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TERRITORIAL INTEGRATION OF SCIENTIFIC AND INNOVATIVE CRITERIA OF ECONOMIC SECURITY OF OIL AND GAS REGIONS

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Scientific and innovative activity is an important component of the economic security of the oil and gas region, creating opportunities to offset the risks of oil and gas exports by high-tech deep chemical processing of hydrocarbons and the redistribution of financial flows to high-value-added products in other industries. The aim of the research is to find approaches to improving the economic security of the oil and gas region based on its scientific and innovative potential in the context of the oil and gas embargo, limited access to global technologies and financial resources, transformation of the global fuel and energy balance and high volatility of oil and gas quotations in global commodity markets. The main scientific problem of the study is the development of territorial aspects of ensuring meso-level economic security based on the increased economic security of the system of interacting regions using the advantages of their industrial specialization and rational spatial integration of scientific and innovative potential to adapt the administrative-territorial division of the country to the challenges of the new economy. To achieve this aim, we identified and solved the following main tasks: to carry out an economic and theoretical review of possible ways to improve regional economic security based on new forms of territorial integration of the scientific and innovative potential of the oil and gas industry, the development of import-substituting high-tech oil and gas

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equipment and services, and the intersectoral expanded reproduction of fixed assets; to carry out an economic and theoretical review of threats to the economic security of the innovative and industrial development of the oil and gas region, the effectiveness of its technological entrepreneurship and venture business, the sustainability of the financial and investment policy of replacing critical imports, the balance of resource and processing capabilities of regional producers with domestic and external demand; to develop scientific and innovative criteria for regional economic security and conduct their structural, dispersion, cluster analysis. As a result of the research, we presented a model of hierarchical cluster interregional integration of the oil and gas regions of the Volga Federal District according to the developed criteria of economic security. It is aimed at developing scientific and methodological foundations for increasing the protection of national economic interests while smoothing regional spatial polarization and rational territorial distribution of innovative and industrial resources in the system of interacting regions.

Regional economy, economic security, oil and gas region, economics of innovation, economics of industry, regional finance, economics of environmental management.

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Introduction

The economic security of an oil and gas region is largely determined by the level of its scientific and innovative potential in the production activities of extracting and processing oil and gas resources. To enhance this potential under conditions of sanctions restrictions, interregional integration of investment activity in knowledge-intensive, high-tech projects and developments is required[1].

The oil and gas industry, as one of the main sources of federal budget revenue, exhibits properties of resilience and revitalization, with a multidirectional impact on regional economic security. As the scientific and innovative component in the production activities of extracting and processing hydrocarbon raw materials grows, the value added of products based on them increases, new international and interregional markets for their sale are developed, and transnational economic ties are formed, creating opportunities and mechanisms for circumventing sanctions.

Stagnation in the innovative development of the oil and gas industry reduces technological and financial independence, creating preconditions for the vulnerability of the economic systems of oil and gas regions and the state to embargoes on major export types, volatility of assets in global commodity markets, and the agreements of the OPEC+ alliance.

This vulnerability can manifest itself in a reduction in export duties directed to the federal budget, as well as in profits and, consequently, in corporate profit taxes of oil and gas companies and related industries, which flow to both the federal and regional budgets. There is also a decline in income and, consequently, in personal income tax (which primarily goes to regional budgets) in the corresponding economic sectors. In the oil

[1] On the Strategy for Scientific and Technological Development of the Russian Federation: Presidential Decree 145 dated February 28, 2024.

and gas sector, along with the financial and IT sectors, wages have been recognized for many years as among the highest.

Accordingly, addressing the issues of protecting the economic interests of oil and gas regions by leveraging national science and innovative achievements can enhance the sectoral, functional, institutional, and other aspects of their industrial, financial, fuel and energy, trade and logistics, and other forms of independence[2].

A new era of oil and gas is dawning, and it must be far more complex than the last hundred years, during which fossil fuels were synonymous with wealth, a complex geopolitical tool, and a driver of economic development. Currently, the structure of the global fuel and energy balance is increasingly influenced by renewable energy sources, a resurgent nuclear energy sector, and evolving socio-economic and ideological trends.

Contemporary theoretical aspects

The contemporary significance of scientific and innovative activity in Russian regions with developed industries and endowed with their own mineral resources is widely covered in a number of authoritative studies, primarily from the perspectives of such scientific fields as innovation economics, economic security, regional economics, industrial economics, environmental economics, territorial finance, and corporate finance. It has been demonstrated that neo-industrialization in the oil and gas sector – driven by the development of import-substituting modern equipment and services, as well as the innovative and resource potential of the industry – can serve as a driver for creating new forms of spatial economic interactions. This is essential for protecting national interests in the global competition of high-tech, knowledge-intensive industries, especially amid growing structural imbalances in international financial and economic relations (Kryukov, Borisova, 2024; Kryukov, Tokarev, 2025; Kryukov, Kryukov, 2025).

Under conditions of expanding sanctions, institutional mechanisms to enhance regional economic security in areas of "old" extraction and processing –specifically for hard-to-recover, high-viscosity, high-sulfur oil and associated petroleum gas with a wide fractional composition – can be developed by strengthening the innovative and industrial sector of the oil and gas region. This can serve as a counterweight to the spread of the costs associated with an oil embargo (Karavaeva, Lev, 2024; Malkina, 2024; Kryukov, Tokarev, 2023; Malkina, 2024). For instance, according to data from the Ministry of Natural Resources and Environment of the Russian Federation[3], in the Volga Federal District, the share of oil reserves with high density (over 0.9 g/cm^3 and 0.87–0.9 g/cm^3) stands at 26.7 and 30.9%, respectively; with high viscosity (over 30 mPa*s) – 25.2%; and with low permeability (less than 0.05 μm^2) – 27.9%. Given the technical and economic challenges of extracting and processing such oil, and its presence in the main Urals export blend, Russia's oil and gas sector requires proactive measures to reduce its vulnerability to restricted access to foreign scientific, technological, investment, and financial resources, as well as to the growing conflictual atmosphere in key areas of the country's economic interests. This can be achieved through interregional material, technical, financial, and industrial integration within a framework that combines spatial development and fiscal federalism, leveraging the advantages of the digital transformation of innovation ecosystems in oil

[2] On the Strategy for Economic Security of the Russian Federation for the Period up to 2030: Presidential Decree 208 dated May 13, 2017.

[3] State Report on the State and Use of Mineral Resources of the Russian Federation in 2023. Ministry of Natural Resources and Environment of the Russian Federation. Moscow, 2024. 716 p.

and gas regions (Akberdina, Smirnova, 2023; Akberdina, Vasilenko, 2023; Lavrikova et al., 2024; Lavrikova et al., 2025).

In planning the algorithms for strategic industrial development during the technological transition to Industry 5.0 and the digital infrastructure of the regional economy, a cluster-based model for organizing interregional scientific and innovative activity in the oil, gas, and petrochemical complex can improve the economic security of an oil and gas region against fluctuations in international commodity and financial markets (Glukhov et al., 2024; Glukhov et al., 2023; Babkin et al., 2025). The impact of structural transformations in the fuel and energy balance on the economic security of an oil and gas region can be mitigated through the development and application of a range of Russian critical technologies[4] in the fields of deep hydrocarbon processing and closed-loop production cycles. Transitioning to these technologies requires building portfolios of regional investment projects based on available resource potential (Akaev et al., 2024; Vasil'eva et al., 2025; Buchwald, Bessonov, 2025).

Enhancing regional economic security through the achievements of technological sovereignty – amid the transition to noonomics, combined with neo-industrialization and the variability of oil and gas revenues in federal and regional budgets – is constrained by Russia's spatial heterogeneity in scientific and innovative activity, as well as by the regulatory frameworks of intergovernmental economic associations that govern innovation markets and venture capital (Bodrunov, 2023; Bodrunov, Zolotarev, 2024; Filimonova et al., 2024; Bufetova, 2025). The scientific and technological development level of Russian regions shows some correlation with their endowment of mineral resources and industrial capacity for deep processing. This is likely due to a distinct "institutional code" in regional economic systems with highly profitable oil and gas production activities, which both creates the need and provides the means for increased corporate spending on research and development (Lazhentsev, 2023; Myslyakova, 2023; Myslyakova, Martynenko, 2024; Uskova, Ustinova, 2025).

The strategic importance of the fuel and energy sector in the context of a future multipolar geopolitical landscape and slowing export-driven economic dynamics – rooted in scientific and innovative achievements – is likely to persist. Maintaining high levels of economic security for oil and gas regions amid global risks posed by speculative foreign capital is possible by reducing vulnerabilities in the infrastructure of technological entrepreneurship, particularly in the area of accelerated import substitution of critical goods (Aganbegyan, 2022; Dmitrievskii et al., 2021; Frolov et al., 2023a). Achieving this requires that Russian non-resource companies maintain strong positions in international business. This, in turn, depends on developing scientific approaches to fostering a favorable innovation and investment climate. Such approaches can also form the basis for nationally oriented structural and technological shifts in industry, high-tech modernization of R&D implementation in small and medium-sized enterprises, and the reduction of excessive organizational and administrative barriers (Frolov et al., 2023; Porfir'ev, Shirov, 2024; Terebova, Borisov, 2019).

In the oil and gas regions of the Volga

[4] List of Critical Technologies of the Russian Federation. Approved by Presidential Decree 529 dated June 18, 2024.

Federal District, innovative production clusters[5] in the field of oil, gas, and petrochemicals have existed for over a decade. Their purpose is to achieve breakthroughs in creating new and promising high-tech developments, enhance key competencies and workforce qualifications using regional scientific and educational resources, boost the competitiveness of non-resource exports, and increase integration into global value chains. Such regional growth poles can serve as anchor points for interregional innovation and industrial integration. This would help reduce the heterogeneity of the economic space caused by the asymmetric effects of state monetary policy under sanctions pressure. In these circumstances, fiscal decentralization appears to be the primary option for smoothing territorial disparities in the country's scientific and technological infrastructure and for ensuring long-term financial mechanisms for the expanded reproduction of fixed assets in the oil and gas industry across regions (Demidova et al., 2021; Pyankova, Kombarov, 2023; Kurilova, 2024; Izmodenova, Khromtsova, 2024; Lev, 2025).

Based on the review of the scientific literature, it can be clarified that the theoretical significance of this research direction lies in its attempt to link the category of regional economic security with parameters of scientific and innovative activity, interpreting them as elements of regional resilience and adaptation to new challenges. The practical significance may be found in developing a typology of oil and gas regions in the Volga Federal District and creating a basis for discussing options for interregional coordination of innovation and industrial policy, grounded in a logical connection between innovation activity and economic security. The theoretical foundations of spatial and regional economics reveal mechanisms for the rational territorial distribution of tangible and intangible assets to maintain high levels of economic security in regions, considering their sectoral specialization. These foundations help create optimal conditions for adapting regional poles of industrial growth and scientific-innovation development to the new economic geography.

Proactive territorial planning of interregional integration associations focused on the scientific and innovative renewal of economic systems at both primary and aggregated stages of production activity can support the competitive advantages of Russia's export-oriented sectors. Increasing economic integration among regions can serve functions related to organizational and managerial support for the transfer and implementation of advanced and promising technological achievements. This, in turn, leads to diversification and expansion of non-resource export areas, thereby contributing to enhanced economic security.

A review of the extensive scientific literature reveals no generally accepted system of criteria for the economic security of Russian regions or macro-regions with specific economic specializations. Widely known and legally established macroeconomic indicators of economic security include "physical volume index of gross domestic product", "gross domestic product per capita (at purchasing power parity)", "share of Russian gross domestic product in world GDP", "share of fixed capital investment in GDP"[6], among others. However, it is not obvious which of these are

[5] List of Innovative Territorial Clusters (Instruction of the Government of the Russian Federation DM-P8-5060 of August 28, 2012).

[6] On the Strategy for Economic Security of the Russian Federation for the Period up to 2030: Presidential Decree 208 dated May 13, 2017.

most appropriate to use at the regional level (for instance, replacing GDP with GRP, etc.), given the specific features of how regional and federal budgets are formed from revenues of the oil and gas industry – an industry that remains highly profitable but faces unique challenges. In this study, we propose using the following indicators: "ratio of organizations' expenditure on scientific and innovation activities to total volume of goods shipped, work performed, and services rendered" and "ratio of the volume of scientific and innovative goods, works, and services to the total volume of goods shipped, work performed, and services rendered". The rationale for these indicators is presented in the analytical section of the article. The scientific literature also contains attempts to develop criteria for the economic security of the Russian oil and gas industry as a whole, or for individual oil and gas enterprises. However, the results of these studies have not been systematized within the context of current sanctions restrictions, do not address issues of regional economic development and economic security, and, in our view, have not yet achieved a stable scientific consensus. The passport of the Higher Attestation Commission (VAK) scientific specialty 5.2.3 – Regional and Sectoral Economics (Economic Security) – does not elaborate on the conceptual category "Criteria for Economic Security" included within it.

Materials and methods

The object of the study is the economic systems of regions in the Volga Federal District that have a budget-forming oil and gas complex: the Republic of Bashkortostan (RB), the Republic of Tatarstan (RT), the Udmurt Republic (UR), Perm Territory (PT), Orenburg Region (OR), and Samara Region (SR) *(Tab. 1)*.

Table 1. Volumes of oil and gas activity in the regions of the Volga Federal District in 2024

Region	Volume of goods of own production, work and services performed in house for the economic activity "Mining and quarrying", million RUB	Structure of the volume of shipped products (work, services) for the economic activity "Mining and quarrying", %			
		Extraction of crude petroleum and natural gas	Mining of metal ores	Mining of other minerals	Support services for mining
Republic of Bashkortostan	506 407	60.5	9.9	…*	28.0
Republic of Mari El	2 137	–	–	…	…
Republic of Mordovia	334	–	–	100.0	–
Republic of Tatarstan	1 309 946	86.9	…	…	12.5
Udmurt Republic	442 484	90.8	–	0.4	8.8
Chuvash Republic	583	–	–	100.0	–
Perm Territory	796 222	93.3	0.1	2.3	4.3
Kirov Region	1 989	10.8	–	74.4	14.8
Nizhny Novgorod Region	6 537	–	–	99.0	1.0
Orenburg Region	997 365	86.5	5.0	…	6.7
Penza Region	3 960	…	–	…	–
Samara Region	746 335	89.6	–	0.9	9.5
Saratov Region	70 358	87.4	–	8.9	…
Ulyanovsk Region	35 383	81.8	–	17.9	0.3

* Data are not published to ensure the confidentiality of primary statistical data obtained from organizations, in accordance with Federal Law 282-FZ of November 29, 2007, "On Official Statistical Accounting and the System of State Statistics in the Russian Federation" (Clause 5, Article 4; Part 1, Article 9).
Source: Compiled from: Regions of Russia. Socio-Economic Indicators. 2024: Statistical Compendium. Rosstat. Moscow, 2024. 1081 p.

The oil and gas regions of the Volga-Ural oil and gas province share similar challenges in the extraction and processing of viscous and high-sulfur oil, as well as in the efficient use of associated petroleum gas. They are characterized by the near depletion of large deposits and a significant number of small and medium-sized reserves[7]. This makes it necessary to actively involve small and medium-sized innovative, high-tech oil and gas businesses in the processes of extracting and deeply processing hydrocarbon resources in these territories[8].

At the same time, the manufacturing industries of the oil and gas regions in the Volga Federal District are highly differentiated, and their levels of economic dynamics and sustainable development relative to one another vary widely. This leads to asymmetric effects in terms of threats to their economic security *(Tab. 2)*.

The subject of the study is the system of economic relations between the budget-forming regional oil and gas industry and the region's scientific and innovation potential. This potential includes the full range of human resources, information and communication capabilities, resource base, material and technical facilities, financial and economic resources, and infrastructural support for the region's innovation policy. Regression, structural, variance, and cluster analysis were used as the main methods of economic and statistical analysis.

Results and discussion

The need for expanded state support for scientific and innovation activity – aimed at reducing critical dependence on foreign trade turnover and imports of high-value-added products – is steadily growing. To a large extent, this support can be offset by the collective high-tech achievements developed and applied by regions with a highly profitable oil and gas industry. These regions act as important drivers of territorial development through technology implementation activities and improved innovation commercialization systems. Interregional integration processes in scientific and innovation activity – driven

Table 2. Structure of main types of shipped products (works, services) by economic activity "Manufacturing" in 2024, %

Region	Food products, beverages, tobacco products	Coke and petroleum products, rubber and plastic products	Chemical substances, pharmaceutical products	Metallurgy, fabricated metal products	Machinery and equipment
Volga Federal District	13.5	17.9	13.4	14.6	21.6
Republic of Bashkortostan	9.3	39.7	17.0	6.0	15.8
Republic of Tatarstan	9.3	35.0	13.0	6.7	23.1
Udmurt Republic	13.1	1.6	1.7	33.6	23.7
Perm Territory	7.4	9.8	31.2	14.7	10.6
Orenburg Region	12.0	26.0	3.3	44.0	4.9
Samara Region	13.6	8.5	13.4	14.1	39.5
Source: compiled from Rosstat data.					

[7] State Report on the State and Use of Mineral Resources of the Russian Federation in 2023. Ministry of Natural Resources and Environment of the Russian Federation. Moscow, 2024. 716 p.

[8] Strategy for the Development of the Mineral Resource Base of the Russian Federation until 2035, approved by RF Government Resolution 2914-r dated December 22, 2018.

by the development of efficient methods for extracting and processing energy resources based on modernized oil, gas, and petrochemical machinery – can help achieve a level of economic security that supports Russia's technological and energy independence. This is accomplished by creating new sources of venture investment and new innovation markets.

Over the observed period, domestic spending on research and development (R&D) carried out by regional organizations shows steady growth and correlates well with the increase in the number of advanced production technologies developed and used. Average R&D spending, as well as the number of advanced production technologies developed and used, is higher in oil and gas regions than the average for the Volga Federal District as a whole. At the same time, the Orenburg Region and the Udmurt Republic show the lowest levels and growth rates across all indicators under consideration *(Fig. 1–3)*. This may be explained by the significant share of raw materials in their gross regional product and points to the need for mechanisms to enhance their regional economic security by stimulating scientific and innovation activity.

Up until 2022, the level of innovation activity of organizations was growing; thereafter, growth persisted only in the Republic of Tatarstan. For the oil and gas regions of the Volga Federal District on average, and for the district as a whole, a subsequent decline was observed. The decline was more pronounced in the oil and gas regions, likely due to sanctions restricting exports of oil, gas, and petroleum products, as well as imports of high-tech machinery, equipment, and components widely used in oil and gas extraction and processing. Domestic oil, gas, and petrochemical machinery manufacturing has not yet achieved full, high-quality import substitution.

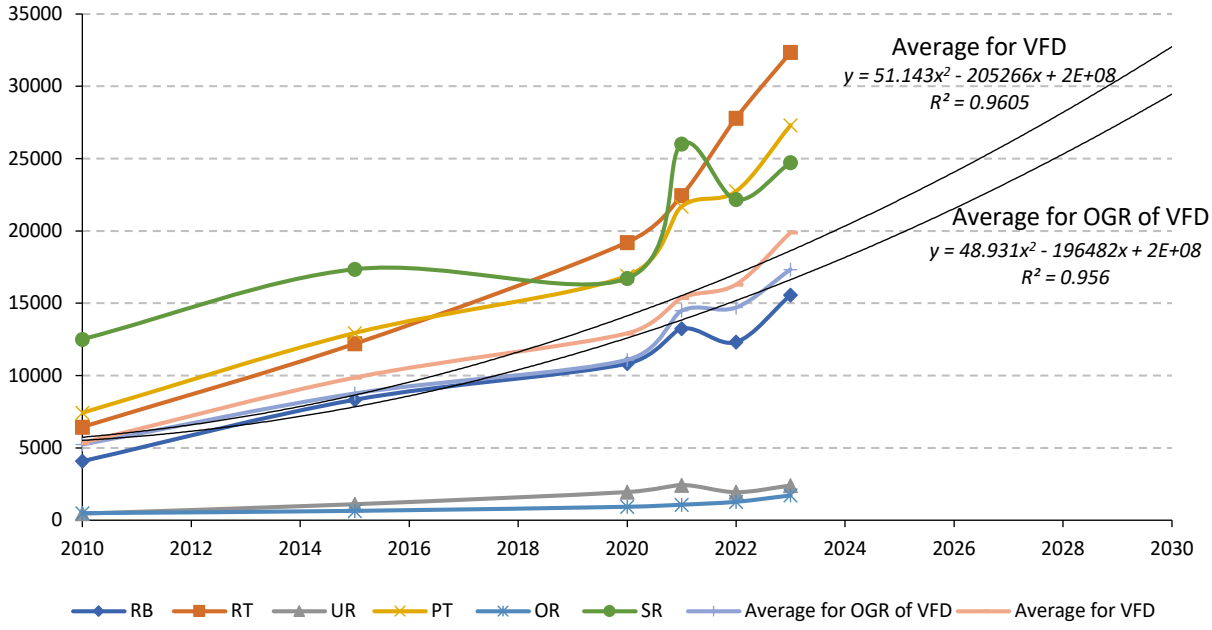

Figure 1. Dynamics and forecast of domestic* R&D spending in the oil and gas regions of the Volga Federal District, million RUB

*Domestic R&D spending refers to expenditures on research and development carried out by organizations in-house, including current and capital expenditures, during the reporting year, regardless of funding source.

Source: compiled from Rosstat data.

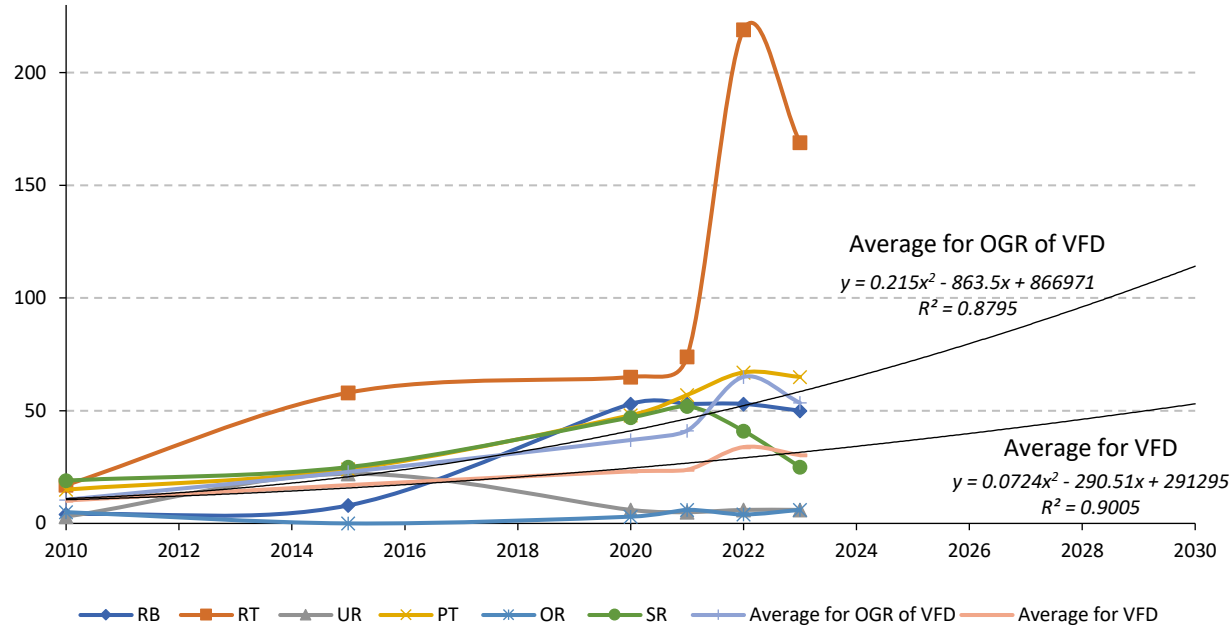

Figure 2. Dynamics and forecast of the number of advanced production technologies developed in the oil and gas regions of the Volga Federal District

Source: compiled from Rosstat data.

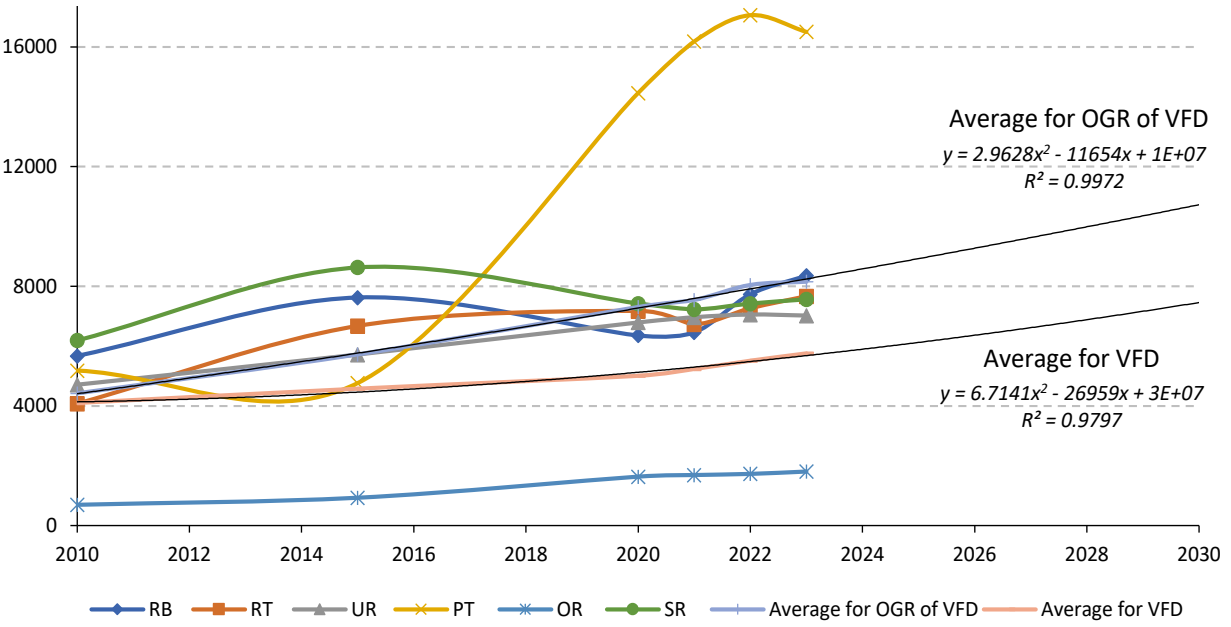

Figure 3. Dynamics and forecast of the number of advanced production technologies used in the oil and gas regions of the Volga Federal District

Source: compiled from Rosstat data.

A similar pattern is seen in the share of organizations engaged in technological innovation: growth until 2022, with no subsequent decline in the Republic of Tatarstan. However, the differences between oil and gas regions and non-oil-and-gas regions largely disappear. This may be because engagement in technological innovation is not so closely tied

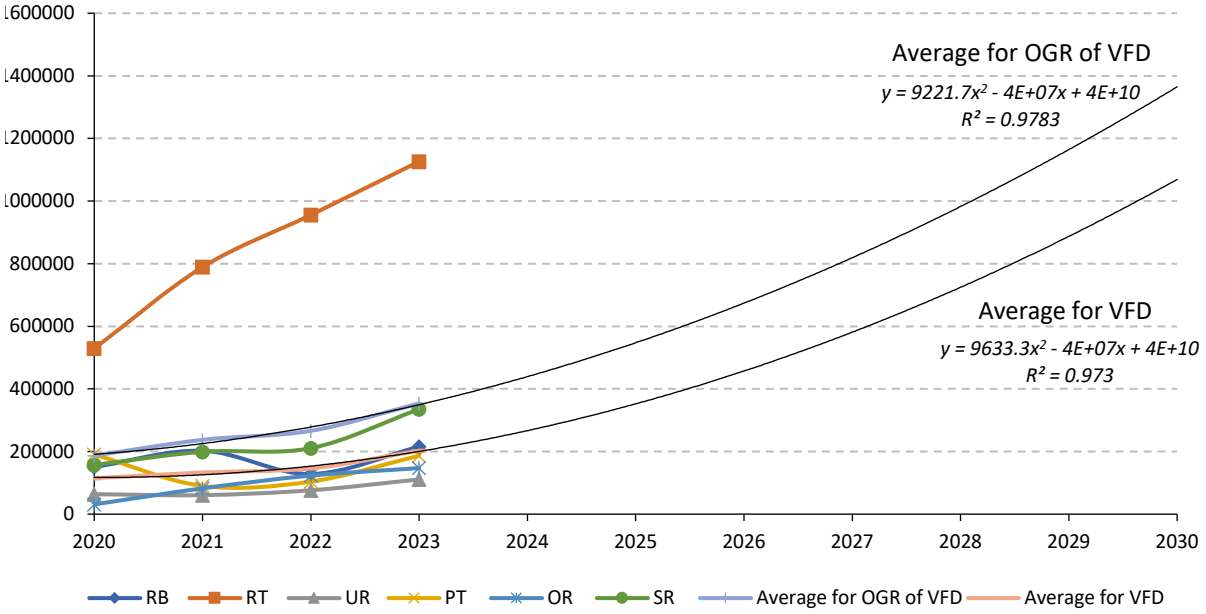

Figure 4. Dynamics and forecast of the level of innovation activity of organizations in the oil and gas regions of the Volga Federal District, %

Source: compiled from Rosstat data.

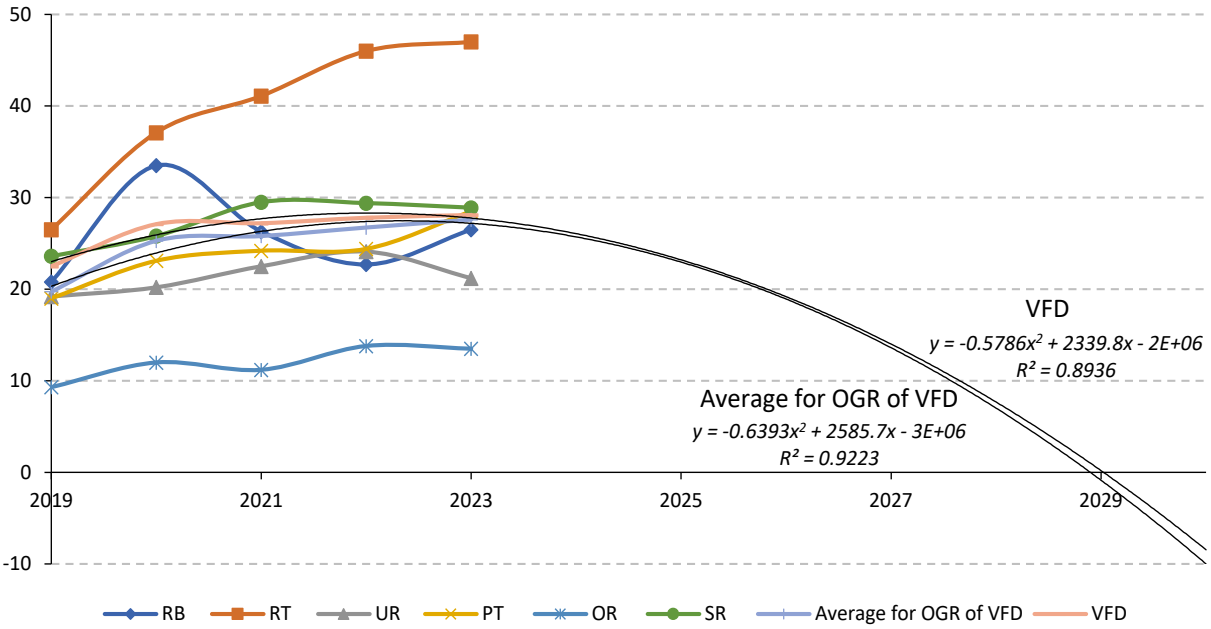

Figure 5. Dynamics and forecast of the share of organizations engaged in technological innovation in the oil and gas regions of the Volga Federal District, %

Source: compiled from Rosstat data.

to a region's sectoral specialization, but rather to unified state programs[9] and mechanisms[10] for supporting scientific and innovation activity. Under sanctions, these activities are constrained by limited access to foreign capital and international cooperation *(Fig. 4, 5)*.

[9] List of State Programs of the Russian Federation, approved by RF Government Resolution 1950-r dated November 11, 2010 (as amended on July 14, 2025): V. Development of Science, Industry, and Technology; VII. Balanced Regional Development; VIII. Ensuring National Security and International Cooperation.

[10] On the Strategy for Scientific and Technological Development of the Russian Federation: Presidential Decree 145 date February 28, 2024.

Despite the decline in the level of innovation activity among organizations and the share of organizations engaged in technological innovation relative to the total number surveyed[11], both innovation expenditure and the volume of innovative goods, works, and services increased during the period under review. This holds true both for the oil and gas regions and for the Volga Federal District average. This trend may be explained by the fact that small and medium-sized innovative businesses – most vulnerable to sanctions – were disproportionately affected, while large companies, in contrast, scaled up their innovation efforts in response to import substitution goals and the drive for technological sovereignty. The fact that innovation expenditure and the volume of innovative goods, works, and services in the oil and gas regions exceed the district average can be attributed to the highly profitable activities of large vertically integrated oil and gas companies and their affiliated service providers operating in these territories: Rosneft in the Samara Region, the Republic of Bashkortostan, and the Udmurt Republic; Lukoil in the Perm Territory; Gazprom in the Orenburg Region; and Tatneft in the Republic of Tatarstan *(Fig. 6, 7)*.

The scientific and innovation criteria for the economic security of a region should include indicators that reflect the state of the region's scientific and innovation sphere relative to the scale of its productive activity and its contribution to ensuring economic security. These criteria are justified by the fact that science and innovation are among the main drivers of economic development. They can enhance the economy's competitiveness, its resilience to threats, and its ability to transition to new, highly efficient technological solutions. In the oil and gas regions of the Volga Federal District, with the exception of the

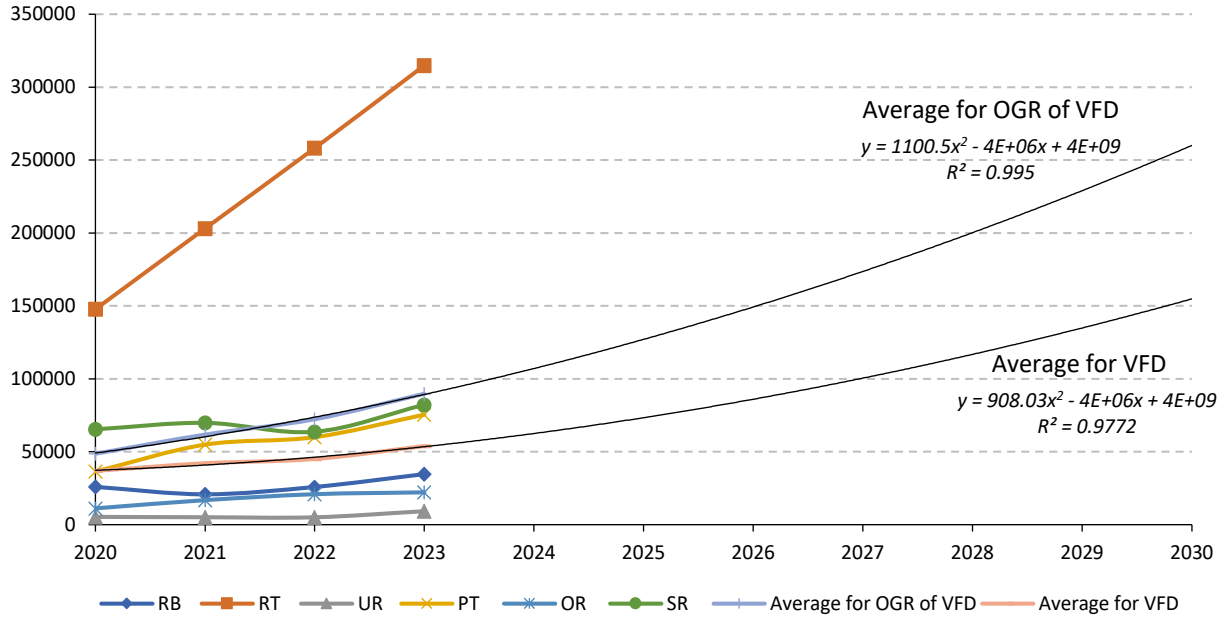

Figure 6. Dynamics and forecast of innovation expenditure by organizations in the oil and gas regions of the Volga Federal District, million RUB

Source: compiled from Rosstat data.

[11] The indicator "Share of organizations engaged in technological innovation in the total number of surveyed organizations" is calculated in accordance with the methodology approved by Rosstat Order 788 dated December 20, 2019, as amended by Order 813 dated December 18, 2020.

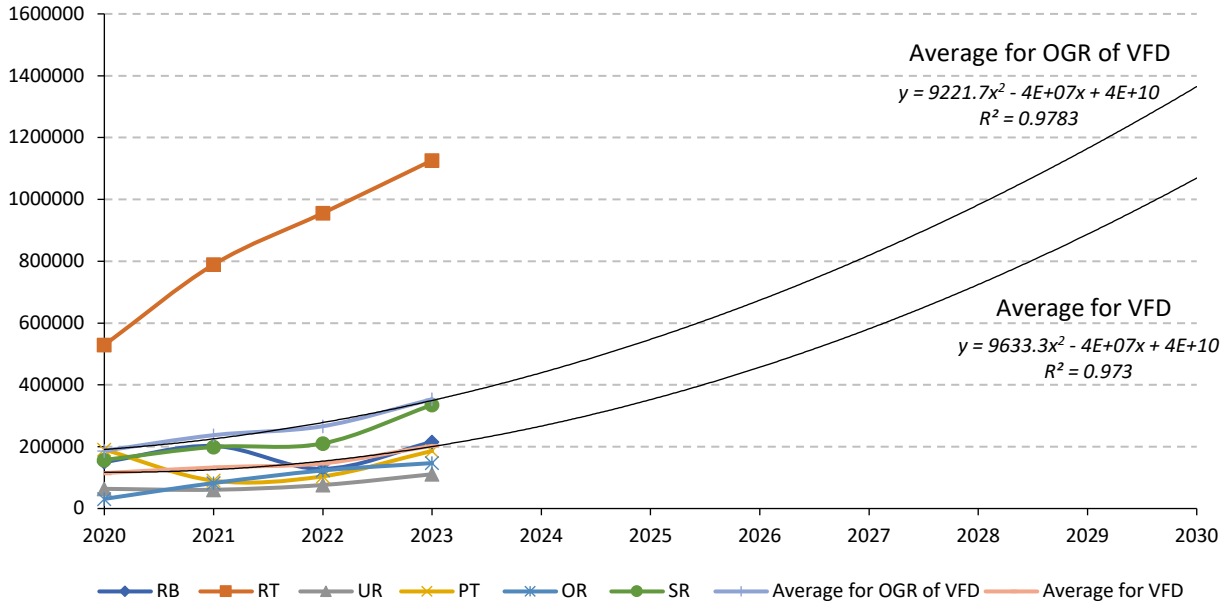

Figure 7. Dynamics and forecast of the volume of innovative goods, works, and services in the oil and gas regions of the Volga Federal District, million RUB

Source: compiled from Rosstat data.

Republic of Tatarstan, the ratio of innovation expenditure to total value of goods shipped, work performed, and services rendered, as well as the ratio of innovative goods, works, and services to that same total, are significantly lower than the district average. This is likely due to the influence of factors such as oil and gas embargoes, speculative manipulation of derivative financial instruments on global commodity markets, OPEC+ agreements, the energy transition, and other powerful forces affecting the oil and gas industry. Given the dominant role of this industry in the productive activity of oil and gas regions, its specific development and functioning characteristics are closely intertwined with the region's scientific and innovation potential. This suggests that the proposed scientific and innovation criteria are appropriate for investigating possible ways to enhance the economic security of oil and gas regions. Such efforts would be based on the rational spatial distribution and efficient use of the region's natural and economic resources, combined with targeted scientific and innovation activity *(Tab. 3)*.

Analysis of variance (ANOVA) for the scientific and innovation criteria of economic security of the oil and gas region revealed statistically significant differences between groups for both criteria. The largest difference between the calculated and critical F-values was observed for the ratio of innovation expenditure to total goods shipped, work performed, and services rendered *(Tab. 4)*.

The statistically significant differences found between oil and gas regions of the Volga Federal District with respect to the scientific and innovation criteria of economic security necessitated a cluster analysis. The purpose was to identify options for pursuing interregional industrial policy based on scientific and innovation activity, drawing on the material, technical, financial, and economic potential of the highly profitable oil and gas industry *(Tab. 5, Fig. 8)*.

Table 3. Scientific and innovation criteria for the economic security of an oil and gas region

Region	2020	2021	2022	2023	2020	2021	2022	2023
	Ratio of innovation expenditure by organizations to total volume of goods shipped, work performed, and services rendered in oil and gas regions of the Volga Federal District, %				Ratio of the volume of innovative goods, works, and services to total volume of goods shipped, work performed, and services rendered in oil and gas regions of the Volga Federal District, %			
RB	1.4	0.8	1	1.2	7.9	8	5.1	7.4
RT	5	4.7	5.1	5.5	18.1	18.3	19	19.8
UR	0.9	0.7	0.6	0.9	10.4	7.9	8.8	11.4
PT	2.1	2.7	2.7	3.1	11	4.4	4.7	7.6
OR	1.2	1.3	1.3	1.4	3.4	6.3	7.6	9.1
SR	3.8	3.1	2.9	3.2	9.2	8.9	9.5	12.9
Average for OGR of VFD	2.4	2.2	2.3	2.6	10.0	9.0	9.1	11.4
VFD	3.6	3.3	3.1	3.3	11.3	10.3	10.2	12.5
Source: compiled from Rosstat data.								

Table 4. Results of ANOVA for the scientific and innovation criteria of economic security of oil and gas regions in the Volga Federal District, 2023

Source of variation	SS	df	MS	F	p-value	F-critical
Ratio of innovation expenditure by organizations to total volume of goods shipped, work performed, and services rendered in oil and gas regions of the Volga Federal District, %						
Between groups	53.88	5	10.78	123,16	0,00	2,77
Within groups	1.58	18	0.09			
Total	55.46	23	η^2=97.15%			
Ratio of innovative goods, works, and services to total volume of goods shipped, work performed, and services rendered in oil and gas regions of the Volga Federal District, %						
Between groups	427.63	5	85.53	21,64	0,00	2,77
Within groups	71.14	18	3.95			
Total	498.78	23	η^2=85.74%			
Source: compiled from Rosstat data.						

Table 5. Data for cluster analysis of oil and gas regions in the Volga Federal District by scientific and innovation criteria of economic security

Region	1	2	3	4	5	6
	RB	RT	UR	PT	OR	SR
Ratio of innovation expenditure by organizations to total volume of goods shipped, work performed, and services rendered in oil and gas regions of the Volga Federal District, %	1.2	5.5	0.9	3.1	1.4	3.2
Ratio of innovative goods, works, and services to total volume of goods shipped, work performed, and services rendered in oil and gas regions of the Volga Federal District, %	7.4	19.8	11.4	7.6	9.1	12.9
Source: compiled from Rosstat data.						

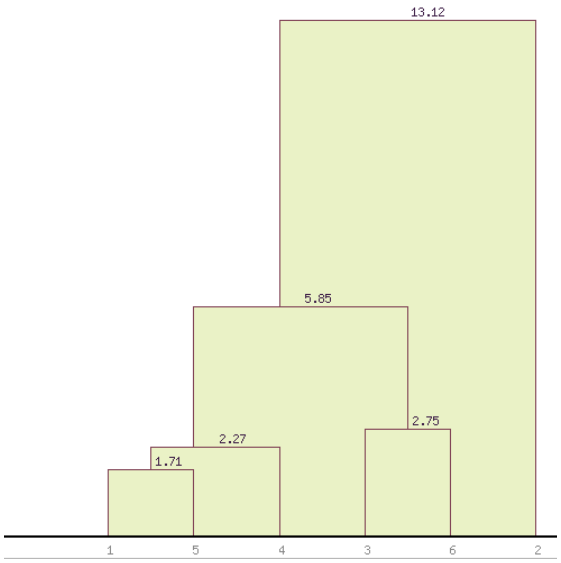

Figure 8. hierarchical territorial clustering of oil and gas regions in the Volga Federal District by scientific and innovation criteria of economic security

Source: compiled from Rosstat data.

The results of the cluster analysis show that, in terms of the ratio of innovation expenditure and the ratio of innovative goods, works, and services to total output, the Republic of Bashkortostan (1) and the Orenburg Region (5) are the closest, with a similarity score of 1.71. The Perm Territory (4) can also be included in this cluster, with a similarity score of 2.27. Another pair of oil and gas regions suitable for pursuing a coordinated scientific and innovation policy are the Udmurt Republic (3) and the Samara Region (6), with a similarity score of 2.75. The Republic of Tatarstan (2) stands relatively far apart from the others in terms of the need for interregional integration, with a similarity score of 13.12. This likely reflects the high degree of self-sufficiency of the region in terms of economic security, achieved through highly effective organization of innovative industrial development. Its capabilities are underpinned by active coordination among the region's largest company, Tatneft, the entire regional oil, gas, and petrochemical complex, and related key industries, as well as scientific and educational activities, carried out by regional government authorities. Supporting this ecosystem are the Kamsky Innovation Territorial Production Cluster "Innokam", the Investment and Venture Fund of the Republic of Tatarstan, the Khimgrad technopolis, Innopolis University, the Innopolis Special Economic Zone, and the Alabuga Special Economic Zone.

Conclusion

Under conditions of sanctions restricting oil and gas exports and high-tech imports, the transformation of the global fuel and energy balance, and other external threats, the state of economic security in the innovative and industrial development of an oil and gas region requires continuous organizational and managerial monitoring. Its level must be adapted to global trends in neo-industrialization. Scientific and innovation activity is a crucial component of the economic security of oil and gas

regions, because the oil and gas business is knowledge-intensive and high-tech, and sanctions primarily target its most critical elements – namely, imports of innovative equipment and components and exports of hydrocarbon raw materials and petroleum products. Enhancing the economic security of an oil and gas region is possible through horizontal innovation and industrial integration with regions that also engage in highly profitable oil and gas activities. Such activities can cover the costs of developing import-substituting innovative technologies aimed at increasing value added. The resulting rise in tax revenues at both the federal and regional levels can then be used to support the economic security of non-oil-and-gas regions. To realize these opportunities, further research is planned into the strategic development of investment and financial mechanisms for ensuring regional economic security, taking into account increasing social and environmental responsibility, geographical location, the composition of the resource and material-technical base, and innovation-industrial potential. In addition, there is a need to develop scientific mechanisms and tools to enhance the economic security of resource-rich regions through economic integration, considering their production specialization, the share of strategic mineral reserve growth relative to total reserves depleted, and the ratio of resource-based to non-resource-based regional exports.

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ТЕРРИТОРИАЛЬНАЯ ИНТЕГРАЦИЯ НАУЧНО-ИННОВАЦИОННЫХ КРИТЕРИЕВ ЭКОНОМИЧЕСКОЙ БЕЗОПАСНОСТИ НЕФТЕГАЗОВЫХ РЕГИОНОВ

Научно-инновационная активность является важной компонентой экономической безопасности нефтегазового региона, создавая возможности компенсации рисков нефтегазового экспорта высокотехнологичной глубокой химической переработкой углеводородов и перераспределением финансовых потоков на продукцию с высокой добавленной стоимостью в других отраслях промышленности. Целью исследования является поиск подходов к повышению уровня экономической безопасности нефтегазового региона на основе его научно-инновационного потенциала в условиях нефтяного и газового эмбарго, ограничения доступа к мировым технологиям и финансовым ресурсам, трансформации мирового топливно-энергетического баланса и высокой волатильности нефтегазовых котировок на мировых товарно-сырьевых рынках. Основной научной проблемой исследования выступает разработка территориальных аспектов обеспечения мезоуровневой экономической безопасности на основе повышенной экономической защищенности системы взаимодействующих регионов с использованием преимуществ их про-

изводственной специализации и рациональной пространственной интеграции научно-инновационного потенциала для адаптации административно-территориального деления страны к вызовам новой экономики. Для достижения заданной цели были определены и решены следующие основные задачи: осуществить экономико-теоретический обзор возможных путей повышения региональной экономической безопасности на основе новых форм территориальной интеграции научно-инновационного потенциала нефтегазовой отрасли, развития импортозамещающего высокотехнологичного нефтегазового оборудования и сервиса, межотраслевого расширенного воспроизводства основных фондов; произвести экономико-теоретический обзор угроз экономической безопасности инновационно-промышленного развития нефтегазового региона, эффективности его технологического предпринимательства и венчурного бизнеса, устойчивости финансово-инвестиционной политики замещения критического импорта, сбалансированности ресурсных и перерабатывающих возможностей региональных производителей с внутренним и внешним спросом; разработать научно-инновационные критерии региональной экономической безопасности и провести их структурный, дисперсионный, кластерный анализ. В результате исследования была представлена модель иерархической кластерной межрегиональной интеграции нефтегазовых регионов Приволжского федерального округа по разработанным критериям экономической безопасности. Она направлена на развитие научно-методологических основ повышения защищенности национальных экономических интересов при сглаживании региональной пространственной поляризации и рациональном территориальном распределении инновационно-промышленных ресурсов в системе взаимодействующих регионов.

Региональная экономика, экономическая безопасность, нефтегазовый регион, экономика инноваций, экономика промышленности, региональные финансы, экономика природопользования.

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