Assessment of Transformational Processes in Regional Development

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Abstract

In the current conditions of socio-economic instability of the development of economic systems at all levels, global challenges, growing interregional disparities and intensification of the processes of restoration of territories that have undergone significant transformational impacts due to various reasons, there is a need for in-depth analysis and assessment of transformational processes of regional development. This and other factors determine the need to develop methodology to assessing transformational processes that allow taking into account the specifics of each region, its resource potential, level of vulnerability and adaptive capabilities. The purpose of the study is to substantiate the methodological approach to assessing transformational processes of regional development, which involves determining the transformational impact on the development of regions through the complex transformation value according to its structure using a value that is numerically equal to the area of the figure and partial correction coefficients of transformation of regional development. To this approach to assessing transformational changes in the development of regions, regions of Ukraine were selected in which transformational changes were caused by losses, losses and damage. The practical significance is that in addition to determining transformational changes according to their structure and total transformational changes, the methodological approach can be used as a basis for developing directions for strategies for the restoration and development of regions, both at the local and state levels. The results of the calculations can also be used to forecast the development of regions, taking into account transformational changes.

Keywords: Transformation, Development, Region, Economic System, Assessment, Forecasting.

Introduction

In general, if we talk about transformation, then from the primary Latin origin this term is translated as "transformation". The concept of "transformation" in economic works of scientists is found and used quite actively in the study of economic systems of different levels, as well as

heterogeneous processes and phenomena. Without transformation, the transition from one economic system to another is impossible, and transformation is also considered as creative destruction, multifaceted rapid changes, transformations, impulses to the organization of a new system, which are not a continuation of development, but act as radical changes. The transformation process determines the set of qualitative changes or the formation of a new economic structure of different levels, which ensures its transition to another stage of development and/or functioning.

Transformation is directly related to development. At the same time, transformation can be considered in relation to the evolutionary and revolutionary development of economic systems of different levels. Transformation is a process caused by bifurcation, which contributes to the fact that economic systems of different levels acquire new characteristics, properties, parameters and directions of development. Transformation can be both discrete, situational, cyclical and continuous in time and space, intensive and extensive, long and fast, caused by both endogenous and exogenous factors, which can be objective and subjective. Like any deep structural process, transformation is at the same time a natural, complex and contradictory process, which is determined by the dynamics of internal relationships and the external environment.

The process of development of regions is directly correlated with the phenomena of progress, modernization, transformation, which are the main determinants of structural changes. These changes are aimed at achieving a higher level of perfection, optimization, efficiency and progressiveness, and are also aimed at eliminating disparities in regional development. The process of transformation of the economic system is characterized by a wide range of changes, regardless of the vector and consequences accompanying these processes, which ultimately lead to a different economic state, the formation of new results of activity and the setting of new goals and objectives of development. However, it is important that transformation does not always lead to a positive effect in relation to the development of economic systems. The reasons that determine the transformation of the processes of development of regions can be such phenomena as, for example, a pandemic, various natural disasters, man-made disasters, military actions and other transformational phenomena that are capable of significantly changing the direction and course of development of the regional economic system.

Literature Review

Admar A. M.et al. (2024), Breul Moritz. (2024), Garafonova O.et al. (2021) devoted their research to the development of a model of digital transformation of population management services for regional development, the formation of a regional transformation strategy and outlining the course of development, and the analysis of the functions of state management of regional development under the influence of digitalization processes.

Gazuda M.et al. (2025), Chlebna C.et al. (2025), Jakubek P.et al. (2023) analyzed the impact of digitalization on the transformation of mechanisms of state management of regional development, investigated the features of transformation in regional transitions to sustainable development, and also identified managerial control in the system of ensuring economic security.

KirzhetskaM. et al. (2024), Liang J. et al. (2024), Liu Y. et al. (2025) investigated the transformation of a regional IT cluster into a cross-border IT cluster, analyzed the development of the regional digital economy and the digital transformation of enterprises, and substantiated the connection between smart transformation of production and regional economic development.

Lv Xiaotinqet al.(2024), NazFarah et al. (2025), Nikiforov P. et al.(2022)analyze the green effect of digital transformation, explore the features of regional development and transformation of rural areas, and outline the conceptual principles of regulating state policy.PopeloO.et al.(2022), Qian J. et al.(2024), Rismawati Hamid et al.(2024) the features of the transformation of regional models of household financial behavior are revealed, interregional energy optimization and transformation for sustainable development are analyzed, and the inclusive policy and distribution of green

economic transformation of mining regions are revealed. Thuda A. et al.(2024 a, b), Tulchynska S.et al.(2022)demonstrates the results of research on business transformation, the role of business transformation strategy, methodological approaches to assessing transformational processes of regional development based on innovation and digitalization.

Wong Linqliet al.(2023), Xiao K.et al.(2025), Yang Y. et al. (2024)reveal strategic policy innovations for the transformation of regional development, based on the progressive differential model, explore regional disparities for sustainable development and economic transformation, and justify the feasibility of including sustainable development goals in regional green transformation and reforms. You L. et al.(2023), Zhang Y. et al.(2024), Zhavoronok A.et al.(2022), Zhuo Chong et al.(2024)outlines the design-oriented transformation and modernization of regional industry, explores the digital transformation of regional development, regulatory policy, and reveals the features of regionally coordinated development and green transformation as a strategic priority.

The conducted study of current publications on this topic of research makes it possible to note that many publications are devoted to improving methodological approaches to assessing the development of regions and their further forecasting. At the same time, publications devoted to assessing transformational impacts on the development of economic systems are insufficient and require further scientific exploration in this area.

The purpose of the study is to substantiate a methodological approach to assessing transformational processes in regional development.

Methodology

Proving the relevance of the study makes it possible to assert that there is a need to substantiate a methodological approach to assessing the transformational processes of the development of regions. The absence of a comprehensive system for assessing the processes of transformational changes significantly complicates the formation of effective regional policy aimed at ensuring balanced development, spatial justice and competitiveness of regions.

Transformational changes can cover various aspects of regional development, including: economic, social, demographic, institutional and environmental, etc. This and other require the development of modern methodological approaches to identifying the dynamics, features, depth and consequences of these transformational changes. Proper assessment of transformational processes allows not only to identify problem areas, but also to substantiate the directions and tools of regional intervention, support and adaptation.

An assessment of transformational effects in relation to the development of regions can be carried out through analysis and scenario forecasting of changes in the integral index of regional development. At the same time, it is necessary to take into account the existing transformations that have occurred at the regional level when forecasting. This is proposed to be done by determining the corrective coefficients and calculating their impact on the integral index of development of regions. In addition, it is appropriate to forecast the forecast values according to three scenarios: optimistic, neutral and pessimistic.

Forecasting scenarios for the development of regions, under the influence of transformation, is based on a combination of alternative, internally consistent ideas about the future. To ensure the coherence of such ideas, it is necessary to use specialized forecasting, which allows the formation and analysis of individual scenarios.

Each scenario is analyzed autonomously, after which all scenario options are integrated into a logically coherent, consistent structure of the predicted future. This approach forms the so-called "window of opportunity", within which it becomes possible to justify strategic decisions regarding regional development under the influence of transformational processes in conditions of uncertainty.

To determine the transformational impact on the development of regions, it is proposed to determine the complex transformation value (CTQ) according to their structure and calculate it by a value that is numerically equal to the area of the figure formed by the transformation structure using the following formula:

$$CTQ_j \equiv S_j = \sum_{j=1}^{m} \left(\frac{1}{2} d_{ji} \cdot d_{jk} \cdot \sin\left(\widehat{d_{ji}; d_{jk}}\right) \right) \quad (1)$$

where is the d_{ji}, d_{jk}i - th and k -th vectors of the transformation structure for *the j* - th region;

$d_{ji}; d_{jk}$– angle between vectors.

In addition to the complex transformation indicator, it is proposed to determine partial correction coefficients of transformation of the development of regions, which are determined by individual indicators of transformational changes. The partial correction coefficient of transformation characterizes the share of transformation by their types in the total amount of transformational changes.

Partial correction coefficients of transformation ($PCFT$) of the development of regions are proposed to be calculated using the formula:

$$PCFT_{36(ji)} = d_{ji} = \frac{MTC_{ji}}{\sum_{i=1}^{n} MTC_{ji}}, \quad (2)$$

where MTC_{ji}– the magnitude of transformational changes as a result of losses/damage in relation to all or a certain group of regions;

$\sum_{i=1}^{n} MTC_{ji}$– total losses in a group of regions, or in relation to all regions;

j – variable indicating the corresponding group of regions for which calculations were performed;

and– a variable that indicates the corresponding type of transformational changes as a result of damage or loss.

The value of the complex transformation indicator characterizes the state of regions in terms of total losses, while partial correction coefficients of transformation characterize individual types of transformational changes as a result of losses.

Results

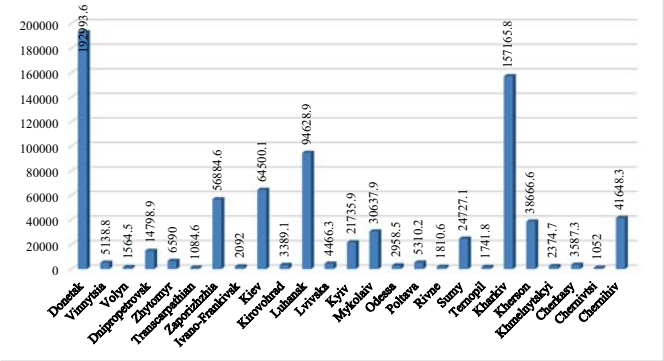
To carry out calculations using the proposed methodological approach, regions of Ukraine were selected in which hostilities took place, as a result of which the regional economic system underwent significant transformational changes due to the destruction of critical and social infrastructure, production facilities, or was temporarily occupied, which resulted in a significant decrease in its socio-economic development and population migration.

Transformational changes in the regions of Ukraine caused by military actions are assessed by various international and national organizations. Based on this assessment, reports were generated on transformational changes as a result of military actions in the regions of Ukraine, the results of which are presented in Fig. 1-7. The data serve as the starting point for calculating transformational changes in the development of regions, due to the identified losses and damage.

The data make it possible to state that different organizations, due to the use of different methodological approaches to calculations, provide different values of estimates of transformational changes in the form of calculations of damage caused, direct costs and losses.

The largest total losses by all presented indicators are observed in Donetsk (192993.6 million USD), Dnipropetrovsk (14798.9 million USD), Zaporizhia (56884.6 million USD), Kyiv (64500.1 million USD) Luhansk (94628.9 million USD), Mykolaiv (30637.9 million USD), Sumy (24727.1 million USD), Kharkiv (157165.8 million USD) and Kherson (38666.6 million USD) regions. In such regions, the impact of transformational changes on development will be most significant (Fig. 1).

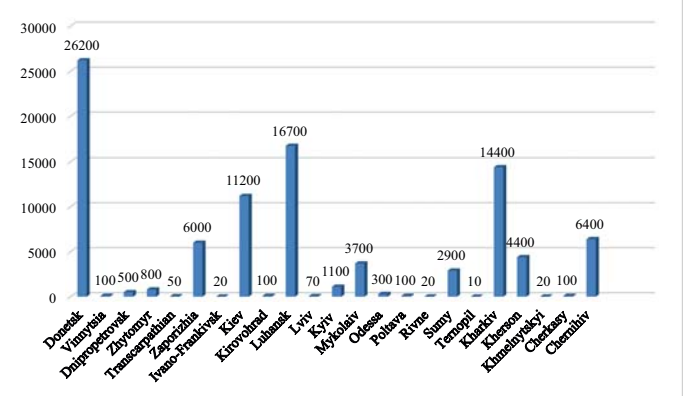
Fig 1.Transformational changes in the form of generalized losses by region, million USD



Source:Worldbank (2023), Kyiv School of Economics (2023), Slovoidilo (2023)

The greatest damage in selected sectors occurred in the Luhansk (16700 million USD), Donetsk (26200 million USD), Kharkiv (14400 million USD), Kyiv (11200 million USD), Chernihiv (6400 million USD) regions (Fig. 2).

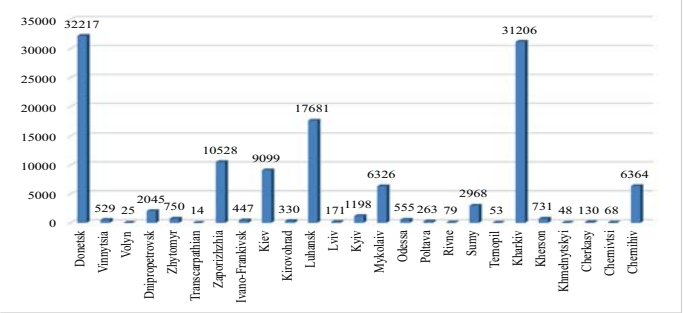
Fig 2.Transformational changes in the form of damage in selected sectors, million USD



Source:Worldbank (2023), Kyiv School of Economics (2023), Slovoidilo (2023)

In terms of direct losses, the Kharkiv (31206 million USD), Zaporizhia (10528 million USD), Luhansk (17681 million USD), and Donetsk (32217 million USD), Kyiv (9099 million USD) regions were the most affected (Fig. 3).

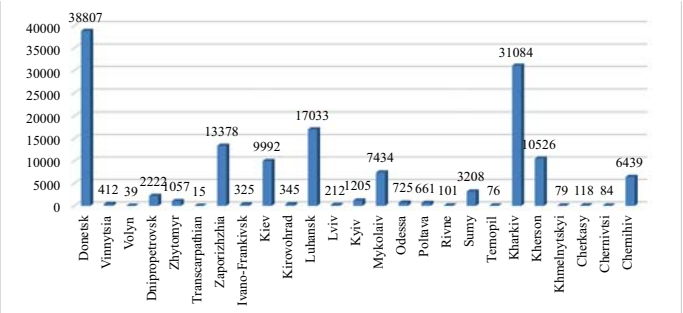
Fig 3.Transformational changes in the form of direct loss estimate, million USD



Source:Worldbank (2023), Kyiv School of Economics (2023), Slovoidilo (2023)

In terms of direct losses, the Kherson (10526 million USD), Zaporizhia (13378 million USD), Donetsk (38807 million USD), Luhansk (17033 million USD), Kharkiv (31084 million USD) regions suffered the greatest losses (Fig. 4).

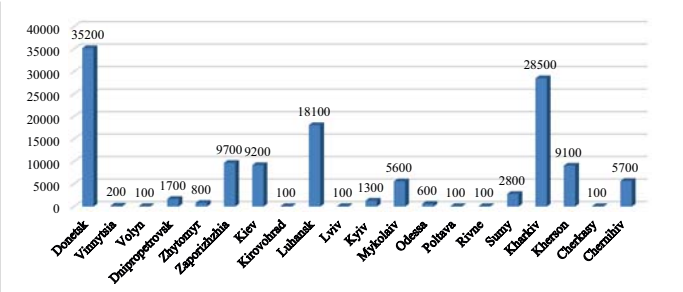
Fig 4.Transformational changes in the form of direct damage assessment, million USD



Source:Worldbank (2023), Kyiv School of Economics (2023), Slovoidilo (2023)

The greatest damage was recorded in the Donetsk (35200 million USD), Kharkiv (28500 million USD), Luhansk (18100 million USD), Zaporizhzhia (9700 million USD), Kyiv (9200 million USD) regions (Fig. 5).

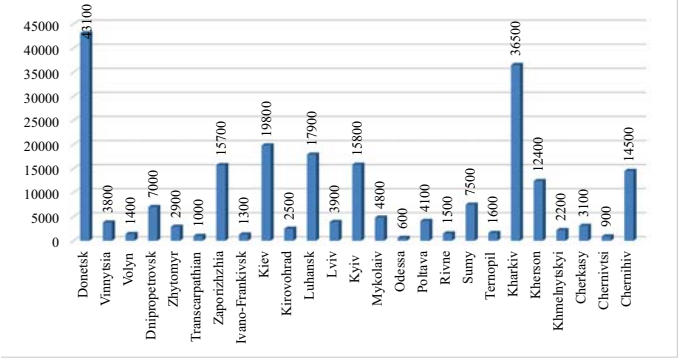
Fig 5.Transformational changes in the form ofdamage, million USD



Source:Worldbank (2023), Kyiv School of Economics (2023), Slovoidilo (2023)

As for losses, according to experts' estimates, the Donetsk (43100 million USD), Kharkiv (36500 million USD), Kyiv (19800 million USD), Luhansk (17900 million USD), Chernihiv (14500 million USD) regions and Kiev city (5800 million USD) suffered the greatest losses (Fig. 6).

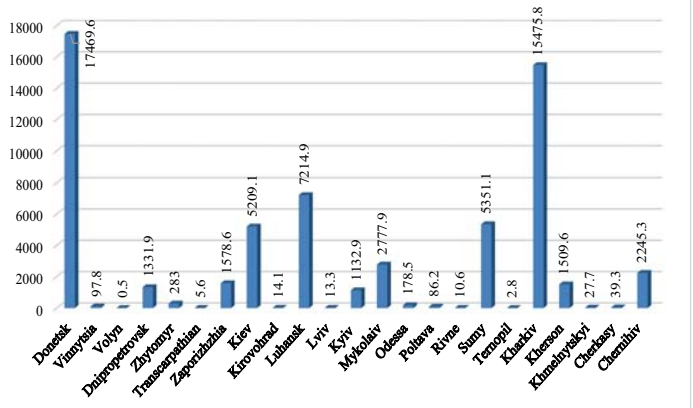
Fig 6.Transformational changes in the form of losses, million USD



Source: Worldbank (2023), Kyiv School of Economics (2023), Slovoidilo (2023)

Analyzing losses in the residential sector, it should be noted that the largest losses in this sector were observed in the Donetsk (17469.6 million USD), Kharkiv (15475.8 million USD), Luhansk (7214.9 million USD), Sumy (5351.1 million USD), and Kyiv (5209.1 million USD) regions (Fig. 7).

Fig 7.Transformational changes in the form of damage to the housing sector, educational institutions and medical infrastructure, million USD



Source: Worldbank (2023), Kyiv School of Economics (2023), Slovoidilo (2023)

Different regions have different transformational changes, for further research, the regions in which these transformations are the largest were taken, namely: Donetsk, Zaporizhia, Luhansk, Mykolaiv, Odessa, Kharkiv, Kherson, Dnipropetrovsk, Kyiv, Sumy, Chernihiv regions and the city of Kyiv. However, it should be emphasized that transformations due to losses and damage caused by military actions continue, taking into account the fact that military actions have not yet ceased.

It should be noted that according to the calculations of different institutions, which are presented in Table 1, the values of losses, damages and losses vary, which is due not only to the difference in the calculation methodologies, but also to the different time intervals covered in the assessment process. Also, in some cases, there is the presence of losses in the absence of direct damage, for example, in the Chernivtsi region.

In further analysis and forecasting of transformational changes as a result of armed aggression on the territory of Ukraine, it is proposed to use both differentiated indicators of losses/damage by individual types and their aggregated values.

In accordance with the proposed formula (2), Table 1 presents partial correction coefficients of transformation for the given transformational changes due to losses and harm to the regions of Ukraine, which are given in Fig. 1-7.

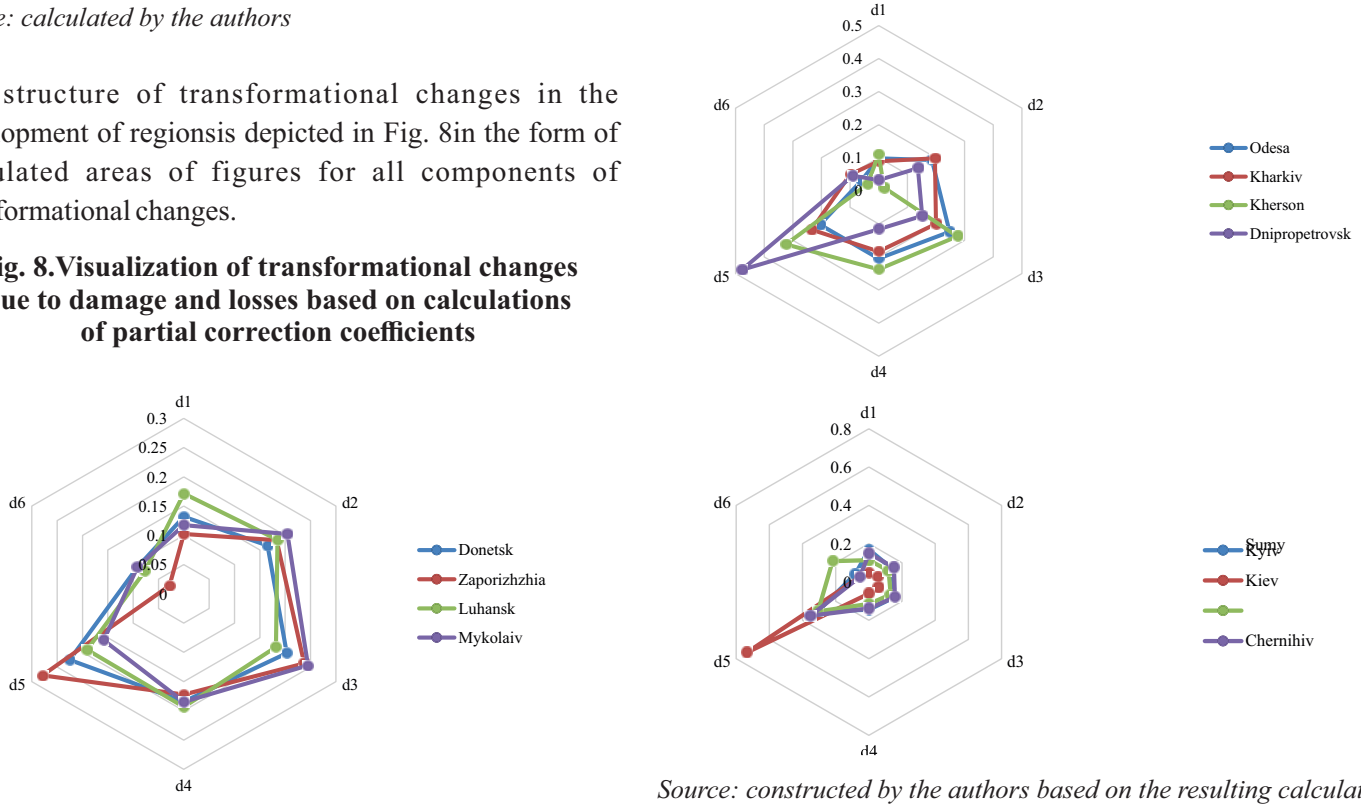
Table 1– Results of calculations of relative partial correction coefficients of transformation for regions of Ukraine due to damage and losses

Regions	Shares (relative values of the structure of components) in total losses						Sum
	caused in individual sectors with a breakdown by region as of June 1, 2022	Direct Loss Assessment, February 2023	Assessment of direct losses	Damage February 2022-February 2023	Losses February 2022-February 2023	Damage to the housing sector, educational institutions and medical infrastructure February 2023	
	d1	*d2*	*d3*	*d4*	*d5*	*d6*	
Donetsk	0.1317	0.1652	0.2031	0.1842	0.2255	0.0914	1
Zaporizhzhia	0.1023	0.1832	0.2376	0.1722	0.2788	0.0281	1
Luhansk	0.1712	0.1849	0.1818	0.1932	0.1911	0.0770	1
Mykolaiv	0.1172	0.2044	0.2450	0.1846	0.1583	0.0916	1
Odesa	0.0984	0.1857	0.2476	0.2048	0.2048	0.0609	1
Kharkiv	0.0889	0.1966	0.1998	0.1831	0.2345	0.0995	1
Kherson	0.1104	0.0187	0.2749	0.2377	0.3239	0.0394	1
Dnipropetrovsk	0.0328	0.1368	0.1516	0.1160	0.4777	0.0909	1
Kyiv city	0.0491	0.0545	0.0560	0.0604	0.7342	0.0526	1
Kiev	0.1684	0.1397	0.1564	0.1440	0.3101	0.0816	1
Sumy	0.1138	0.1188	0.1310	0.1143	0.3063	0.2186	1
Chernihiv	0.1491	0.1513	0.1561	0.1383	0.3517	0.0544	1

Source: calculated by the authors

The structure of transformational changes in the development of regionsis depicted in Fig. 8in the form of calculated areas of figures for all components of transformational changes.

Fig. 8.Visualization of transformational changes due to damage and losses based on calculations of partial correction coefficients



Source: constructed by the authors based on the resulting calculations

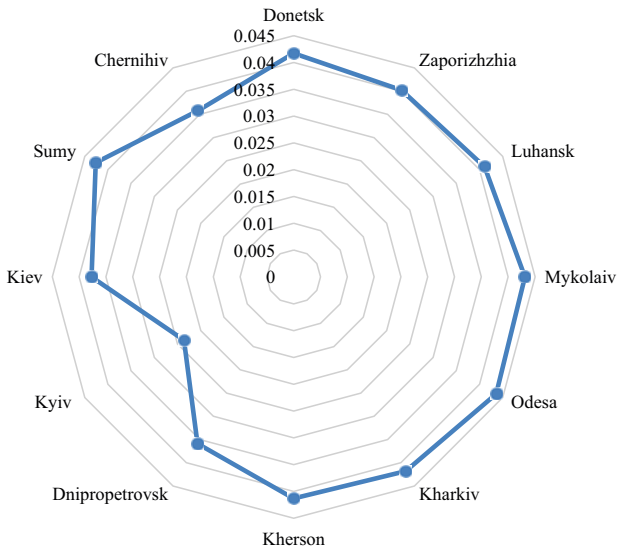
Table 2 shows the calculations of partial correction coefficients of transformation of the development of regions, which were calculated using formula (1). The complex transformation value for regions is numerically equal to the area of the figure presented in Fig. 9.

Table 2– Correcting partial and total transformation coefficients of development of regions by determining the areas of figures

Region	Relative values of complex losses according to their structure (by f.2)						Sum
	S 1	*S 2*	*S 3*	*S 4*	*S 5*	*S 6*	
1	***2***	***3***	***4***	***5***	***6***	*7*	***8***
Donetsk	0.0055	0.0083	0.0093	0.0103	0.0052	0.0031	0.0417
Zaporizhzhia	0.0048	0.0108	0.0101	0.0119	0.0019	0.0007	0.0402
Luhansk	0.0080	0.0083	0.0087	0.0091	0.0036	0.0034	0.0411
Mykolaiv	0.0060	0.0124	0.0112	0.0073	0.0035	0.0027	0.0431
Odesa	0.0047	0.0114	0.0125	0.0104	0.0031	0.0015	0.0436
Kharkiv	0.0044	0.0097	0.0091	0.0106	0.0058	0.0023	0.0418
Kherson	0.0005	0.0013	0.0162	0.0191	0.0031	0.0011	0.0413
Dnipropetrovsk	0.0012	0.0051	0.0043	0.0137	0.0107	0.0008	0.0359
Kyiv city	0.0007	0.0008	0.0008	0.0110	0.0096	0.0007	0.0236
Kiev	0.0059	0.0054	0.0056	0.0110	0.0063	0.0035	0.0377
Sumy	0.0034	0.0039	0.0037	0.0087	0.0166	0.0064	0.0426
Chernihiv	0.0057	0.0058	0.0054	0.0120	0.0047	0.0021	0.0358
Average value							***0.0390***

Source: calculated by the authors

Fig. 9. Total transformation coefficient of region's development



Source: constructed by the author based on the results of calculations

The statistical validity of the proposed approach to assessing transformational changes is confirmed by the values of the squared coefficient of variation calculated for total transformational changes (in absolute terms), which is $K_{v(1)} = 159{,}28$ (according to Table 1). At the same time, for the structure of transformational changes, which was determined in accordance with the proposed methodology (given in Table 3), the squared coefficient of variation is only $K_{v(1)} = 14{,}39\%$.

Conclusions

The study substantiates that transformation is considered as a sequence of interrelated changes in time, encompassing the formation, development, transformation and transition of an economic system of any level to a new state. It is an immanent characteristic of regions, which, being under the influence of certain changes, constantly undergo structural transformations in time and space.

The scientific novelty of the study lies in the substantiation of a methodological approach to assessing transformational changes in the development of regions, which involves determining the transformational impact on the development of regions through the complex transformation value according to its structure using a value that is numerically equal to the area of the figure and partial correction coefficients of the transformation of regional development.

Thus, the proposed methodology for assessing transformational changes in the development of regions contributes to the elimination of disparities both in the orders of magnitude of losses and in their absolute ratios. In addition, the proposed approach to assessing transformational changes provides the ability to determine both partial indicators of transformation in accordance with its structure for a separate regional economic system, and a general indicator of transformational changes by determining the complex value of transformation for both a separate region and for all regions selected for research.

The practical significance is that, in addition to determining transformational changes by their structure and total transformational changes, the methodological approach can be used as a basis for developing directions for strategies for the restoration and development of regions, both at the local and state levels. The results of the calculations can also be used to forecast the development of regions taking into account transformational changes.

Further research is required on issues related to the development of strategic measures and financing mechanisms for the development of regions to eliminate the negative manifestations of transformational changes caused by negative external factors.

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