the region into quadrant IV.

Finally, let's analyze the structure of the quadrants for the EU and Ukraine (Fig. 20).

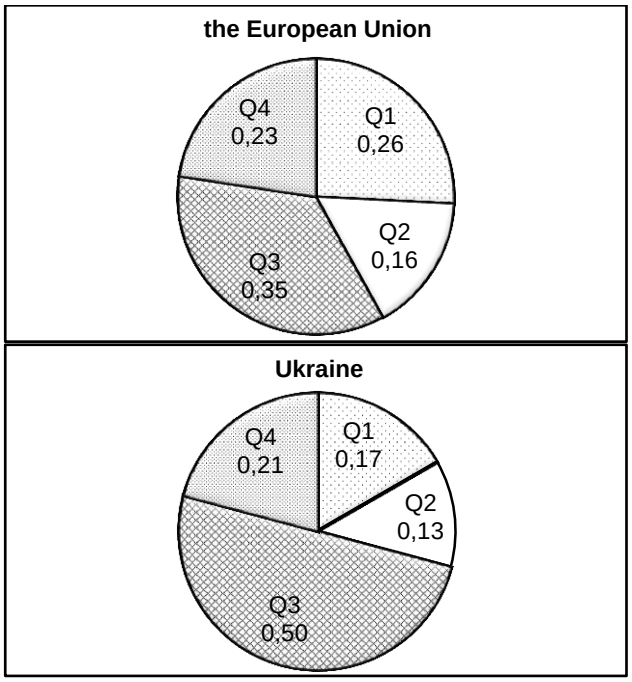

Fig. 20. **The quadrants' structure for the EU and Ukraine**

In both cases members of quadrant I and quadrant II demonstrate the highest level of socioeconomic development. The members of quadrant II are relatively stable. The members of quadrant I produce "growth impulses". The advantages of these members may eventually increase. The higher the share of these two quadrants, the better economic situation of the system as a whole. The share of the first and the second quadrants equals 48 % for the EU and 38 % for Ukraine. That means a more even distribution for the EU.

In both cases, the third quadrant is the most numerous one. Its share equals almost one third for the EU. But in the case of Ukraine this value equals 50 %. So, half of the regions of Ukraine do not demonstrate any growth potential.

In general, the structures are comparable with each other.

The absence of intersections on the graphs of Δy_{ti} shows a relative stability of the composition of the quadrants over time for the EU. However, in the case of Ukraine the structure of the quadrants may change.

The model suggested by the authors makes it possible to analyze the quadrants' structure in dynamics. It also helps determine those regions which are situated near the axes and may migrate from the quadrant. Those regions do not demonstrate a stable position. Thus it is crucial to investigate the opportunity of changing their membership and select the factors that may support such changes.

The results obtained by the authors correspond to the cumulative growth theory. The levels of economic development of regions are not aligned with the times. With specialization and economies of scale, the limited advantages of the industrial areas can grow and be multiplied with time. The distribution of this effect in the regions or the so-called "divergent effects" lead to the fact that the benefits of individual areas, growth poles, lead to their catalyzed development and greater stagnation of the adjacent regions against this background.

Regional unevenness of development often leads to aggravation of social tension in society, decline in the level of social security. That is why it is crucial to construct and implement a set of models that will produce short-term and long-term forecasts of the level of unevenness. Moreover, such models should be able to determine the most significant factors which cause the unevenness.

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Information about the authors

S. Prokopovych – PhD in Economics, Associate Professor of the Department of Economic Cybernetics of Simon Kuznets Kharkiv National University of Economics (9-A Nauky Ave., Kharkiv, Ukraine, 61166, e-mail: Svitlana.Prokopovych@m.hneu.edu.ua, prokopovichsv@gmail.com).

N. Chernova – PhD in Economics, Associate Professor of the Department of Economic Cybernetics of Simon Kuznets Kharkiv National University of Economics (9-A Nauky Ave., Kharkiv, Ukraine, 61166, e-mail: Natalia.Chernova@m.hneu.edu.ua, natacherchum@gmail.com).

Інформація про авторів

Прокопович Світлана Валеріївна – канд. екон. наук, доцент кафедри економічної кібернетики Харківського національного економічного університету імені Семена Кузнеця (просп. Науки, 9-А, м. Харків, Україна, 61166, e-mail: Svitlana.Prokopovych@m.hneu.edu.ua, prokopovichsv@gmail.com).

Чернова Наталя Леонідівна – канд. екон. наук, доцент кафедри економічної кібернетики Харківського національного економічного університету імені Семена Кузнеця (просп. Науки, 9-А, м. Харків, Україна, 61166, e-mail: Natalia.Chernova@m.hneu.edu.ua, natacherchum@gmail.com).

Информация об авторах

Прокопович Светлана Валерьевна – канд. экон. наук, доцент кафедры экономической кибернетики Харьковского национального экономического университета имени Семена Кузнеца (просп. Науки, 9-А, г. Харьков, Украина, 61166, e-mail: Svitlana.Prokopovych@m.hneu.edu.ua, prokopovichsv@gmail.com).

Чернова Наталья Леонидовна – канд. экон. наук, доцент кафедры экономической кибернетики Харьковского национального экономического университета имени Семена Кузнеца (просп. Науки, 9-А, г. Харьков, Украина, 61166, e-mail: Natalia.Chernova@m.hneu.edu.ua, natacherchum@gmail.com).

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