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Modelling Regional Sustainable Development in Ukrainian Crisis and War

Modelowanie zrównoważonego rozwoju regionalnego podczas kryzysu i wojnie w Ukrainie

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Abstract

The article investigates the impact of force majeure crisis factors that appeared in the Ukrainian economy as a result of the global recession, the events of 2014-2021 (annexation of Crimea, temporary occupation of part of the industrial territories of Donetsk and Luhansk regions, military operations in Donbas, during the fight against pandemic (COVID-19), war in 2022 on the stable development of regions. Based on the analysis of official indicators of the State Statistics Service of Ukraine, it was proved that the said factors create additional multiplier and acceleration effects that adversely affect the dynamics of the gross regional product in the crisis conditions. It has been determined that the result of these effects is the transformation of crisis signals from a proactive to an active phase. The construction of a heat map of GRP correlation indicators made it possible to determine the existence of a disbalance between the economic and social development of the regions. Building a model of linear regression, allowed us to draw conclusions about the existing disbalance of GRP regions during the crisis and war.

Key words: crisis factors, gross regional product, sustainable, war, economic development, multiplier effect, acceleration effect, transformation of crisis signals, heat correlation map

Słowa kluczowe: czynniki kryzysowe, produkt regionalny brutto, zrównoważony, wojna, rozwój gospodarczy, efekt mnożnikowy, efekt akceleracji, transformacja sygnałów kryzysowych, mapa korelacji ciepła

1. Introduction

A new paradigmatic formation of economic thought is taking place, marked by transformations in thinking, evolutionary and revolutionary changes. Significant changes are also taking place in the approaches determining the correctness and adequacy of new terms and categories. Specialists stress the positive direction of these changes, as they are based on a broader view and do not invalidate existing experience, but allow us to compare theoretical achievements with the empirical results obtained and outline the pragmatism of future developments. A special place in this process belongs to the study of the genesis of the crisis with all its manifestations and consequences for each subject of economic relations. It is worth noting that so far, we cannot fully predict the scale of the destructive impact of force majeure crisis on the world space as a whole and individual economic entity in particular. Number of global problems and noticeable changes in their usual environment, which became factors of increased attention to the problem of countries and regions functioning in crises, the nature of which is force majeure. The crisis has acquired a significant dimension and requires a careful approach to its analysis and forecasting. The growing losses from the impact of crisis factors of unpredictable nature pose a real threat to the economies of states and regions. Emergencies level the performance of even the most developed states in a very short period of time. The crises of recent years have sharpened the focus of the international community on the need for greater cooperation in finding and applying proactive crisis management not only at the enterprise level, but also at the regional and national levels, as the global manifestation of crisis phenomena prompts a search for common crisis management measures that would ideally form an emergent reality that would result in a new paradigmatic phase.

The presented article is dedicated to the study of the impact of crisis-forming factors on the sustainable development of Ukraine as a whole, and its regions, in particular. The basis of such development is the economic component, which ensures the maximum social effect and takes into account the ecological (Koziuk et al., 2020) orientation.

2. Research materials and methods

The problem of economic development of regions can be considered from the standpoint of both theoretical and empirical research. Theoretical research is based on the development of economic models that establish functional relationships between economic development and crisis-generating factors. Empirical research is based on the generalization of observations on changes in the impact of crisis-forming factors of force majeure on the economic development of the country (regions). At the same time, the obligatory basis of all empirical research is a set of theoretical preconditions that are reflected in modern concepts of economic development.

The concept of stability is important for the analysis of how quickly the system reacts to the manifestation of crisis phenomena of various nature, its possibilities for their overcoming/leveling and recovery. Because of this, this concept is increasingly used in economic geography, where more and more research results on regional sustainability appear.

The concept of sustainable development, as a long continuous process, entered the circulation of economic research in the last three decades – after the report of the UN Commission in 1987 (World Commission on Environment and Development. (1987), which is connected with the problems of limited resources. The basis of the theory is the provision of balanced growth rates of the national economy as a socio-economic system based on the harmonization of production forces (Voloshin, & Gordienko, 2000). This harmonization takes place by ensuring the economic stability of structural elements of the national economy – regions. At the same time, sustainable development is based on three main components – economic, social and ecological (Munasinghe, 1993), which, ideally, determine the further strategy of the state's development with the simultaneous implementation of tactical solutions at the regional level.

The basis of the economic component is the concept of income by J. Hicks (1975), which provides for increasing the efficiency of production through the use of advanced technologies, product life cycle management (Kozlovskyi & Fonitska, 2013), innovation, risk management, etc., which provide an opportunity for balanced economic growth in conditions of effective use of limited resources.

The social component is based on the fair distribution of resources and takes into account the development of human capital. At the same time, decision-making processes regarding sustainable development are carried out with direct human participation, through investments in human capital.

The ecological component ensures the stability of biological and physical systems and takes into account the consequences of the relationships between these systems. This is due to the need to reduce the negative impact of production on the environment by implementing an environmental management system.

The strategic vision of sustainable development of Ukraine (National Economic Development Strategy of Ukraine for the period until 2030) is based on ensuring national interests and fulfilling international obligations and involves solving a number of tasks, among which, within the framework of the study, it is worth highlighting such as:

- overcoming imbalances in the economic, social and environmental spheres;
- building a peaceful and safe, socially cohesive society with proper governance and inclusive institutions;
- ensuring partnership interaction of state authorities, local self-government bodies, business, science, education and civil society organizations;
- maintenance of the environment in proper condition, which will ensure quality life and well-being of present and future generations;
- decentralization and implementation of regional policy (Kreidych et al., 2018), which provides for a harmonious combination of national and regional interests.

At the same time, it is noted that each region of Ukraine is able to independently identify, realize and multiply its own potential to ensure a decent life for people living on its territory with the application of socio-humanitarian and ecological development (Kozlovskyi, 2010) priorities.

It may be unnecessary due to: introduction of high social standards of living; health care, implementation of healthy lifestyle standards; ensuring the rights of people with special needs and limited physical capabilities; guaranteeing the human right to a safe environment; compliance with the principles of gender equality; development of educational and scientific space; harmonization of inter-ethnic and inter-confessional relations; free access of broad sections of society to cultural assets and protection of cultural heritage; support of modern forms of artistic and intellectual creativity; development of dialogue between the state and civil society; formation of ecological thinking; environmental responsibility, achieving a state of the natural environment that is safe for human health; raising the level of public awareness on issues of environmental protection; improving the environmental situation and increasing the level of environmental safety; improvement of the system of integrated environmental management by including an environmental component in development programs of economic sectors; improvement of regional environmental policy, reduction of the negative impact of urbanization processes on the natural environment; ensuring ecologically balanced use of natural resources.

It can be seen that the presented tasks take into account all components of sustainable development, but the greatest attention is paid to the social and environmental sphere.

Along with this, taking into account the limited resources, including human and time, the economic component comes first as the foundation of sustainable development, which forms the appropriate financial support for the implementation of strategic goals and the anti-crisis potential for restoring the system from crisis shocks.

This work is devoted to the study of crisis-forming factors of force majeure on the economic component of sustainable development of the regions of Ukraine, which ensures maximum social and environmental effects. Special attention in the work is directed to the study of regional imbalances, regarding the implementation of the goals of sustainable development through ensuring effective planning of regional development; increasing the institutional capacity of local executive bodies, local self-government bodies and regional development agencies; ensuring effective financing of regional development.

The notion of resilience is important for analyzing how quickly a system responds to crises of different nature, its capacity to overcome and recover from them. Because of this, the concept is increasingly being used in economic geography, where more and more research on regional sustainability is emerging.

In the presented study, we pay the greatest attention to the economic sphere – as the foundation for the formation of anti-crisis capacity to restore the system from crisis shocks.

There are almost no scientific papers that would contain a comprehensive study of the economic essence of the processes of modeling regional development, taking into account the impact of crisis-causing factors of unpredictable nature.

The study of existing approaches to the interpretation of the essence of the crisis provides an opportunity to determine its main features and the impact of force majeure on the life of the country as a whole and its regions in particular.

R. Barton (1993) presents the crisis as an unpredictable event, usually having negative consequences and leading to a decline in production, employment, financial results.

Group of authors (G. Gandolfo (1991), D. Schottke, A. Pollak (2001), B. Wright (2014) D. MacDonald, (2016)) define the crisis as an extreme aggravation of contradictions in the socio-economic system, which threatens its viability in the environment. The crisis phenomenon from the point of view of A. Berumen (2013) is a constant deterioration of certain quantitative indicators of the state and its structural components.

The approach of I. Petruk (2020) to determining the impact of crisis phenomena on development is noteworthy. This approach is based on the initial definition of a crisis. This is any qualitative change in the process, the transition from the existing state to one that differs significantly in basic parameters. In this definition, a crisis is a transition from stability to deterioration, or a crisis situation in the development of the system.

The issue of the impact of the crisis on economic development through a study of the significance of the two cheeks - the collapse in trade and the sharp decline in financial flows – is addressed by O. Blanchard, M. Das, and H. Faruqee (2010), B. Gurtner (2010).

O. Pretorius et al. (2021) examined the ability of a regional economy to recover from the initial impact and lingering effects of crisis events, depending on the vulnerability of that economy to their impact.

The definitions made by experts in the field of crisis management reveal the essence of the crisis as a negative phenomenon in socio-economic development, which suddenly arises and leads to irreversible consequences.
Coombsa, T. & Lauferb, T. (2015) sees crisis management as a defined *set of factors designed to deal with crises and reduce the actual damage caused by the crisis*.
The work of I. Emilova (2022) brings up the requirements for crisis management as a system, as a set of mechanisms and processes, specific technologies and management styles.
The possibilities of enhancing the process of public crisis management in the context of domestic market destabilization, structural and social changes are considered in Taneja, Pryor, Sewell and Recuero (2014). The role of monetary policy, which ensures the stability of the currency and the balance of external payments to emerge from crisis situations, is defined in Trofymenko et al. (2021).
Khan et al., (2019) analyzed methods that can be applied in crisis management practices. The identification of threats and tracking their impact in the economic security system is reflected in the studies of Duceppe et al. (2017), Leva et al. (2017), O. Ilyash et al. (2021) and Munns et al. (2017). Identification and substantiation of the relationship and interdependence of factors of regional development on the quality of life of the population is based on the work of S. Hrynkevych (2020) and her colleagues.
The crisis, as a turning point in the life cycle of the country and its regions, involves the transition to qualitatively new characteristics, including positive ones. In addition, in modern conditions of development of innovative technologies and the existence of economic laws that form the principles of management (feedback law, the law of transparency of economic relations, the law of identity in most situations the crisis becomes predictable. However, the emergence of unpredictable crisis-forming factors of force majeure for Ukraine, including the annexation of Crimea, the temporary occupation of part of the industrial territories of Donetsk and Luhansk regions, hostilities in the Donbas, economic and social constraints in the fight against the COVID-19 pandemic (Frolova et al., 2021) to the essence of the crisis and its consequences for economic development.
In addition, special attention in the gradation of the crisis is paid to such concepts as the depth and scale of the crisis. These include: catastrophe, severe crisis, mild crisis. The depth of the crisis can be assessed through the diagnosis of regions on the following indicators: gross regional product, industrial production index, capital investment by region, foreign trade, basic and reverse subsidies. to conduct a SWOT-analysis of the potential for production development by individual regions and industries.
The economic nature of the crisis, providing an opportunity to identify the situation and apply appropriate anti-crisis management measures needed to mitigate the crisis and its consequences. Predicting the consequences of the crisis, determining the end result of the impact of crisis contingencies on the stability of economic development of the country (regions) is one of the main tasks facing anti-crisis management.
Although recent studies have extensively investigated the impact of crisis drivers on sustainable development, both national and regional, the processes of transforming the proactive stage of the crisis into an active one at the regional level have been seriously obscured. Also, little has been done to explain the impact of force majeure crisis factors on the main indicators of regional development.
Thus, the objectives of this paper are:

- to discuss theories of crisis and sustainable regional development.
- to identify and discuss the main crisis factors of a force majeure nature that hinder the sustainable development of the regions of Ukraine – revolution, pandemic, war.
- study the changes of basic regional development indicators as a result of force-majeure crises factors.
- to identify and discuss the main regional development strategies, taking into account the distribution of donors and recipients.

This paper consists of five sections – introduction, theories of economic development and crisis, results and discussion, as well as conclusions and implications for regional sustainable development, taking into account the transformational nature of the crisis.

3. Results and discussion

The regional indicators have been considered to provide an evidence base for the impact of the crisis on the economy. To identify and investigate the prioritization of the impact of the crisis-forming factors. The regions of Ukraine differ significantly from each other by the nature of the available resource potential, the degree of comparative importance for the state economy, the severity of socio-economic problems. As a result of the structural-dynamic analysis, we can say that the state of the economy of the regions reflects the national macroeconomic trends, revealing their contradictions. The disbalance of economic and social development of the regions, the imbalance of inter-budgetary relations remains an urgent problem. It should be noted that today, taking into account the action of crisis factors of force-major nature in Ukraine, the regional differentiation has reached a scale at which it generally becomes a factor of violation of economic security (Ukrainian Institute for the Future, 2022).

All this is directly reflected in the sustainable development of Ukraine and provides an opportunity to take regional imbalance into account during the development and implementation of anti-crisis measures based on the analysis of the main indicators reflecting the level of economic development of the regions.

3.1. The main crisis and war factors of a force majeure nature that hinder the sustainable development of the regions of Ukraine

The last twenty years in Ukraine are characterized by the presence of successive crisis phenomena of a force majeure nature, which was reflected in the sustainable development of the country. We include the Revolution of Dignity of 2014, the annexation of Crimea, the temporary occupation of part of the industrial territories of the Donetsk and Luhansk regions, hostilities in Donbas, economic and social restrictions in the fight against the COVID-19 pandemic, and the war with the Russian occupiers in 2022.

Until 2013, Ukrainian society was experiencing an identity crisis caused by certain conflicts, which were related to the problems of forming a national identity based on regional sub-identities with different dominant values. The Revolution of Dignity of 2014 became the force that united representatives of ethnic communities into a single whole, resulting in the ability to motivate to achieve socially significant goals and promote cultural, intellectual and economic upliftment, which corresponds to the goals of sustainable development.

At the same time, since 2014, Russia's external aggression, which resulted in the annexation of Crimea, the temporary occupation of part of the industrial territories of the Donetsk and Luhansk regions, as well as the hostilities in the Donbass, exposed a number of serious socio-economic and environmental problems of the country's sustainable development and at the same time gave rise to new moral, political and international aspects of this problem not only for Ukraine, but also for the modern system of international relations, which concern not only the European region, but also the world in general.

The most serious social problems of Ukraine have become: a rapid decline in the standard of living of the population, which in turn led to an increase in poverty, deepening inequality, an increase in internally displaced persons and the intensification of external migration from dangerous regions (due to direct losses and destruction in the industrial and social infrastructure) in order to preserve peace and appropriate level of well-being of their families. Economic depletion of Ukraine occurred due to resource losses of production infrastructure; depletion of the financial sphere, failure of reforms in the economic, social and other spheres of state activity. At the same time, the loss of Black Sea gas fields led to a deterioration in the energy sector.

As a result of the deterioration of the environment (increased emissions of harmful substances into the atmospheric air, discharges of untreated wastewater into natural water bodies, placement of waste from the coal, chemical industry, mining and metallurgical complex, which is the specialty of the Luhansk and Donetsk regions) due to the impact of projectiles and emergency violations the work of numerous enterprises led to significant environmental pollution and the destruction of life support infrastructure.

The COVID-19 pandemic, which swept the world in 2020, fundamentally changed the lives of people all over the world, primarily due to the feeling of financial difficulties, loss of work and income, changes in lifestyle, leisure and communication. The experts of the OECD (2022) are already emphasizing the negative consequences for the entire world community, which are expressed primarily in the slowdown of global economic growth (Kozlovskyi et al., 2020) against the background of the ongoing fight against the COVID–19 pandemic.

In February 2022, a war with the Russian occupiers began in Ukraine, as a result of which the country suffered significant losses, which jeopardizes the possibility of sustainable development not only for Ukraine, but also for the entire world order. Humanitarian and ecological catastrophes, the destruction of transport infrastructure, the increase in the cost of living due to the destructive effect of inflation due to the sharp increase in the cost of energy resources also threaten the food security of the world's poorest countries.

According to the data of the Kyiv School of Economics (Project on the collection, evaluation and analysis of information on the material losses of Ukraine from the war with Russia, 2022), as of the beginning of July 2022, the losses of the Ukrainian economy from damage to the physical infrastructure since the beginning of hostilities amounted to about $600 billion, in including, in case of complete destruction of objects - $103.9 billion. At the same time, the consequences of the attack on Ukraine for the world GDP in 2022 will be at least -1% of growth, or $1 trillion.

Table 1. Adjustment of forecasts of the dynamics of the world economy in 2022 after the start of hostilities in Ukraine, source: own author`s draft based on data from the Fitch Ratings, Moody`s, OECD, S&P (2022)

Organization	New forecast	Previous forecast
Fitch	3,5%	4,2%
Moody`s	3,6%	4,3%
OECD	2,4%	3,2%
S&P	3,4%	4,1%
Oxford Economics	3,8%	4,0%

In the energy sector, since the beginning of the war, 5% of generating capacities have been destroyed, 35% are located in the occupied territories; 50% of thermal capacities, 30% of solar, and more than 90% of wind generation have been disabled (NBU, Department of Monetary Policy and Economic Analysis, 2022). According to the UN (Situation Ukraine Refugee Situation 2022), as of May 21, the number of refugees from Ukraine exceeded 8 million, of which the largest number remained in Poland (almost 1.2 million) and Germany (0.8 million).
This means that now, in the conditions of the war and after it, first of all, regions and business should focus on an effective way to restore the economy based on a global approach based on the criteria of business sustainability – ESG (ecological, social and state management), which involves the formation of an ecosystem of partnership and interactions. This will enable the use of common resources and optimize costs, while increasing collective capabilities and potential.
The force majeure nature of crisis factors multiplies the negative consequences of crises of any economic nature, nullifies the obtained positive results, and exacerbates unresolved problems, both at the state and regional levels. War as a crisis of force majeure completely transforms the goals of the development of the system and brings it to the level of maximum conservation of resources, including human resources.

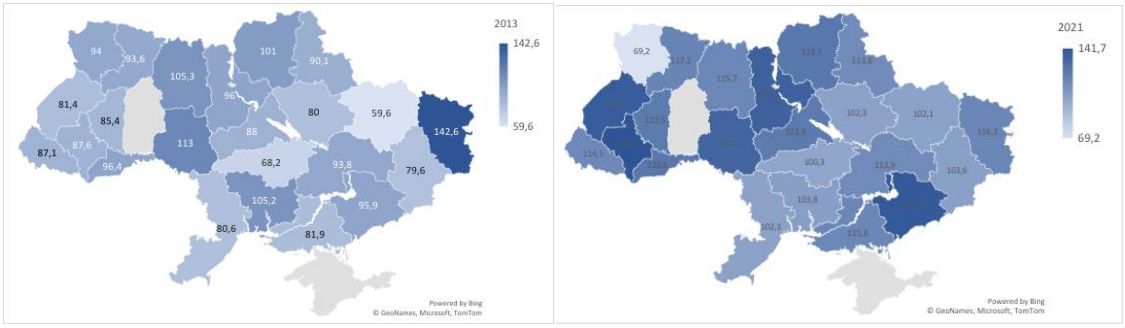
3.2. The Industrial Production Index
One of the main characteristics reflecting the level of economic development of Ukraine's regions and the country as a whole is the industrial production index (Fig. 1).

Figure 1. Volume indices of gross regional product for 2013-2020, at comparative prices,
source: own author`s draft based on data from the State Statistics Committee of Ukraine (2022)

The country experienced the greatest impact of force majeure crisis factors: in 2014-2015 (annexation of Crimea, loss of part of the industrial areas of Donetsk and Luhansk regions, harsh hostilities in Donbas), which resulted in some business closures or significant asset losses and in 2020 due to social restrictions that arose during the COVID-19 pandemic and led to bankruptcies/closures/full or partial income losses.
It can be stated that during the crisis of 2014-2015, Ukraine's industrial production index was 93.4% and 90.2%, respectively, and in 2020 the index was 96.2% (State Statistics Committee of Ukraine, 2021). Almost all regions of the country developed at roughly the same level, except Donetsk and Luhansk oblasts, which were most negatively affected by the military conflict.
Since 2016, the situation across the country has stabilized considerably and the industrial production index has almost levelled off across all regions. However, since the start of the pandemic, some regions have experienced a significant decrease in the index. In particular, Kirovograd and Mykolaiv Oblasts, which are characterized by low level of development of industrial infrastructure and transport and logistics networks, were the most negatively affected by the COVID-19 pandemic.

3.3. Capital investment by region
An equally important indicator of the impact of the crisis on development is capital investment (Kozlovskyi et al., 2013) by region, which is a key condition for economic development and growth given the technological compo-

sition of Ukrainian enterprises (Fig. 2 a, b). Moreover, increased investment is a foundation of anti-crisis potential of both the state and the regions.



a) capital investment indices by region, 2013 b) capital investment indices by region, 2021

Figure 2. Capital investment indices by region, 2013-2021, million UAH,
source: own author`s draft based on data from the State Statistics Committee of Ukraine (2022)

There are some dependencies and parallels 2014-2015 was a period of force majeure crisis factors, when the volume of capital investments decreased significantly. The period of influence of force majeure crisis factors, when the volume of capital investments decreased significantly. In the following years a certain intensification of investment activity, but investment activity has not been recovered pre-crisis volumes. The process of investment activity, due to the unstable political and economic situation. A chance to determine and prove the existence of a multiplicative effect of crisis factors, of their negative impact deepened the effect of others, which, before the crisis situation referred to the phase of *weak* signals of an active anti-crisis concept, but under the above conditions, they passed into the phase of *active signals*. These signals include:

1) growing regional disbalance; significant increase of transactional conditions of doing business;
2) unresolved issues of protection of investors' property rights;
3) growing migration processes resulting in outflow of inexpensive and qualified workforce; opportunity to obtain resources without investment due to lack of relevant duties and quota restrictions;
4) lack of systematic policies to encourage investment in the production sphere similar to those applied in other countries;
5) low investment interest.

3.4. External trade volume

Foreign trade acts as one of the most important means of increasing resources at the state level, which in case of crisis situations will be used to overcome them and rebuild the regions.

The external market is more dynamic and competitive than the internal market. Exports and imports are essential for the implementation of anti-crisis management of regional reconstruction. Exports provide opportunities for regional economic agents to develop their activities to a level beyond the domestic market demand (Mazhara & Kapustyan, 2022). Export orientation enhances the competitiveness of national products on the world market. Imports are a necessary feature of the functioning of any economic system, including regions. In the short term, importing certain products is more profitable than producing domestic counterparts. With the spread of globalization processes, increased imports, on the one hand, contribute to saturation of the market with a variety of goods. On the other hand, imports act as an impetus to increase the competitiveness and economic status of individual economic systems. By increasing imports, regional economic agents gain access to foreign technologies embedded in the means of production.

Therefore, it is possible to discern some trends that affect the speed of recovery of regions from crisis factors of force majeure nature. Namely, changes in the development of productive forces and production relations in the world economy; changes in the priorities of international trade towards high-tech and knowledge-intensive products; increased trade in services; and expansion of scientific-technical and investment-production cooperation.

The multiplicative effect of force majeure crisis factors and the analysis says the factors that deepened the crisis processes include: the lack of a coherent and balanced national paradigm and strategy for the development of international trade policy based on the preference for Ukraine's national interests and a programme for implementing priority tasks. Uncertainty in the areas of specialization of Ukrainian exports from the position of in addition, domestic exports have undergone significant transformation in recent years due to both European integration processes and political and military challenges. The European Union is currently the main foreign trade partner. But despite positive trends in foreign trade with the EU, the balance remains negative due to partial access to the European market, low competitiveness of national goods, structural weaknesses in products: low value-added and a backward technological component. They from crisis factors and leads to the loss of Ukraine's economic potential.

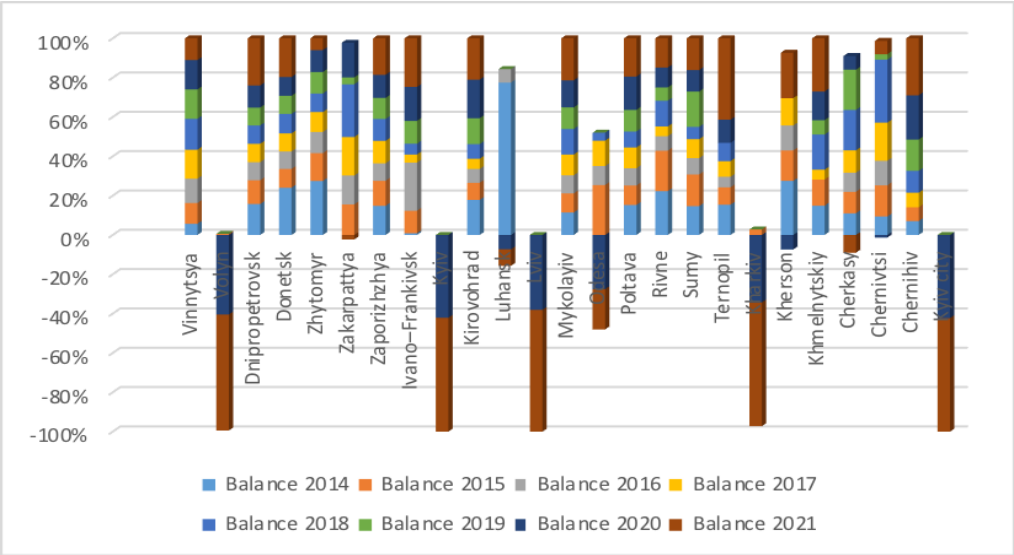


Figure 3. Balance of foreign trade in goods in 2014-2021,
source: own author`s draft based on data from the State Statistics Committee of Ukraine (2022)

3.5. Analysis of Ukraine's Regional Distribution into Donors and Recipients

The number of the latter has not changed positively (Fig. 4). The annexation of Crimea, the loss of part of the industrial areas of Donetsk and Luhansk oblasts, the hostilities in Donbas, all this has significantly affected the economic potential of our state.

Most of the regions remain subsidised, and are unable to provide an adequate level of income. Moreover, Ukraine's method of financial aid distribution is not adapted to the conditions of the crisis. The number of recipient regions will grow. Due to force majeure factors, the most profitable regions will lose their donor status, as average indicators will decrease, so the more unstable regions will pass into the category of recipients, purely statistically.

a) base subsidies, 2014-2021 b) reverse subsidies, 2014-2021

Figure 4. Base and reverse subsidies, 2014-2021,
source: own author`s draft based on data from the State Statistics Committee of Ukraine (2022)

As of 2021, only four regions (Kyiv, Dnipropetrovsk, Poltava and Zaporizhzhia) out of 24 are in the donor zone, while as of 2013 there were six (Kyiv, Poltava, Donetsk, Kharkiv, Zaporizhzhia and Crimea), (according to the Law of Ukraine On the State Budget of Ukraine for 2014 and 22).

The existing tendency to the multiplier effect of the impact of crisis factors on economic development, the potential of donor regions will be overestimated, due to which budget transfers may be incorrectly allocated, and therefore not all regions will receive the necessary financial assistance. A SWOT analysis of the production development potential of individual regions and industries is proposed for application (Table 2). The table shows only donor regions, which despite their high development potential remain technologically backward and have significant potential external threats.

The most pressing problem is the disbalance of economic and social development of the regions and the imbalance of interbudgetary relations. And given the force-majeure factors of the crisis in Ukraine, regional differentiation has reached a scale that makes it a factor of economic security disruption. This has a direct impact on Ukraine's anti-crisis potential.

Table 2. SWOT analysis of production development otential by selected regions and industries, *source: own author`s elaborations*

Region	Internal strengths (S)	Internal weaknesses (W)	Potential external opportunities (O)	Potential external threats (T)
Dnipropetrovsk	Favourable business environment, investor protection; high level of knowledge of graduates (qualified workforce)	Polluted environment; high concentration of metallurgical plants; depreciation of fixed assets	production Non-ferrous metal production; Machinery and energy, food, chemical industries	Dependence on natural resources, temporary fluctuations in Demand on markets; Increased risk of man-made hazards
Zaporizhzhya	Industrial infrastructure Engineering and technical personnel; Developed industrial sector sector	Significant level of depreciation of the main production assets	metallurgy; mechanical engineering, energy; food processing	Lack of financial resources, High level of competition
Kyiv	Developed infrastructure, proximity to Kiev	Low level of development of production infrastructure; Significant level of depreciation of main production assets	Engineering, power generation; wood processing, pulp and paper, light industry and food industry	High level of competition
Poltava	Availability of significant amount of productive agricultural land Strong agro-industrial complex; Significant reserves of minerals; Availability of land for an industrial park	Wear and tear of municipal engineering infrastructure, Weak implementation of high technologies, lack of innovation infrastructure, and low innovation activity; High energy and resource intensity of production Dependence of large enterprises on imported raw material suppliers and external conditions	Agriculture; food and chemical industry	Increased imports of agricultural products as a result of WTO accession
City of Kyiv	Developed infrastructure High level of High level of education. Concentration of capital of resources,	Severely deteriorated engineering and transport infrastructure; High operating costs	Development of the high-tech sector: engineering, information technology, precision engineering, electronics, pharmaceutical production, telecommunications. food industry	reduction investment in production

Given the effects of multiplier and acceleration effects on national income dynamics under crisis conditions, when there is a significant reduction in gross regional product for all regions, foreign trade and investment, intergovernmental fiscal relations are distorted and regional disparities increase, resulting in inappropriate allocation of financial resources (aid). For the most part, donor regions will receive insufficient financial assistance to get to the pre-crisis state. We consider it prudent to review the financial assistance provided to the recipient regions. In our view, in order to overcome the crisis manifestations, it should be more adequate to increase financial assistance to donor regions, as a foundation of the anti-crisis potential of the state.

That is why, in the (National Economic Development Strategy of Ukraine for the period until 2030) special attention is paid to the issues of effective financing of regional development and a number of indicators are highlighted that increase the regional imbalance: inconsistency of the targeted use of the State Fund for Regional Development and state investments; outdated inter-budgetary relations; lack of programs for the development of functional types of territories; lack of additional credit resources for local self-government bodies; inefficiency of industrial parks, which negatively affects the sustainable development of the country.

In order to determine the inter-regional correlation of economic development on the basis of this indicator we suggest to build correlation heat map with the indicator of regional development – gross regional product (Fig. 5).

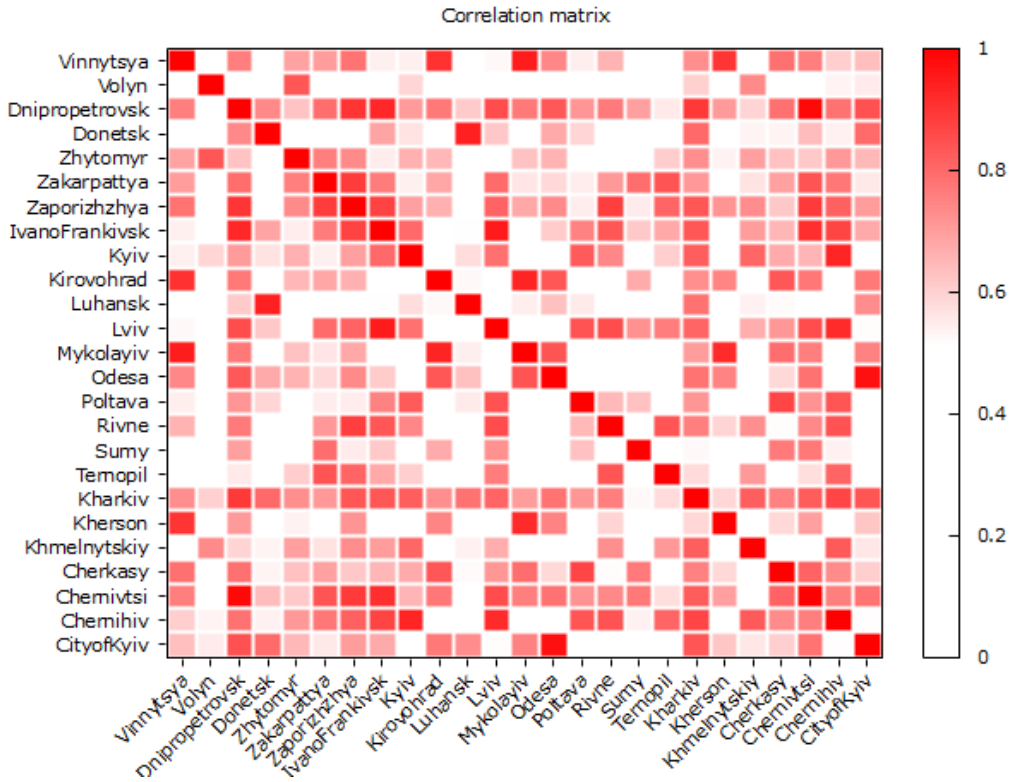


Figure 5. Correlation matrix for gross regional product. source: own author`s impression

A heat correlation index card indicates a *hotter* (more colored) stronger correlation that is close to 1. The existing correlation between the gross regional product indicator between the regions is weak (Vinnytsia and Ivano-Frankivsk regions), and sometimes absent (Volyn and Dnipropetrovsk regions), it is not systematic. There is a strong connection only between some oblasts, in particular (Mykolaiv and Kirovohrad, Lviv and Ivano-Frankivsk)

The linear multifactor regression of dependence of gross regional product of one region considers the dependence between the specified indicator of Kyiv region as a donor and other regions as recipients. For this purpose, the method of smallest squares was used (Table 3).

The least square method is a mathematical regression analysis used to determine the line of best fit for a set of data, providing a demonstration of the relationship between the data points. Each point of data represents the relationship between a known independent variable and an unknown dependent variable. In our case we use it to determine and describe the relationship between Kyiv oblast and 6 other regions, mentioned as Factors.

In order to do it we used Gretl software, which used all-known method mentioned above.

The main indicators for analysis are R-squared, t-ratio, p-value, and the model itself.

Let's observe them from the table and provide the analysis.

Table 3. Model 6: OLS, using observations 2013-2020 (T = 8) with dependent variable: Kyiv (Y), source: own author`s model based on data from Table 1

Factors	Coefficient	Std. Error	t-ratio	p-value
const	−35.5116	139.147	−0.2552	0.8409
Vinnytsia (x1)	−0.217073	1.19245	−0.1820	0.8854
Dnipropetrovsk (x2)	0.320651	3.01000	0.1065	0.9324
Donetsk (x3)	0.0582046	0.470614	0.1237	0.9217
Zhytomyr (x4)	0.875452	1.55431	0.5632	0.6734
Zakarpattya (x5)	−0.612108	2.05707	−0.2976	0.8159
Zaporizhzhya (x6)	0.940770	3.39982	0.2767	0.8281

Mean dependent var	100.6625		
Sum squared resid	67.98033	S.E. of regression	8.245019
R-squared	0.659142	Adjusted R-squared	-1.386007
F(6, 1)	0.322295	P-value(F)	0.871365
Log-likelihood	−19.91062	Akaike criterion	53.82123
Schwarz criterion	54.37732	Hannan-Quinn	50.07062
rho	−0.088375	Durbin-Watson	1.487929

Consequently, the resulting model will look like (Formula 1):
Y=-35,5-0,217x_1+0,321x_2+0,0582x_3+0,875x_4-0,612x_5+0,941x_6 (1)
The R-square value is the mean.
The p-value of all variables is not significant.
T-ratio of variables less when the table meaning (Table 4).

Table 4. Table meaning, source: authors own elaboration (statistic table)

right-hand probability	0.05
complementary probability	0.95
two-sided probability	0.1
Critical value	1.85955

The relationship of gross regional product by region is not significant, in spite of high R-square (which confirms the significance of the model). The regional income of Kyiv region does not depend on similar indicators of other regions. The studied factors have no multicollinearity and collinearity. The adequacy of the chosen model and the lack of interrelation of factors confirm the factors are not interrelated.
The impact of force majeure crisis factors has increased disbalance of economic and social development of regions, which confirms the phase of active crisis signals. The crisis impact has, in turn, highlighted the lack of a correct and adequate assistance strategy to the regions, which leads to a complete aberration in inter-budgetary relations and redistribution of budgetary resources.

Conclusion

The theories of crisis and sustainable development of regions have been studied. It was determined that the formation of the region's anti-crisis potential is based on its ability to quickly respond to changes in the external environment. As a result of the structural and dynamic analysis, it was proved that the regions of Ukraine differ significantly in the level of economic development and the severity of socio-economic problems, which directly affects the effectiveness of anti-crisis measures and the possibility of returning to the pre-crisis state.
The main crisis factors of a force majeure nature, which hinder the sustainable development of the regions, are considered. These include the annexation of Crimea, the loss of part of the industrial territories of the Donetsk and Luhansk regions, severe fighting in Donbas and the COVID-19 pandemic, the war with the Russian invaders in 2022.
The methodical toolkit of dispersion analysis of the selection of indicators was used to determine the consequences of the impact of force majeure crisis-forming factors on the development of regions due to their dynamics over the years. It was determined that:

- the country was most affected by such factors: in the period 2014-2015 (annexation of Crimea, loss of part of the industrial territories of Donetsk and Luhansk regions, severe fighting in Donbas) in 2020, as a result of social restrictions that arose during the fight against the COVID-19 pandemic (Kirovohrad and Mykolaiv regions were the most affected) and the war with the Russian occupiers in 2022 as a result of the destruction of social, economic and energy infrastructure throughout the country;
- under the influence of crisis factors, the regions of Ukraine are characterized by an increase in the imbalance of economic and social development and a violation of the balance of inter-budgetary relations;
- after the 2014-2015 period. there was a significant reduction in investment activity in the regions, which has not yet been restored due to the emergence of new crisis-forming factors of a force majeure nature (the COVID-19 pandemic) and the war with the Russian occupiers in 2022;
- the development of the region's anti-crisis potential depends on both exports and imports. As a result of the study, it was determined that the process of increasing the export component of foreign trade in goods with the highest added value does not depend on time and is always a priority direction for increasing the economic stability of the region, against the increase in import volumes, which is a priority only in the short term;
- for national producers, the European Union is the main foreign trade partner. However, the trade balance still remains negative due to partial access to the European market, low competitiveness of national goods, structural weakness of products, in particular, low added value and backward technological component;
- the existing correlation between crisis-forming factors increases the negative impact of *ordinary* crises, there is a transition of *weak* crisis signals to the *active* stage;
- due to the effects of multiplication and acceleration. the influence of crisis factors, which restrain the economic development of regions and significantly reduce their stability, increased.
- the construction of a hot map of the GRP correlation indicators confirmed the existence of an imbalance in the economic and social development of the regions, and the construction of a linear regression model made it possible to draw conclusions about the strengthening of the GRP imbalance of the regions during crisis events and the violation of inter-budget relations.

The analysis of the main development strategies of the regions, taking into account the allocation to donors and recipients, made it possible to determine that the drop in the gross regional product, the volume of foreign trade and investments violates the balance of inter-budgetary relations and the distribution of financial aid. Regions that are usually donors do not receive adequate financial assistance to accelerate the processes of exiting the crisis. Because of this, it is proposed to increase the financial assistance specifically to the donor regions, as the foundation of the anti-crisis potential of the state. The theories of crisis and sustainable development of regions were investigated. It has been established that the formation of the anti-crisis potential of a region is based on its ability to respond quickly to changes in the external environment. As a result of the structural-dynamic analysis it has been proved that Ukrainian regions significantly differ from each other by the level of economic development and the severity of socio-economic problems, which has a direct impact on the effectiveness of anti-crisis measures and the possibility of returning to pre-crisis state.

The main force majeure crisis factors preventing the sustainable development of the regions have been considered. These include annexation of Crimea, loss of a part of industrial areas in Donetsk and Luhansk oblasts, heavy fighting in Donbas, and the COVID-19 pandemic.

A methodological toolkit of dispersion analysis of indicator selection was used to determine the impact of force majeure crisis factors on regional development due to their dynamics year by year. It was determined that:

- the country experienced the greatest impact of such factors: during 2014-2015 (annexation of Crimea, loss of part of the industrial territories of Donetsk and Luhansk regions, harsh hostilities in Donbas) and in 2020 due to social constraints arising during the fight against the COVID-19 pandemic (Kirovograd and Nikolaev regions were the most affected);
- during the impact of the crisis factors, Ukrainian regions were characterized by a growing disbalance of economic and social development and an imbalance in inter-budgetary relations;
- after the period 2014-2015 there has been a significant reduction in investment activity in the regions, which has not yet been recovered due to the emergence of new crisis factors of force majeure nature (pandemic COVID-19);
- development of anti-crisis potential of the region depends on both exports and imports. As a result of the research, it was determined that the process of increasing the export component of the foreign trade in goods with the highest added value is independent of time and is always a priority in terms of increasing the economic resilience of the region against increasing the volume of imports, which is a priority only in the short term;
- for national producers, the European Union is the main foreign trade partner. However, the trade balance is still negative, due to partial access to the European market, the low competitiveness of national products, structural weaknesses in products, in particular – low added value and a backward technological component;
- the existing correlation between the crisis factors strengthens the negative impact of the *ordinary* crises, the *weak* signals of the crisis move towards the *active* ones;
- as a result of multiplication and acceleration effects. the impact of crisis factors has increased, constraining economic development of regions and significantly reducing their sustainability.
- the construction of a hot map of GRP correlation indicators has confirmed the existence of imbalances in economic and social development of regions, and the construction of a linear regression model, allowed to draw conclusions about the increasing disbalance of GRP regions during the crisis phenomena and the violation of inter-budgetary relations.

The analysis of the main strategies of regional development taking into account the distribution into donors and recipients allowed us to determine that the decline in gross regional product, foreign trade and investment disturbs the balance of inter-budgetary relations and the distribution of financial assistance. Regions, usually donors, do not receive adequate financial assistance to accelerate recovery processes. Therefore, it is proposed to increase financial assistance to donor regions as the foundation of the anti-crisis potential of the state.

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