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THE ROLE OF THE INSTITUTIONAL ENVIRONMENT IN REGULATING INNOVATIVE ACTIVITIES IN THE INDUSTRY

Purpose. To determine the factors of innovative development of industrial enterprises of Ukraine in conditions of economic destabilization, based on taking into account the asymmetric influence of the institutional environment, human capital and market development, for further identification of priority areas of state policy.

Methodology. To assess the impact of the institutional environment, human capital and market conditions on the results of innovation activity, a multifactor econometric model was applied, which allows for the identification of asymmetries in the impact of different components on innovation efficiency. Statistical analysis of the Global Innovation Index indicators was used to identify key environmental factors that stimulate or inhibit the innovative activity of industrial enterprises.

Findings. The key indicators of innovation activity in Ukraine were analyzed, and their compliance with the target challenges was established. The dynamics of the Global Innovation Index and its components were assessed. Key areas requiring improvement were identified, and the indicators of international ratings relatively to the formation of Ukrainian innovation ecosystem were assessed. The main results of the study indicate the presence of an imbalance in the influence of the institutional environment and human capital on innovation efficiency, which indicates the fragmentation of policy and insufficient integration of scientific developments into industry. At the same time, market mechanisms show a positive impact, emphasizing the importance of investment activity, access to financing and developed innovation infrastructure.

Originality. An economic and mathematical model is constructed of the multifactorial efficiency of state regulation of the innovative activity of industrial enterprises of Ukraine, which considers the asymmetric influence of key factors: the negative impact of the institutional environment and human capital, as well as the positive impact of market development. The proposed approach allows assessing the relationship between the conditions for innovative activity and their performance as well as identifying priority areas of state policy.

Practical value. The developed model can serve as a tool for monitoring the effectiveness of regulatory measures and determining priority areas of economic stimulation of innovations. The results obtained can be used to implement effective mechanisms of state regulation of innovation activity in conditions of limited resources, martial law and economic instability.

Keywords: *innovations, industrial enterprises, state regulation, investments, innovation market*

Introduction. Innovative activity is a fundamental driver of economic growth, fostering competitiveness and enabling technological advancements. For Ukraine, developing resilient and adaptable macro-level mechanisms to manage innovation is an economic priority and a necessity in the face of shifting global dynamics. These mechanisms must align with the evolving economic realities while stimulating industrial progress and technological transformation.

However, the ongoing war has drastically altered Ukraine's economic environment, presenting formidable challenges to innovative development. The war has severely restricted access to financing and investment, curtailed export potential, and dampened enterprise incentives to engage in technological advancements. Enterprises grapple with the destruction of production facilities, declining research and development capacities, resource depletion, and the pressing need to adapt to unstable and unpredictable working conditions.

At the same time, the war has unveiled unique opportunities for innovation, compelling enterprises to develop cutting-edge solutions to immediate challenges and opening avenues for entirely new markets. From advancements in defense technologies to the modernization of infrastructure and resource optimization, these pressures have spurred a rethinking of innovation as a tool for resilience and growth.

In light of these complexities, formulating strategic and dynamic innovation management policies at the macro level is crucial. These policies must address the structural disruptions caused by the conflict, bolster industrial resilience, and capitalize on emerging opportunities to secure sustainable development for enterprises and the national economy. By prioritizing innovation amidst adversity, Ukraine can position itself as a model for transformative economic recovery and technological leadership in the face of crisis.

Literature review. Recently, interest in innovative industrial development has grown significantly, especially in the field of management. The article by Bila I. and other authors emphasizes that innovations are a key factor for restoring and stabilizing the Ukrainian economy in the post-war period [1]. The authors Bokovets V., Moroz O. and Krayevska A. analyzed the prospects for innovative and investment activities in Ukraine, emphasizing the tole of foreign investment to stimulate the industrial sector [2].

The studies by Dzyuba O. M. and Shevchenko O. E. focused on legal aspects of implementing the Strategy for the Development of the Innovation Sector by 2030 and the need to harmonize national legislation with European standards [3]. Lepetyukha N. V. and Lypska A. S. noted that innovative industrial development is determined by an important indicator of the competitiveness of enterprises but also requires significant structural reforms [4].

In their works, Mamchur V. and Studinska G. reveal the paradoxes of Ukrainian innovative development, exploring the contradictory aspects of implementing innovative strategies in the country's socio-economic conditions [5]. Pidoricheva I. Yu. and Kovchukha L. I. point to a correlation of innovative costs and volumes of products sold [6].

Strilets V. and other researchers conduct a comparative analysis of domestic and European innovative development, stressing the low competitiveness [7]. Tebenko V. examines the problems of innovative development factors determining [8].

Khomenko O. A. emphasizes the importance of methodological aspects of governance as key factors for effectively managing innovation processes [9].

Foreign researchers, particularly Coutinho E. and Oliveira M., analyze the Global Index, emphasizing international cooperation's importance in strengthening innovation potential [10]. Hamid N. and Zhang S. investigated the impact of innovation factors on global rankings by panel analysis to identify key determinants of innovation management [11]. Oturakci M. focused on strategic approaches to innovation management, emphasizing statistical analysis's importance in forming effective innovation policy [12].

The generalization of literary sources shows that Ukrainian innovative development is a complex process that requires a systematic approach, especially in public governance. Improving the regulatory framework requires harmonizing national standards with European norms to create a favorable environment for innovation. In addition, it is important to intensify cooperation between scientific institutions, industrial enterprises and state authorities to optimize solutions in production processes. The problem of ensuring stable financing of innovation projects, which should combine state support, internal resources of enterprises and attraction of external investments, deserves special attention. The solution of these tasks will ensure an increase in the competitiveness of the industrial sector, acceleration of economic development and strengthening of Ukraine's position in the global innovation system.

The purpose of the article is to determine the factors of innovative development of industrial enterprises of Ukraine in conditions of economic destabilization, based on taking into account the asymmetric influence of the institutional environment, human capital and market development, for further identification of priority areas of state policy.

Materials and methods. The main methods for assessing the prospects for innovative activity of industrial enterprises are systematization, statistical analysis, and economic and mathematical modeling of regulatory factors at the international and national levels. The results obtained allowed us to establish the relationship between the elements of state regulation of innovative activity of industrial enterprises in conditions of economic instability in Ukraine.

Results. The difficult economic situation, the COVID-19 pandemic, and full-scale military operations create significant obstacles to innovations. These emphasize the importance of strategic document analysis that outlines key areas of activity to overcome crisis phenomena and activate innovative activity at the macro level.

As of 2024, Ukraine has two current strategies (The Strategy for the Development of the Innovation Sphere for the Period Until 2030 (MES) [13] and the National Economic Strategy 2030 (Ministry of Economy) [14]. A draft strategy for developing the innovative environment of Ukraine was also created [15].

The analysis of innovation indicators in 2015–2023 indicates negative trends, particularly due to the impact of military operations that began in 2022 (Table 1).

In 2015–2019, the share of innovative enterprises was relatively stable. Still, since 2020 it has decreased significantly (from 15.8 % in 2019 to 8.9 % in 2023), reflecting the deterioration of conditions for innovation activity due to the economic crisis, the COVID-19 pandemic, and subsequently military operations.

The maximum share of innovative products sold was observed in 2015 (1.4 %), but the indicator decreased yearly, reaching 0.3 % in 2023. This decline indicates a decrease in the activity of enterprises in the development and implementation of innovations.

In 2015–2023, spending on scientific and technical work in GDP remained at a low level, decreasing from 0.8 % in 2015 to 0.37 % in 2023.

The share of high- and medium-tech product exports fell from 19.2 % in 2015 to 11.8 % in 2023, possibly due to reduced production and export opportunities due to the military conflict. There is a steady decline in the share of workers in high- and medium-tech sectors – from 21.2 % in 2015 to 18.7 % in 2023 (Fig. 1).

None of the indicators studied for 2023 meet the target values planned by the Strategy, especially critical are

Table 1

Expected and current results according to the Strategy for the Development of the Sphere of Innovation Activity for the Period Until 2030 [16]

Years	Share of innovative enterprises in the total number of enterprises, %	Share of sold innovative products in the total volume of sold industrial products, %	Share of expenditures on scientific and scientific-technical work in gross domestic product, %	Share of exports of goods produced by enterprises of high- and medium-tech sectors of industry in the total volume of exports of goods, %	Share of employees employed at enterprises belonging to the high- and medium-tech sectors of industry in the total number of employees employed in industry, %
2015	17.3	1.4	0.8	19.2	21.2
2016	18.9	1.1	0.7	17.3	21.1
2017	**16.2**	**0.7**	**0.4**	**15.4**	**21.3**
2018	16.4	0.8	0.4	17	21.6
2019	15.8	1.3	0.5	16.4	21.5
2020	8.5	1.1	0.83	16.4	20.5
2021	9.6	0.9	0.62	14.6	20.1
2022	10.5	0.6	0.39	13.5	19.8
2023	8.9	0.3	0.37	11.8	18.7
Trend	↓(11.6)	↑(0.8)	↑(0.5)	↓(15.0)	↓(20.4)
2030	30	10	3	30	29

↓ – negative dynamics of the average annual value of the indicator (2018–2023) compared to the indicative base of 2017, established in the Strategy, ↑ – positive dynamics of the average annual value of the indicator (2018–2023) compared to the indicative base of 2017, established in the Strategy

the low shares of spending on scientific work and sold innovative products. Military actions have significantly complicated the development of innovations.

Despite the challenges associated with the destabilization of the economic system of Ukraine, the activation of the Strategy indicators remains possible, provided that the directions of development of innovation activity are stimulated after the end of the military conflict.

Analysis of the indicators allows us to investigate the current state in the field of innovation development and identify the main priorities for further improvement. However, for a deeper understanding of Ukraine's place in the global context, we need to analyze international ratings that reflect the effectiveness of innovation activity at the global level. One of such important indicators is Global Innovation Index (GII) published by the World Intellectual Property Organization (WIPO) [17].

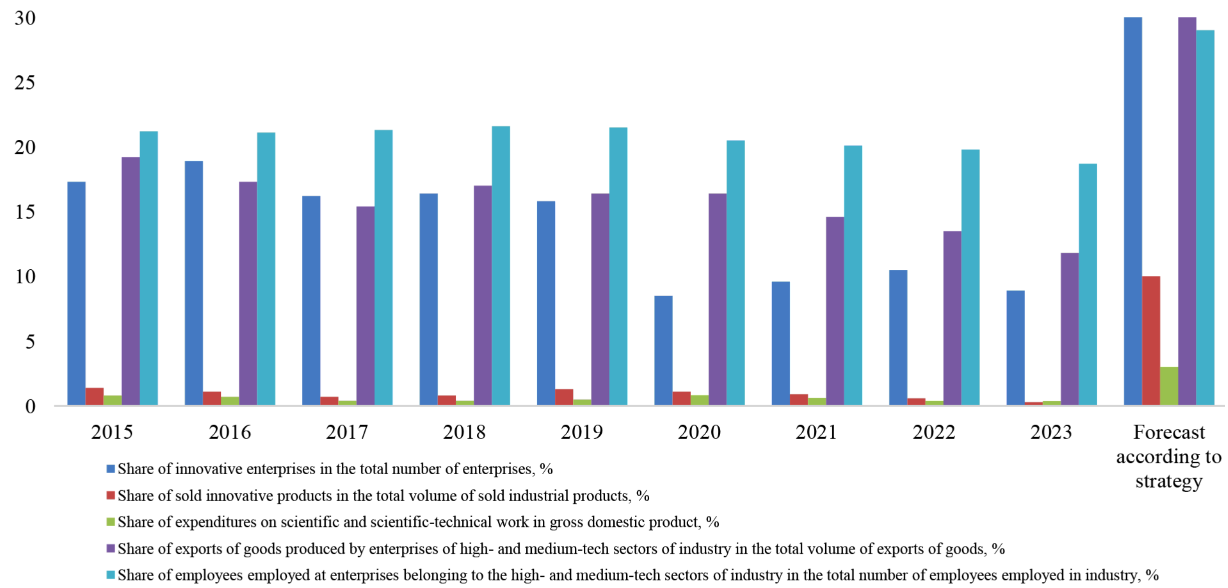

Fig. 1. Analysis of the trend of innovation activity indicators of industrial enterprises of Ukraine in the period 2015–2023, compared with the expected results according to the Strategy for the Development of the Innovation Sector for the Period Until 2030 [13, 16]

The Global Innovation Index is one of the most authoritative tools for assessing the innovation potential of countries due to its methodological depth, wide geographical coverage (over 130 countries) and international recognition. It is prepared by leading institutions – WIPO, Cornell University and INSEAD, which ensures objectivity and high quality of data. The index is based on more than 80 indicators that cover both resources (institutions, education, infrastructure) and the results of innovation activity (knowledge, technology, creative products), which allows for a comprehensive analysis of the innovation ecosystem of each country. Unlike other ratings, such as the European Innovation Scoreboard, Bloomberg Innovation Index or WEF's Global Competitiveness Report, the GII has a broader analytical framework and focuses exclusively on innovation. It takes into account not only technical and economic indicators, but also the political, educational and cultural environment. OECD reports, despite their scientific value, are mainly analytical reviews and do not provide a standardized assessment of countries. Due to this, the GII serves as a key global reference for strategic planning and research in the field of innovation.

The analysis of the dynamics of ranks and scores that form the GII and its components in Ukraine for the period 2015–2024 is presented in Tables 2 and 3. The GII reflects the overall level of innovation development of the country, covering key factors, in particular, the institutional environment, infrastructure, human capital, scientific research and business development. Since industrial enterprises are the leading subjects of innovation activity, GII data serve as a relevant contextual basis for assessing their innovation potential and external constraints. An analysis of the dynamics of GII indicators allows us to identify national trends that directly affect the conditions for the functioning of the industrial sector in the innovation sphere. Therefore, consideration of national innovation indicators is an important stage in forming a holistic picture of the current state and prospects of innovation activity of industrial enterprises in Ukraine. Fig. 2 shows the innovation efficiency indicator (ratio of output to input parameters).

The WIPO publication highlights the challenges and prospects for Ukraine, emphasizing the importance of a strategic approach to supporting the innovation ecosystem, education, and scientific research.

This potential is also evident in the context of startup ecosystems, as highlighted by the Global Startup Ecosystem Index 2024 from StartupBlink. Ukraine ranked 46th globally, up three positions from last year, and entered the top ten in Eastern Europe. An important feature is that six Ukrainian cities, including Kyiv, Lviv, and Kharkiv, are among the TOP-1000 startup ecosystems in the world, which indicates the country's growing attractiveness for innovative entrepreneurship [18].

Such dynamics demonstrate that Ukraine maintains strong positions in certain aspects of innovative development and forms a promising platform for startups and technological innovations

The analysis of the strengths and weaknesses of innovation activity in Ukraine in 2024 based on reports [17] makes it possible to identify key factors that affect the effectiveness of innovation activity and determine priorities of this area.

Ukraine exhibits notable strengths in its innovation landscape, driven by advancements in applied research,

Table 2

Dynamics of the ranks of the Global Innovation Index and its components for Ukraine for 2015–2024 [17]

Indicator	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
1. Global Innovation Index	64	56	50	43	47	45	49	57	55	60
1.1. Input parameters:	84	76	77	75	82	71	76	75	78	78
- institutions;	98	101	101	107	86	93	91	97	100	107
- human capital and research;	36	40	41	43	51	39	44	49	47	54
- infrastructure;	112	99	90	89	97	94	94	82	77	82
- market sophistication;	89	75	81	89	90	99	88	102	104	85
- business sophistication.	78	73	51	46	47	54	53	48	48	45
1.2. Output parameters:	84	40	66	35	36	37	37	48	42	54
- knowledge and technology outputs;	34	33	32	27	28	25	33	36	45	34
- creative outputs.	75	58	49	45	42	44	48	63	37	68

Table 3

Dynamics of scores forming the Global Innovation Index and its components for Ukraine for 2015–2024 [17]

Indicator	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
1. Global Innovation Index	36.5	35.7	37.6	38.5	37.5	36.3	35.6	31.0	32.8	29.5
1.1. Input parameters:	39.1	38.9	41.0	40.5	40.9	40.2	39.6	35.7	33.3	31.6
- institutions;	52.2	48.7	47.9	49.1	53.9	55.6	56.2	47.4	38.4	30.8
- human capital and research;	40.4	40.8	39.6	37.9	36.5	40.5	38.2	36.6	35.6	34.3
- infrastructure;	26.3	32.3	39.3	38.1	36.0	33.1	32.3	38.7	36.9	35.5
- market sophistication;	43.9	42.1	43.2	42.7	43.3	42.1	42.3	23.4	23.2	25.7
- business sophistication.	32.4	30.6	35.3	34.5	34.8	29.5	28.9	32.3	32.4	31.8
1.2. Output parameters:	33.9	32.6	34.2	36.6	34.1	32.5	31.6	26.4	32.3	27.4
- knowledge and technology outputs;	36.4	34.1	32.8	36.7	34.6	35.1	32.3	32.9	30.0	31.1
- creative outputs	31.1	31.0	35.6	36.5	33.5	29.9	30.9	19.8	34.6	23.7

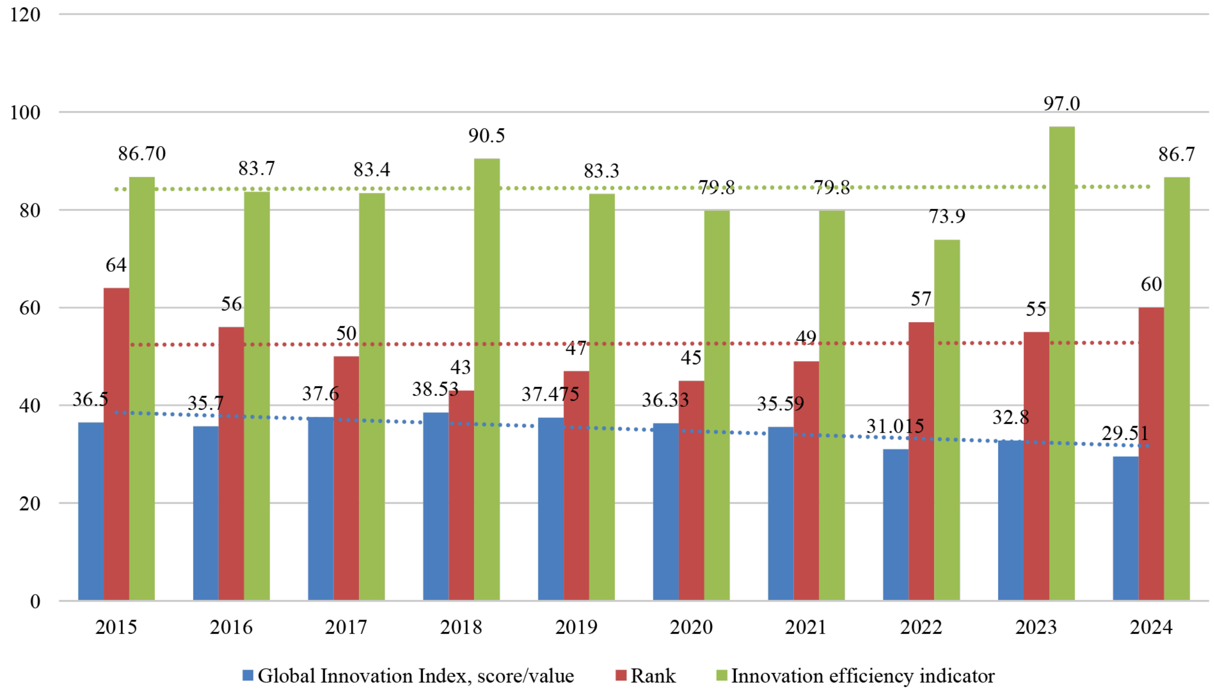

Fig. 2. Visualization of the dynamics of the Global Innovation Index, Ukraine's ranking and innovation efficiency indicator [17]

cutting-edge developments in IT, and robust investments in software and education. These efforts underscore the nation's preparedness to integrate transformative technologies while emphasizing the strategic importance of cultivating human capital and expanding technological capabilities. A particularly encouraging indicator is the high employment rate of women with advanced degrees, signaling meaningful strides toward greater gender inclusivity in innovation and leadership.

Despite these achievements, critical vulnerabilities hinder the full potential of Ukraine's innovation ecosystem. Stagnant labor productivity, insufficient investments in fixed assets, and challenges to business operational stability undermine sustainable growth and resilience. Addressing these systemic issues is essential to creating an environment where innovation can thrive and contribute more effectively.

To overcome the noted shortcomings, it is necessary to introduce comprehensive measures aimed at improving the institutional environment, attracting investments and strengthening support for scientific research and technological developments [19].

Based on the data in Table 3, we will conduct a correlation analysis to determine the most influential subcomponents of input parameters and components of output parameters of innovativeness on the results of knowledge and technology and creative results, allowing us to assess the factors with the greatest impact on innovation efficiency in Ukraine, as well as on the connection between the conditions for innovation activity and the outcomes that showcase progress in the field of knowledge, technology and creative innovations (Table 4).

The analysis showed that the key factors that most influence the level of innovation in Ukraine are institutional system, human potential and scientific research, and sophistication of market approaches. These factors not only create favorable conditions for innovations, but also contribute to their effective application, ensuring the sustainable development of knowledge, technologies, and creative results, emphasizing the importance of a comprehensive approach to managing innovation processes.

The analysis showed a high level of correlation between the efficiency of institutions and the initial parameters of innovation in Ukraine, in particular with the results of knowledge and technology (0.64), which indicates the role of the institutional and business environment, regulatory policy as important factors creating the foundation for the innovations development. Institutional improvements contribute to increasing trust, stability and stimulating investments in research and technology sectors.

Analysis of statistical consistency between subcomponents of input parameters and output indicators of innovation in Ukraine showed that three factors have a key impact on the results of innovation activity of industrial enterprises: institutional environment, human capital and market development. These components not only form a favorable innovation environment, but also provide conditions for the transformation of ideas into practical solu-

Table 4

Statistical consistency (correlation between subcomponents of input parameters and components of output parameters of innovativeness) in Ukraine

Subcomponents of input parameters and components of output parameters of innovativeness	Knowledge and technology outputs	Creative outputs
Institutions	**0.64**	0.29
Human capital and research	**0.62**	0.32
Infrastructure	–0.37	0.01
Market sophistication	**0.72**	**0.60**
Business sophistication	0.17	0.38

tions, increasing the ability of the industrial sector to generate knowledge, technologies and creative solutions.

In particular, a high level of correlation was established between the effectiveness of the functioning of institutions and indicators of knowledge and technologies (0.64), emphasizing the importance of a stable regulatory field, protection of intellectual property rights, transparency of procedures and predictability of state policy for the innovation activity of enterprises in the industrial sector. Improving the institutional environment helps to increase trust in the innovation management system, stimulates domestic investments and encourages cooperation with research structures.

No less important is the role of human capital, which demonstrates a high correlation with technological results (0.62), characterizing the direct dependence of the innovative capacity of industrial enterprises on the availability of qualified engineering and technical personnel, the level of higher technical education, as well as the volume of investments in scientific and research activities. It is through the development of human capital that enterprises are able to quickly integrate the latest technologies into production processes and create unique products with added value.

Market development deserves special attention, which has a strong correlation with both knowledge and technology results (0.72) and creative results (0.60), confirming that industrial enterprises' access to financial instruments, investments, logistics and sales networks is critically important for scaling innovations. Market competition conditions, export support and domestic market development largely determine the ability of companies to introduce technological innovations and remain competitive both at the national and global levels.

The results of the analysis prove that integrated management of institutional, educational, scientific and market components is a key condition for activating innovative activity in the industry of Ukraine. Without their balanced development, it is difficult to expect systemic changes in technological renewal of production and increasing its efficiency. To activate these influential criteria, the authors conducted a comprehensive analysis of their current state, identified weaknesses, and set development priorities that allowed for a systematic approach to innovation management and creation of conditions for achieving sustainable innovation growth in Ukraine.

1. Institutions (institutional environment, regulatory environment, business environment). In Ukraine, when forming and implementing, in the innovation field, the absence of a single responsible authority was identified, which results in the fragmentation of the process, and the main aspects of this problem were considered:

- decentralization of innovation management involves the participation of four ministries in shaping innovation policy. The Ministry of Education and Science of Ukraine is tasked with formulating and executing state policies in education, science, research and development, innovation, and technology transfer. The Ministry of Economy of Ukraine oversees innovation policy within the real economy sector. The Ministry of Digital Transformation of Ukraine focuses on the development of policies related to digital innovations and technologies. Meanwhile, the Ministry of Strategic Industries of Ukraine manages innovation policy in key strategic industries. Such dispersion makes it impossible to adopt a structured approach to the development of innovation policy and actions coordination between ministries [20];
- lack of a single executive body – Ukraine does not have a central authority that would purposefully implement innovation policy at the state level;
- insufficient organizational structure, both in the government and at the local level self-government authorities – there is no effective organizational structure responsible for managing innovation activities, which complicates the coordination of stakeholders within the innovation ecosystem and monitoring the activities of state authorities;
- absence of unified legislative coordination – there is insufficient coordination in the development of laws and regulations that regulate innovation activities and the expansion of the ecosystem;
- lack of clear performance indicators – existing strategies lack clear key performance indicators. This makes it difficult to evaluate the progress and effectiveness of their implementation;
- lack of a strategic vision obstructs the organized growth of the innovation ecosystem, partnerships with investors, and the capacity to secure international support;
- transfer of state institutions between authorities without a strategy. The absence of a strategic approach in transferring functions of state institutions and enterprises between central executive bodies prevents the achievement of effective results;
- disconnect between innovation and investment, as innovation activities in Ukraine are not linked to investment, and the amount of state funding is insufficient;
- lack of focus on priority areas – the policy is not oriented towards clearly defined goals and strategic areas which are essential for the country's progress;
- insufficient protection of intellectual property – the insufficient protection of intellectual property rights in Ukraine, patent verification and update systems limit the innovations development;
- Ukraine lacks appeal for international researchers, as it is not a center for attracting foreign experts in innovation and technology.

Systemic fragmentation of management, weak coordination and the lack of a clear innovation strategy greatly hinders the growth of Ukraine's knowledge economy. To address the issue, it is necessary to establish a unified governing body, to introduce a transparent system for monitoring innovation policy, to protect intellectual property, and to develop a national vision for the development of innovations.

2. Human potential and scientific research. During the analysis of the condition of human capital and research in Ukraine, some critical problems were identified that impede the effective realization of the nation's capacity for innovation and the advancement of the knowledge economy, which require attention:

- population decline – as of 2022, the population decrease rate stood at 1.01 %, linked to a prolonged demographic decline, and is also accelerating due to a full-scale military invasion, which leads to higher migration and a reduction in the working-age population;
- low labor productivity – despite the high level of education, it does not translate into labor productivity. As reported by the World Bank, Ukraine's labor pro-

ductivity amounts to just 25 % of the OECD average, ranking among the lowest in Europe [21];

- the disparity between education and innovation – Ukraine demonstrates weak positions in key indicators, such as employment in knowledge-intensive industries (*38th* place), cooperation between universities and businesses in R&D (*73rd* place), cluster development (*102nd* place), and availability of financing (*124th* place);

- competition for talent – in the Global Talent Competitiveness Index, Ukraine received 40.56 points, which is among the lowest in Europe. For comparison, Estonia ranks *20th* in the world with 62.47 points, demonstrating how developed countries use human capital to achieve an innovative breakthrough;

- institutional fragility of the education system – education spending is not converted into quality, which is confirmed by Ukraine's low position in the knowledge economy rankings (*63rd* in the world with 46.5 points).

The main problem remains disparity in educational levels, people's ambitions and limited institutional and infrastructural support. In conditions of insufficient financing and complex business administration, knowledge and skills do not become a source of innovation. Simultaneously, developing nations possess distinct opportunities. The absence of connection for outdated technologies and practices makes it easier to integrate modern approaches and create new knowledge. For Ukraine, this may become an entry barrier to a new technological order if investments are directed only to the advancement of human capital, rather than the implementation of innovations.

The enhancement of human capital development should focus on the following key priorities: stimulating investments in knowledge-intensive industries and education; creating conditions for cooperation between universities and businesses; ensuring access to funding and support for innovative startups; improving conditions for attracting and retaining talent in Ukraine.

The measures outlined will help bridge the gap between the potential of human capital and actual innovation outcomes. This, in turn, will foster the advancement of the knowledge economy and drive an innovative breakthrough.

3. Market development (loans, investments, trade, diversification and market size). Crediting of innovative enterprises in Ukraine is characterized by extremely low access to financing challenges arising from significant risks, absence of collateral, lengthy project payback periods, and elevated interest rates.

Access to specialized credit programs is limited, and state support for innovations is insufficient. Banks avoid financing innovations due to low project predictability, while international organizations have limited participation. Venture financing remains underdeveloped, and alternative lending mechanisms, such as leasing or factoring, are hardly used.

To enhance the situation, it is necessary to create specialized preferential lending programs, attract international funds, develop venture financing and provide state guarantees for loans, contributing to the development of innovative entrepreneurship and reducing financial barriers.

The level of ESG investment in innovation in Ukraine remains insufficient, which is due to the lack of a sustainable ecosystem for financing environmentally responsible projects. Despite the growing international interest in supporting sustainable development, industrial enterprises face difficulties in attracting capital due to high risks, a low level of environmental responsibility and a lack of effective state incentives [22]. The integration of ESG principles could become a catalyst for attracting investment, contributing to the creation of modern technologies and reducing the impact of industry on the environment.

State investments are mainly aimed at fundamental research, while financing for applied developments is limited. Insufficient level of intellectual property protection and weak integration of science and business limit the attraction of both Ukrainian and foreign investors.

To encourage investment in innovation, it is essential to offer tax incentives for investors and enhance intellectual property protection. Additionally, creating specialized innovation support funds, ensuring transparent conditions for science-business partnerships, and developing innovation infrastructure, such as technoparks and incubators, are key steps.

The innovation market of Ukraine demonstrates potential for development, but faces several issues that hinder its growth. Exports of high-tech products remain limited, and most Ukrainian innovative enterprises are focused on the domestic market. The proportion of innovation exports within the total trade structure is low, and the country is not yet a global supplier of innovative products and technologies.

Market diversification for Ukrainian innovative companies is limited due to the weak development of export infrastructure, insufficient state support and low competitiveness of products at the international level. Geographically, the main sales markets are focused in the European Union, but this orientation is not sufficiently diversified.

The scale of the innovation market remains small due to insufficient domestic demand for innovative products. The main consumers of innovations are large enterprises, while small and medium-sized businesses often lack access to such solutions due to their high cost or insufficient understanding of their benefits.

Main issues and obstacles in the market for innovative products in Ukraine: lack of a state strategy for the development of innovative exports; low level of integration of Ukrainian innovations into global value chains; restricted access to international markets due to regulatory and technical barriers; insufficient promotion of Ukrainian innovations at the international level.

Taking into account the identified problems of limited access to external financing, insufficient export support for innovative enterprises and low integration into global markets, it is advisable to: create mechanisms for state financing of applied developments focused on the needs of international markets, in particular through grant programs for export-capable innovations; pilot implementation of an export incubator for innovative SMEs, which would combine the functions of mentoring, legal support, logistics and certification; develop sectoral roadmaps for entering target markets, in particular in the ICT, biotechnology, defense industry and clean technology industries; introduce a program to co-finance the participation of Ukrainian innovative companies in international exhibitions, technology forums and technology transfer projects. The measures correspond to the diagnosed barriers and will contribute not only to the diversification of exports, but also to the formation of an ecosystem of innovation activity with an international orientation.

The adoption of these measures will enable the expansion of the scale of the market for innovative products, diversify exports and contribute to the integration of Ukraine into the global innovation ecosystem. From here it is possible to deduce the conditions that must be met for optimal regulation of the innovation activity of industrial enterprises.

The theoretical model of such management can be presented as a theoretical model reflecting the relationships between the key factors determining the effectiveness of innovation activity. The basic formula for describing the functioning of the mechanisms for regulating innovation activity can be as follows

$$E = ([R, G, P], [L, T], [S, C, M]), \qquad (1)$$

where E is efficiency of state regulation (ensuring favorable conditions for the development of innovative activities of industrial enterprises); grouped complex of factors: *institutions* – x_1 (R is regulatory instruments; G is public administration and general macroeconomic factors; P is external business environment of industrial enterprises that act as subjects of innovation activity); *human capital and research* – x_2 (L is human capital; T is research and development work and the degree of innovation activity); *market development* – x_3 (I is investments in innovation projects – level and availability of capital for innovation projects; C is lending to innovative enterprises; M is commercialization of innovations).

Formula (1) describes the effectiveness of state regulation of innovation activity in Ukraine as a function of various indicators that interact with each other. Each indicator is crucial in establishing favorable conditions for innovation development and ensuring its success.

Let us give a brief, meaningful description of each indicator.

1. The effectiveness of state regulation is an indicator reflecting the overall effectiveness of policies and measures applied by the state to support innovation activity. It is determined through the impact of executing state programs, legislative initiatives, economic incentives and regulatory measures.

2. Regulatory instruments are measures and instruments used by the government to encourage innovation activity. These include tax breaks, subsidies, quotas, state investment programs and regulations that establish a regulatory environment for enterprises.

3. State management and general macroeconomic factors are indicators considering the influence of economic stability, the political situation and strategic priorities of the government on the development of innovation. Encompasses economic stability, government initiatives, and their effect on the innovation environment.

4. Industrial enterprises are an indicator reflecting the level of development of industrial enterprises, their technological potential, innovative activity and ability to adapt to new technologies; it includes the features of innovation entities that implement innovation projects.

5. Human capital refers to the education and skill level of the workforce, the availability of highly qualified personnel, and their ability to apply new technologies and foster innovation. Human capital determines the potential for innovative development through higher education, research and specialized knowledge.

6. Research and development, along with the level of innovative activity, pertains to the scope and effectiveness of R&D conducted in innovative sectors. This includes the creation of new technologies, scientific research, and their application in industry.

7. Investment in innovative projects – the level and availability of capital for innovative enterprises that secure funding for the adoption of new technologies and the development of startups and innovative projects. An important factor is the presence of investors capable of financing innovations.

8. Lending to innovative enterprises – accessibility of financial resources via loans and other financing methods that allow innovative enterprises to receive funds for carrying out projects. This includes bank loans, and specialized financial instruments for innovations.

9. Commercialization of innovations is the process of transforming scientific and technological developments into marketable products, services or technologies that bring economic benefits. It includes the stages of assessing innovation potential, attracting investments, entering the market and scaling innovative products.

To identify and assess the impact of innovation development indicators on the growth of multifactorial efficiency of state regulation of innovative activity of industrial enterprises, which is manifested in the indicators "results of knowledge and technologies" and "creative results", the method of correlation-regression analysis was applied using the analytical package "Data Analysis" in Excel. The results obtained made it possible to determine the factor loads that affect the resulting indicator – the efficiency of state regulation (providing favorable conditions for the development of innovative activity of industrial enterprises), as well as to generalize partial indicators of innovative development of these enterprises. To build an econometric model of the impact of the level of innovation activity on the effectiveness of state regulation, three groups of initial indicators were selected that have the closest relationship with the resulting feature: x_1 is institutions; x_2 is human capital and research; x_3 is market development.

The interaction of the resulting indicator (Y) with factor features (x_1, x_2, x_3) is described by the linear multifactor regression equation. As a result of solving the set goal of the 3-factor correlation-regression analysis, an economic and mathematical model of the impact of these complexes of factors on the multifactor effectiveness of state regulation of innovative activity of industrial enterprises was built. It is worth emphasizing that each of the presented factors was tested for multicollinearity using VIF analysis to confirm the feasibility of its inclusion in the polynomial model as an independent variable. The assessment of the adequacy of the regression equation demonstrated the reliability and acceptable accuracy of the results obtained. The resulting regression equation looked as follows

$$Y = 29.58 - 0.08x_1 - 0.2x_2 + 0.34x_3. \qquad (2)$$

The coefficient of determination is 0.77, which indicates the acceptability of the model and its high level of reliability. The value of the Fisher criterion confirms the conformity of the model, since it is within the permissible interval of 0.001–0.05–0.1. In this case, this indicator is 0.018.

The modeling results demonstrate that when each of the factors in the complex changes by 1 %, a corresponding change in the level of multifactorial efficiency of state regulation of innovative activity in industrial enterprises is observed. It is worth emphasizing that some factors affect the final indicator positively, while others have a negative impact.

Within the framework of the constructed regression model (2), it was established:

- the coefficient for variable x_1 (institutional component) is –0.08, which means that, other things being equal, an increase in the value of the institutional component by one conditional unit leads to a decrease in the efficiency of state regulation of innovation activity by 0.08 units. This result indicates the existence of policy inconsistency, ineffective regulatory procedures and possible duplication of functions that hinder innovative activity.

- the coefficient for x_2 (human capital and research) is –0.2. The negative impact of this variable indicates insufficient institutional and market support for technology transfer mechanisms and commercialization of scientific results, which reduces the overall efficiency of innovation policy.

- the coefficient for x_3 (market conditions for innovation) is +0.34, which demonstrates a significant positive effect of the development of innovation infrastructure, expanding access to financing, and intensifying investment activity, which contributes to increasing the efficiency of state regulation.

Thus, the obtained coefficient values confirm the asymmetry of influence: institutional and research factors have a negative or deterrent effect, while the market component is the only factor that demonstrates a clearly positive impact, which indicates a structural disproportion in the innovation development environment and allows us to identify priority areas for state policy: development of market mechanisms, stimulation of commercialization, strengthening of innovation infrastructure, and harmonization of institutional support.

The formal absence of interaction between variables in equation (2) reflects the actual inconsistency in the existing institutional environment. This result indicates the fragmentation of regulatory practices, weak integration of institutional support with market incentives and research initiatives. Overcoming this imbalance is possible only under the condition of systemic reform of regulatory policy, strengthening institutional support for innovation activities and harmonizing state intervention with market incentive mechanisms. Theoretically, these factors should function as interconnected elements of a single innovation policy; however, empirical data reveal inter-system gaps that reduce the overall effectiveness of state regulation.

Consider the interaction between the components of effective state regulation of innovation activities of industrial enterprises (*E*, *R*, *G*, *P*, *L*, *T*, *I*, *C*, *M*) and their connection with the stages of innovation policy implementation in Ukraine (Fig. 3).

The components of effective regulation form a complex system, where each of them has a specific role in supporting and developing innovation processes. The relationship between various parameters of innovation activity of industrial enterprises in the economy can be viewed as a system where each component interacts with others, creating a complex network for supporting and developing innovations. An important element of this network is state regulation of innovation activity (*E*), which interacts with regulatory instruments (*R*) and public administration (*G*), providing conditions for investment (*I*) and lending (*C*). In general, the regulatory system creates a basis for the development of innovation processes and supports them through appropriate mechanisms.

Stimulation of innovation activity (*R*) interacts with the effectiveness of regulation (*E*) and provides support for enterprises (*P*) through benefits, subsidies and financing through lending (*C*), which is necessary for the active introduction of innovations into the economic process.

Research and development (*T*) requires support from human capital (*L*), financing through investment (*I*) and is regulated through regulatory effectiveness (*E*) and regulatory instruments (*R*). Accordingly, research is an important element of the innovation cycle, which is directly related to the development of new technologies and products.

The advancement of new technologies and products (*L*) is influenced by the support provided through government regulation (*E*) and regulatory instruments (*R*). It ensures the effectiveness of research (*T*) and the functioning of enterprises (*P*). This process is key to creating innovations, which in turn stimulate economic development.

The production of innovative products (*P*) uses the outcomes of scientific research (*T*), attracts human capital (*L*), and also receives financing through investments (*I*) and lending (*C*). This stage is the final stage at which innovations are transformed into competitive products.

Commercialization and promotion to the market (*M*) depends on government (*G*), support for enterprises (*P*), demand created through innovations (*T*), and the general investment climate (*I*), ensuring the transition of innovations to the market and their further popularization among consumers.

Scaling and expansion of production (*C*) provides resources (*I*) for enterprises (*P*) and scientific research (*T*), works through regulatory instruments (*R*) and stimulates market development (*M*), which ensures the growth of production capacities and expansion of market opportunities for innovative products.

Strategic innovation management (*G*) forms a strategy and policy to support regulatory instruments (*R*), effective state regulation (*E*), stimulates investment (*I*) and promotes the development of human capital (*L*) and commercialization of innovations (*M*), allowing all efforts to be directed to maximizing the results of innovation activity.

Investments are taken into account in several stages, since they represent a crucial component in the development of innovations. The role of investments at the first stage is the development of regulatory mechanisms to attract investors and create conditions for effective investment in innovation projects; at the second stage, financing scientific research and development (*T*) and providing enterprises (*P*) with resources to create innovative technologies; at the third stage, creating an innovation market (*M*), attracting investments to expand production (*P*) and providing enterprises with resources through financing mechanisms.

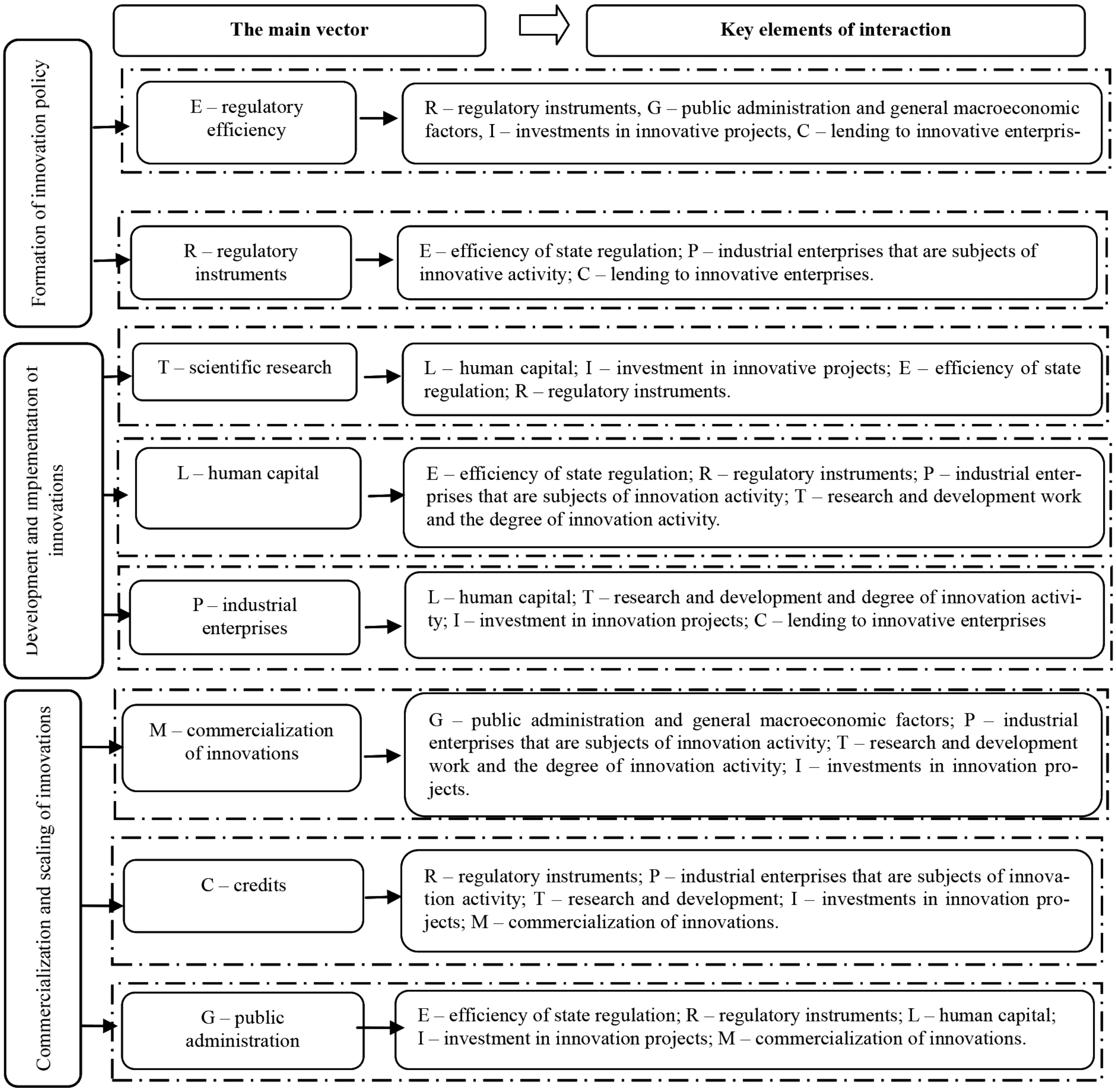

Fig. 3. A comprehensive system of interconnection of key factors of effective public management of innovation support and development processes

In general, each element of the innovation system interacts with others, forming a complex mechanism that supports the development of innovations, technologies, enterprises and the market. Taken together, these factors interact and influence the effectiveness of state regulation of innovation activities, creating conditions for the country's innovative development.

Conclusions. Management of innovation activities of industrial enterprises in conditions of economic destabilization in Ukraine requires a comprehensive approach that covers the key elements of state regulation, economic stability, investment support, human capital and innovation infrastructure. The connection between these components forms a holistic system, where each element influences the others, providing a synergistic effect. An important role is played by public administration, which creates favorable conditions for the development of innovations, supporting enterprises through regulatory instruments, stimulating investments, lending and the development of the innovation market.

Innovative activities of industrial enterprises require a strategy focused on scientific research, training of highly qualified personnel, financial support and the introduction of modern technologies. Attracting investments, developing the innovation market and commercializing new products contribute to economic growth and increasing the competitiveness of industry. Successful innovation management is possible under the condition of a purposeful strategic approach that ensures the integration of all components of the innovation system.

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Роль інституційного середовища в регулюванні інноваційної діяльності промисловості

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Мета. Визначення факторів інноваційного розвитку промислових підприємств України в умовах економічної дестабілізації на основі врахування асиметричного впливу інституційного середовища, людського капіталу й розвитку ринку, для подальшої ідентифікації пріоритетних напрямів державної політики.

Методика. Для оцінки впливу інституційного середовища, людського капіталу й ринкових умов на результати інноваційної діяльності застосована багатофакторна економетрична модель, що дозволяє виявити асиметрії у впливі різних компонентів на інноваційну ефективність. Використано статистичний аналіз показників Глобального індексу інноваційності для ідентифікації ключових факторів середовища, що стимулюють або стримують інноваційну активність промислових підприємств.

Результати. Проаналізовані ключові показники інноваційної діяльності в Україні та встановлена їх відповідність цільовим викликам. Оцінена динаміка Глобального інноваційного індексу та його складових. Визначені ключові напрями, що потребують удосконалення, оцінені показники міжнародних рейтингів відносно формування інноваційної екосистеми України. Основні результати дослідження свідчать про наявність дисбалансу у впливі інституційного середовища й людського капіталу на інноваційну ефективність, що вказує на фрагментарність політики та недостатню інтеграцію наукових розробок у промисловість. Водночас ринкові механізми показують позитивний вплив, підкреслюючи важливість інвестиційної активності, доступу до фінансування й розвиненої інноваційної інфраструктури.

Наукова новизна. Полягає у розробці економіко-математичної моделі багатофакторної ефективності державного регулювання інноваційної діяльності промислових підприємств України, що враховує асиметричний вплив ключових факторів: негативний вплив інституційного середовища й людського капіталу, а також позитивний вплив розвитку ринку. Запропонований підхід дозволяє оцінити взаємозв'язок між умовами для інноваційної діяльності та їхньою результативністю, а також ідентифікувати пріоритетні напрями державної політики.

Практична значимість. Розроблена модель може слугувати інструментом для моніторингу ефективності регуляторних заходів і визначення пріоритетних напрямів економічного стимулювання інновацій. Отримані результати можуть бути використані для впровадження ефективних механізмів державного регулювання інноваційної діяльності в умовах обмежених ресурсів, воєнного стану та економічної нестабільності.

Ключові слова: *інновації, промислові підприємства, державне регулювання, інвестиції, ринок інновацій*

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