Development of Regional Innovation Potential under the Influence of the Oil and Gas Industry

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ABSTRACT

Relevance In the context of a nationally oriented economy, the formation of innovative potential for regional economic development based on the industrial determinant of the budget-forming oil and gas industry is the most important driver of structural and technological shifts, modernization of modern industrial production and "energy transition 4.0" taking into account the challenges of the latest geopolitical reality. The economic production efficiency of an oil and gas region has a high impact on the functioning of the national economic system due to a number of large taxes transferred to the federal budget. At the same time, the profitability of the regional petrochemical complex is dependent on international commodity and stock markets. Income taxes on profit, personal income and property of the oil and gas industry, as well as its servicing sectors of the economy, contribute significantly to the formation of regional budgets, meanwhile, sustainability and energy security of the economy of oil and gas regions to overcome external shocks can be supported by innovative interregional and intersectoral industrial clusters with "anchor" enterprises for hydrocarbon extraction and processing. **The objective** of the study is to assess the formation problems and disclose the innovative potential of the regional oil and gas industry as a set of scientific and technological achievements and investment climate of the oil and gas region in the conditions of transformation of the global energy balance, technological and financial independence, sanctions restrictions on oil and gas exports. **The result of the study** is the development of an equilibrium cyclic model of the system of priority conditions and optimal results of formation and disclosure of the innovation potential of regional development under the influence of the industrial determinant of the budget-forming oil and gas industry and aimed at maintaining the economic resilience of the region.
Keywords: industrial economy; oil and gas region; regional economy; innovation activity; petrochemical complex; high-tech development; energy sovereignty

INTRODUCTION

Systemic transformations in the Russian fuel and energy complex have potential to develop in conditions of growing innovation activity of the industry. The transformations are aimed at solving the problem of demonopolisation and development of an inclusive competitive environment, as well as liberalisation of economic processes and institutional and structural remodeling in order to eliminate economic dependence in rent and raw materials. The implementation of oil and gas innovative industrial potential in regions can contribute to such significant results in the regional industrial development, as the following:

• certain definiteness of economic conditions for the entire time period of development of natural resources, enabling to intensify oil production in the long-run extraction fields and exploitation of its satellites;

• increasing the depth of oil extraction up to 99 per cent, the yield of light oil products up to 89 per cent, and the utilisation rate of processed petroleum gas up to 95 per cent;

• stimulating investment potential of industrial sector of gas and oil regions in view of achieving a compromise between a high capital intensity of the oil and gas industry and comfortable payback periods for oil and gas projects;

• developing new technological models in view of taking into account the forthcoming probability of a long-term, sustainable reduction in global hydrocarbon consumption.[1]

The author has accomplished the following research work:

• theoretical analysis of the potential for regional economic development influenced by innovations in high-tech industries and services in the oil and gas chemical complex taking into account the problems of producing and processing high viscosity, hard-to-recover oil, as well as the management of innovative industrial activities in clusters, and the environmental agenda;

• theoretical analysis of problems related to spatial location of innovative industries, in view of global trends of decarbonisation and circular economy, digital modernisation in the manufacturing industry and the institutional framework of innovation-resource industrially developed oil and gas regions, in the context of changing technological and global economic patterns;

• regression analysis and forecasting of dynamics of production volume, work and services of oil and gas regions in accordance with economic activity type, such as "Mining and quarrying" and "Manufacturing industries", analysis of the structure of the shipped products and the volume of services rendered by regional oil and gas chemical complexes, as well as profitability of assets and products of industrial enterprises in oil and gas regions;

• analysis of level of innovation activity, potential of companies that have implemented technological innovations compared to the total number of surveyed enterprises in the oil and gas regions, as well as the ratio of costs and expenses on their innovation activities to the volume of innovative products, works and services, expressed as a percentage of the total volume.

THEORETICAL REVIEW

The main sources of regional budget revenues, which ensure regional economic development (involving the social sphere, infrastructure, science and innovations), become taxes on organisational profits and property, as well as the individual income taxes.[2] Oil and gas companies are among the most profitable entities, sometimes they are regarded budget-forming companies and some of their employees earn the highest salaries. This fact determines the paramount significance of developing the innovation potential of the oil and gas industries and their interrelated regional supply chains,

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[1] URL: https://www.mnr.gov.ru/docs/gosudarstvennye_doklady/gosudarstvennyy_doklad_o_sostoyani_i_ispolzovani_mineralno_syrevykh_resursov_rossiyskoy_federatsii/

[2] Regions of Russia. Socio-economic indicators. 2023: Statistical compendium. Moscow: Rosstat; 2024. 1126 p.

which is also affected with challenges aggravated by the technological embargo and the transformation of the global energy balance.

In view of such issues, the priority institutional drivers of regional economic dynamics in production and processing territories of high-viscosity and hard-to-recover hydrocarbon raw materials could become a programme indicative management, which takes into account the operational specific features of the changing resource base and innovative investments in the oil and gas industry [1, 2]. Innovative approaches and resource-based strategies for the evolution of regional industry become effective solutions to overcome existing and projected challenges to the economy of the oil and gas region. It is quite realistic, taking into account the modern trends in the transition to noonomics and technological sovereignty, in order to achieve the fundamental principles and criteria of the long-term sustainable development of raw material regions [3–5].

Revealing the innovative potential of regional economic development under the influence of a determinant of budget-forming oil and gas industry requires the intensification of digital transformation processes. For this matter, it is required to take into account the material and technical bases of industrially developed regions, the impact of foreign policy on the structure and dynamics of the Russian fuel and energy complex, as well as the capability of adaptation of industry to new technological and global economic patterns [6–8]. An economy operating in sanctions requires a specific feature: innovative industrial development of the oil and gas region involving a systematic effort to analyse transformations in financial and socio-economic field, as well as enhancement of mechanisms for attracting investment capital to modernise the structure and technology of economic activity. In order to achieve this, among all measures, introducing cluster-type innovation activities should be taken in industry at regional, interregional, sectoral, and inter-sectoral levels. [9–11]

Oil and gas regions display the dominant presence in the sectoral structure of gross value added for the economic activity, such as "Mining and quarrying" (including the section "Manufacturing industries"). This reduces the significance of other types of economic activity, which determines the main directions of technological inversion of resource-intensive industry prior to energy transition 4.0 [12–14]. Highly profitable oil and gas extraction, as well as processing activities can become an effective means to unfold the innovation potential by introducing a proper norm to make the region's industrial complex eco-friendly, using agent-oriented approaches to management in order to solve problems of regional economic security, as well as to create a sustainable innovation and investment climate [15–17].

Regional innovation systems, which operate with their own mineral and raw material resources, determine the territorial conditions for locating production forces based on the fundamental strategies of budget-forming industries, in the context of the paradigms of the new Russian industrialisation generated by the evolving structure of international trade turnover of innovative goods and technological innovations [18–20]. Global carbon neutrality requires developing methods to increase the profitability of "green" investment capital and, at the same time, to reduce material and energy intensity of regional industrial complexes. It also requires the adaptation of entire national economic systems to the most current geopolitical conditions, which make a strong impact on the economies of oil and gas regions particularly sensitive to the consequences of oil embargoes, technological deficits and financial deficiency [21–23].

Digital transformation makes an important component of productivity growth and interconnection between extractive and manufacturing industries in oil and gas regions.

Table 1

Oil and gas activity coefficient of the region

Region	SSGVA[a], %		ONGE[d], %	MCPPRPP[e], %	ROGAC[f] = (A*C + B*Д)* 10^{-3}	Relative indicator of ROGAC
	MQ[b], %	PI[c], %				
	A	B	C	Д		
1	2	3	4	5	6	7
Volga Federal District	17.4	22.4	86.9	19.5	1.95	0.47
Republic of Bashkortostan	4.3	30.3	54.1	41.7	1.50	0.36
Republic of Mari El	0.2	24.9	-	2.1	0.05	0.00
Republic of Mordovia	0	28.6	-	2.1	0.06	0.00
Republic of Tatarstan	29.6	18.9	90.7	36.4	3.37	0.82
Udmurt Republic	29.6	17	90.4	2	2.71	0.66
Chuvash Republic	0	24.2	0	2.3	0.06	0.00
Perm Krai	26.5	26.8	92.6	9.7	2.71	0.66
Kirov Oblast	0.2	33.6	-	3.1	0.10	0.01
Nizhny Novgorod Oblast	0.1	26.5	-	7	0.19	0.04
Orenburg Oblast	44.5	11.3	85.7	24.4	409	1.00
Penza Oblast	0.4	18.7	-	2	0.04	0.00
Samara Oblast	20.6	21.5	92.9	9	2.11	0.51
Saratov Oblast	4.4	20.7	88	5.1	0.49	0.11
Ulyanovsk Oblast	3.2	23.6	88	9.8	0.51	0.12

Source: compiled by the author.

Note: [a] Sectoral structure of gross value added; [b] Mining and quarrying; [c] Processing industry; [d] Oil and gas extraction in the structure of shipped products (works, services) by type of economic activity "Mining and quarrying"; [e] Manufacture of coke and petroleum products, rubber and plastic products in the structure of shipped products (works, services) by type of economic activity "Manufacturing"; [f] Regional oil and gas activity coefficient.

This can invigorate achieving economic resilience on the basis of the development of regional adaptive mechanisms of resistance to economic shocks, in addition to the resilience mechanisms of economic systems, which reinforce permanent preparedness against imminent crises [24, 25]. The systemic efficiency of such mechanisms can contribute to the growth of endogenous regional economy, which involves a targeting impact on the process of organisation of the spatial structure of the national economy. It also determines projected trends in the innovative modernisation of the oil and gas industry by means of macroeconomic balances in the context of the evolving structure and dynamics of international demand for extraction of fossil fuels [26, 27].

METHODOLOGICAL APPROACHES

The principal formalised criterion for properly classifying entities in oil and gas regions is the "Regional Oil and Gas Activity Coefficient" (ROGAC), which has been developed by the author earlier. ROGAC includes two components: 1) percentage share of oil and natural gas production compared to the volume of shipped products (works and services) in the economic activity sector "Mining and quarrying", 2) percentage share of production of coke, oil products, rubber and plastic products compared to the volume of shipped products (works and services) in the economic activity sector "Manufacturing industries".

Consequently, if the determination of the coefficient is more than 1 (one), the region is classified as an oil and gas region. The higher its absolute value, the greater the dependence of the region's budget system on the oil and gas industry. The Volga Federal District takes the second place in the country in terms of production and the leading position in terms of the physical and advanced refining chemical processing of oil and gas resources. The Orenburg Oblast has the highest oil and gas activities coefficient in the region (4.09),

followed by the Republic of Tatarstan (3.37). The Perm Krai with the Udmurt Republic follow them, each with a coefficient of 2.71. The Samara Oblast and the Republic of Bashkortostan close the list with their coefficients amounting to 2.11 and 1.50 respectively (see *Table 1*).

Considering the data reflected in *Table 1,* the coefficient of oil and gas activities is significantly less than 1 in the other subjects of the federal district under consideration, ranging from 0.51 and 0.49 in the Ulyanovsk and Saratov regions respectively, to 0.04 and 0.06 in the Penza region, the Republic of Mari El, the Republic of Mordovia, and the Chuvash Republic respectively.

The abovementioned coefficient developed by the author of the article has become a quantitative tool for a selective regional economic policy. If its absolute values projected into relative form, it provides additional indicators for analysing the impact of the industrial determinant of budget-forming oil and gas industry on the innovation potential of oil and gas regions.

Another effective methodological approach towards studying the innovation potential of regional economic development is to assess the dynamics and the forecast of the volume of production, work and services in oil and gas regions by type of economic activity. Such types include "Mining and quarrying", "Manufacturing industries", the structure of the volume of products and services shipped by regional oil and gas chemical complexes, as well as the profitability of assets and products sold by industrial companies in the region. The choice of methods between the paired regression and the single-factor dispersion analysis is justified by the structure and quantity of the information available for the study, the temporary nature of the data series, the preliminary non-obviousness of the null hypothesis, as well as compliance of the methods with the set goal. All of this is determined by an entire complex modern scientific research through econometric

modelling of the spatial effects of innovation-industrial growth of the region's economy. The objectivity and scientific significance of the methodology is determined through correlation of the obtained data with the relative coefficient of oil and gas activity in the region, as well as with innovation activity, the business level of enterprises, which have introduced technological innovations, and the volume of expenditure on innovation activity and innovative products in oil and gas regions.

RESEARCH FINDINGS AND THEIR DISCUSSION

The volume of production, activities and services of oil and gas regions (OGRs) significantly exceeds the average value of this indicator throughout all subjects in the Volga Federal District (VFD), not only in the economic activity type of "Mining and quarrying", but also in manufacturing industries. This illustrates a stable trend towards a further growth in both

absolute and relative terms compared to regions of no oil and gas industry.

Evidently, the reason is not only the impact of the highly profitable oil and gas industry on the situation of the domestic economy, which is clearly noticeable in the most resource-dependent regions, such as the Orenburg Oblast (OO) and the Udmurt Republic (UR). It is also determined by the processes of re-industrialisation aimed to achieve sustainable energy perspectives in the future, which can be significantly supported by oil and gas revenues in federal and regional budgets, as well as by oil and gas companies.

Consequently, despite very different structures of their industry, the Republic of Bashkortostan (RB), Samara Oblast (SO) and Perm Krai (PK) display similar dynamics and forecast of their volume of production, works and services in the type of economic activity "Manufacturing industries". The unchallenged leadership of the Republic of Tatarstan (RT)
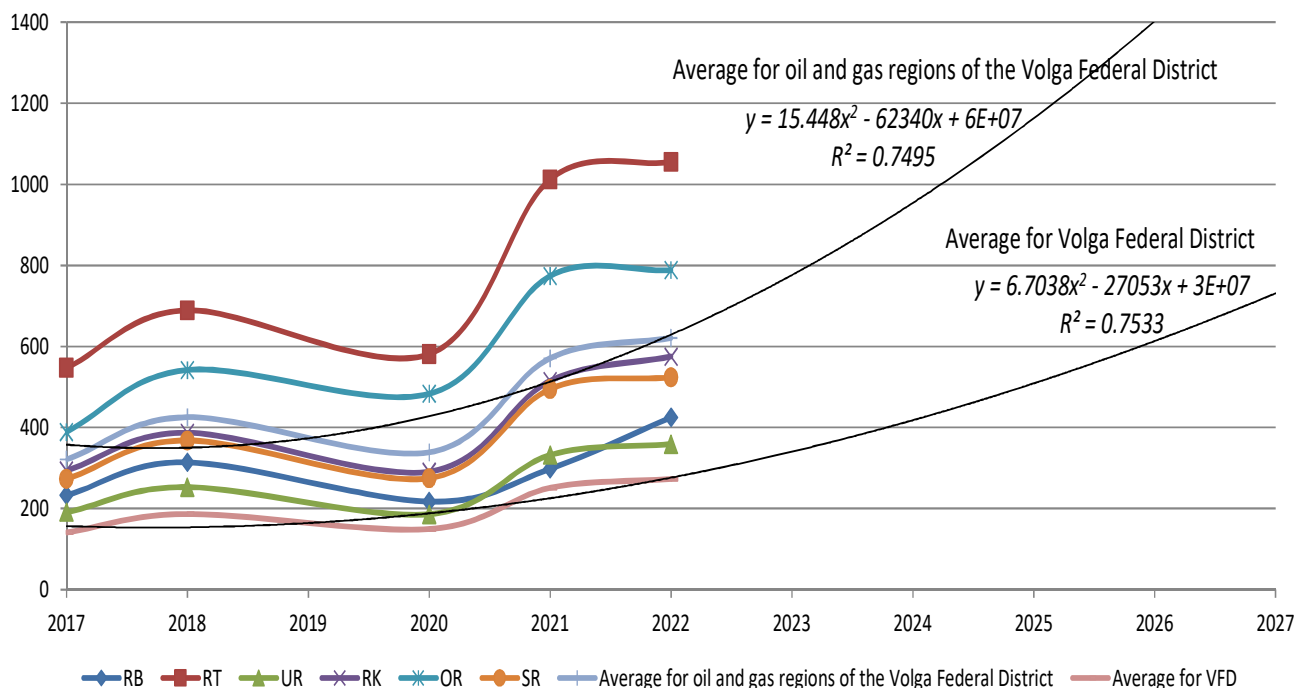

Average for oil and gas regions of the Volga Federal District
$y = 15.448x^2 - 62340x + 6E+07$
$R^2 = 0.7495$

Average for Volga Federal District
$y = 6.7038x^2 - 27053x + 3E+07$
$R^2 = 0.7533$

RB   RT   UR   RK   OR   SR   Average for oil and gas regions of the Volga Federal District   Average for VFD
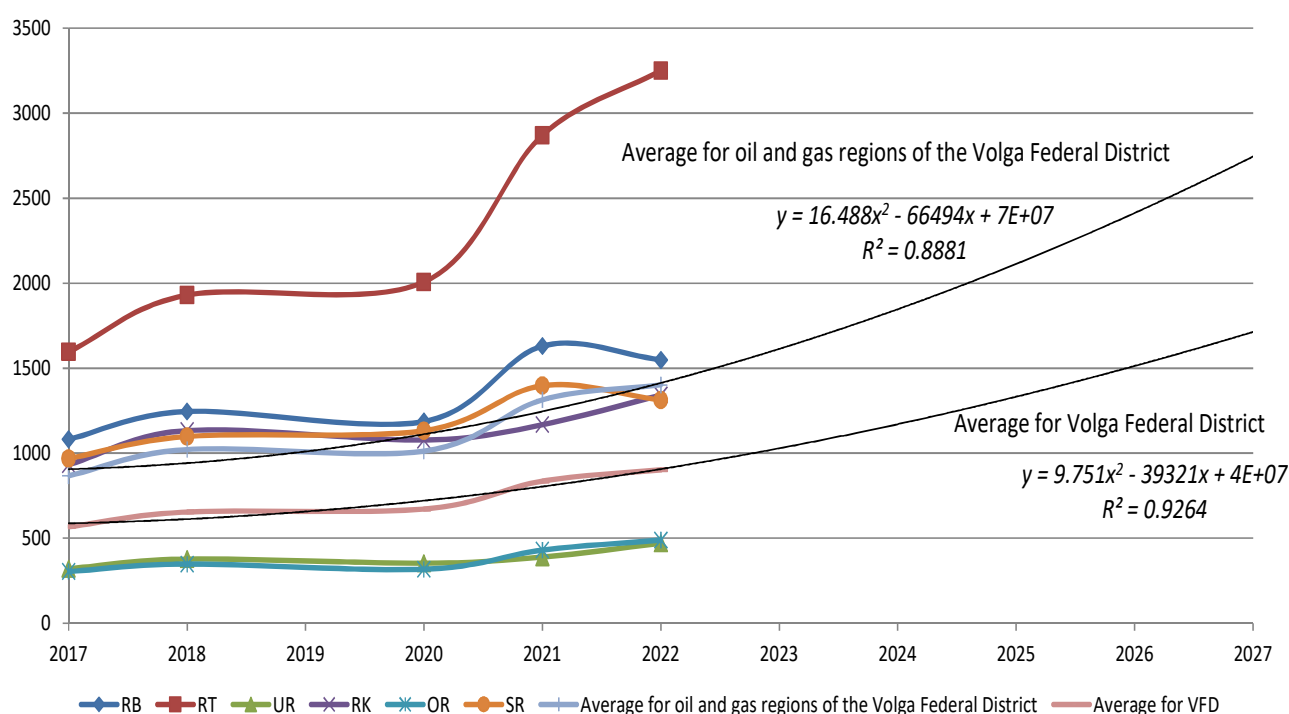
Fig. 1. **Dynamics and forecast of the volume of production, works and services of oil and gas regions of the Volga Federal District by the type of economic activity "Mining" (billion Roubles)**

Source: compiled by the author.

Fig. 2. **Dynamics and forecast of the volume of production, works and services
of oil and gas regions of the Volga Federal District by the type of economic activity
"Manufacturing" (billion Roubles)**

Source: compiled by the author.

in the considered indicator of the activity "Mining and quarrying" is even more impressive indicated in the manufacturing industry, which, among other reasons, can be attributed to the innovative production policy coordinated with regional administration (*Fig. 1, 2*).

Transformation of pairwise regression equations from polynomial into their logarithmic form leads to the following system of equations for the model of economic activity "Manufacturing":

$$Y \text{ OGR in VFD} = 201776\ln(x) - 2E + 06,$$

$$Y \text{ Average in VFD} = 127046\ln(x) - 966179.$$

The research work has indicated that the lowest coefficient value of the oil and gas activity in the Republic of Bashkortostan correlates both with the smallest ratio of oil production in the industrial structure of the region and with the lowest profitability of sold products in three of the four integral components of the industrial sectors. The region with the highest value of this coefficient is the Orenburg Oblast, which in turn has an average value of asset and product profitability. However, their maximum values of asset and product profitability are observed in the Republic of Tatarstan and the Perm Krai for two main types of industrial economic activity: "Mining and quarrying" and "Manufacturing industries". This can be attributed to the above-the-average level of the coefficient of oil and gas production activity in these regions, as well as to other internal economic and innovation-investment factors. Such factors turned out predominant in the Samara Oblast and in the Udmurt Republic, which have an average or below-the-average level of the studied profitability, respectively, however, both reached a significant share of shipped products from the extractive industries (see *Fig. 3* and *Tables 2* and *3*).
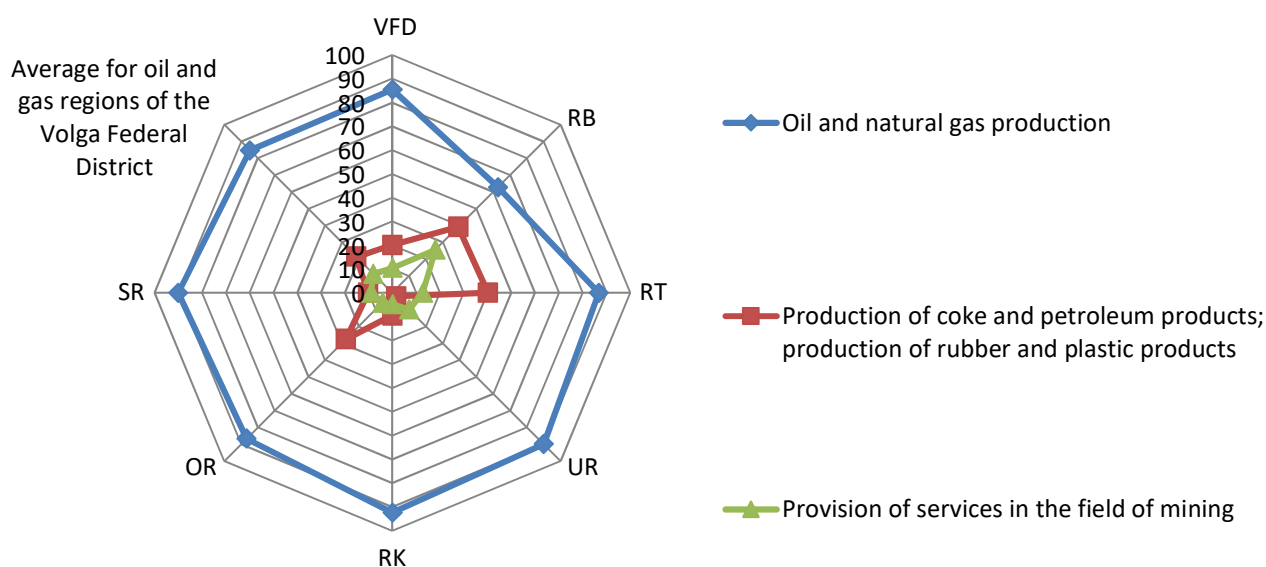
Fig. 3. **Structure of the volume of products shipped and services provided by the regional oil and gas chemical complexes in 2022, in % of the total volume**

Source: compiled by the author.

Table 2

Return on assets of industrial organisations in the oil and gas regions of the Volga Federal District in 2022, in % of the total volume of assets

Region	Mining and quarrying	Manufacturing industries	Provision of electricity, gas and steam; air conditioning
VDF	13.5	11	6.5
RB	7.2	13.2	7.3
RT	24.1	11.2	8.1
UR	5.4	5.2	5.8
PK	19.4	15.5	7.3
OO	7.1	10.9	6
SO	9.6	7.8	6.1
Average of OGR in VFD	12.1	10.6	6.8

Source: compiled by the author.

Profitability of sold goods, products (works, services) of industrial organizations of oil and gas regions of the Volga Federal District in 2022, % of the total volume

Region	Mining and quarrying	Manufacturing industries	Provision of electricity, gas and steam; air conditioning
VDF	18.8	18	6.5
RB	12.3	9.5	8.4
RT	30.8	19.8	7.8
UR	8.9	10.7	2,7
PK	16.3	49	3.1
OO	12.6	20.1	33.1
SO	11.6	17.1	4.4
Average of OGR in VFD	15.4	21.0	9.9

Source: compiled by the author.

Regional scientific and technological development predominantly reflects the level of innovation activity and the scale of enterprises that have implemented technological innovations. As to the dynamics of these indicators in oil and gas regions and in the non-oil and gas regions, they are practically of the same level. This circumstance reveals the issue of identifying the innovative potential of regional economic development under the influence of the determinant of budget-forming oil and gas industry, which can be influenced by various factors. Among the cost-related factors could be expenditure on R&D, generation or use of intellectual property, as to analytical factors, such as the study of the life cycle of innovative products or technologies, or among structural factors, such as the transformation of organisational structures for innovative purposes. At the same time, the exponential growth of both indicators in the Republic of Tatarstan, as well as the stable non-increasing curve demonstrating that the given region lags significantly behind other oil and gas regions in the Orenburg area, brings down the author to conclusion, that the optimal relative value of the regional oil and gas activity coefficient is nearly 0.8. Notably, if this coefficient increases, the region's innovation potential considerably reduces (see *Figures 4* and *5*).
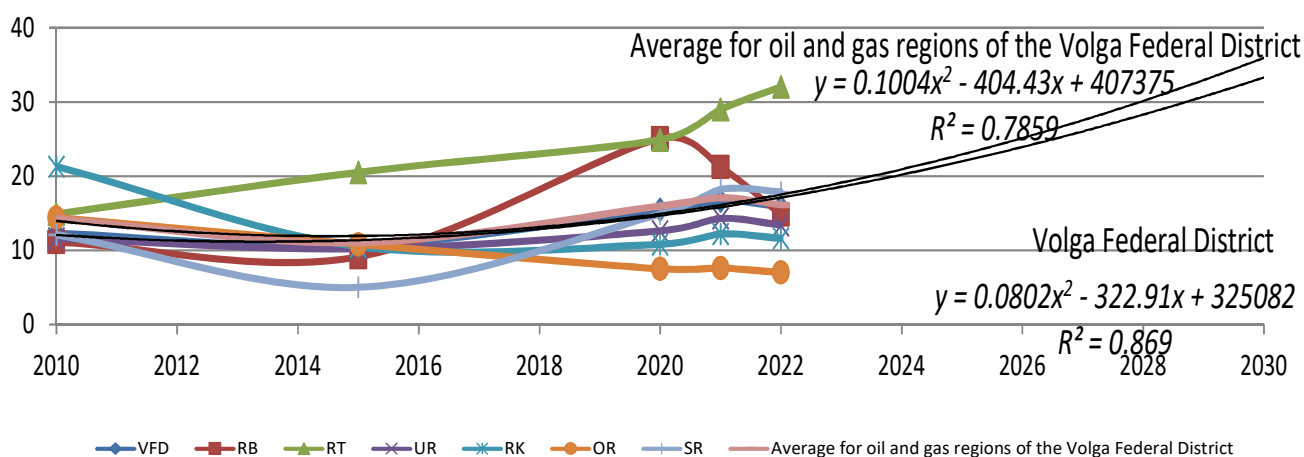
Fig. 4. **The level of innovation activity of the organizations in the oil and gas regions of the Volga Federal District**

Source: compiled by the author.
Note: From 2019 onwards, statistical information on the indicator was provided in accordance with the updated methodology (The Rosstat Decree No. 818 of December 27, 2019).
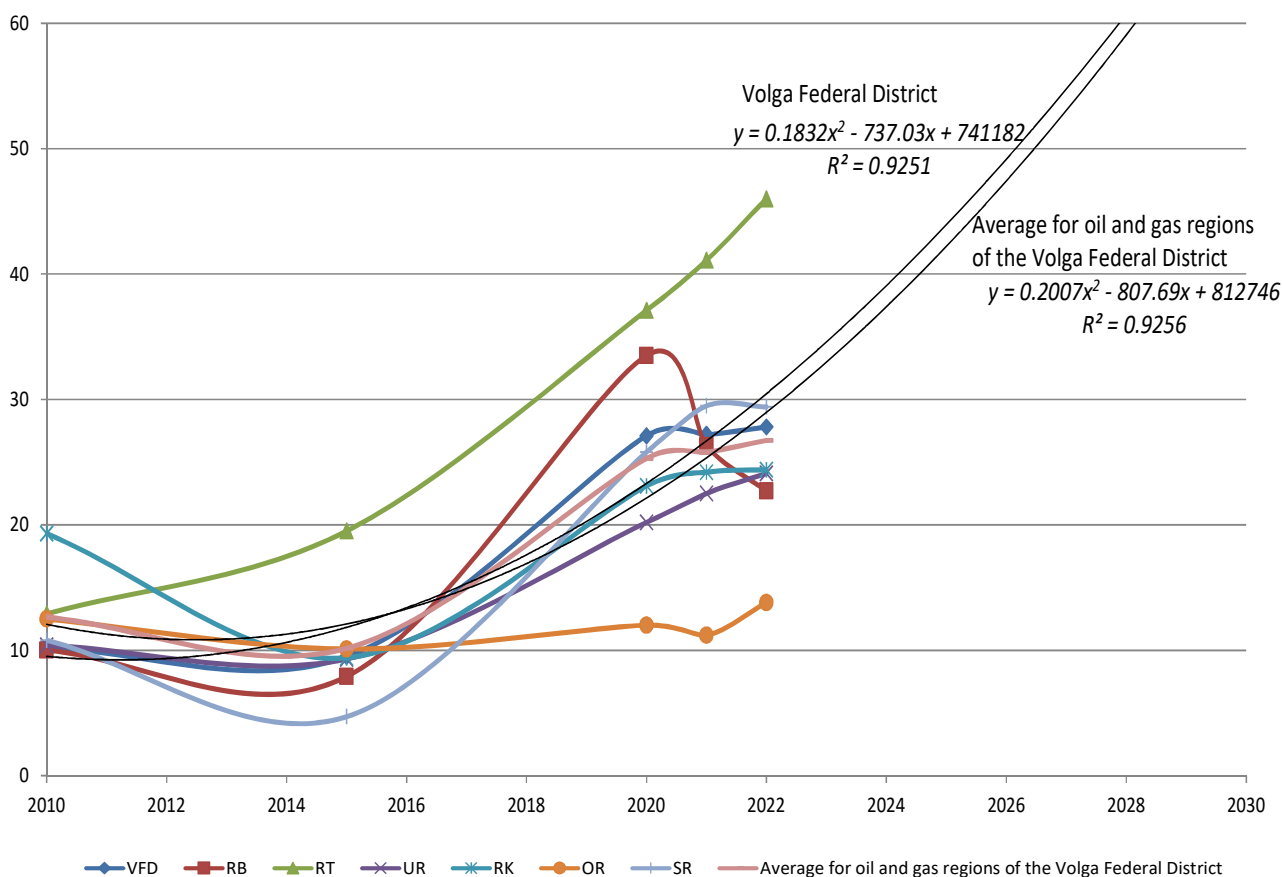

Fig. 5. **The share of organizations that implemented technological innovations in the total number of surveyed organizations in the oil and gas regions of the Volga Federal District**

Source: compiled by the author.
Note: From 2019 onwards, statistical information on the indicator was provided in accordance with the updated methodology (The Rosstat Decree No. 788 of December 20, 2019 with amendments No. 813 of December 18, 2020).

Transformation of pairwise regression equations from polynomial form into their logarithmic form leads to the following system of equations for the model of the level of innovation activity of regional enterprises:

Transformation of the paired regression equations from polynomial into their logarithmic form leads to the following system of equations for the model of the share of enterprises that implemented technological innovations in the total number of surveyed enterprises:

$$Y \text{ OGR VFD} = 2857.8\ln(x) - 21726,$$

$$Y \text{ average in VFD} = 3537.6\ln(x) - 26900.$$

Consequently, the average cost of innovation activities for enterprises in the oil and gas regions of the Volga Federal District was lower than the average for all regions. This is determined by

the expenditure levels significantly below the standard in the Republic of Bashkortostan, the Orenburg Oblast and the Udmurt Republic, which respectively have the lowest, highest and average oil and gas activity coefficients in the region. The structure of costs and expenses on innovation activities by enterprises in oil and gas regions showed a close mutual dependence on the volume of their innovative goods, works and services. In both cases, the Republic of Tatarstan has become in a predominant position, meanwhile the three above mentioned regions lagged behind, which could lead to an institutional trap in the conditions of a technological embargo (see *Figures 6* and *7*).

The transformation of pairwise regression equations from polynomial form into their logarithmic form leads to the following system of equations for the model of the volume of innovative goods, works and services of regional enterprises:
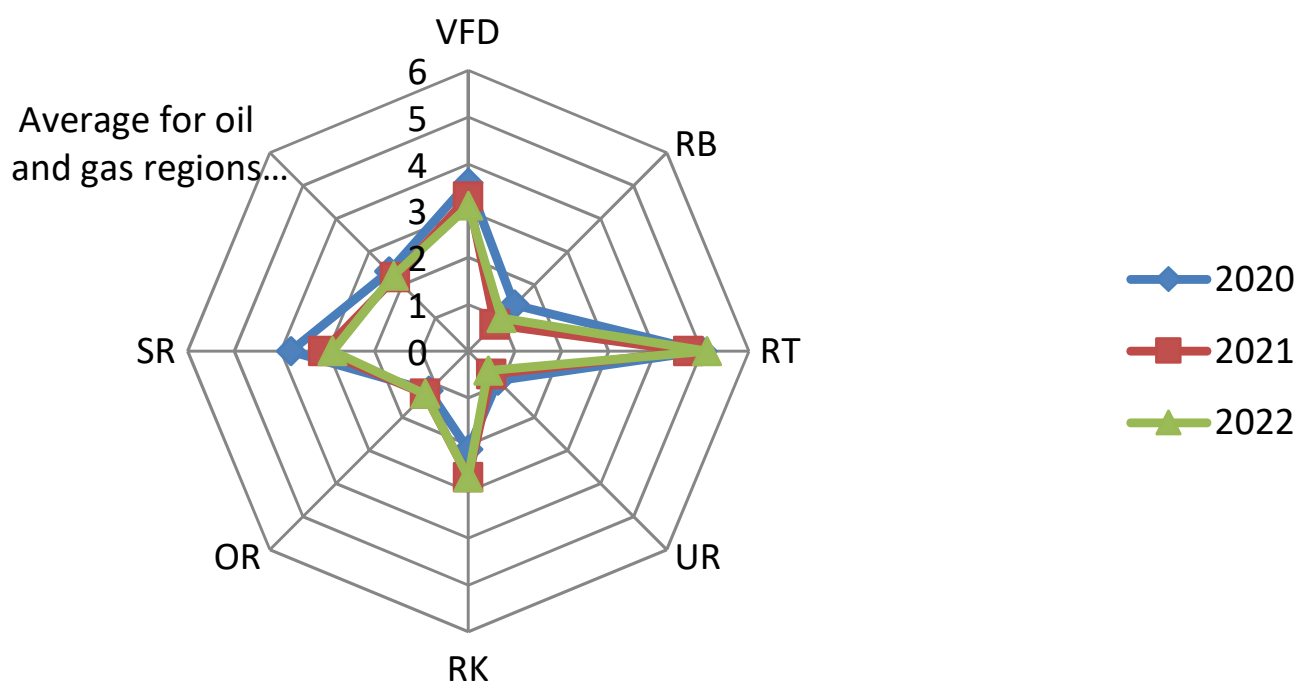

Fig. 6. **Expenditure on innovation activities of organisations in the oil and gas regions of the Volga Federal District, % of the total volume of goods shipped, works performed and services rendered**
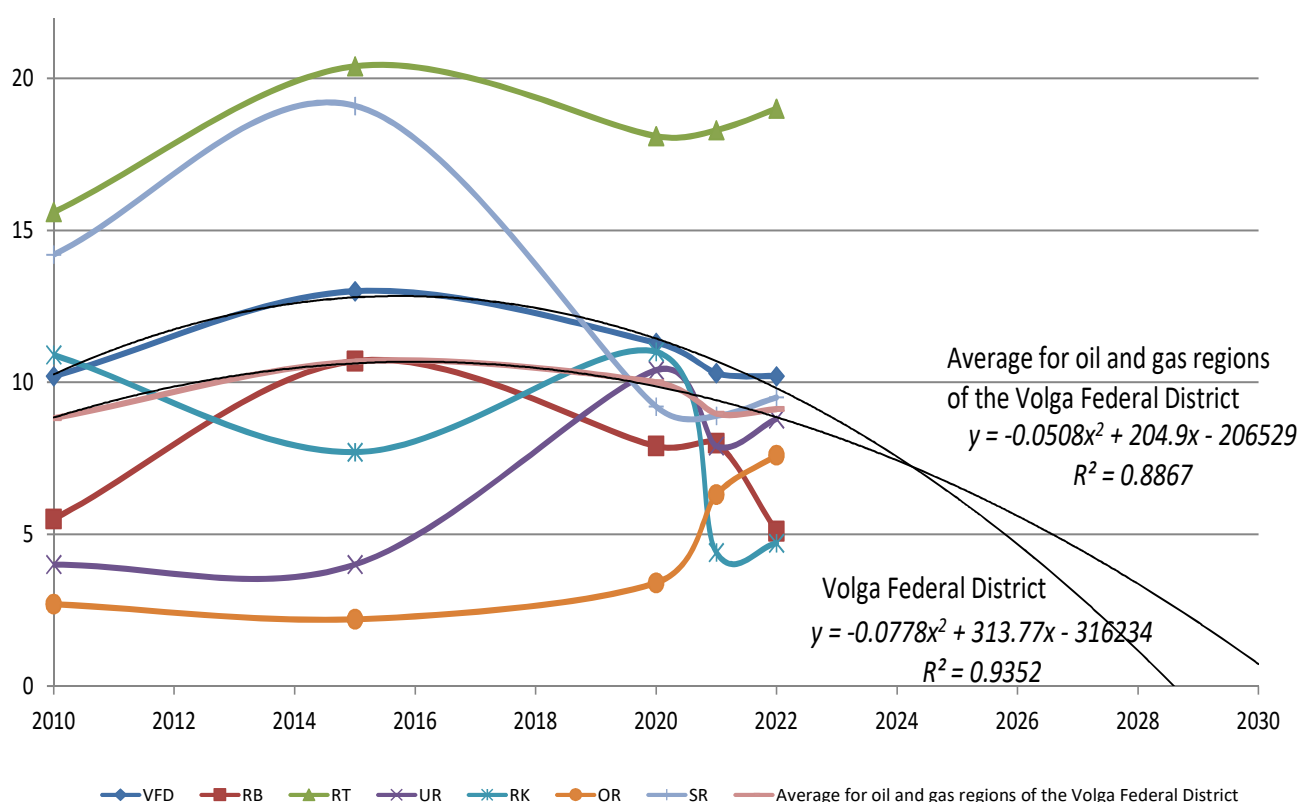
Source: compiled by the author.

Fig. 7. **Volume of innovative goods, works, services of organizations of oil and gas regions of the Volga Federal District, % of the total volume of goods shipped, works performed and services rendered**

Source: compiled by the author.

$$Y\,OGR\ in\ VFD = -3.433\ln(x) - 35,638,$$

$$Y\,average\ in\ VFD = -85.32\ln(x) - 660,29.$$

Nationally oriented economic policy can include a wide range of conditions and factors, which can make an impact on the formation of the innovative potential of regional economic development, under the influence of the budget-forming oil and gas industry determinant. Probably, among the first of them become the principles of balancing technological and reproductive innovation investments aimed to increase refunding of regional capital stock. To achieve these principles, enterprises should elaborate their strategies of innovation for commercialisation focused on transitioning to new technological models, and cost-effectively influencing the

structure of innovation capital on the regional property complex, in view of the problems of scientific and technological development, as well as the institutional entrapments of the highly profitable oil and gas chemical complex. Advancing in these designed areas in the context of transformation of the global energy balance is possible only by means of development of mechanisms for simple and expanded innovative reproduction of fixed assets in the oil and gas sector. The basic contribution is the methodology of indicative programme management of regional economic system of cyclicality in view of the optimisation and strategic planning of interregional and foreign trade turnover, based in their turn on the fundamentals of interaction between industrial and trade policy (*Fig. 8*).

The formation and disclosure of the innovative potential of regional economic development,

influenced by the budget-forming oil and gas industry, can attract additional investments for reproducing fixed assets and achieving economic and technological independence within the industry.

Besides, within the framework of the problem under consideration, innovation process of inclusive institutional transformations is essential, which is developing in primary and aggregated

industrial structures, as well as a liable tariff policy for restructuring regional oil and gas industry in the context of external shocks to the fuel and energy complex.

Due to uncertainty in the global demand for fossil fuels, as well as in the consumption of raw materials and energy, the industries require profitability forecasting of assets and products in
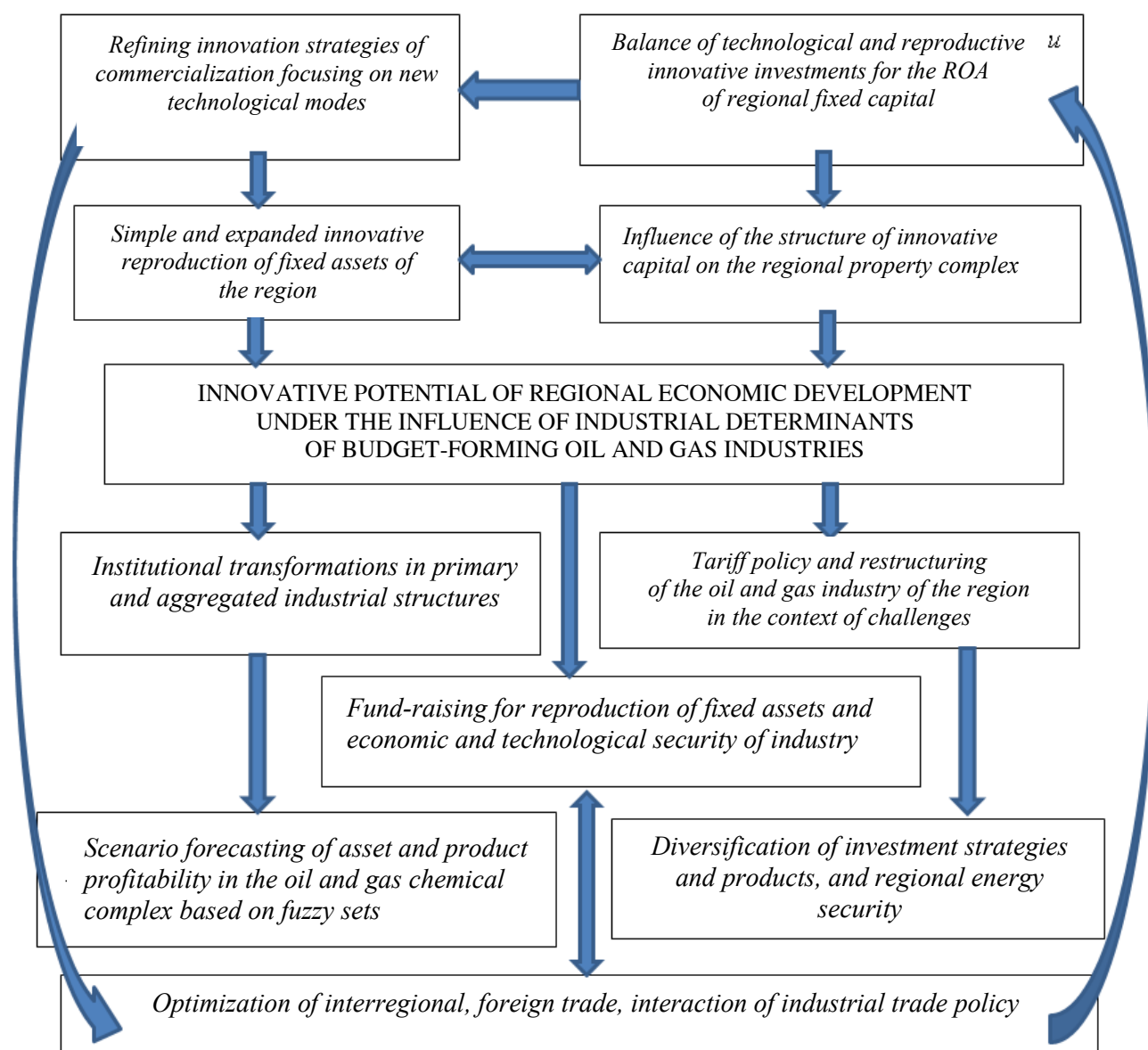

Fig. 8. **Equilibrium cyclic model of the system of priority conditions and optimal results to determine and disclose the innovative potential of regional economic development under the influence of the industrial determinant of the budget-forming oil and gas industry**

Source: compiled by the author.

the oil and gas complex developed on the basis of fuzzy set theory methods. This method appears to be an important factor in diversification of investment strategies and innovative products for regional energy security.

Under the influence of the industrial determinant of the budget-forming oil and gas industry, the equilibrium of the developed cyclical model of the system of priority conditions and optimal results contributes to determine (by the balance and pairing of the included indicators) the formation and disclosure of the innovation potential of regional economic development. The cyclicality character of the model is substantiated by the necessity that combined technological and reproductive innovation investments are essential for the growth of refunding of capital stock in the region, through advanced innovation commercialisation strategies and new industrial models. They also become a direct condition for optimising interregional and foreign trade turnover, as well as the interaction mechanisms between industrial and trade policy.

CONCLUSIONS

The obtained results of the given research work take into account the specific feature of oil and gas region management, which is substantiated by:

• the presence of a budget-forming regional oil and gas complex, which requires the encouragement of regional programmes;

• high volatility of oil quotations and, subsequently, depending on it gas quotations on world commodity markets, which leads to uncertainty regarding oil and gas revenues in the regional budget.

In the context of the Russian economy, the major problems of management of oil and gas regions can be summarised as follows:

• additional diversification tasks of the regional budget's oil and gas revenues;

• ecological issues: contamination of the atmosphere and agricultural land, as well as the problem of the coherent use of associated petroleum gas.

Theoretical significance of the given research work is substantiated by its focus on tackling a neo-institutional scientific approach to the economic mechanisms of an innovative industrial development model, taking in consideration of market competitive advantages and the issues related to the concept of the so-called "oil curse" in highly profitable oil and gas industries and their related regional economic sectors.

In practice, the results obtained in the given article are applicable for the industries involved in activities related to natural resources, as well as in areas of territorial concentration of high-tech industries and knowledge-intensive services [28–32]. This leads to the subsequent research work into developing a comprehensive strategy for managing the economic development of oil and gas regions, based on the management of their financial and industrial systems, as well as the social and environmental responsibility mechanisms in oil and gas production and processing territories, taking into account the factors and consequences of using the regional industrial innovation potential model. Besides, the study of the problems of regional regulation during the transition to new business models in foreign trade is of current scientific interest as well. Specifically, due to a focus on the development of inter-sectoral approaches and horizontal industrial policies in the production of raw materials and industrial goods, as well as the import substitution of products with a high added value, resulting from the deep chemical processing of hydrocarbons.

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