

TO THE QUESTION OF SPATIAL DIFFERENTIATION OF THE RUSSIAN INNOVATION SYSTEM

Global changes in the production technologies of goods and services are connected with the development of the innovation system. Spatial differentiation plays an important role for the Russian Federation. It is associated with the inhomogeneous distribution of economic activity and the historically formed structure of the economy, which ultimately determine the inhomogeneity of the economic space and in the spatial differentiation of the innovation system as well. A presented method for evaluating and analysing the structure of the innovation system by region confirms a significant inhomogeneity of the Russian Federation subjects in terms of expenditures on technological innovations of organizations. The article presents the application areas of statistical tools for levelling the impact of economies of scale of the regions with excess expenditures. We proposed measures aimed at overcoming adverse conditions and barriers for the transition of the national economy to the knowledge-model within the innovation system.

Keywords: innovation system, knowledge economy, post-industrial society, spatial differentiation.

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К ВОПРОСУ О ПРОСТРАНСТВЕННОЙ ДИФФЕРЕНЦИАЦИИ ИННОВАЦИОННОЙ СИСТЕМЫ РОССИИ

Глобальные изменения, происходящие в технологиях производства товаров и оказания услуг, связаны с развитием инновационной системы. Важную роль для Российской Федерации играет пространственная дифференциация, связанная с неравномерностью размещения экономической деятельности, исторически сложившейся структурой экономики, которые, в конечном счете, и определяют неравномерность экономического пространства, в том числе в пространственной дифференциации инновационной системы. Изложенная методика оценки и анализа структуры инновационной системы в разрезе регионов подтверждает существенную неоднородность субъектов Российской Федерации по объему затрат на технологические инновации организаций. В статье представлено приложение статистического инструментария для нивелирования влияния эффекта масштаба регионов со сверхрасходами. Предложены меры преодоления негативных условий и барьеров для перевода национальной экономики на знаниевую модель в рамках инновационной системы.

Ключевые слова: инновационная система, экономика знаний, постиндустриальное общество, пространственная дифференциация.

Modernization and innovation development are crucial directions, the directions that determine changes in the socio-economic system of the Russian Federation. It is the state of the innovation system that determines the efficiency of the national economy, creates potential possibilities and determines long-term horizons of growth and development of the region' economy at the regional level. The potential of the innovation system becomes a determining factor in the creation of new and

unique products and services, technologies and management practices, which in turn serves as a basis for increasing the competitiveness of economic subjects. [7]

The development of an innovative system is associated with social and economic development of the society, features of the demographic situation in the country. Development and implementation of measures aimed at improving the innovation system should be based on the analytical model that allows getting the long-term forecast for the given parameters of development. Drawing up the analytical model of the innovation system requires a high-quality statistical data, development of the data processing technology, accounting for spatial features of the innovative development by the RF regions. In this regard, elaboration of the statistical research methodology for the status and development of the innovation system, as well as spatial differences, specific to the subjects of the Russian Federation, which influence the long-term sustainability of the system, becomes particularly relevant.

A peculiarity of the Russian Federation, which must be taken into account, when carrying out a statistical research on the innovation system, is the incomparability of the conditions for the social and economic development of individual areas: natural and climatic conditions, availability of natural resources, transport accessibility.

Specified circumstances contribute to the urgency of finding ways to implement the strategy of innovations production and to improve the competitiveness of economic entities and regions based on that, which ultimately would lead to a decrease in the spatial differentiation by regions in terms of the innovation system development.

Application of the «innovation» concept became widespread in the transitional economy of Russia. The application of the concept is associated with the designated concept of related notions: innovative solution, innovation process, innovation system, innovation etc. Modern theorists and practitioners of economics commonly refer to innovations as to the final result, which is implemented as: 1) new or improved product or service; 2) new or improved technological process. On the contrary, western researchers adhere more to the process approach more often. [4]

From the point of view of the «result» approach, the term «innovation» is identical to the term «innovative product». On the contrary, from the point of view of the process approach, an innovation activity is an implementation of practical steps in the areas related to achieving innovation goals, i.e. introduction of new goods or services into production. It is also important to note that in its essence both of them are a process, however, it is the process of innovation that serves as a result of innovation activity. [8]

At an early stage, the result of the innovation process is primarily new unique knowledge (which is implemented as fundamental, basic technologies). At the next stage, a prototype or a trial model serves as a result of the innovation process. At the third, final stage, the result of innovation is the documentation that provides the state registration of intellectual property rights for single or mass production. Thus, each company is not only interested in selling the created unique product or

service, but also in the ability to use the results of the innovation process by selling these results as a commodity [1].

We selected specific features of the innovation activity that underpin the innovation system: uncertainty in the future and a related time lag between the creation and application of innovations; discrepancy between public and private effects; asymmetry of information, available to researchers, potential investors, consumers; substantial investment risks; strict requirements to recruitment and the state of a quality management system. It is important to note that peculiarities of the innovation activity may differ even for enterprises, operating in the same industry or in the same area. A part of enterprises is engaged exclusively in innovation projects (including the development and introduction of a new product or service); others mainly make changes to existing products or services, manufacturing operations and processes.

Expenditures on technological innovation of individual economic entities, as well as national and regional economies play a leading role in the operation of the innovation system. [11] Expenditures on technological innovation of organizations are inhomogeneous across regions, which is due to the economies of scale, different economic specialization, social and economic situations. The analysis of the innovation system structure by region confirms a significant inhomogeneity of the Russian Federation subjects in terms of expenditures on technological innovations of organizations [12].

The city of Moscow takes the first place in terms of expenditures on innovation activity (12.1 % of expenditures are directed to technological innovations of organizations), the Leningrad region (7.48 %) — the second place, followed by the Moscow region (7.31 %), the Krasnoyarsk Territory (6.09 %), Samara region (5.92 %), the city of St. Petersburg (5.73 %), Nizhny Novgorod region (5.47 %), Tyumen region (5.22 %). The last places are taken by the Republic of Adygea (0.01 %), Republic of Dagestan (0.01 %), Republic of North Ossetia (0.01 %), Republic of Kalmykia (less than 0.01 %), Republic of Khakassia (0.01 %), the Altai Republic (less than 0.01 %), and Republic of Tyva (less than 0.01 %).

In order to carry out a qualitative comparative analysis of the innovation activity expenditures at the level of the Russian Federation subjects, it is necessary to consider the expenditure indicator for technological innovations of organizations calculated per capita. By the indicator per capita, the Sakhalin region takes the first place (the indicator value is 42.76 ths. rub.), followed by the Krasnoyarsk Territory (23.73 ths. rub.), Samara region (20.51 ths. rub.), Nizhny Novgorod region (18.55 ths. rub.), the Republic of Tatarstan (16.79 ths. rub.), Kaluga region (15.5 ths. rub.). The smallest value is in the Republic of Kalmykia (30.98 rub.), The Republic of Tuva (109.14 rub.), The Altai Republic (110.53 rub.), Republic of Karelia (267.08 rub.), Republic of Khakassia (304.73 rub.), Republic of Adygea (339.26 rub.), the Ivanovo Region (362.26 rub.), Karachay-Cherkess Republic (364.96 rub.), Kaliningrad region (459.15 rub.).

There is strong differentiation of the Russian Federation subjects by volume of expenditures on innovation activity per capita, as demonstrated by the value of the variation coefficient, which is equal to 82.6 %. To assess the inhomogeneity degree

of this type of expenditures distribution by region suggested, we suggest using the Gini coefficient, which is calculated by the total expenditures on technological innovations of organizations in per capita (Table 1).

Table 1 – Results of the distribution inhomogeneity assessment of expenditures on innovative activity by the regions of Russia in 2010-2013

Indicators	Values of the Gini coefficient			
	2010	2011	2012	2013
Expenditures on technological innovations	0.30	0.31	0.32	0.35

The calculation results indicate a spatial inhomogeneity in the distribution of expenditures on innovation activity. Values of the Gini coefficient do not allow us to judge the nature of indicator distribution, the prevalence of the «poor» or «rich» regions.

The average value of expenditures on innovative activity by regions totalled 5.97 thousand rubles per one inhabitant, the median value of the indicator amounted to 3.25 ths. rub. More than half of the regions are characterized by expenditures on technological innovations that are below the average. During the reporting period, the inhomogeneity of distribution of the indicator values by region increased, it is demonstrated by the variation values. A left-sided asymmetry in the distribution of indicator values is observed, that is the regions with the low value of the studies indicator prevail.

The basis for the use of statistical methods is the assumption that the distribution indicator corresponds to the normal law. To test the hypothesis on the law of distribution of the random variable to the normal law, we used the Pearson criterion χ^2 .

The results of testing the hypothesis regarding normality of the expenditures distribution law for innovation activity, calculated per one inhabitant of the region, using χ^2 — Pearson criterion, showed that the indicator distribution does not correspond to the normal law: critical value of χ^2 — criterion amounted to 63.08, it misses the 5 % confidence region of the criterion.

Then we carried out the selection procedure for a distribution law, tested the hypotheses on the distribution of expenditures on innovative activity calculated per capita by the exponential, lognormal, gamma and χ^2 — distribution types. The results of these statistics are presented in Table 2.

Table 2 – Testing the hypothesis on the distribution type of expenditures on technological innovations of organizations per 1 citizen by the Russian Federation subjects

Types of the distribution law	χ^2 criterion	The number of degrees of freedom	Confidence region
Exponential	65.7	6	[1.23-14.4]
Gamma	21.2	4	[0.48-11.1]
Lognormal	13.2	7	[1.69-16.01]

The value of χ^2 — criterion, calculated for the hypothesis on the correspondence of the test indicator distribution to the lognormal distribution, is in the confidence

region. Distribution of expenditures values of innovation activity calculated per capita by the subjects of the Russian Federation has the lognormal distribution. To ensure proper distribution of the studied indicator, its values are converted by taking logarithms. Converted values of the indicator correspond to the normal distribution law. The average value of the expenditures indicator for innovation activity calculated per capita by the RF subjects corresponds to the median value; the asymmetry coefficient has a value close to zero. Based on the converted values of the studied indicator, we constructed a statistical grouping of regions, grouping intervals are determined with the use of standard deviation and the average value (Table 3).

Table 3 – Groups of the Russian Federation subjects by the level of expenditures on technological innovation of organizations in 2013

No.	Expenditures on technological innovation of organizations	Level of expenditures	Number of regions	Share of a group, %
1	below 340.23	Low	8	6.2
2	340.23-982.37	Below average	12	14.8
3	982.37-8763.96	Average	44	54.3
4	8763.96-16583.02	Above average	10	16.1
5	above 16583.02	High	6	8.6

Bringing the distribution of the indicator values to the normal law by taking logarithms allowed us to construct a statistical group, which takes into account the differentiation of regions with median expenditures to a greater degree. That is the centre of statistical grouping shifted from the average to the median value. The impact of the economies of scale of regions with excess expenditures is levelled.

The first group includes 8 regions with the low level of expenditures on innovation activities, the second group — 12 regions with the level of expenditures below-average, the third group consists of 44 regions with the average level of expenditures on technological innovations of organizations, the fourth group includes 10 regions with the level of expenditures above average, the fifth group consists of 6 regions with the high level of expenditures. The identified groups of regions had been stable during the period of 2010 — 2013, significant changes in the composition of the groups were not found. The situation in the Sverdlovsk region improved (the region passed from the third to the fourth group), the situation in the Lipetsk region worsened (from the fourth to the third), as well as the situation in the Kostroma region (from the third to the second).

Thus, the composition of identified groups of regions by the level of expenditures on technological innovation of organizations per capita is stable. Movement of regions is observed between the second, third and fourth groups, that is improvement or deterioration of the situation in the region, with respect to other RF subjects, is possible in connection with the leading or lagging development dynamics of the factors, affecting innovation expenditures in the region. The composition of groups with extremely high and low expenditures on technological innovation of organizations is unchanged, which is a consequence of objective reasons for being a leading or lagging region: natural and climatic conditions,

geographical location, historically formed economic specialization, distance from sales markets, transport accessibility.

Below is a brief economic characteristic of the selected groups of regions that reflects geographic, economic features. The first group consists of regions, which are characterized by a critical socio-economic position. The geographical position of these regions is adverse; there is no access to external markets; the transport and infrastructure situations of urban settlements are adverse. The regions are characterized by a complex political and social situation: high levels of unemployment, social conflicts.

The second group includes regions with low levels of socio-economic development. The main reason for lagging is low competitiveness of the regional production due to an outdated technology base, poor transport situation, competition from neighbouring regions, «takeover» of the regional consumer market by neighbouring regions.

The third group includes regions with an average level of socio-economic development, including old industrial and underdeveloped regions. Regions experience a structural crisis of the economy, production of leading industries becomes unclaimed and uncompetitive in the market. Further development requires restructuring of the economy through the implementation of major regional projects, which involve budget, private investments.

The fourth group consists of industrialized regions with a growing economy, which have a favourable geographical position and are major transport hubs. The regions have a high scientific and technical potential, high level of urbanization has a positive impact on their development.

The fifth group includes the centres of federal significance — Moscow and the Moscow Region, St. Petersburg and the Leningrad region, as well as raw materials regions specializing in the production and export of fuel and energy resources. Raw materials regions are characterized by low population density due to unfavourable natural and climatic conditions.

Expenditures on technological innovations by the subjects of the Russian Federation are characterized by inhomogeneity due to spatial distribution features of the innovation system. The share of regions with low levels of expenditures on technological innovation prevails in the Russian Federation. The highest expenditure per capita is in the regions with raw materials specialization.

Stable socio-economic development of the Russian Federation regions with significant spatial differentiation by the level of innovation development, largely depends on the choice and implementation of unique and innovative strategies that are based on the use of unique intellectual resources and opportunities inherent in a particular territory that open up due to that.

The importance of a differentiated approach, which takes into account individual characteristics of the regions, the choice of strategic ways of innovative development, are substantiated in the works of theorists and practitioners of economics [2].

Overview of the approaches to the classification of innovative strategies, presented in contemporary literature, shows their great diversity in terms of a large number of classifications that underpin the type design.

According to the degree of involvement in the innovation process, the strategies of decentralized control, active intervention and mixed effects are distinguished. The classification by the stimulation object distinguishes a strategy that focuses on leadership in science, the spread of innovations and stimulation of innovations. [5]

Transition of the national economy to an innovative knowledge-based model requires implementation of the following basic measures.

– To resolve the problem of mutual distrust, which became an all-out all over the country: between society and government, between business and government, between society and business, etc. Satisfying public demand for objectivity, restoring trust in a vertical manner are basic elements to force start driving forces of the economy, including the one based on knowledge.

– To improve efficiency of the education system solely by improving its quality. Fold increase in the number of people with higher education has become a characteristic feature of modern Russia. Among them, economists, lawyers and other humanitarians prevail. In the Soviet period, the percentage of university entrance among high school graduates ranged from 20 to 25 %, today the range of those who have not entered universities is the same. In addition, upcoming problematic demographic proportions in the country reduce the time horizon for the use of the accumulated intellectual capital. Having spent huge sums on the socialization of the individual and further training of a highly qualified specialist, the society needs to maximize returns from the accumulated intellectual capital of the nation. At the same time, short life expectancy and high mortality rate due to injuries and illnesses reduce the potential time of using human resources, thereby reducing returns from education expenditures.

– The growing number of institutions of higher education on the background of long-term reduction of state funding led to the commercialization of knowledge in universities. In these circumstances, the criterion for graduation is not knowledge, but tuition fees. Extensive development of higher education through the commercialization leads to such situation when national education is gradually forced out into the marginal sector in the world ranking of universities.

– To form the system of state organizational, legal and economic measures for the selection of the knowledge economy. The state policy regarding the knowledge-based economy must comply with 3 principles: a) the primacy of the state in those segments where the applied innovation theory is formed up to the moment when it is implemented in a commercial product; b) support for real types of innovation activity instead of helping specific organizations; c) promotion of productive interaction between education, science and business, and the formation of innovation clusters on this basis (for example, the partner countries of the BRICS). [9]

– Gradual replacement of the outdated accumulated capital structure in Russia, inherent at the early stages of the industrial society. In the post-industrial era the

main factor in state development is to create conditions for the production of intellectual products and the corresponding pace of technological renovation. [3]

– The problem of introducing scientific developments into the real economy is a chronic disease of Russian science and practice. A productive relationship between science and the real production, characteristic of developed economies, is implemented in Russia fragmentarily, except for the defence sector. On the one hand, industries do not create demand for research and development, and on the other hand, science often does not have units for commercialization of their developments. Thus, movement of science and economy is parallel and does not cross, which leads to the fact that Russian business imports advanced technology from abroad and the domestic science exports its scientific ideas and developments. According to Rospatent in 2013, non-residents have patented more than half of domestic scientific developments. Scientific inventions, not implemented in innovative means, are scientific materials, which are exactly the same as hydrocarbon and others raw materials. Thus, in this situation we need a mechanism to overcome the so-called «valley of death» between science and practice. (Chikov 2013, 6)

Formation of functioning institutions — conductors of the scientific and technological progress into the economy, in our opinion, needs to be started with the establishment of an independent department in the Government of the Russian Federation, responsible for the scientific and technical policy of the Russian state. For example, at the end of 2000's the Government of the Republic of Korea reorganized the Ministry of Economy into the Ministry of Knowledge Economy. Twenty-year practice of combining the state educational and scientific functions in one ministry has shown its ineffectiveness, that has led to the loss of education quality and the increasing scientific and technological gap between Russia and the world's leading countries.

Overcoming the «valley of death» between science and practice presupposes a revival of industrial science, responsible for research and development. Taking into account today's realities and trends, most likely, it must be built into technological and industrial parks and large corporate entities such as «Rosnano», «Rostekhnologii» and others. It is necessary to revive public institutions, promoting STP, starting with the reanimation of the Society of Inventors and Innovators with the state support of private initiatives, information communications (e.g. centres of scientific and technical information) and the promotion of scientific and technological knowledge in the media.

Such or similar state actions, aimed at restructuring the national scientific and technological complex, are the first and the most important step for the formation of the emerging framework of the Russian knowledge economy and further expansion of the knowledge innovation system.

Innovative activity of economic entities and their potential opportunities are important subjects for identification and analysis. At the level of the regional economy, there is a number of problems that are associated, primarily, with the presence of significant spatial differentiation of the innovation system of the Russian Federation.

Objective reasons associated with the inhomogeneous distribution of economic activity, historically formed economic structure, which ultimately determine the inhomogeneity of the economic space, underpin the differentiation of the RF subjects in terms of the innovation system development.

It is determined that the innovation activity features are the following: uncertainty in the future and a time lag between the creation and application of innovations, which arises from the former; discrepancy between public and private effects; asymmetry of information, available to researchers, potential investors, consumers; substantial investment risks; strict requirements to recruitment and the state of a quality management system.

The presented method for evaluating and analysing the structure of the innovation system by region confirms a significant inhomogeneity of the Russian Federation subjects in terms of expenditures on technological innovations of organizations. To ensure proper distribution of the studied indicator, its values are converted by taking logarithms. The value of χ^2 — criterion, calculated for the hypothesis on the correspondence of the test indicator distribution to the lognormal distribution, is in the confidence region. Converted values of the indicator correspond to the normal distribution law.

The proposed method for regions classification allows obtaining the distribution values of the expenditure indicator of technological innovation, in accordance with the normal law, that is, taking into account the differentiation of regions with median expenditures to a greater degree. The centre of statistical grouping shifted from the average to the median value. The impact of the economies of scale of regions with excess expenditures is levelled.

The resulting classification of regions allows us to formulate proposals for further development of the innovation system of the Russian Federation at the regional level, taking into account the unique features inherent in each subject.

We determined basic contradictions and problems on the way to further development of the innovation system and construction of the Russian model of the knowledge economy. We proposed measures aimed at overcoming adverse conditions and barriers for the transition of the national economy to the knowledge-model within the innovation system. It is noted that such and similar state actions will contribute to further expansion of the innovation system.

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