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ОБЗОР КЛЮЧЕВЫХ ИННОВАЦИОННЫХ ПОКАЗАТЕЛЕЙ РОССИЙСКИХ РЕГИОНОВ: АНАЛИТИЧЕСКИЙ ОБЗОР ИННОВАЦИОННО-АКТИВНЫХ ТЕРРИТОРИЙ ЦЕНТРАЛЬНОГО ФЕДЕРАЛЬНОГО ОКРУГА

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Аннотация.
В статье представлены результаты исследования инновационного потенциала российских регионов. В качестве субъектов исследования были выбраны три региона Центрального федерального округа, лидирующие в 2020 году по уровню инновационной активности организаций среди субъектов Российской Федерации (Тульская область, Белгородская область, Ивановская область). Был проведен обзор инновационной инфраструктуры и ключевых стратегических приоритетов инновационного развития в отдельных регионах. Изучена взаимосвязь между параметрами "затраты на инновационную деятельность организаций региона" и "уровень инновационной активности организаций региона". Составлены корреляционно-регрессионные модели, выражающие взаимосвязь между временными характеристиками уровня инновационной активности и затратами на инновационную деятельность.

Ключевые слова: инновации; регионы; Центральный федеральный округ; инновационная активность; затраты на инновационную деятельность; корреляционно-регрессионные модели

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OVERVIEW OF KEY INNOVATION INDICATORS OF RUSSIAN REGIONS: ANALYTICAL PROFILE OF INNOVATION-ACTIVE TERRITORIES OF THE CENTRAL FEDERAL DISTRICT

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Abstract.
The article presents the results of the study on the innovation potential of Russian regions. Three regions of the Central Federal District have been selected as research subjects, leading in 2020 in the level of innovation activity of organizations among the subjects of the Russian Federation (Tula Region, Belgorod Region, Ivanovo Region). A review of innovation infrastructure and key strategic priorities of innovative

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development in selected regions has been undertaken. The correlation between the parameters "costs of innovation activity of organizations in the region" and "level of innovation activity of organizations in the region" has been studied. Correlation-regression models have been compiled that express the relationship between the temporal characteristics of the level of innovation activity and the costs of innovation activity.

Introduction

Innovation is a global trend that has become a key strategy for many countries to seek competitive advantage. Innovation processes are the result of a large number of interactions between various participants and institutions that form the national innovation system as a whole.

The innovation system consists of relationships and exchanges with enterprises, governments and academia on science and technology development.

The theory and practical aspects of innovative development have been a relevant area for researchers for many years. Almost all research on innovation was based on results previously obtained by J. Schumpeter (Theory of Dynamic Economics), F. Hayek (Diffused Knowledge Concept), D. North (Institutional Theory), R. Solow (role of scientific and technological progress in economic growth), P. Romer and R. Lucas (Endogenous Growth Theory).

In the 21st century, the role of innovation in the economy has significantly increased, and the scientific and innovation potential of countries has become a vital aspect of competitiveness, both within countries and within regions.

Research objective is to study the innovation activity of the Russian regions of the Central Federal District, in particular Belgorod Region, Ivanovo Region, and Tula Region. The regions in question are currently characterized by a high level of innovation activity among the subjects of the Russian Federation.

The methodological basis for studying the innovation activity of regions is the system approach that allows generalization and synthesis of the studied material.

The analysis of a number of indicators of innovation activity in the Russian regions makes it possible to underscore the vector of their innovative development.

Main part

In 2020, there were 4,175 scientific research and development organizations in the Russian Federation. Most of them was concentrated in the Central Federal District (1579 organizations or 37.8%) and the Volga Federal District (690 organizations or 16.5%). Compared to 2019, the number of relevant organizations increased by 3.1%. 11,386 organizations in the Russian Federation carried out innovation activities in 2020, which is 15.7% more over 2019[On Innovation Activities…, 2009].

To assess the success of the implementation of certain aspects of innovative development in the Russian Federation, we will conduct a comparative analysis of the state of the innovation sphere in a number of regions (limited to the territory of the Central Federal District).

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Таблица 1

Уровень инновационной активности организаций по субъектам Российской Федерации, %
[Лидеры по показателям..., 2020; Федорова Л.А., 2020]

Table 1

Level of innovation activity of organizations, by subjects of the Russian Federation, %
[Leaders in terms…, 2020; Fedorova, L.A., 2020]

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | | 2018 | 2019 | 2020 |
								according to the Oslo Manual (3rd ed.) criteria	according to the Oslo Manual (4th ed.) criteria			
Russian Federation	9.5	10.4	10.3	10.1	9.9	9.3	8.4	8.5	14.6	12.8	9.1	10.8
Central Federal District	8.6	10.2	10.9	10.7	10.9	10.9	10.3	9.9	18.5	16.2	10.8	12.5
Belgorod Region	*10.9*	*12.2*	*9.2*	*9.6*	*11.5*	*12.7*	*14.1*	*14.8*	*19.8*	*18.2*	*15.1*	*18.0*
Bryansk Region	8.8	9.6	8.9	7.8	8.2	7.7	6.8	6.2	9.5	8.2	10.1	10.9
Vladimir Region	9.5	10.8	12.8	10.7	12.6	11.2	10.4	9.0	15.3	13.0	10.5	12.6
Voronezh Region	8.6	9.2	9.0	10.0	10.3	11.0	11.6	11.7	18.6	17.1	13.4	15.9
Ivanovo Region	*5.8*	*5.1*	*8.5*	*8.4*	*6.3*	*4.4*	*3.2*	*4.2*	*9.0*	*8.1*	*10.0*	*16.2*
Kaluga Region	8.3	7.9	10.6	10.9	9.7	10.9	8.5	9.0	17.5	16.6	11.5	12.1
Kostroma Region	8.5	9.1	6.0	7.0	6.0	8.2	8.6	2.8	6.5	5.8	4.6	5.6
Kursk Region	7.1	13.7	13.0	10.7	9.9	7.3	6.5	5.0	10.6	8.9	5.4	7.6
Lipetsk Region	8.9	10.0	14.1	17.5	18.6	20.0	19.2	18.5	29.1	23.6	11.1	11.5
Moscow Region	6.7	8.1	8.5	8.4	8.7	8.0	8.5	8.9	18.8	14.1	8.6	10.8
Oryol Region	*11.5*	*10.7*	*10.1*	*8.4*	*8.4*	*9.6*	*7.4*	*6.8*	*11.0*	*8.6*	*10.4*	*13.7*
Ryazan Region	7.0	8.4	11.0	11.4	13.1	12.7	12.3	12.1	17.5	16.4	11.8	10.9
Smolensk Region	5.5	6.6	6.7	6.6	6.6	7.3	6.9	6.5	11.7	10.8	8.4	7.1
Tambov Region	8.2	5.9	8.5	8.8	9.1	9.6	10.6	11.0	12.3	11.0	10.2	12.5
Tver Region	5.1	7.8	9.3	9.2	8.0	7.9	7.9	8.7	16.3	15.6	12.1	12.0
Tula Region	*10.5*	*11.0*	*13.1*	*12.9*	*13.4*	*12.9*	*10.9*	*9.2*	*16.9*	*15.4*	*11.7*	*20.2*
Yaroslavl Region	10.0	12.0	12.3	11.0	10.3	8.7	7.1	8.3	16.3	14.2	10.6	10.7
Moscow	*13.3*	*18.6*	*18.6*	*18.3*	*18.8*	*19.7*	*16.1*	*14.3*	*32.4*	*33.8*	*12.1*	*13.0*

Some regions of the Central Federal District have drawn our attention, namely, those with the most significant results in this sphere: Belgorod Region, Ivanovo Region, Tula Region. These regions are the leaders (TOP-3) in 2020 in the level of innovation activity of organizations among the subjects of the Russian Federation.

It should be noted that, in general, this district has results above the average. This clearly indicates that the regions of the Central Federal District are most successful in implementing the main objectives of the innovative development strategy.

Let us analyze the innovation potential of the selected regions.

Belgorod Region. To date, the region is actively working to formulate an updated Strategy for the Socio-Economic Development of Belgorod Region up to 2030. The key direction of development in the strategy being developed is "Innovative Belgorod Region". The goal of this priority area is to ensure a scientific and technological breakthrough in key sectors of the Belgorod and Russian economy, and to increase the share of innovative products in the shipment due to comprehensive support of researchers and developers.

The main strategic objectives of the innovative Belgorod Region up to 2030 are:
– developing the region as a point of attraction for researchers;
– introducing Belgorod technologies to the Russian and world markets;
– creating a closed-loop economy;
– reducing ecological footprint;
–increasing cooperation between science and business.

On the territory of Belgorod Region, the Law of Belgorod Region dated October 1, 2009 No. 296 "On Innovation Activities and Innovation Policy in the Belgorod Region" is in force [On Innovation…, 2009].

With regard to innovation infrastructure, institutions include:
–Department of Investment and Innovation (part of the Ministry of Economic Development and Industry of Belgorod Region), which ensures the implementation of public

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innovation policies at the regional level, providing a maximum enabling environment for the implementation of the innovative scenario for the development of the region;

–Belgorod Regional Resource Innovation Center (Business Incubator), which is the regional representative of the Foundation for Assistance to Small Innovative Enterprises in Science and Technology (Innovation Assistance Fund) since 2016. The Center implements innovation development programs aimed at creating new and developing existing high-tech companies, as well as commercializing the results of scientific and technical activities;

–World-class Scientific and Educational Center "Innovative Solutions in the Agro-Industrial Complex", which is considered a connecting element for the development of innovations in Belgorod Region and through which trending scientific technologies are transferred to real business. The Center was established in 2019 as part of the implementation of the "Science" National Project. The activities of the Center are aimed at actively participating in ensuring the competitiveness of the Russian Federation as a world scientific power and leader in the field of agrarian science; strengthening food security and the independence of the country; expanding Russia's presence in world food markets; improving the well-being and quality of life of citizens of Russia and Belgorod Region.

Also, the regional innovation infrastructure of Belgorod Region includes Belgorod Regional Fund for the Support of Small and Medium Enterprises, Belgorod Intellectual and Innovation System Development Fund, "Severny" Industrial Park, Patent and Information Center of the Belgorod State Universal Scientific Library, Regional Center for Intellectual Property at Belgorod State National Research University (NRU BelSU), Technological Park "High-Tech" of NRU BelSU, Center of High Technologies of Shukhov Belgorod State Technological University (BSTU), Business incubator of Shukhov BSTU, Innovation and Technology Center of Shukhov BSTU, Educational and Scientific

Innovation Center "Agrotechnopark" of Gorin Belgorod State Agrarian University, Biryuch Innovation Center, Centers for Youth Innovative Creativity "CLUSTER" and "Metamorphosis".

Ivanovo Region. Decree of the Government of Ivanovo Region dated April 27, 2021 approved the Strategy for Social and Economic Development of Ivanovo Region until 2024, within which the block "Innovation Development Strategy of the Region" was identified. The objective of the innovation strategy of development of the region is "formation of an innovative-oriented structure of the economy, a comfortable economic environment and institutional conditions for enhancing the innovative development of the region".

Among the priorities for innovative development in the region are:

–technological upgrading and modernization of industrial enterprises;

–development of science and innovation activity.

The main areas of innovation and scientific activity of Ivanovo Region, which generally determine the specialization of the region, are developments in the textile industry, in the sphere of manufacturing of industrial machinery and equipment, special and construction equipment, in energy-saving technologies, as well as fashion and design.

From 2014 to 2024, the Ivanovo Region State Program "Economic Development and Innovative Economy of Ivanovo Region" (with changes of 01/20/2022) is being implemented. Under the State Program, such subprograms as the development of small and medium-sized enterprises, fundamental scientific research, human resources for the innovative economy, and the creation of a favorable investment environment operate.

The region's innovation infrastructure is quite extensive. It includes Industrial Park "Rodniki", Educational and Scientific Center for Technological and Ecological Safety in Energy, Center for Design and Improvement of Reliability of Electrical Equipment, Center for Energy Efficient Technologies, Research

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Center and Experimental Biomedical Clinic with Vivarium, Research Institute for Macro-Heterocyclic Compounds, Regional Center for Nano Industry, etc [Lukasheva, N.A., 2015].

Tula Region. According to the Program for Social and Economic Development of Tula Region (2021-2026), one of the strategic objectives of the region (there are 7 in total) is "building a highly efficient and sustainable scientific ecosystem of the region with the volume of 100 billion rubles per year of shipped innovative domestically produced goods by 2030" [Program of Social…, 2022].

In general, the priority direction of the region's development is its innovation activity ("Knowledge: Innovation Activity"), focused on improvement and development of higher education, general innovation development and creation of breakthrough technologies.

Regional priority projects within the strategic direction of development "Knowledge: Innovation Activity" by 2026 are: active operation of the Scientific and educational center of the world level "TulaTECH"; formation of research and innovation infrastructure of the innovative scientific and technological center "Composite Valley"; increased share of new advanced high-tech products; formation of the Center of Technological Excellence of the Tula Region; creation of an ecosystem of personnel training at the request of enterprises for their research and production activities; implementation of new approaches in the design, production and testing of prototypes; enhancement of technological and digital maturity of industrial production [On Approval…, 2021]; transformation of educational space in the field of general, secondary vocational and higher education, and formation of a single educational ecosystem of the region, including development of student technological entrepreneurship.

The region has a Strategy for the Development of Science, Technology and Innovation in Tula Region until 2030 (approved by Decree of the Government of Tula Region No. 539 dated August 27, 2021).

The existence of this strategic document is a certain competitive advantage of Tula Region in innovation activity.

The Strategy contains an assessment of regional innovation policies, including the innovation activity of organizations, the performance of higher education organizations, activities of regional authorities to develop innovative infrastructure and measures to support innovation projects.

As for the innovation infrastructure of Tula Region, it includes the Committee of Tula Region on Science and Innovation (which forms and implements the regional policy in the field of science and innovation in the Tula Region); Autonomous Non-Profit Organization "Scientific and educational center of the world level "TulaTECH" (association of universities, scientific organizations and organizations operating in the economic sector); innovative scientific and technological center "Composite Valley" on the basis of Tula State University.

In 2022, eleven scientific laboratories began their operation in the region at Tula State University, Tolstoy Tula State Pedagogical University (TSPU), and Novomoskovsk Institute of the Mendeleev Russian Chemical-Technological University. The main activities of the new laboratories are developments in the areas of defense and weapons, the creation of new materials and technologies for their production, environmental safety, and medicine.

After analyzing the current state of innovation activity in the selected regions, we address to recent statistics that illustrate the increase in innovation capacity in the above-mentioned regions (Table 2).

Our main indicator for evaluating success has been the level of innovation activity, which is defined in the guidelines as the ratio of the number of organizations that have implemented technological, organizational, or marketing innovations to the total number of organizations surveyed in the country, industry, and region over time.

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Таблица 2

Уровень инновационной активности организаций по отдельным субъектам
Центрального федерального округа, %

Table 2

Level of innovation activity of organizations, for selected subjects
of the Central Federal District, %

	2018	2019	2020	Deviation +/-, %	
				2019 to 2018	2020 to 2019
Russian Federation	12.8	9.1	10.8	-28.9	18.7
Central Federal District	16.2	10.8	12.5	-33.3	15.7
Belgorod Region	18.2	15.1	18.0	-17.0	19.2
Ivanovo Region	8,1	10.0	16.2	23.5	62.0
Tula Region	15.4	11.7	20.2	-24.0	72.6

Compiled by author

Although these regions have shown the most successful performance in recent years, the data in Table 1 indicate a decline in innovation activity in 2019 compared to 2018 in the following regions: Belgorod Region by 17% and Tula Region by 24%. In 2020, there was no negative dynamics, a-nd the largest increase was in the Ivanovo Region by 62%.

This indicator can be considered as the resulting value (final outcome) that correlates with the costs of innovation activity of organizations in the region. The dynamics of costs for innovation activity in the analyzed territories is presented in Table 3.

Таблица 3

Затраты на инновационную деятельность организаций по отдельным субъектам
Центрального федерального округа, млн руб.

Table 3

Costs of innovation activity of organizations, for selected subjects
of the Central Federal District, million rubles

	2018	2019	2020	Deviation +/-, %	
				2019 к 2018	2020 к 2019
Russian Federation	1472822.3	1954133.3	2134038.4	32.7	9.2
Central Federal District	494893.3	844271.4	890687.9	70.6	5.5
Belgorod Region	20703.2	30653.0	21540.9	48.1	-29.7
Ivanovo Region	154.7	195.3	1402.4	26.2	7 times more
Tula Region	18717.7	56822.0	26638.5	203.6	-53.1

Compiled by author

As can be seen from Table 3, the dynamics of the costs of innovation activity is different. In 2020, the decline was in Belgorod Region (by 29.7%) and Tula Region (by 53.1%). Against this background, in Ivanovo Region in 2020 there was a significant increase in the costs of innovation activity of

organizations, the figure in 2020 exceeded the level of 2019 by more than 7 times. This explains the significant increase in innovation activity.

To objectively substantiate the correlation between the level of innovation activity and the costs of innovative activity, a correla-

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tion and regression analysis based on the growth rates of these indicators is conducted. We have to use relative indicators, since in 2017 some adjustments were made to the cal- culation of the level of innovation activity (Oslo Manual). The growth rates allows for a convergence of the series and a review of the period from 2015 to 2020 (Table 4).

Таблица 4

Данные для корреляционно-регрессионного анализа

Table 4

Data for correlation regression analysis

	Growth rate	2016 to 2015	2017 to 2016	2018 to 2017	2019 to 2018	2020 to 2019
Russian Federation	level of innovation activity, %	90.3	101.2	87.7	71.1	118.7
	costs of innovation activity, %	106.7	109.4	104.8	132.7	109.2
Central Federal District	level of innovation activity	94.5	96.1	87.6	66.7	115.7
	costs of innovation activity	128.4	86.6	108.2	170.6	105.5
Belgorod Region	level of innovation activity	111.0	105.0	91.9	83.0	119.2
	costs of innovation activity	850.0	117.3	86.8	148.1	70.3
Ivanovo Region	level of innovation activity	72.7	131.3	90.0	123.5	162.0
	costs of innovation activity	127.7	70.2	61.1	126.2	718.1
Tula Region	costs of innovation activity	84.5	84.4	91.1	76.0	172.6
	costs of innovation activity	151.2	92.6	116.1	303.6	46.9

Moreover, by constructing histograms for the growth rates of the selected indicators we present their comparative analysis in the territorial comparison of data (Fig. 1).
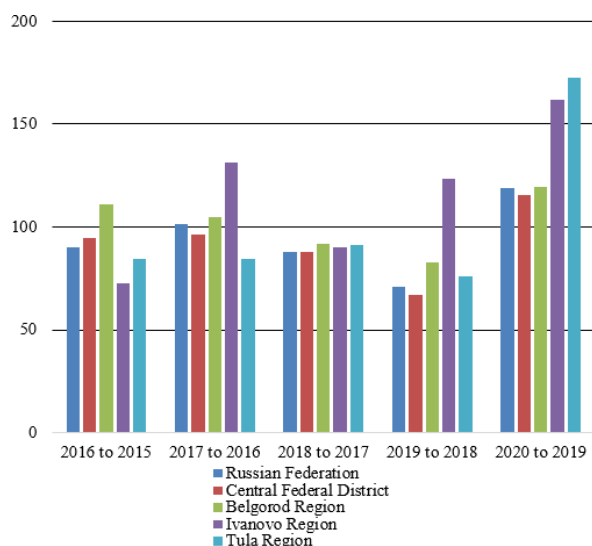
a) Growth rate of the level of innovation activity
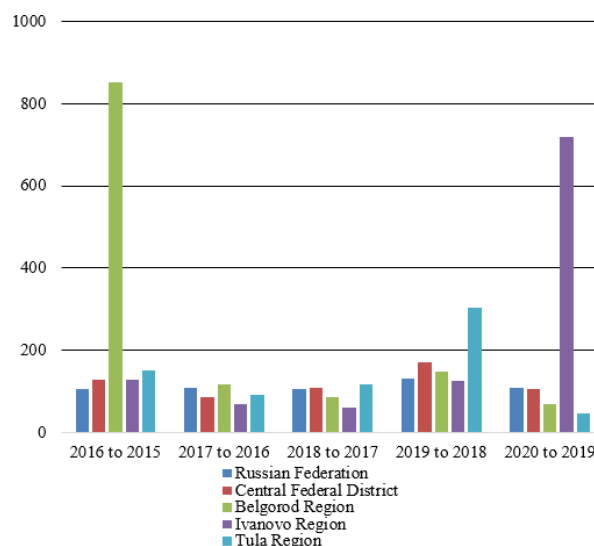
б) Growth rate of the costs of innovation activity

Рис. 1. Гистограммы временных характеристик уровня инноваций и затрат на инновации

Fig. 1. Histograms of the temporal characteristics of the level of innovation and the costs of innovation

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A graphic representation of the temporal characteristics of the level of innovation activity and the costs of innovation activity (Fig. 1) does not show a clear correlation between the growth rates of the indicators considered. This can be explained by the lack of synchrony in the influence of factor magnitude and the responsiveness of the result. The results of the construction of the regression equations are presented in Fig. 2 and Fig. 3.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,617419
R Square	0,381207
Adjusted R Square	0,174942
Standard Error	15,98965
Observations	5

ANOVA

	df	SS	MS	F	Significance F
Regression	1	472,5135	472,5135	1,848147	0,267161
Residual	3	767,0065	255,6688		
Total	4	1239,52			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95,0%	Upper 95,0%
Y-intercept	200,948	79,13998	2,539146	0,084743	-50,9107	452,8067	-50,9107	452,8067
Variable X 1	-0,95192	0,700216	-1,35947	0,267161	-3,18032	1,276479	-3,18032	1,276479

а) Российская Федерация a) Russian Federation

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,747664
R Square	0,559002
Adjusted R Square	0,412002
Standard Error	13,52354
Observations	5

ANOVA

	df	SS	MS	F	Significance F
Regression	1	695,4695	695,4695	3,802745	0,146265
Residual	3	548,6585	182,8862		
Total	4	1244,128			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95,0%	Upper 95,0%
Y-intercept	141,5101	26,03953	5,434435	0,012231	58,64072	224,3795	58,64072	224,3795
Variable X 1	-0,41207	0,211309	-1,95006	0,146265	-1,08454	0,260413	-1,08454	0,260413

б) Центральный федеральный округ b) Central Federal District

Рис. 2. Результаты регрессионного анализа для Российской Федерации
и Центрального федерального округа
Fig. 2. Results of the regression analysis for the Russian Federation
and the Central Federal District
Compiled by author

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SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,282156
R Square	0,079612
Adjusted R Square	-0,22718
Standard Error	16,13763
Observations	5

ANOVA

	df	SS	MS	F	Significance F
Regression	1	67,57865	67,57865	0,259496	0,645573
Residual	3	781,2694	260,4231		
Total	4	848,848			

	Coefficients	Standard Error	T Stat	P-value	Lower 95%	Upper 95%	Lower 95,0%	Upper 95,0%
Y-intercept	98,89012	9,478147	10,43349	0,001879	68,72643	129,0538	68,72643	129,0538
Variable X 1	0,012298	0,024142	0,509407	0,645573	-0,06453	0,089129	-0,06453	0,089129

а) Белгородская область a) Belgorod Region

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,711866
R Square	0,506753
Adjusted R Square	0,342337
Standard Error	28,54887
Observations	5

ANOVA

	df	SS	MS	F	Significance F
Regression	1	2512,066	2512,066	3,082145	0,17742
Residual	3	2445,114	815,0381		
Total	4	4957,18			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95,0%	Upper 95,0%
Y-intercept	96,13523	17,02212	5,647666	0,010987	41,96326	150,3072	41,96326	150,3072
Variable X 1	0,089571	0,05102	1,755604	0,17742	-0,0728	0,25194	-0,0728	0,25194

б) Ивановская область b) Ivanovo Region

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,633726
R Square	0,401608
Adjusted R Square	0,202144
Standard Error	35,71456
Observations	5

ANOVA

	df	SS	MS	F	Significance F
Regression	1	2568,199	2568,199	2,013438	0,250964
Residual	3	3826,589	1275,53		
Total	4	6394,788			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95,0%	Upper 95,0%
Y-intercept	138,4855	30,43756	4,549822	0,019892	41,61957	235,3513	41,61957	235,3513
Variable X 1	-0,25877	0,182364	-1,41896	0,250964	-0,83913	0,321596	-0,83913	0,321596

в) Тульская область c) Tula Region
Рис. 3. Результаты регрессионного анализа для отдельных регионов
Центральный федеральный округ
Fig. 3. Results of the regression analysis for selected regions of
Central Federal District
Compiled by author

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As we can see, the dependence under study is not strongly related, as evidenced by factor and residual dispersion values. For some regions, the value of the factor dispersion is less than the residual. Therefore, the resulting regression equations do not have practical value, but they can be applied as theoretical models.

Thus, the tested hypothesis of a direct correlation between the observed temporal indicators is confirmed in the models of Belgorod Region and Ivanovo Region, where the coefficient for the variable X1 is positive. In practice, these are the subjects that most successfully implement the strategic tasks in the innovation sphere facing the regions. In other models, the coefficients are negative. However, if we take into account the lag in the dynamics of changes in factor and output variables, then in all models the coefficient will be positive.

Conclusion

In summary, it is possible to say that the impact of innovation policies can be assessed by the timeliness of their implementation in economic activity. In other words, the longer the pace at which innovation activity lags from the cost of innovation, the less effectively the strategy of innovative development of the region is implemented.

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