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INNOVATIVE ACTIVITY AS A DRIVER OF STRENGTHENING EXPORT ORIENTATION OF REGIONS: MICROECONOMIC DETERMINANTS AND MANAGEMENT MECHANISM

ABSTRACT

The goal of the study was to develop a methodology for assessing the impact of innovative activity on strengthening the export orientation of Ukraine's regions in the context of stimulating the activities of industrial enterprises and organizing the necessary management processes. Based on the analysis of Ukrainian export volumes as a performance indicator, as well as the indicators that influence its volume, a linear regression model was constructed.

This model takes into account the specific features of the innovative activity of industrial manufacturers and allows for the assessment of the export capacity of regions. Using Sturges' formula, the obtained data formed the basis for analytical grouping of regions by their export capacity levels and were interpreted according to a proposed scale with specific economic meanings. Based on the distribution of indicators across twenty-four regions of Ukraine, six levels of export orientation were defined. The most significant influencing factors are the sales volumes of innovative industrial products and the attraction of capital investment across regions. It was established that Kyiv, Dnipropetrovsk, and Lviv regions are characterized by a significant level of export orientation, and according to the authors' proposal, their activity is interpreted as states of "development", "growth" and "revival".

The general findings are systematized in the proposed structural-logical scheme for managing the export-oriented activities of regions on Ukraine's path toward integration into the European Union, which includes measures to promote the innovative activity of enterprises and is reinforced by necessary microeconomic management processes. In order to strengthen these activities, current tools used in the European Union for finding partners and investors were grouped. The practical value of the study lies in the possibility of using the results to elaborate regional development programs and manage the foreign economic activity of export-oriented entities. The research is valuable in defining an analytical basis for stimulating sustainable partnerships during integration, analyzing the strengths and weaknesses of production organization, and establishing synergy between regional administrations, businesses, and entrepreneurs.

Keywords: export orientation, integration, factors of innovation activity, regression analysis, management, regional level, industrial enterprises

JEL Classification: O31, O32, F14, R11, L26

INTRODUCTION

The modern conditions of change in the external environment under the influence of rapid development and reorientation of production systems on a global scale are prompting the national economies of countries and their regions to develop constructive approaches to adaptation and response at all levels of social reproduction. The microeconomic level of management is no exception, which, together with the processes of integration and resource constraints, has become an integral part of industry specialization and its business activity.

Ukraine, as a country with sufficient and diverse industrial potential in terms of its regional units, cannot ignore the trends in global economic transformations that are taking place as a result of the unstable tariff policy of the developed countries, the intensification of the struggle for leadership in the development and implementation of new technologies, the actualization of energy efficiency in production and innovative transformations. At the same time, the intensity of integration processes with the EU under the difficult circumstances provoked by Russia's aggression against Ukraine has only further highlighted these issues on the agenda of regional administrations and enterprises.

In this direction, the key to the regions' development should be their diversification and positioning based on export capacity as a criterion that can ensure the inflow of capital, job creation, production differentiation, specialization deepening, and infrastructure improvement. From this perspective, domestic manufacturers striving to be technologically advanced, flexible, and profitable need to develop their own exports, with innovation serving as the foundation for change. The more innovative technologies a company applies, the higher quality and more competitive products it can produce. Overall, this will present and create new opportunities for individual regions of Ukraine, allow for faster integration into EU structures, and contribute to the growth of the country's gross domestic product.

In our opinion, the main hypothesis is that regions with higher levels of innovative activity demonstrate higher shares of technology exports and greater stability in foreign economic activity (FEA). But the main issue with this tendency is that Ukrainian regions' economies are quite different within its infrastructure, financing sources, production capabilities, and transportation, and not many of them can be innovative in all branches of industry, especially when we speak about technology development. In this way, investors and businessmen from abroad need to know which region of Ukraine can be more appropriate for payback, and every Ukrainian regional administration needs to find out the key elements of strengthening its export orientation through enhancing the most influential factors of innovative activity at the industrial enterprises. We consider that, at the regional level, this will allow us to work out the necessary production programs that are directed to the appropriate enterprise or industrial group, deepen specialization, and find investment for those companies that are interested in export development. We suppose that managing strong and common cooperation between regional administrations and producers on the one side and with foreign contractors on the other is very important. To achieve these tasks, we aim to conduct statistical analysis and analytical grouping and define the export-orientation level of all regions of Ukraine, interpret their economic features, advantages, and disadvantages.

All these arguments indicate that the topic of this article is relevant and timely for research, both for the regions of Ukraine and the economies of other countries.

LITERATURE REVIEW

In the recent scientific literature, in order to reveal the essence of the interdependence between exports and innovation, it is mainly highlighted aspects related to the general nature of economic processes or the situation within a particular country (Edeh et al., 2020; Barrère et al., 2022; Ortigueira-Sánchez et al., 2022). Other evidence consolidates this domain by mapping out research agendas on how internationalization drives organizational innovation (Du et al., 2023), while also emphasizing the long-term evolution of global export performance metrics over the past five decades (Melese et al., 2024). In this way, the market is considered as a whole, and the enterprise is considered in isolation from systemic and regional influence and management, which creates an objective need to justify and develop an integrated approach to the synergy of the concepts of "innovation", "export orientation" and "regional development".

The significant input of the innovative element in the development of export production has also been made throughout conceptions of Ukrainian economic scholarship (Mekh, 2011; Poliakova, 2020). Besides this, expanding export opportunities in foreign markets and increasing their competitiveness at the same time is widely recognized among production companies as the priority for their transition to an innovation-focused economy (Mnych, Sapotnitska, 2020). However, concerning the aim to integrate into the EU countries, there are many controversial issues in the problem of identifying the export capacity of Ukrainian enterprises at the regional level.

At the same time, certain aspects of research into the intensification of exports within a specific territorial economic division through the growth of innovation are highlighted using the example of regional processes and developing countries, or at the global level – within continents (Moughari, Daim, 2023; Petković et al., 2023; Tran, 2023). From a macro-regional perspective, external structural dynamics play a critical role, as seen in how the geographical enlargement of integrated blocks like the European Union reshapes export competition and alters the incentives for regional innovation among member and candidate states (Kang, 2025; Tomàs-Porres J. et al., 2023). Furthermore, the spatial and institutional determinants of trade engagement are highly asymmetrical, where the development of digital infrastructure and regional ICT

networks directly determines the likelihood of small and medium enterprises entering international markets, particularly within developing trade blocks (Haini, 2026).

In the context of Ukraine's integration into the EU networks, researchers emphasize the necessity of reshaping managerial mechanisms and improving the system of state regulation to enhance the industrial enterprises' performance (Mishchuk, Voronov, 2024; Babets, 2024), alongside the analysis of structural and geographical ways of export flows realization directed by European integration impact (Khalin, 2025). However, for domestic manufacturers in Ukraine, this experience requires detailed adaptation and justification, since the current economic opportunities of Ukraine's regions are determined by the impact of martial law (Ponomarenko et al, 2024) and are characterized by constructive differences in financing, resource provision and transport route planning, where sustainable export-import activities and new foreign trade approaches based on the foundation of sustainable development and innovations will provide economic resilience (Vnukova, 2025; Kalinichenko, 2026). Therefore, in order to identify a rational distribution of export priorities in the functioning of domestic foreign economic entities on the path to integration with the EU, among the structure of indicators of innovative activity of twenty-four territorial units of Ukraine, we aim to study the most significant ones that determine the regional approach to specialization. This is because, despite the common rules and requirements under which industry develops, the processes of strengthening the export capacity of regions can be initiated by various factors.

After analyzing well-known scientific studies devoted to statistical analysis of key factors influencing the subject under investigation, it should be noted that their foundation was laid in the classical works of Fisher and Sturges (Fisher, 1928; Sturges, 1926) and developed in the economic context of constructing regression linear models for evaluating enterprises' activities, their business processes and individual operations (Zaman, Tanewski, 2024; Najafi-Tavani et al., 2025).

At the same time, this econometric foundation is essential for capturing complex, non-linear market behaviors that concern the impact of heterogeneous market sizes and exogenous demand shocks on firm-level export and innovation trajectories (Aghion et al., 2024). Moreover, regulatory activity significantly conditions these mathematical relationships, as modern environmental control forces a structural realignment between sustainable innovation investments and international competitiveness outcomes (Fabrizi et al., 2024).

To advance further research, the topic of management at the enterprise level is becoming increasingly relevant and acts not only as a derivative tool for interpreting statistical calculations, but also reinforces their significance and validity and provides a systemic and strategic vision for development.

This behavioral nexus is heavily dependent on firm-specific operational choices, where dynamic innovation capabilities serve as a critical strategic activity that preserves and enhances export performance during macroeconomic shocks (Ledesma-Chaves & Arenas-Gaitán, 2022; Muñoz et al., 2022). Within this microeconomic framework, entrepreneurial traits and high-growth planning act as a powerful catalyst that links radical Schumpeterian market entry to combined approaches of product innovation and export expansion (Estrin et al., 2022).

In the context of strategy, Bıçakcıoğlu-Peynirci et al. (2020) and Savitskyi et al. (2022) shift the focus to meta-analysis and sustainable profitability management through statistical evaluation and multivariate regression models. Mainly, this configuration must be governed by institutional contexts, where the interplay between formal mechanisms and informal institutions shapes a complex interrelationship between necessary learning, continuous innovation, and export outcomes (Escandon-Barbosa & Salas-Páramo, 2023). To achieve these strategic goals, enterprises must balance their internal capabilities with external environments. That's why, in order to develop the specific innovative potential, the specific mediation through cost leadership or cost focus strategies is important, especially to maximize export performance within emerging market realities (Navaia et al., 2024; Sharko et al., 2025).

In addition to the above-mentioned, the methodology proposed in this article for assessing and influencing the impact of innovation activity on strengthening the export orientation of Ukraine's regions through microeconomic aspects and management offers alternative approaches to solving key issues in this area and allows for well-founded conclusions to be drawn for further consideration in practice.

AIMS AND OBJECTIVES

We aim to present and substantiate our own approach to strengthen the export orientation of regions under the influence of the innovative activity of production enterprises, taking into consideration the aspects of the national market and the

management mechanism on the microeconomic level based on appropriate calculation. To achieve the stated aim, the following objectives were set within this study:

1. To introduce an original methodology developed by the group of authors by forming the theoretical part of the study to determine the level of export orientation of Ukraine's regions, with further proposals to manage their activity, maintaining the innovative and productive systems of industrial enterprises' performance.
2. To set and describe the elements of innovative activity in the formation of export orientation of regions.
3. To select input data for analyzing the influence of innovation activity factors in shaping the export orientation of regions, namely: the volume of innovative industrial products (goods, services) sold by region; capital investments by type of economic activity (by industry) by region; number of employees involved in scientific research and development, by personnel categories (goods, services) by region, thousand people; innovation costs of industrial enterprises by region.
4. To describe and highlight the meaning of separate coefficients and parameters of the built regression model.
5. To make analytical grouping based on quantitative lower and upper limits of the regions' distribution intervals by the volume of product exports.
6. To propose levels of assessment of export orientation of Ukraine's regions that give understanding of its current state and economic significance.
7. To construct a structural and logical scheme of managing export-oriented activities of regions based on innovation development that would contribute to the microeconomic performance of the industrial enterprises.

METHODS

Determining the level of innovative activity as a driver of export orientation in regions requires a comprehensive approach to assessing and analyzing the necessary indicators, which will allow concluding what micro-level management model should be applied to organize these processes.

The assessment methodology should be presented in terms of individual stages, which will be revealed on the basis of the relevant applied mathematical tool and methodological approaches. As a result, these stages should complement the overall conclusion and make it possible to establish specific export orientation positions by stimulating innovation activity in the region:

Stage 1. Determining the impact of regional innovative activity factors on the formation of their export orientation.

To shape the structure of the research, it is necessary to:

- conduct a theoretical analysis of current concepts that are integral elements of the innovative activity of regions at both the meso- and microeconomic levels and, according to their importance in social reproduction, are capable of determining the degree of innovative potential in export-oriented industrial production;
- analyze data from official statistical sources in Ukraine, which contain indicators of economic activity in the regions that characterize the innovative performance of the last 2016-2024. The choice of this period should be explained by the fact that, due to the annexation of the Crimean Peninsula by the Russian Federation in 2014, it was in 2016 that Ukraine gained unofficial status of accession to the Free Trade Area (FTA) with the EU and began to use all benefits of its membership, preferences, and rules for conducting FEA. In 2017, when all the relevant regulatory and legislative procedures were completed, this status became official. Therefore, we consider this sample to be relevant for detailed research;
- identify the structure-forming indicators that correspond to the innovative potential, group them, and perform further analysis and calculations.

To assess the impact of innovation activity factors based on selected indicators, we believe it is appropriate to use multi-factor regression linear modeling approaches. This mathematical tool allows us to determine the impact of several independent variables on the resultant indicator (dependent variable, y). The resultant indicator should be understood as the volume of industrial exports of the regions, which is the basis of their export orientation, and the independent variables (impact factors) ($x_1, x_2 \dots x_n$) should be understood as indicators of innovation activity.

The multivariate linear regression model, as a tool for economic and mathematical modeling, is widely used by scientists and economists. (Fisher, 1928; Savitskyi et al., 2022; Zaman, Tanewski, 2024; Najafi-Tavani et al., 2025). In our opinion,

in order to simplify calculations and achieve the effect of data analysis automation, as an optimal approach to saving time and improving the efficiency of assessment, both for researchers and practitioners of enterprises, it is important to use Microsoft Excel. In particular, using the options of the Data Analysis Tools add-in, it is possible to perform the specified calculations reliably and with high quality. As for the structure of the model, it will look as follows:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_n x_n + \varepsilon \quad (1)$$

where: y – the volume of regional exports; $x_1, x_2 \dots x_n$ – indicators of innovative activity; $\beta_0, \beta_1, \beta_2 \dots \beta_n$ – regression coefficients for determining the change in y when the corresponding $x_1, x_2 \dots x_n$ per unit.

To prepare for calculations, it is necessary to create a table of input data in the form of a matrix, where the columns will contain 24 regions of Ukraine (number of observations), and the rows will contain the resultant indicator (y) and corresponding indicators ($x_1, x_2 \dots x_n$). Using the options in the "Data Analysis Package," we perform calculations and obtain results. Accordingly, the key indicators for interpreting the model are: $x_{\text{variable } 1}, x_{\text{variable } 2} \dots x_{\text{variable } n}$ according to the table coefficients of calculations, R^2 , F-statistics, and t-Student's test.

The algorithm for interpreting the model and its results contains the following:

1. Interpretation of variables (pairwise, with other variables fixed): if $x_1, x_2 \dots x_n$ increases by one integer (1.0), the export of industrial products by the region increases by the calculated value of the table coefficient (Coefficient).
2. The quality of the model is explained by the value of the coefficient of determination R^2 , which allows us to verify how much the obtained data results confirm the constructed multivariate linear regression model. R^2 is a statistical indicator used to determine the degree of dependence of the variation of the resulting indicator y on variations of independent variables $x_1, x_2 \dots x_n$. If R^2 approaches the unit (1.0 or 100 %), then the obtained result can be considered reliable to the extent of its value, and the calculated data confirm the constructed model.
3. In the case of industrial exports, the higher the value of R^2 (R square), the greater the percentage of export variation that can be explained between regions. Also, the adjusted R^2 (Adjusted R Square) is calculated, which allows us to understand whether, taking into account $x_1, x_2 \dots x_n$, the model remains explanatory.
4. To check whether the relationship between the data is significant and the model is significant, the F-criterion (Fisher's test) is calculated. As an assumption, the hypothesis is put forward that the model is not significant ($R^2 = 0$), and if the value of the F-criterion is recorded as greater than the tabular value ($F_{\text{calculated}} > F_{\text{tabular}}$) (Fisher-Student table), the multiple linear regression equation is significant. As a result, the relationship that will be found will be significant, and the set $x_1, x_2 \dots x_n$, in general, will reliably explain the differences in exports between regions.
5. The assessment of the statistical significance of individual coefficients (variables) is carried out on the basis of the Student's t-test (t stat), which is a criterion for statistical testing and allows us to establish the most significant variables among the independent ones. If $t_{\text{calculated}} > t_{\text{tabular}}$, then the difference is statistically significant (the null hypothesis is rejected); if $t_{\text{calculated}} < t_{\text{tabular}}$, then the difference is not significant enough (the hypothesis is accepted). According to this, several of the most important (influential) indicators of innovation activity ($x_1, x_2 \dots x_n$) for the growth of industrial product exports of regions (y) will be identified.

Stage 2. Analytical grouping of Ukrainian regions by product export volumes.

In order to establish which regions of Ukraine are the most capable and dominant in terms of product export volumes, and therefore have priority for stimulating industrial export production, profitable for investment and innovation, we consider it appropriate to use the analytical grouping method and Sturges' formula in particular (How Grouping Analysis works; Sturges, 1926). In our opinion, unlike other tools, this method will allow not only to carry out a deductive description of the studied data sets, but also to explain the dynamics of economic phenomena and processes and how a change in one of them affects another, creating new patterns. The essence and algorithm will be the following:

1. The components of the grouping feature that cause an increase or decrease in the export of regional products should be understood as indicators of innovative activity (economic phenomena or independent factors $x_1, x_2 \dots x_n$).
2. Number of observations – 24 (regions of Ukraine).
3. If the grouping feature has a smooth variation pattern, equal data distribution intervals can be applied, and the number of corresponding groups can be determined using Sturges' formula (Sturges, 1926):

$$n = 1 + 3.322 \log N \quad (2)$$

where: n – the number of export groups of products of the regions (y); N – number of observations.

1. The established groups will make it possible to identify the reasons for the growth and decline in product export volumes and, in the future, to substantiate the conditions that shape their mutual dynamics.
2. As a conclusion, we compare the distribution of y in these groups: if, in regions with a high value of x_1 or $x_2 \dots x_n$, exports are higher, then this indicates a connection between these two economic phenomena and explains "why" it changes as a driver of influence on overall export orientation.

Stage 3. Determining the export orientation level of regions based on statistical analysis and developing a proprietary assessment scale, the values of which will be based on the lower and upper limits within one integer (equal data distribution intervals).

We understand the intervals will determine a specific limit of export opportunities, indicate common signs of development, and can be fully interpreted as levels of export orientation, which will characterize the current position of export capabilities of a separate group of regions and the behavior of their foreign economic entities.

Stage 4. Development of a structural and logical framework for managing export-oriented performance of regions based on innovative activity and taking into account the microeconomic aspects of their production systems (in accordance with stages 1-3).

RESULTS

Determining the level of innovative activity as a driver of the formation of export orientation of regions requires the interpretation of factors that have influence. However, today, under the influence of factors, as working resources in action, it is possible to understand a large number of economic concepts, phenomena, and processes, because the current development of market relations is quite variable to the transformations that occur in the external environment. For certain economies, both within the region and in the activities of their business entities, some influencing factors are the most significant, and for others – varied. In our opinion, the main driving forces of such a trend are: technological progress, the volume of financing and capitalization of business, the operating environment (market), and competition.

If we look at a set of indicators from official statistical sources (International Trade Centre (ITC); National Bank of Ukraine; State Statistics Service of Ukraine), which are proposed for the analysis of the development of export activity at the regional level, as well as indicators of innovative activity associated with its strengthening, we note that in general, they relate to sales volumes, capital investments, expenses and business activity.

Based on this, Table 1 groups the key elements of innovation activity at both the meso- and microeconomic levels, which, to the extent of their importance in social reproduction, are capable of determining the degree of innovation potential in export-oriented industrial production, and thus act as individual factors of influence.

Table 1. Elements of innovative activity in the formation of export orientation of regions. Note: *proposed to characterize the current state

Elements	The potential that provides*	Manifestation at the regional level*	Manifestation at the micro-economic level*	As a factor in the formation of export orientation*
Implementation of innovative products	Competitive potential	The region is integrated with new technological developments	Formation of a long-term production development strategy	Promotes expansion of the offer and signing of new contracts
Capital investments in industrial activities	Economic potential	The region is more profitable	Increasing the financial sustainability of advanced capital channels	Promotes a reliable financial image and creates opportunities for new foreign investments
Number of employees involved in research and development	Human capital potential	The region is resilient to innovation and adaptable to change	Improving the quality of human resources and their ability to perform complex tasks	Promotes the acquisition of foreign experience and competence of employees involved in joint export developments
Innovation spending in industry	Innovation potential	The region is efficient in the use of invested resources	Use of resource-saving technology and cost reduction for energy-intensive production	Promotes acceleration of production flows and flexibility in fulfilling contract terms

According to Table 1, we note that to promote the formation of a higher level of export orientation, the region, like any economic system, relies on the basic laws of economic theory. This case is also no exception, and the statement that demand creates supply is confirmed. If the market is properly researched and priority sales segments are established on the basis of successfully implemented innovations, export-oriented industrial enterprises can become more competitive, and thereby contribute to the flow of capital investments into the region. As a result, such a trend will require greater innovative activity from exporting enterprises, since their management will be interested in further scientific implementations and organization of work of qualified personnel. This will give impetus to international experience exchange in the field of quality and actualize the need for financing the energy-saving technology purchase, increase efficiency in production, create opportunities for flexible labor administration for impartial fulfillment of foreign economic agreements terms and acceleration liquidity.

Given the above, we consider it appropriate to highlight the following as structure-forming indicators for analyzing the impact of innovation activity factors using regression linear modeling tools:

1. The resultant indicator: the volume of product exports (goods, services) by region, UAH thousand (y).
2. The independent variables: the volume of innovative industrial products (goods, services) sold by region, UAH thousand (x1); capital investments by type of economic activity (by industry) by region, UAH thousand (x2); number of employees involved in scientific research and development, by personnel categories (goods, services) by region, thousand people (x3); innovation costs of industrial enterprises by region, UAH thousand (x4). The input data for constructing a multivariate linear regression model are presented in Table 2.

Table 2. Input data for analyzing the influence of innovation activity factors in shaping the export orientation of regions. (Source: compiled by the authors based on data from the International Trade Centre (ITC), National Bank of Ukraine, and State Statistics Service of Ukraine)

Region	y	x1	x2	x3	x4
Vinnitsia	72245150.02	3965013.9	8406413	508.0	1289149
Volyn	43259790.56	325671.6	5294477	163.0	240400
Dnipropetrovsk	197499605.7	60691637.4	33456627	4574.0	1469244
Donetsk	8376442,844	6473	3565858	148.0	23277.5
Zhytomyr	29404381.88	2548105.6	6618406	602.0	351756
Transcarpathia	68893084.21	509380.2	6758980	491.0	23084
Zaporizhia	61188490.34	6788294.1	5227759	2397.0	720397
Ivano-Frankivsk	27276074.14	820271.8	7511073	404.0	111821
Kyiv	482400635.6	79337132.5	108415578	35810.0	6131896
Kirovohrad	34220155.52	3905423.3	3148367	72.4	122059
Luhansk	15460.46796	88374	15537	127.1	21101.1
Lviv	115502341.6	6017485.2	15467665	3461.0	476784
Mykolaiv	42357853.59	140557.2	2346158	838.0	137385
Odessa	76112379.34	459801.3	5755127	1647.0	74311
Poltava	60763294.7	5273732.9	10332276	496.0	187706
Rivne	27566222.37	272955.7	5857132	179.0	54294.88654
Sumy	30019828.38	2061840.3	3225675	1228.0	57440
Ternopil	31176141.74	1896227.4	4094889	541.0	521855
Kharkiv	32679311.42	3770531.2	8822980	8275.0	1409681
Kherson	905676,2291	298645	592198	327.5	1388.796746
Khmelnyskyi	33005639.37	5582285.2	5504770	200.0	928124
Cherkasy	51767205.7	892691.4	5339487	525.0	552627
Chernivtsi	8829737.951	520243.1	1443523	466.0	123279.7167
Chernihiv	38504505.7	2098275.5	3037366	367.0	63198

Based on the data in Table 2 and using the options of the "Data Analysis Package" of the Microsoft Corporation Excel program, the necessary calculations were performed. The constructed model takes on the following form:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \varepsilon \quad (3)$$

As noted earlier, the number of observations: 24 regions. The main calculations are:

- $\hat{y} = 15.880,338,2 + 0,425 x_1 + 4,963 x_2 - 2807,16 x_3 + 0,0345 x_4$
- β_0 (const) = 15.880,338,2;
- β_1 (x_1) = 0.425;
- β_2 (x_2) = 4.963;
- β_3 (x_3) = -2807.16;
- β_4 (x_4) = 0.0345.

Table 3 presents the initial data for interpreting the variables of the constructed model.

Table 3. Initial data for interpreting variables of the model.					
	Intercept	x1	x2	x3	x4
Coefficients	15880338.2	0.425	4,963	-2807.16	0.0345
Standard Error	5201056.06	0.6	1.1	2777.18	12.83
t Stat	3.05	0.71	4.51	-1.01	0
P- value	0.01	0.49	0	0.32	1

According to Table 3, we note that, provided that all variables are fixed, the volume of product exports of the region (y), on average, may vary, namely:

- if the volume of innovative products (x_1) increases by UAH 1 thousand, the region's exports, on average, increase by UAH 0.425 thousand;
- if capital investments (x_2) increase by UAH 1 thousand, the region's exports, on average, increase by UAH 4.96 thousand;
- however, the increase in the number of scientists (x_3) by 1 thousand people doesn't influence export growth (the model presents a decrease of approximately UAH 2.8 thousand);
- we believe this can be explained by the assertion that the planned growth in export volumes will be accompanied by an increase in the number of employees involved in scientific research and development related to the FEA;
- an increase in innovation spending (x_4) by UAH 1 thousand, on average, leads to an increase in export volumes by UAH 0.0345 thousand. Table 4 presents the initial data for analyzing the quality of the model.

Table 4. Initial data for analyzing the quality of the model.	
SUMMARY OUTPUT	
Regression Statistics	
Multiple R	0.985
R Square	0.970
Adjusted R Square	0.963
Standard Error	18789115
Observations	24

The coefficient of determination R^2 characterizes the proportion of variation in the resulting trait interpreted by the variables included in the model.

According to Table 4, $R^2 = 0.970$, which indicates that the constructed model explains 97 % of the variation in exports between regions. We see that R^2 almost approaches unity (or 100 %) and thereby confirms the reliability of the calculated data of the model. Structurally, this indicates a high possibility of further variation in exports between regions and the need to stimulate their export potential through innovative activity and the indicators selected for analysis.

The adjusted coefficient of determination ($R^2_{adj} = 0,963$) is practically identical to the original value, which confirms the absence of overloading the model with unnecessary regressors and its stability with respect to the change in the number of factors. This means that even taking into account 4 influencing factors (x_1, x_2, x_3, x_4), the model constructed remains sufficiently explanatory.

To verify the reliability of the model data, we will pay attention to the analysis of variance to establish the significance of the relationship between its variables (factors) (Table 5).

Table 5. Output data for testing the significance of the relationship between variables of the model.

ANOVA					
	df	SS	MS	F	Significance F
Regression	4	213867396942103000.0	53466849235525700.0	151.5	0.0000000000000040
Residual	19	6707586036728870.0	353030844038361.0		
Total	23	220574982978832000.0			

According to Table 5, the significance of the model, in general, was tested using Fisher's F-test. The calculated value with $p\text{-value} \approx 3.96e-14 > 0.0000000000000040$ ($F_{\text{calculated}} > F_{\text{tabulated}}$) confirms that the included explanatory variables in the aggregate have a statistically significant impact on the resulting indicator. In this case, the identified relationship between the selected indicators of innovation activity of regions (variables) and their impact on the volume of product exports is significant, and the proposed set (x_1, x_2, x_3, x_4) sufficiently explains the differences in exports between regions. Given this, it can be concluded that the constructed model is not random and can be used for analytical conclusions regarding the factors that determine the volume of product exports in the regions.

The statistical significance of individual coefficients was assessed using the Student's t-test. The most significant variables are those characterizing the volume of innovative products sold ($x_1 = 0.71$) and the volume of capital investments in industry ($x_2 = 4.51$). Regions with a higher level of innovation activity and investment support demonstrate significantly higher export volumes (Kyiv region – UAH 482400635.6 thousand, Dnipropetrovsk region – UAH 197499605.7 thousand, Lviv region – UAH 115502341.6 thousand).

The next stage of the study is to identify the most capable regions of Ukraine for understanding the priorities and opportunities for stimulating export production, investment, and innovative developments. To do this, guided by the statistical data in Table 2 and using the analytical grouping method and Sturges' formula, we will conduct the assessment. Further, this will allow us to determine and substantiate the levels of export orientation of regions in the field of industrial production and machine building.

Determining the number of intervals using Sturges' formula:

$$n = 1 + 3.322 \log 24 = 6 \quad (4)$$

Table 6 presents the results of the analytical grouping of Ukraine's regions by product export volumes (y).

Table 6. Quantitative lower and upper limits of the regions' distribution intervals by grouping feature: the volume of product exports, UAH thousand.

Intervals	Lower limit	Upper limit	Distribution of regions, f
1	15,460.47	80,412,989.66	21 Regions: Luhansk, Kherson, Donetsk, Chernivtsi, Ivano-Frankivsk, Rivne, Zhytomyr, Sumy, Ternopil, Kharkiv, Khmelnytskyi, Kirovohrad, Chernihiv, Mykolaiv, Volyn, Cherkasy, Poltava, Zaporizhzhia, Ivano-Frankivsk, Vinnytsia, Odesa
2	80,412,989.66	160,810,518.85	1 Region: Lviv
3	160,810,518.85	241,208,048.04	1 Region: Dnipropetrovsk
4	241,208,048.04	321,605,577.23	0
5	321,605,577.23	402 003 106.42	0
6	402 003 106.42	482,400,635.61	1 Region: Kyiv

According to Table 6, taking into account the input data of 24 regions of Ukraine, a total of 6 distribution intervals were determined. 21 regions can be attributed to the first distribution interval and one each to the second, third, and sixth intervals.

As we see from Table 2, the volume of product exports has a smooth pattern, and the calculations provided using Sturges' formula in the framework of 24 regions of Ukraine gave us equal data for the distribution intervals that can be applied as a number of corresponding groups. Taking into account that Sturges' formula is strictly tied to the number of observations

(24), the number of intervals (6) is objectively determined by the volume of statistical data. In this way, as the authors of this study, we aimed not to do rough, by-eye grouping, while using 2-3 levels of distribution will obscure critical details, and using more than 6 will turn the data into a chaotic situation without evident meaning to explain. We consider that a scenario with 6 intervals of distribution is scientifically proven and represents a compromise to preserve the underlying data structure.

To highlight further analysis, we must emphasize that the volume of product exports as the grouping feature is the resultant indicator (y), and the components that influence its rates within each region are the appropriate indicators of innovative activity $x_1 - x_4$). In the context of grouped data, we note that $x_1 - x_4$ have a steady nature of variation and allow us to explain the reasons for the growth and decrease in the volume of product exports. The grouped data show that within the six specified intervals, significant differences are manifested in the dynamics of y , which, in general, form individual levels of export activity. The key reasons for this trend should be considered to be the fact that the predominant share of the influence on the grouping feature in the context of regions is concentrated in the values of the indicators x_1 and x_2 . Therefore, their main essence is as follows:

1. Together with Ukraine's membership in the Deep FTA with the EU, a number of opportunities have been created to activate cooperation between domestic manufacturers and foreign partners, which consist in simplifying access regimes to necessary technologies, resources, exchange of experience, international advanced training, establishing favorable conditions for financing, transportation and logistics, informatization and electronic document management, joint database systems, automation and acceleration of new scientific and technological developments.
2. Under the conditions of European integration, significant attention is paid to the conclusion of long-term foreign economic agreements, which are a tool for the further development of FEA, a guarantor of stable production and sales; however, foreign counterparties tend to order more innovative products, since they can be successfully sold and have greater competitive stability compared to other analogues.
3. Also, foreign investors are interested in investing their capital in the productive forces of those countries where production is cheaper, since this allows reducing costs, procedural issues, creating additional infrastructure, transporting resources, personnel, and avoiding a large number of taxes.

The largest share of regions (21 out of 24: the first interval), where statistical indicators from UAH 15.46 million to UAH 80.41 billion are concentrated, shows that they are mainly characterized by territorial concentration with a low or medium level of export capacity, and therefore export orientation. Only one region was recorded in the second, third, and sixth intervals. They demonstrate significantly higher export volume indicators compared to the majority of regions. This is due to the concentration of business entities, the presence of powerful industrial clusters and centers of innovation, a high share of the processing industry, infrastructure features of the location and transportation resources, the cost advantage of industrial and heavy production over trade and services, and a high level of purchasing power. For example: Lviv region is located close to the border and serves more as a transport hub and is distinguished by stable and numerous international connections; Dnipropetrovsk region specializes in the development of technology and heavy industry, has the advantage of access to minerals and significant potential in the processing sector.

Separately, the Kyiv region (sixth distribution interval) is the most different from the others in terms of the scale of production, capital investments, and the level of innovative activity. In fact, the Kyiv region forms a separate "pole" of the country's FEA, since it is not only an industrial and service center for all types of social reproduction, but is also located at the intersection of transport routes from and to the border. This circumstance significantly affects the favorability of the internal environment for the accumulation, circulation, and distribution of resources, the signing of long-term contracts with external partners, and the increase in GDP. Also, we note that the city of Kyiv is a financial center for the inflow of capital for the development of the region and the management of the productivity of the entire country, where a large number of offices of national and international companies are concentrated.

At the next stage of the study, guided by the results obtained in Table 6, in the authors' vision, it is necessary to develop an own scale for understanding and assessing the current state of Ukraine's regions' exports. As noted earlier, such a scale will be based on the range of values within one integer and will be interpreted as levels of export orientation (Table 7). Taking into account the determined number of intervals according to Sturges' formula (six), the length of each of them (L_i) will be calculated as follows:

$$L_i = 1,0/6 = 0.16666667 \approx 0.16 \quad (5)$$

where: L_i - is the length of one interval within one integer.

As for upper and lower limits, they were determined on the basis of calculations made with the help of Microsoft Excel algorithms using Interval Methods. Mainly, according to the defined intervals of distribution (6) within the data of Ukraine's regions' product export volumes, it was obvious to use the following formulas:

$$R = X_{\max} - X_{\min} \quad (6)$$

where: R – range of variation; $X_{\max}$, $X_{\min}$ – maximum and minimum rates of product export volumes, UAH thousand.

$$h = R/n = (X_{\max} - X_{\min}) \quad (7)$$

where: h – Interval width; n – the number of intervals.

In this way, calculated upper and lower limits of the regions' distribution intervals by product export volumes, we consider proven scientifically.

Table 7. Levels of assessment of export orientation of Ukraine's regions.

Levels	Statistical values	Compliance with the lower/upper limits of the regions' distribution intervals by product export volumes, UAH thousand	Interpretation of activity	Current state of the region's export orientation and its economic significance
1	0.01-0.16	Lower limits: >15,460.47 Upper limits: ≈80,412,989.66	Beginning	The region is not characterized by high growth rates; however, it is an important element of its overall economic stability, indicating unused reserves and opportunities to activate the export production potential by attracting additional resources, investments, innovations, and a qualified workforce.
2	0.17-0.33	Lower limits: > 80,412,989.66 Upper limits: ≈ 160,810,518.85	Revival	The region is characterized by existing advantages to revive export production activity; however, it requires reducing the impact of negative environmental factors.
3	0.34-0.5	Lower limits: > 160,810,518.85 Upper limits: ≈ 241,208,048.04	Growth	The region is characterized by a fixed potential for export production and indicates increased attention to institutional, financial, and foreign interaction between the FEA entities.
4	0.51-0.66	Lower limits: > 241,208,048.04 Upper limits: ≈ 321,605,577.23	Stability	The region is characterized by stable export production according to set order volumes and a clear distribution of finances and productive forces distribution.
5	0.67-0.83	Lower limits: > 321,605,577.23 Upper limits: ≈ 402,003,106.42	Intensity	The region is characterized by the diversification of export production, the increase in its volumes, and stable positions in sales markets.
6	0.84-1.0	Lower limits: > 402,003,106.42 and more	Development	The region is characterized by a higher level of development and indicates a heavy concentration of export producers who prefer high-tech and full compliance with international business standards.

According to the proposed values in Table 7, we highlight that most of the studied regions of Ukraine (Table 6: 21 regions) are characterized by a widespread trend and existing opportunities to form their export orientation level, which is the lowest (first interval). We believe the main reason that destabilizes the activation of positively influential factors (x_1 , x_2) and contributes to the stable manifestation of weaker ones (x_3 , x_4) is the protracted phase of disrupted production cycles throughout the country, since the armed aggression of the Russian Federation against Ukraine is accompanied by the inability to plan, increase productivity, develop new projects, and attract partners. The important obstacles are unstable security and constant power outages. In the opposite case, in peacetime and on the path of enhanced European integration, each region of Ukraine can develop more specialization through the development of innovations, FEA, create cluster production, and thereby contribute to GDP growth.

Along with this, the Lviv region is characterized by a higher level of export orientation (second interval), which is interpreted as "revival"; Dnipropetrovsk – the third level – "growth". The main advantage in the development of export-oriented production in the Lviv region is proximity to the borders with the EU and globalized markets; in Dnipropetrovsk – a large concentration of technological enterprises and a convenient location at the intersection of transport routes and quick access to minerals.

The highest level of export orientation (sixth interval), which is interpreted as “development”, is represented by the Kyiv region, the economic situation of which was described earlier.

For further conclusions and proposals, as shown by the conducted research, it is necessary to highlight the statement that, to form the export orientation of regions, the volume of innovative industrial products sold (x_1) and capital investments by type of economic activity (by industry) (x_2) are significant and decisive.

However, based on the fact that the well-being and positive economic situation of any territorial unit in each country, in the vast majority, is ensured by the development of its productive forces, the activities of an individual enterprise and a set of enterprises still remain in the field of view of regional administrations heads, representatives of international organizations, independent practitioners, experts, and most importantly – developers and investors. Therefore, the issues of management of innovative activity and attraction of capital investments at the micro level are always on the agenda when drawing up operational plans of regional management, because the establishment of a transparent dialogue between the authorities and economic entities is crucial.

We consider it important that each region should independently determine its level of export orientation and develop its own export industrial specialization, since there are a number of conditions that limit and enhance these opportunities. And as has already been studied in the article above, the most important of them are the region's innovative activity, the presence of technological enterprises and their concentration, investments, location, and intersection of transport routes. In general, all this creates a favorable environment for the integration of domestic production systems into European structures, because then export-oriented enterprises can more quickly find partners, investors and satisfy foreign demand, bringing the Ukrainian economy closer to the level of the EU's.

We believe that to make it work, a number of changes to institutional and administrative measures should be implemented. They concern the careful work of regional state administration (RSA) and regional development organizations (RDOs) on the creation of step-by-step programs to strengthen export cooperation, management regulations, and the provision of consulting and organizational services for enterprises that are FEA subjects. The main thing is that RSA, within its competence, must provide an effective and transparent regulatory and legislative environment that would allow increasing the export potential of industrial producers. To do this, it is necessary to set up cooperation within the framework of three functional components: innovation, investment, marketing, and implementation.

Figure 1 proposes a structural and logical scheme for managing export-oriented activities of regions, constructed and systematized by the authors. We note that this must be a comprehensive, multi-level, and complex process, in which a large number of business entities must be involved.

According to the author's vision, in the RSA structure, it is necessary to create a separate department for foreign relations and establishing long-term cooperation, the competence and responsibility of which will be to carry out constant work on finding partners and investors.

In order to bring together external counterparties with domestic manufacturers, it is advisable for each RSA to conclude dozens of cooperation agreements, the regulations of which will stipulate the legality and obligations of the parties of all participants. In the future, similar agreements should be signed with industrial export-oriented FEA entities.

To maintain this, over the past 10-15 years, many specialized platforms and financial programs for finding partners and investors (Electronic trading platforms, databases of enterprises from foreign countries; Investor Database – VCs & Angels Directory; Ten Proven Ways That Find an Investor For a Project) have been launched, including grant proposals from embassies and foundations, bank export crediting, support programs for research projects such as Horizon Europe, as well as networks for finding collaborations and innovators, such as Angellist or BAEX (Business Asset Exchange). For Ukrainian manufacturers, the EU initiatives through innovation and export support programs, as well as joint projects with Ukrainian business angels (iClub, Toloka) and investment communities (for example, those working within the European integration) are especially useful.

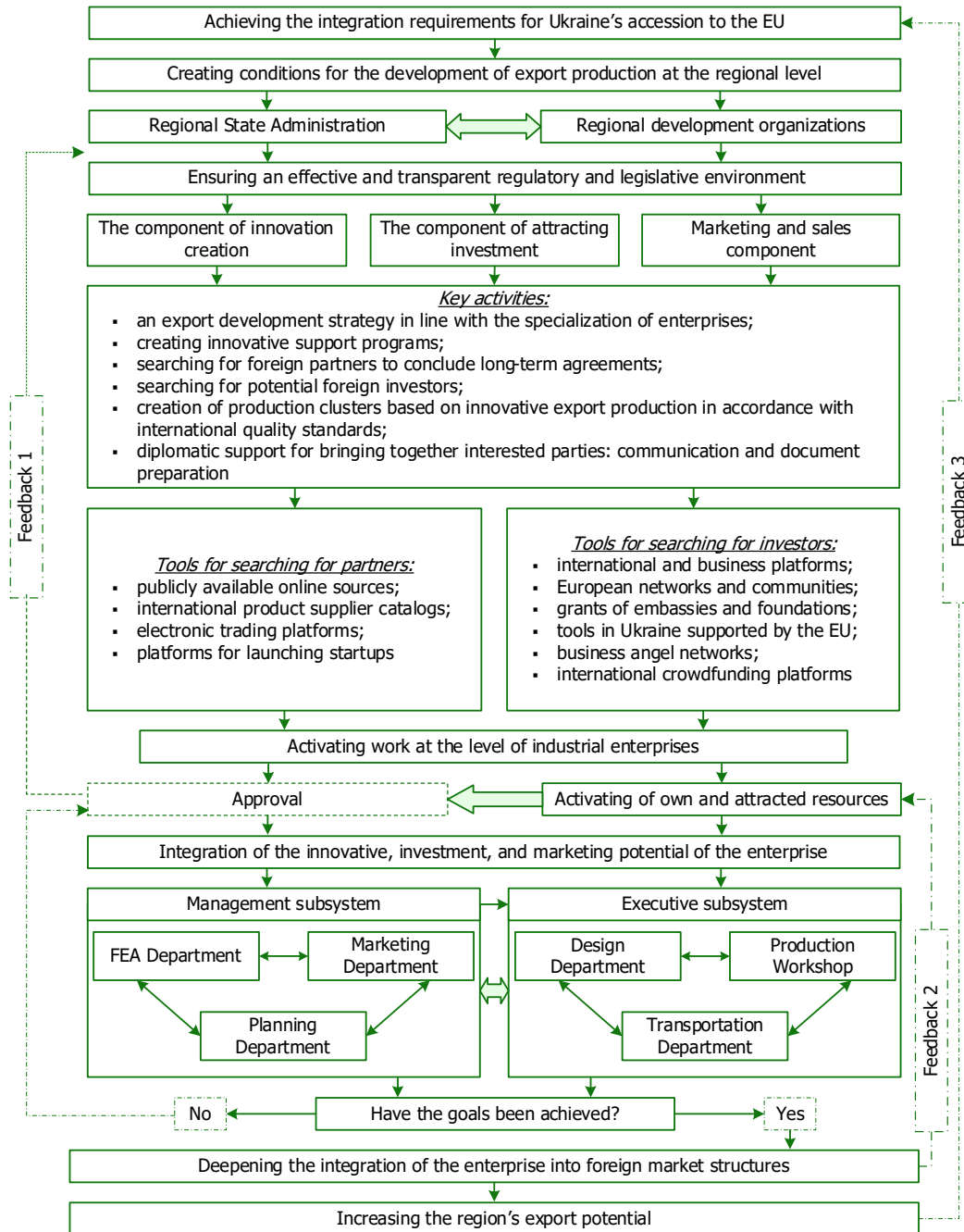


Figure 1. Structural and logical scheme of managing export-oriented activities of regions based on strengthening innovative activity and taking into account the microeconomic aspect of their production systems.

The main EU tools and resources for finding potential partners and investors include:

1. Investment and business platforms: BAEX: for buying or selling businesses in the EU; IndieMaker: a platform that helps in finding small and large amounts of investment; Angellist: global, but one of the main ones for connecting European venture funds and investors; Horizon Europe program: designed for researchers and startup funding, allows presenting results and seeking collaborations through their online apps.
2. European business incubators and accelerators, which are often involved in the implementation of Ukrainian projects, provide access to investors and facilitate the exchange of information about their activities. The largest European accelerator and venture fund aimed at supporting technology startups in the early stages of development, offering access to international investors, mentoring, and networking, is Seedcamp.

Within Ukraine, the following have gained significant importance:

1. All-Ukrainian (1991 Accelerator, iHub, Radar Tech, Sigma Software Labs, Sikorsky Challenge, Startup Ukraine, UNIT. City) and industry (agri-tech, AI, defence-tech, health-tech) accelerators.
2. Chatbots of the Ministry of Economy, Environment and Agriculture of Ukraine, which simplify the process of attracting investments by searching for industrial parks and proposals by regions of Ukraine (Ministry of Economy of Ukraine).

For enterprises that are starting their business or developed manufacturers that seek to diversify their activity by creating startups, separate specialized online platforms have been made. Such tools provide support at all stages of a startup: from developing an idea, researching markets, establishing agreements with investors, and directly to the launch. The most relevant platforms used in the EU are: AngelList, Crunchbase, Gust, OpenVC, Start Engine.

Also, business angel networks have gained significant popularity, focusing cooperation on two key functions: financing and organization (mentoring, project expertise, establishing contacts). Business angel networks are distinguished by a strategic approach to working on a project, helping identify risks and enter new markets by forming competitive advantages. The most relevant international platforms used in the EU are: Angel Capital Association (USA), Angel Investment Network (international), European Business Angels Network (an association uniting national networks and investors from the EU), Keiretsu Forum (a private international network of online and offline communities in the USA, Europe and Asia), Startup Grind (global community of entrepreneurs and startups), TCA Venture Group (USA), UK Business Angels Association (Great Britain).

Along with the above networks, crowdfunding remains an appropriate and effective tool for finding partners and investors. The most effective international platforms are: Indiegogo, Kickstarter, OurCrowd; and the European: Invesdor, Seedrs.

Given the grouped opportunities of the external and partly internal market, RSA and RDOs should take a clear role in establishing links between domestic industrial exporters, potential partners and investors. And as emphasized in Figure 1, in this direction, the creation of an appropriate institutional, regulatory and infrastructural FEA environment that would facilitate the launch of own and attracted resources is crucial for activating work at the level of enterprises.

According to the authors' proposals, to activate the innovative activity of an export-oriented manufacturer, it is necessary to establish logical and systematic work on the integration of its innovative, investment, and marketing potentials. In this way, we propose to organize close interaction between the management and executive subsystems of enterprises. These units must be in constant communication regarding the flow of information, which requires coordination during the planning and organization of production processes. The joint work of responsible departments will ensure the proper implementation of strategic plans and increase the enterprise's export orientation through the introduction of necessary innovations. At the level of the FEA entity, this will allow it to deepen its integration into foreign markets and obtain the corresponding financial benefits for further development. At the regional level, this will contribute to strengthening specialization and interpreting export activity as a decisive and dominant component in the formation of gross regional product.

DISCUSSION

Given all the above research in this study, we understand that there are a lot of discussions that still remain. Some of them can be fulfilled with further studies; some are just different. In general, the obtained results strongly substantiate the basic hypothesis that local innovative activity acts to strengthen the export orientation of Ukraine's region. But as for comparative analysis, we must admit a few common and dissimilar fundamentals between our findings and other scholars' results. As for the commonalities, we must underline that our findings concerning the sales volume of innovative products and capital investment serving as microeconomic determinants can be consistent with the remarks made by Edeh et al. (2020), Barrère et al. (2022) and Ortigueira-Sánchez et al. (2022), who interpreted the idea that managing technology scales would broaden enterprises' external market sales. Also, we believe it will help establish new cooperation and long-term agreement assignments. Besides this, when it comes to the indicators of innovative activity and its influence on product export volumes, we revealed significant regional asymmetry across Ukraine's regions as a whole. Similar trends were noticed in the studies by Mekh (2011) and Poliakova (2020). This gives us confirmation that Ukraine's economic infrastructure is segmented and disarticulated.

As for dissimilarities, we must mention that, concerning international research, given Melese et al. (2024), who treated export performance as an aggregate macroeconomic variable, and Du et al. (2023), who interpreted it only at the level of the enterprise, our study fills the gap. Speaking about statistical methods using a linear regression model, we adapted it

to the regional industrial indicators and step away from considering the region only as the territorial background, emphasizing that it has a much deeper system for managing and developing at the level of separate companies, groups of producers, and other economic entities. For example, Mnych and Sapotnitska (2020) proposed qualitative ways for EU integration, whereas our approach provides an accurate statistical breakpoint scale to identify classification for fixed or desirable export orientation.

At the same time, we can find some scientific polemics when defining six levels of export orientation, because if we speak about a small-sized region where a lot of enterprises have strict specialization, our approach will need further adaptation and fewer than six intervals to consider. In particular, it can be fair for regions with high mineral supply, when transportation costs are much lower, and capital investment sums would be diverse. However, we can partly argue against it, because, as observed from our model, in order to achieve an international breakthrough in product export volumes, non-core regions must focus on specific microeconomic determinants rather than separate local specialization. To confirm this at some point, we must emphasize that our study based on Ukraine's regions research with the aim to find new approach to deepen integration to the EU and different scholars we have reviewed concentrate their studies on example of other separate countries (Aghion et al. (2024), Barrere et al. (2022), Edeh et al. (2020), Escandon-Barbosa & Salas-Páramo (2023), Ledesma-Chaves & Arenas-Gaitán (2022), Muñoz et al. (2022), Najafi-Tavani et al. (2025), Navaia et al. (2024), Petković et al. (2023), Tomàs-Porres et al. (2023), Tran et al. (2023), Zaman & Tanewski (2024)). Other scholars research unions of countries (Fabrizi et al. (2024), Haini (2026), Kang (2025)), and there are scholars who prefer metadata analysis concerning the global level of innovation and export development (Estrin et al. (2022), Bıçakcıoğlu-Peynirci et al. (2020), Du et al. (2023), Melese et al. (2024)).

As for conceptual validation, our empirical grouping confirms the classic Core-Periphery Model, where we can observe Kyiv, Dnipropetrovsk, and Lviv regions as clusters and the most successful economic units. When interpreting them through our proposed scales and states like "development," "growth," and "revival", it indicates the accumulation of regional capital and technological opportunities for innovation. Besides this, the Lviv region's closeness to the EU borders also proves an advantage in accelerating technology and developing innovation to strengthen export volumes.

The scientific novelty of this study lies in a few methodological and practical findings. First, we must acknowledge the methodological synthesis that concerns using a linear regression model with further fulfillment of Sturges' formula for establishing the precise scales of export orientation level based on innovative activity indicators with specific economic meanings for regional product export volumes. We suppose it bridges the classification approaches with an objective diagnostic way of setting the state of regional export capacity and microenvironment. For the second, to fulfill the first statement, we proposed a new concept for understanding the scales that are presented as qualitative states where export-oriented enterprises of the region can be ("development", "growth", "revival"). It provided the essence for understanding microeconomic structural flexibility to manage enterprises' performance. For the third, unlike existing research, and to fulfil the second, we built a structural and logical scheme for managing export-oriented activities of regions by integrating EU tools for searching for partners and investors. It aimed to create a direct channel to figure out cooperation between RSA, RDOs, local producers, and entrepreneurs to establish synergy with foreign contractors.

Although we can provide several limitations that stand behind the calculations we have made and recommendations to implement. As for the linear regression model, it assumes structural stability among the variables, whereas the continuing aggression of Russia against Ukraine often causes volatility, supply-chain reshaping, and currency fluctuations, which reduce the value of input capital. This obstacle can be taken into account by traditional linear variables and needs additional mathematical coefficients to adjust. The second limitation concerns the proposed structural and logical management scheme. The main issues here are that, while implementing it, RSA and RDOs can face impacts from bureaucratic subsystems, a lack of digitalization tools, legislative and technical difficulties to obtain assets, and economic local gaps. However, for Ukraine's dominant regions like Kyiv, Dnipropetrovsk, and Lviv, where numerous industries are concentrated, it's easier to cope with.

CONCLUSIONS

Research shows that the innovative activity of industrial enterprises is a significant driver of the formation of export-oriented capacity in Ukraine's regions, as it can ensure significant growth in production and sales, thereby improving the financial and economic situation of foreign economic entities and the country's GDP.

According to the study, the authors' methodological approach is developed to evaluate the influence of innovative activity indicators on strengthening the export orientation of Ukraine's regions. Unlike standard approaches, it proposes to inte-

grate economic determinants into one analytical system and not be limited to assessing the general dynamics of innovations and export. This approach provides a scientific background for regional and local administrations to define structural weaknesses in the production process of industrial enterprises and coordinate regional capacities to face the EU demands on the way of Ukraine's integration. It was interpreted and implemented through four stages concerning the multivariate linear regression model assessment, analytical grouping, developing a proprietary assessment scale of the region's export-orientation level, and building the structural and logical scheme of management.

The further part of theoretical analysis of elements of innovative activity in the formation of export orientation of regions allowed to systemize four main dependable variables to shape structure of regression linear modeling, namely: the volume of innovative industrial products (goods, services) sold by region; capital investments by type of economic activity (by industry) by region; number of employees involved in scientific research and development, by personnel categories (goods, services) by region; innovation costs of industrial enterprises by region.

Based on the selection of input data compiled from the International Trade Centre, National Bank, and State Statistics Service of Ukraine, the integrated data matrix combining core indicators across twenty-four regions of Ukraine was justified and executed to systematically analyze the driving factors of export orientation.

A multifactorial regression analysis showed that the most influential factors in these processes are the volume of sales of innovative industrial products and the attraction of capital investments in the regions. Through the complex description and structural interpretation of the separate parameters and coefficients of the built model, the meaning of its values was mathematically verified. In general, R^2 , R^2_{adj} , F-statistics, and t-Student's test confirmed that a high sensitivity of regional export volumes to dynamics can be caused by the underlined factors. At the same time, the parameters and coefficients associated with raw innovation expenditures presented lower influence. In addition, it gives us an understanding of the issue that there is structural backwardness in converting research inputs into active and profitable export results. This analysis proved to interpret the built model not as an abstract one, but to turn it into a statistical diagnostic tool that allowed us to define further export orientation levels of Ukraine's region and ways to manage the significant changes of influential factors to accelerate or restrict export capacity of the industrial enterprises. Based on the results of analytical grouping, utilizing quantitative lower and upper limits of the regions' distribution intervals by the volume of product that delivered with the help of Sturges' formula calculations and the proposed assessment scale, it was established that the most significant level of export orientation is characterized by Lviv (activity interpretation: "Revival"), Dnipropetrovsk (activity interpretation: "Growth"), and Kyiv regions (activity interpretation: "Development"). The current state and economic importance of export activity in the Kyiv region indicate a significant concentration of export manufacturers who prefer high technology and full compliance with international business standards, in Dnipropetrovsk – an advantage of access to resources extracted in eastern Ukraine, and in Lviv – proximity to the border with the EU. It was revealed that practical application at this scale showed a high degree of economic polarization and defined a clear roadmap for foreign potential partners to seek sustainable cooperation and advantageous investment input.

The calculations and analysis carried out in the study prove that the higher the indicators of sales of export innovative products and capital investments recorded in the region, the higher the total export amounts observed.

As a result, in order to properly promote and develop the export-oriented capacity of the regions, a structural and logical management scheme was developed, in which, based on the creation of appropriate conditions by RSA and RDOs, the role of industrial entities engaged in FEA to increase the gross regional product and integrate Ukraine into the EU should be strengthened. In this regard, measures aimed at activating the innovative, investment, and marketing components, as well as a transparent regulatory and legislative environment to support the functioning of producers, should be key. At the microeconomic level, it is necessary to establish an effective structure of management and executive subsystems based on close interaction between FEA, marketing, planning, design, production workshops, and transport departments. Also, in the work of RSA and export-oriented enterprises, tools for finding partners and investors created by the EU and those that are open to Ukraine should become prominent. This approach will contribute to the intensification of the integration of regions into global economic relations, highlight the most integrated entities, and ensure the fulfillment of requirements for Ukraine's EU accession.

Regarding the prospects for further research, it should be noted that the combination of innovation, export potential and microeconomic management is structural for the development of the modern economy and will remain relevant during Ukraine's post-war recovery. We believe that promising areas of this research are those that encourage the search for adaptive ways for export-oriented enterprises to adjust to conditions caused by the consequences of regional and global changes related to the tariff policies of developed countries, the escalation of conflicts, and limited resources. In the long term, industrial manufacturers must work to develop effective mechanisms for the sustainability of supply chains for resources and finished products through the implementation of innovative management solutions, the use of digitalization

tools to establish close ties with partners, cooperation with regional administrations, and the creation of business clusters. At the same time, it is important that the European development course is increasingly leaning towards “greening” the economies of EU member states, and therefore Ukraine, as a potential candidate for accession, must concern itself with it too. Today, the EU is imposing new requirements on exporters within the European Green Deal and decarbonization in particular, which puts the issue of innovation in energy efficiency and greening of export production at the forefront of the path to integration and increasing the competitiveness of a particular region in EU markets. Therefore, it is advisable for foreign economic entities to implement constructive microeconomic instruments for the development of “green” exports as a factor of unquestionable entry into foreign markets.

ADDITIONAL INFORMATION

AUTHOR CONTRIBUTIONS

All authors have contributed equally.

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CONFLICT OF INTEREST

The Authors declare that there is no conflict of interest.

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ІННОВАЦІЙНА АКТИВНІСТЬ ЯК ДРАЙВЕР ПОСИЛЕННЯ ЕКСПОРТООРІЄНТОВАНOSTІ РЕГІОНІВ: МІКРОЕКОНОМІЧНІ ДЕТЕРМІНАНТИ ТА УПРАВЛІННЯ

Мета дослідження полягала в розробці методології оцінки впливу інноваційної активності на посилення експортоорієнтованості регіонів України в контексті стимулювання діяльності промислових підприємств та організації необхідних процесів управління. Спираючись на аналіз обсягів українського експорту як результативного індикатора, а також показники, які є факторами впливу на його обсяги, побудовано регресійну лінійну модель, що враховує специфічні особливості інноваційної діяльності промислових виробників і дає змогу оцінити експортну спроможність регіонів. З використанням формули Стеджеса отримані дані лягли в основу аналітичного групування регіонів за рівнями їхньої експортної спроможності та, відповідно до запропонованої шкали (в межах однієї цілої), інтерпретовані за окремим економічним значенням. Керуючись розподілом показників у розрізі двадцяти чотирьох областей України, автори встановили шість рівнів експортоорієнтованості. Визначено, що найбільш суттєвими факторами впливу є обсяги реалізації інноваційної промислової продукції та залучення капітальних інвестицій у розрізі регіонів. Констатовано, що значним рівнем експортоорієнтованості характеризуються Київська, Дніпропетровська та Львівська області і, відповідно до пропозиції авторів, їхня активність інтерпретується станом «розвитку», «зростання» та «пожвавлення». Загальні результати систематизовано в запропонованій структурно-логічній схемі управління експортоорієнтованою діяльністю регіонів на шляху інтеграції України до Європейського Союзу, що включає заходи сприяння інноваційної активності підприємств і посилення необхідними процесами мікроекономічного управління. Для забезпечення цих операцій згруповано актуальні інструменти для пошуку партнерів та інвесторів, які використовуються в Європейському Союзі. Практична цінність дослідження полягає в можливості використання отриманих результатів для розробки програм регіонального розвитку та управління зовнішньоекономічною діяльністю експортоорієнтованих суб'єктів. Дослідження є цінним при визначенні аналітичного базису для стимулювання й стійкого партнерства під час інтеграції, аналізу слабких і сильних сторін організації виробництва, а також налагодження синергії між регіональними адміністраціями, бізнесом і підприємцями.

Ключові слова: експортоорієнтованість, інтеграція, фактори інноваційної активності, регресійний аналіз, управління, регіональний рівень, промислові підприємства

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