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Scientific and Technological Development of Russia: State Assessment and Financing Problems *

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Abstract. Given the current conditions of rapid cyclical economic processes, the urgency of tasks related to ensuring sustainable economic growth is increasing. The available experience clearly indicates that sustainability can only be achieved by ensuring the proper level and pace of scientific and technological development. At the same time, the implementation of spatial development concept is entering into the foreground due to globalization, integration and digital technologies development. The purpose of the work is to assess the scientific and technological development of Russia in the context of international comparisons and to study the system of R&D financing in the country. Based on this purpose, the article considers the evolution of approaches to the scientific and technological development of territories, identifies the need to form a single scientific and technological space in Russia, which will reduce the existing imbalances and ensure the uniformity of regional development; substantiates the significance of the financial subsystem in the formation of a single space; analyzes its state. The conducted analysis has

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shown that the current system of research and development financing in Russia is contrary to the global trends. The research has revealed that a crucial role in the process of funding is still played by the state; it has demonstrated the low efficiency of the system of R&D financing and offered recommendations for its improving and optimizing, i.e. the formation of regional funds for scientific, scientific-technical and innovation activities; increasing the availability of federal funding sources of scientific and technological development in the regions and the efficiency of venture activity in Russia. Further stages of the research will involve studying other basic subsystems of the scientific and technological space (organizational, managerial, informational, educational, etc.), as well as working out practical recommendations for their development, efficiency and harmonious interaction and functioning.

Key words: unified scientific and technological space, factors, differentiation of territories, financing of scientific, scientific-technical and innovative activities; support funds, incentive tools.

Introduction

The implementation of national aims and issues related to improving competitiveness in external markets, increasing the human well-being level, as well as ensuring national security, is impossible without relying on a scientific and technological basis. The available foreign experience [1] shows that only the states that have determined the growth of science, technologies, and innovation as a strategic imperative, have been able to achieve sustainable socio-economic development.

This issue is also crucial for Russia. It has been impossible to ensure the increasing efficiency of the scientific and technical activities, and achieve the required level of its competitiveness after the transition to the market economy 30 years before [2]. This problem is worsened by the steady acceleration of the scientific and technological progress. Its importance and relevance are mentioned in the speeches of the President of the Russian Federation. Thus, V.V. Putin mentioned in the Address to the Federal Assembly on February, 2020: "Today the speed of technological change in the world is increasing manifold, and we must create our own technologies and standards in areas that define our future"[1].

The relevance of the scientific and technological development for the state is emphasized in the adopted for implementation the "Science" national project[2] where one of the crucial challenges stated "ensuring the presence of the Russian Federation among the five world leading countries conducting research and development in the areas determined by the scientific and technological priorities".

At the same time, globalization and deepening integration, constant new technologies evolution lead to the fact that the distance and location of the subjects of scientific, scientific-technical and innovative activities are becoming less important factors. Furthermore, the differentiation level of Russian regions in terms of the key indicators of science and technology development continues growing. The difference between the leading and outsider regions is more than 140 times by the indicator of "the share of research and development expenditures in GRP"; in terms of the indicator of "the number of personnel engaged in research and development, people per 10 thousand people", it is more than 160 times (according to Rosstat data in 2018).

[1] Presidential Address to the Federal Assembly. *Official website of the President of Russia*. Available at: http://kremlin.ru/events/president/news/62582

[2] Passport of the "Science" national project. *Official Website of the Russian Government*. Available at: http://static.government.ru/media/files/UraNEEbOnbjocoMLPOnnJZx4OT20Siei.pdf

The provision of science and technology development in the country is impossible in the conditions, where the regions so significantly differ in their development level which leads to increased concentration of all resources in particular territories and the flow of the few resources from other territories to them. From the authors' point of view, the current situation can be leveled if a unified scientific and technological space is formed within the borders of the entire state.

The concept of the spatial evolution is one of the imperatives in Russia. The RF Spatial Development Strategy for the period up to 2025 was approved in 2019[3]. It is intended to ensure the competitive growth of the economy of the RF entities by the implementation of competitive advantages through the development of their promising economic specializations which include both effective existing and potentially effective branches of economic specialization. According to the Strategy, "professional, scientific and technical activities" is marked as promising for more than 50% of the entities of the Russian Federation (48 units) which indicates that there is a significant reserve of scientific, scientific-technical and innovative activities in many regions.

Thus, the provision of scientific and technological development through the formation of the unified scientific and technological space (STSp) of the country is the best variant for ensuring the competitiveness of the state as a whole and increasing the interregional imbalances of the progress. It is important to understand that this approach allows concentrating the possibilities of each RF entity on those subsystems of the scientific and technological space and activity areas which have a certain groundwork or development potential.

[3] On the Approval of the Spatial Development Strategy until 2025: Executive Order of the RF Government no. 207-p, dated February 13. *Official website of the Russian Government. Available at: http://government.ru/docs/35733/*

In this regard, the purpose of the research is to assess scientific and technological development of Russia in the context of international comparisons, and study a system of R&D financing in the country. The following issues should be solved to achieve this aim: to consider theoretical and methodological approaches to the scientific and technological development and understanding the essence of the scientific and technological space; to analyze the key trends and problems of the scientific and technological development of Russia; to study the system of R&D financing at the federal level; to substantiate the priority directions and tools for improving the system of R&D financing in Russia, in order to achieve the issues set in the national projects.

The scientific novelty of the work is in the developing of the theoretical and methodological aspects of the STSp formation, substantiating the role of the financial subsystem in creating the unified space, and analyzing its state; working out the recommendations to improve and optimize the system of R&D financing both at the federal and regional levels.

Theoretical aspects of the research

The issues of the spatial economy development and its separate subsystems have been the subjects of the scientific studies since the begging of the 19th century. At the same time, in recent years, due to the globalization, digitalization of all the aspects of social life, the interstate and interregional borders have been erased, the unified space has been formed where the subjects receive the bigger effect from interaction with each other and from the synergy of these relationships than if they were outside of it [3].

The theory of the scientific and technological development originating in the works of J. Schumpeter (the theory of innovation) [4], has being undergone significant fundamental changes within the 20th and 21st centuries. The theory of innovation of J. Schumpeter fits into the concept of long waves by N.D. Kondratyev

[5] who proves the cyclical nature of economic and technological development processes. In many aspects, Kondratiev's ideas formed the basis of the theory of innovation diffusion by T. Hägerstrand which is interesting, as it takes into account the location theory, i.e. spatial aspects of the development of technology and diffusion processes.

The basis of the theory of scientific, technological and innovative development was laid by F. Perroux's concept of growth poles [7]. In his studies he points out that the inequality of economic actors arising for natural reasons allows generating the development points in space which accumulate economic agents around themselves, playing the role of locomotives, thereby forming agglomerations. Later, this theory was reflected in the emergence of technopolises and other forms of organization of scientific, technological and innovative activities.

The theory of the technological paradigm (D.S. Lvov, S.Yu. Glaziev) [8] should be referred to as the conceptual approaches to describing the processes of organizing innovative activities. The latter is understood as groups of related industries connected with each other by the same type of technological chains [9]. In parallel with the theory of technological paradigm, the theory of clusters was dynamically developing in the studies of M. Porter [10]. One of the main theses is that the most competitive companies are concentrated in the same territory which is associated with the wave nature of innovative development and the peculiarities of the innovation diffusion.

The next stage in the evolution of the theory of management of scientific, technological and innovative development was the formation of the concept of National System of Innovation (C. Freeman, B. Lundvall, R. Nelson) [11; 12; 13].

The National System of Innovation (NSI) is understood as a set of various institutions which contribute to the new technological creation and expansion together and individually, making an organizational and legal basis that serves governments for the policy formation and implementation, affecting the innovation process [14]. This concept has a positive experience of realization in the USA, Japan, and a number of economically developed countries.

The current global changes and the technological development, associated with the forth industry revolution, determine the necessity to use other approaches of management of scientific, technological and innovative development. The existing patterns of innovative development need adjustment, as far as the basic principles of interaction, and the organization of management processes in scientific, scientific and technological, and innovative activities are changing in modern conditions. Moreover, the existing approaches do not allow solving one the most crucial problems, reducing the differentiation level in the arrangement of the territories. From the authors' point of view, it is necessary to talk not about the creation of growth poles (for example, clusters), national systems of innovation, etc. but focus on the space integral development as a unified system of subjects' interaction with equal opportunities and access to the resource base of relationship.

Literature review showed that the subject of STSp has not been properly reflected in research. At the same time, practical steps to solve the problems of creating a unified space have already been realized. Most CIS countries intend "making the transition to the innovative pattern of development which requires shift of cooperation emphasis to the joint elaboration and implementation of innovative projects and programs, and creating solid grounds for the formation of a unified scientific and technological space" [15]. The Agreement on the creation of a common scientific and technological space of CIS countries (as amended on November 11, 2009) came into

effect in 1997. The monograph [16] concludes that the well-timed formation of scientific and technological and innovative policy at the supranational level, as well as organizational and legal forms and mechanisms have become the main respond to the challenge of the scientific and technological progress and, in particular, the forth industry revolution.

The researchers present the experience of forming a unified STSp of the Union State of Russia and Belarus and draw attention to the problematic aspects of this project [17]. The schematization of the directions of formation and functioning of the unified scientific and technological space of the Union State is of particular interest. The authors noted that "the most relevant for theoretical understanding is the creation of mechanisms and tools for building and realization of a unified strategy for innovative development of the Union State, which ensures the effectiveness of integration of innovative systems in Russia and Belarus" [17]. This problem is certainly crucial for organizing a unified STSp in Russia.

The scientists consider the basic principles of creating a unified scientific and technological space: concentration of joint efforts on the most priority areas of innovative development; complementarity of innovative development (elimination of duplication and optimization of resources through the joint research on agreed topics); equal availability of R&D results for participants in common projects [18]. Despite the fact that this research is about the formation of an intercountry scientific and technical space, the basic principles are characteristic and applicable for one state (regions as separate territories within a unified space).

Thus, the issue of developing a unified scientific and technological space capable of responding to global challenges is an urgent practical task.

The term "space" came in economy from geography where it is understood as the "existence form of the geographical objects and phenomena within a geographical environment; a set of relations between geographical objects, located on the specific territories and developing over time"[4]. In economic theory, in general, space means a saturated territory that contains many objects and connections between them; settlements, industrial enterprises, economically developed and recreational areas, transport and engineering networks, etc. [19]. However, depending on the goals of the research, the term can be slightly modified. For example, in the socio-economic approach, space is considered "a system of relations between subjects that realize private economic interests and subjects of the aggregate economic process to form the expected results of their activities" [20]. There are works with emphasis on business entities that exchange signals in the process of economic activity through information flows [21].

The review of the management theories of scientific and technological, and innovative development demonstrated that the category of the "scientific and technological space" ought to generalize and include a number of aspects. First, we should speak about a certain system of interaction that lies within the framework of regulatory and legal area, created by the state through the regulatory legal acts, including the formation of the research agenda. At the same time, the interaction of subjects and their access to the existing resources should be formed on a parity basis, but this principle is not maintained in the current situation.

Based on the aforementioned criteria, we understand the scientific and technological space as a system of entities functioning and interacting within the existing regulatory and legal area in the field of scientific and technological development, geographically limited by the state boundaries whose activity are aimed at the increasing the corresponding

[4] *Geographic Encyclopedic Dictionary. Concepts and terms.* Ed. by A.F. Treshknikov. Moscow: 1988. P. 56.

Table 1. The structure of the scientific and technological space as a system

No.	Subsystem	Contents	Subjects of the subsystem	Indicators assessing the state of subsystem
1.	Knowledge generation	Set of entities, reproducing and generating knowledge and technology	Research establishments; universities	Number of scientific and research organizations; number of patents received, etc.
2.	Personnel	System of training ("growing") personnel for scientific, scientific-technical and innovative activities	State; infrastructure; universities; research establishments	Share of people engaged in research and development in total of the employed population; share of young researchers in total; number of graduates of engineering specialties, etc.
3.	Financial	Set of financial organizations and resources for R&D (private, public)	Producer; infrastructure; state	Share of R&D expenditures in GDP; share of enterprises, received government support; financial structure by sources, etc.
4.	Material and technological	Set of entities, participated in the production of innovative products and commercialization of R&D results	Producer; infrastructure; universities; research establishments	Share of organizations implementing technological innovations; level of innovative activities, etc.

Source: own compilation.

potential, achieving state priorities and leveling out the imbalances in the development of space subsystems.

Previous studies in the field of scientific and technological development [3; 22] allow concluding that STSp should be considered from a systematic approach. STSp consists of the following structural elements (subsystems): material and technological, financial, personnel, and knowledge generation *(Tab. 1)*. In addition, from the authors' point of view, it is the financial subsystem that plays the key role in the structure, as it forms payroll fund for the personnel subsystem, ensure knowledge generation with the necessary resources, and provides opportunities for the commercialization of R&D results.

Research Methods

The methodological basis of the work is the concept of the systematic approach, providing the necessary comprehensiveness of assessing the current level of scientific and technological development, as well as allowing its study from the point of view of the spatial aspect.

We used a set of methodological approaches, ensuring the necessary comprehensiveness of assessing the strengthening of the role of the new industry revolution in the development of production, increasing the efficiency and competitiveness of the Russian economy in the context of the transition to a new technological paradigm.

The research data base was the program documents of Russia's socio-economic development, analytical materials of government and management authorities, official documents of the government of the Russian Federation, and other federal authorities. Rosstat statistical materials, analytical materials on the stated problem, works of leading domestic and foreign scientists in the field of spatial, scientific, technological and innovative development of territories are used as information sources.

The research is based on the systematical approach to studying the problem of forming a unified scientific and technological space. A number of general scientific methods have been applied (for example, analysis and synthesis, comparison, etc.) which allows providing the necessary depth and comprehensive elaboration. When studying the theoretical and methodological foundations of the formation of scientific and technical space, determining its role in the economic development of Russia, the authors used such methods as a literature review, a systematic approach, etc., when processing factual material – tabular and

graphical methods, as well as statistical and comparative analysis, building trends which together will provide the necessary depth, reliability of results and validity of conclusions. Project approach, logical and generalization methods were taken as a basis, when developing measures and tools.

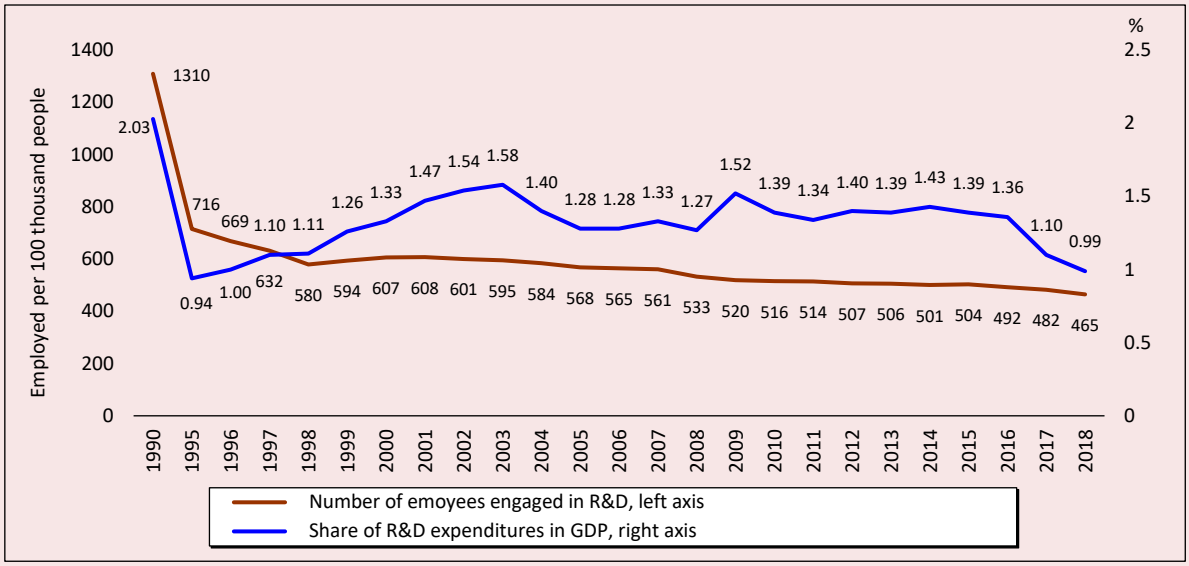
The research of the financial subsystem is based on the usage of various methods of statistical accounting. As noted above, the financial subsystem is a set of financial organizations and resources for conducting research and development, i.e. the institutional environment and the resource (in this case, financial) base. Therefore, the share of domestic R&D expenditures in GDP, gross domestic R&D expenditures by funding sources, the share of enterprises that received state support for innovation, and the budgets of programs of support institutions operating in Russia should be singled out as key indicators for assessing the state of this subsystem.

Research Results

Russia's transition to a market economy system was accompanied by serious shocks in all areas of social life. The research and development (R&D) sector also experienced negative trends. At the same time, the changes that were outlined 30 years ago, by and large, could not be overcome. Internal R&D expenditures fell from 2% to 1% of GDP, and a number of R&D personnel decreased threefold *(Fig. 1)*. If the expenditures on R&D exceeded 1.5% of GDP in 2003 and in 2009, in 2018 this indicator turned out to be at the level of 1995 – 0.99% against the background of the launching the "Science" national project (one of the aims of which is to outstrip the growth of domestic expenditures on research and development in comparison with GDP growth).

Multidirectional vectors in the main processes are revealed when comparing Russia with other countries. Thus, the share of domestic R&D expenditures in the GDP of the leading countries showed moderate growth. For example, in 30 years, China was able to move from zero to the position of one of the world leaders in this indicator *(Tab. 2)*. On the contrary, the opposite situation is observed in Russia.

Figure 1. Share of R&D expenditures and number of employees engaged in R&D in 1990–2018



Source: Rosstat data.

Table 2. Share of domestic R&D expenditures in the GDP, %

Country	1990	1995	2000	2005	2010	2015	2018	2018–1990
Japan	2.96	2.92	3.00	3.31	3.36	3.59	3.26	0.3
Germany	2.75	2.19	2.47	2.51	2.82	2.90	3.13	0.38
USA	2.65	2.51	2.71	2.51	2.82	2.74	2.83	0.18
China	–	0.57	0.90	1.32	1.70	2.05	2.19	1.62
Russia	2.03	0.85	1.05	1.07	1.25	1.13	0.99	-1.04

Source: *Science Indicators 2020: Stat. Coll*. L.M. Gokhberg, K.A. Ditkovskiy, E.I. Evnevich and others. National Research University "Higher School of Economics". Moscow: NRU HSE, 2020. P. 336.

Table 3. Number of employees engaged in R&D*, person per 10 thousand people

Country	1990	1995	2000	2005	2010	2015	2018	2018/1990, %
Germany	54	56	59	58	67	74	85	157.81
Japan	73	76	71	70	69	70	71	97.17
Canada	42	49	55	68	68	63	60	143.37
Russia	131	82	69	64	59	57	52	40.07
China	-	6	7	10	19	27	31	5.2 times**
South Korea	-	34	30	94	125	84	97	2.9 times**

* Here and later, the indicator "employees engaged in R&D" means all specialists, involved in scientific and scientific-technical processes: researchers, engineers, and support staff.
** 2018 to 1995.
Source: *Science Indicators 2020: Stat. Coll*. L.M. Gokhberg, K.A. Ditkovskiy, E.I. Evnevich and others. National Research University "Higher School of Economics". Moscow: NRU HSE, 2020. P. 336.

Russia is practically the only country among developed and developing countries that has demonstrated the decrease in a number of people employed in R&D by 79 people per 10 thousand people in the previous 28 years *(Tab. 3)*. Thus, the share of those employed in R&D has more than halved.

The resulting indicator of scientific and technological activity is a number of publications in leading international data base. Thus, in Russia, on average, there are only 2 articles in journals published in WoS and Scopus per 100 people employed in R&D *(Tab. 4)*. At the same time, the situation has not fundamentally changed since 2010. China is one of the global leaders according to this indicator (on average, one article per person employed in R&D).

In terms of a number of patent applications for inventions, Russia lags behind Germany almost twice *(Tab. 5)*. China has increased a number of applications by 30 times since 2000, while Russia has only increased by 30%. At the same time, this indicator is declared one of the key ones in the "Science" national project, according to which Russia should take the 5th place in the world in terms of a number of patent applications by 2024. This issue can only be achieved if the relevant programs and management decisions are effectively implemented in the country. The available data shows that getting into the top five is problematic. The fifth place is occupied by the EU (excluding Germany), the sixth – by Germany.

According to the Organization for Economic Cooperation and Development (OECD) data, only 7% of big companies and 2% of small and medium businesses from the total amount of companies applied for a patent in Russia in 2016–2017[5]. For example, it is 38 and 12% in Germany, in Japan – 36 and 8%. First, this indicates that the greatest activity in the field of intellectual property in Russia occurs in the academic community and scientific, and educational sphere, rather than in the real sector of the economy.

[5] Business Innovation Statistics and Indicators 2019. Available at: https://www.oecd.org/innovation/inno/inno-stats.htm

Table 4. Number of publications in scientific journals indexed in the Web of Science and Scopus, per one employed in R&D, units

Country	2010–2014	2011–2015	2012–2016	2013–2017	2014–2018
Web of Science					
China	2.7	0.0	0.4	4.4	4.6
Germany	0.9	0.2	1.1	1.1	1.1
Japan	0.4	0.0	0.6	0.6	0.6
South Korea	0.3	0.0	0.4	0.4	0.5
Russia	0.1	0.1	0.1	0.1	0.1
Scopus					
China	1.9	5.6	5.6	5.6	5.7
Germany	3.6	1.2	1.2	1.2	1.2
Japan	2.3	0.7	0.7	0.7	0.7
South Korea	0.9	0.4	0.5	0.5	0.5
Russia	1.6	0.1	0.1	0.1	0.1

Source: *Science Indicators 2020: Stat. Coll.* L.M. Gokhberg, K.A. Ditkovskiy, E.I. Evnevich and others. National Research University "Higher School of Economics". Moscow: NRU HSE, 2020. P. 336.

Table 5. Patent applications for inventions filed by national and foreign applicants to the country's patent authorities including triad applications, units

Country	2000	2005	2010	2015	2018	2018/2000
China	51906	173327	391177	1101864	1542002	30 times
incl. triad	87	523	1425	3167	4215**	48 times
USA	295895	390733	490226	589410	597141	201.8
incl. triad	15626	17374	12743	13280	12021**	76.9
Japan	419543	427078	344598	318721	313567	74.7
incl. triad	18263	18932	19295	17340	17591**	96.3
Germany	62142	60222	592445	66893	67898	109.3
incl. triad	7639	7141	5058	4434	4531**	59.3
Russia	28688	32254	42500	45517	37957	132.3
incl. triad	85	91	88	97	98**	115.3

* Patent applications filed simultaneously with EU, USA, and Japan.
** Data on triad application for 2018 are not provided in the statistics. The table shows the values for 2017.
Source: *Science Indicators 2020: Stat. Coll.* L.M. Gokhberg, K.A. Ditkovskiy, E.I. Evnevich and others. National Research University "Higher School of Economics". Moscow: NRU HSE, 2020. P. 336.

Summary comparison of the indicators clearly demonstrates differently vectored development of Russia and the world. Despite some progress in a number of indicators, the problem of reaching the global average growth rate has not been solved, and the achievements of the aims set within the framework of the "Science" national project is unlikely to be reached.

Russia's lag of the developed and developing countries in the scientific and technological development is worsened by the state of domestic STSp. The most obvious and critical problem is a significant level of the regional differentiation in most indicators that characterize subsystems of space *(Tab. 6)*. For example, the difference in a number of people engaged in research and development is 90 times. Compared with 2010, this indicator rather decreased which is largely due to the reduction of researchers in the leading regions. An enormous difference is also observed in the share of internal research and development expenditures in GDP, both in percentage and in ruble terms (it reached 629 times in 2018).

The number of organizations engaged in R&D is more stable in Russia, and, at the same time, despite the reduction of the gap between

Table 6. Some indicators of the state of the scientific and technological space in 2005–2018

Indicator	2005			2010			2015			2018		
	max	min	**Gap, times**	max	min	**Gap, times**	max	min	**Gap, times**	max	min	**Gap, times**
Number of R&D employees, per 10 thousand people	-	-	**-**	209.0	0.3	**686**	194.2	2.0	**98**	162.4	1.8	**90**
Share of R&D expenditures, % GRP	5.02	0.01	**815**	4.80	0.01	**616**	5.94	0.01	**781**	5.64	0.01	**629**
Number of advanced production technologies used, per 10 thousand people	55.1	0.2	**216**	69.1	0.1	**532**	80.4	0.4	**204**	78.4	0.4	**176**
Number of organizations engaged in R&D, per 10 thousand people	0.8	0.0	**34**	0.9	0.0	**25**	0.9	0.1	**16**	0.9	0.1	**17**
Level of innovation activity of enterprises, %	-	-	**-**	34.3	0.8	**43**	24.0	1.6	**15**	33.7	0.2	**189**

Note: the table for each indicator presents maximum and minimum among all entities of the Russian Federation, and the gap between these values.
Source: Rosstat data.

the leading regions and outsiders by half (from 34 to 17 times), the imbalance remains more than serious.

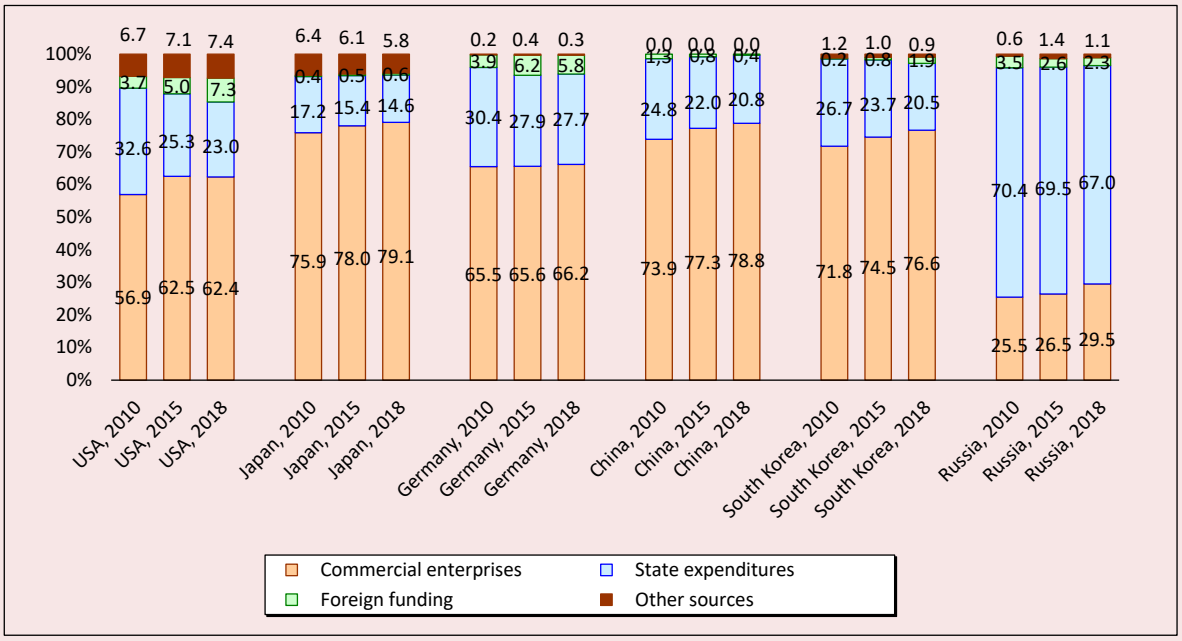
There is also a significant gap in the indicator "a number of used advanced production technologies" (it reached 200 times in 2018). On the one hand, it is logical and understandable, as not all the entities of the Russian Federation are industrially developed. At the same time, the growth rate of the leading regions in this indicator is significantly higher than in other territories which only increase differentiation. Moreover, there are still entities in Russia where the level of companies innovation activity is below 3% (in 2019 – 5 regions), i.e., in fact, modernization processes do not happen there.

Thus, Russia's main internal problem is the significant imbalances in all subsystems of the scientific and technological space. This circumstance turned into logical mistakes in scientific and technological, and innovative development of the territories. The current situation only accelerates negative trends; the regions with richer resources "taking" them from the other territories which increase the imbalance.

Studies of particular scientists [23–26] (including foreign ones [27; 28]) and research teams [29; 30] show that financing of scientific, scientific-technical and innovative activities are the key factor in ensuring an intensive path of economic development. In this regard, as part of our work, we will focus on the financial subsystem of the Russian STSp.

The system of R&D financing in Russia that developed during the period of the planned economy could not but affect its current state. First, we are talking about the financing structure. The main player in the Russian R&D market is the state, which provides two thirds of all expenditures *(Fig. 2)*. This situation is fundamentally different from the situation in the world, where more than 60% of costs are accounted for by the commercial sector. A global trend is increasing the volume of R&D funding by the commercial sector. To a certain extent, this is typical for Russia as well, but the share of private capital in 9 years has grown by only 3 percentage points. Of course, such rates are not enough, but it is possible to change the situation. An example is the experience of China, which switched to a market economy nearly at the same time as Russia: in 2018, the

Figure 2. Gross domestic expenditures on R&D by funding source, %



Source: OECD data. Available at: https://stats.oecd.org/

Table 7. Distribution of the countries by quantity of companies in the world's top 1,000 and their expenditures in 2018

Country	Quantity of companies in rating, unit	Companies R&D expenditures, USD billion	Share of companies' expenditures in total R&D expenditures, %
Japan	160	116.8	68.2
USA	320	328.84	56.5
Germany	44	66.5	49.5
South Korea	33	33.3	33.9
China	133	57.35	10.6
Russia	1	0.28	0.7
Source: The Global Innovation 1000 study. Available at: https://www.strategyand.pwc.com/gx/en/insights/innovation1000.html			

share of government spending on it accounted for only 20% of all spending on research and development.

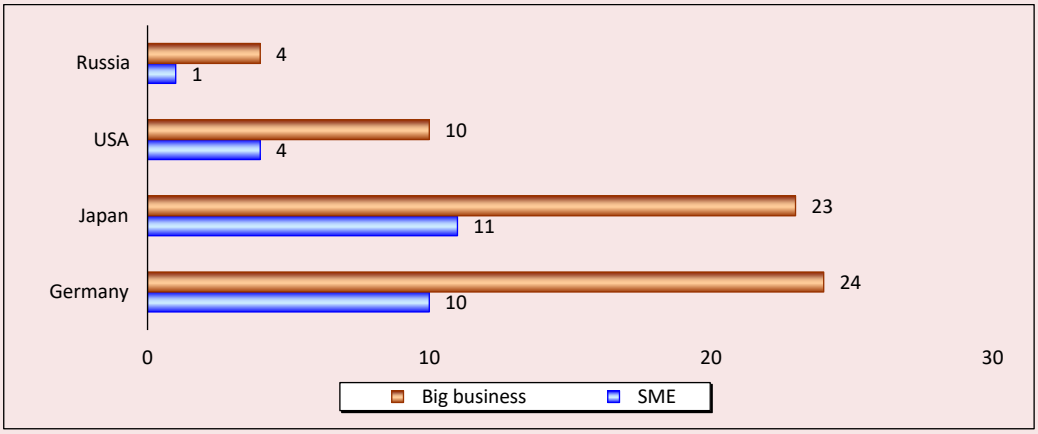
The existing financial structure is also characterized by the fact that only one Russian company (PJSC Gazprom) is in the top 1,000 companies in the world in terms of R&D expenditures, and its share is 0.7% *(Tab. 7)* in the total expenditures of the state. The global picture proves that the most of the R&D expenditures are carried out by the biggest national companies.

Despite the fact that about two thirds of R&D expenditures are budgetary in Russia, the biggest share of the funds remains in the state structures. For example, only about 1% of small and medium business and 4% of big companies received state support for innovation in 2017 *(Fig. 3)*.

As a result, companies lack resources to develop technologies and launch innovative projects which are reflected in a low level of innovation activity in Russia. According to OECD data[6], only 5% of SMEs and 25% of

[6] Business innovation statistics and indicators 2019. Available at: https://www.oecd.org/innovation/inno/inno-stats.htm

Figure 3. Share of companies that received state support for innovation, %



Source: OECD data. Available at: https://stats.oecd.org/

big companies in the country are innovatively active (in the USA – 64 and 73%, respectively, in Germany – 62 and 91%, and in Japan – 41 and 66%).

As already mentioned, the financing problem at the regional level is worsening by significant imbalances in the financial provision of R&D. The difference between leading and outsider regions is 140–150 times. The share of internal expenditures on research and development is less that 1%GRP in 76% (62 of 81) of Russian regions (in some regions, it is less than 0.1%, for example, in the Vologda Oblast – 0.07%). Only 7% of regions spend more than 2% of GRP for this purpose. This situation significantly differs from the foreign experience. For example, in Germany, the share of R&D expenditure exceeds 1.5%[7] in the GRP of 15 out of 16 federal states (in Saxony-Anhalt, it is 1.49%). The difference between the maximum and minimum was 6.2 times.

The main funding share for science and technology falls on the federal budget due to the limited budgetary resources in the constituent entities of the Russian Federation. The Russian Science Foundation, the Russian Fundamental Research Fund, and Grants Council of the President of the Russian Federation carry out grand financing of projects of researchers and science teams by competition. The Foundation for Assistance to Small Innovative Enterprises in Science and Technology and the Skolkovo Foundation provide funding for start-ups and developments of small innovative companies. Innovative and scientific-technical elaborations of medium and big companies can be partially financed through the relevant ministries or organizations operating their support measures (for example, RVC JSC, Skolkovo Foundation, Russian Fund for the Development of Information Technologies).

The Industrial Development Fund (IDF) and VEB RF provide concessional loans as co-financing of projects, aimed at introducing advanced technologies, creating new products or organizing import-substituting. The Ministry of Industry and Trade of the Russian Federation and the Ministry of Economic Development of the Russian Federation pursue subsidizing interest rates under credit and leasing agreements.

In common, the reviewed infrastructure organizations demonstrate positive dynamics of budgets for programs to support scientific and technological development. In particular,

[7] According to Federal Statistical Service of Germany.

Table 8. Support Program Budgets in 2015–2019 at constant prices in 2019, billion rubles

Support Program Budget	2015	2016	2017	2018	2019	Growth rate, 2019 to 2015, %
Russian Science Foundation	8.82	16.3	20.2	22.36	20.8	235.81
Russian Foundation for Basic Research	12.2	10.9	10.82	19.7	22.2	182.17
Innovation Promotion Fund	9.86	6.61	6.45	8.24	12.8	129.75
Skolkovo Foundation	н/д	9.14	7.3	6.6	n/d	72.15
JSC Rusnano	н/д	29.38	9.55	12.87	n/d	43.8
Ministry of Industry and Trade of RF	153.06	166.41	163.15	315.64	360.31	235.4
Industrial Development Fund	22.17	17.73	23.31	28.44	34.5	155.63

Sources: Annual reports of the RSF. Available at: http://www.rscf.ru/ru/documents/; http://www.rscf.ru/ru/archive/ ; Annual reports of the RFBR. Available at: https://www.rfbr.ru/rffi/ru/documents; https://www.rfbr.ru/rffi/ru/documents/n_770; Official website of Innovation Promotion Fund. Available at: www.fasie.ru; Annual reports of JSC "Rusnano". Available at: https://www.rusnano.com/about/highlights/annual-report; Annual reports of the Skolkovo Foundation. Available at: http://sk.ru/foundation/results/annual_reports_ru/p/annual_report_2018.aspx; Official website of Industrial Development Fund. Available at: www.frprf.ru; Annual reports of JSC "Rusnano". Available at: https://www.rusnano.com/about/highlights/annual-report.

for 2015–2019, the budget of the Russian Science Foundation and the Ministry of Industry and Trade of the Russian Federation increased by more than 2.3 times *(Tab. 8)*, the Russian Foundation for Basic Research – by 80%, the IPF – by 29.4%. At the same time, the budget of JSC Rusnano decreased by more than 55% in 2015 – 2018, and the Skolkovo Foundation – by 25%. The total volume of loans issued under the programs of the Industrial Development Fund amounted to 34.5 billion rubles in 2019 which is 55.6% higher than in 2015.

The Innovation Promotion Fund acts in accordance with the approved state assignment[8] which establishes that annually the share of constituent entities of the Russian Federation, legal entities and individuals from which participate in the Fund's tenders, should be 80%, and the share of funding for regional projects (from constituent entities of the Russian Federation, except Moscow) – 60%.

The Skolkovo Foundation finances only their residents' projects (persons, registered in the territory of Skolkovvo, Moscow). 80% of the entities of RF annually receives financial support from the Ministry of Industry and Trade of the Russian Federation, and the budget share, allocated to the business entities registered in Moscow, is on average 20–25% (in 2019% it was 20.9%). Moreover, the authors revealed that the same enterprises annually receive the support in various fields in 2016–2019 by analyzing the results of selections for the programs of the Ministry of industry and trade of the Russian Federation. This is due to the complexity and closeness of competitive selection procedures.

This financial distributions in the entities of RF additionally confirm the significant differentiation of the country's territories in terms of opportunities for scientific and technological development, as well as the existence of a pronounced "growth pole".

The causes lie in a number of factors. First, about 20%[9] of manufacturing and IT companies are redistricted in Moscow which is largely due to more comfortable business conditions, availability of technological infrastructure and personnel. As a result, Moscow is one of the leaders in creating innovative companies. Second, the State regulates fund distributions between the entities, but allowed relation does not contribute to the scientific and

[8] Source: *Official website of Innovation Promotion Fund.* Available at: http://fasie.ru/fund/normativnye-dokumenty/ (accessed: September 9, 2020).

[9] Authors' calculations are based on: *Regions of Russia. Social and Economic Indicators, 2019: Stat. Coll.* Available at: https://rosstat.gov.ru/folder/210/document/13204 (accessed: August 18, 2020).

technological development of the territories, as 60% of the resources is for 84 entities of RF and 40% – for 1 entity. Third, there is still a lack of awareness in the regions about existing federal support measures and possibilities to receive them.

For example, according to the survey in the Vologda Oblast [10], the share of enterprises using various support forms does not exceed 11%, despite a plenty of support measures and state funding. One of the main reasons entrepreneurs noted lack of relevant projects (42.5%), lack of confident in the possibility of receiving funds (28.8%), lack of awareness about support measures (16.4%), and lack of qualifies specialists in preparing documentation (15.1%).

In these circumstances, the main issue is to step up efforts to attract additional funding, including federal funding, as the main source for R&D. Expanding the presence of enterprises in various selections increases competition for preferential funds and, as a result, the efficiency of their distribution by selecting the objectively best projects that contribute to the economy development of the regions and the country as a whole.

Scientific, technological, and innovative projects are characterized by a high level of risks associated with non-achievements of the indicators which, in return, determines possible commercial success of the studies. The state financing system in Russia does not imply a project's failure; having only an idea or preliminary research, the project executor should commit to improving technical parameters, selling an innovative product, and expanding the company's personnel. In this regard, the tool for venture financing of innovative projects at the pre-seed and seed stage has been seriously spread in developed countries. There is a number of venture funds operating in the Russian Federation, but most of the financing of scientific and technological projects is carried out by funds with state participation, namely those managed by RVC JSC.

The company's revenue from its core business amounted 933.8 million rubles in 2018, which is 63.6% lower than in 2015 *(Tab. 9)*. At the same time, 942.2 million rubles was allocated for investment purposes, which is 8% lower than in 2017. Other income of RVC JSC from exchange rate differences, interest receivable, targeted subsidies, etc. exceeded revenue from its core business by 3.4 times, reaching 3194.5 million rubles in 2018 (3.4 times more than in 2015). In addition, other expenses are comparable to other income (2514.8 million rubles in 2018), which is 32.4 times higher than in 2015.

Thus, financial results of activity of RVC JSC are unstable. For example, in 2015 and 2017, net profit was received and dividends were paid in the amount of 752.4 and 138.3 million rubles, respectively. As a result, there was a loss, and no dividends were paid in 2016 and 2018.

The revenue sources of RVC JSC are mainly interest on deposits, accumulated coupon income on Federal loan bonds, and payments on shares (CSIF). At the same time, 5.9 billion rubles were placed on deposits in 2018, which is 2.6 times lower than in 2016[11]. The amount of subsidies allocated from the Federal budget increased 20 times in 2017, and the trend toward growth continued in 2018.

The RVC JSC payroll fund increased by 55% by 2018 compared to 2015, and a number of employees increased by 32% to 181 people *(Tab. 10)*. As a result, the average monthly salary of an employee of RVC JSC in 2018 amounted to 274,2 thousand rubles, which is 17.5% higher than in 2015.

[10] According to the survey "Monitoring of scientific and technological activities in the Vologda Oblast", conducted by FSBIS VolRC RAS in 2018 among heads of enterprises in the Vologda Oblast. A number of respondents is 100 people.

[11] According to the annual reports of RVC JSC in 2016–2018. Available at: https://www.rvc.ru/about/disclosure/(accessed: August 15, 2020).

Table 9. Results of financial activity RVC JSC, million rubles

No.	Indicator	Year				Changes, 2018 to 2015,%
		2015	2016	2017	2018*	
1	Revenue, incl.:	2 543.5	2 132.8	2 072.0	933.8	- 63.6
1.1	Interest from deposit	no data	no data	1 300.4	86.7	–
2	Cost Price	1 047.7	1 252.2	1 023.6	955.1	- 8.8
3	Income from participation in other organizations	–	–	–	95.0	–
4	Interest receivable	27.4	62.0	468.0	725.8	+ 26.5 times
5	Other income	908.0	591.9	182.0	2 373.7	+ 2.6 times
6	Other expenses	77.7	1 279.7	748.2	2 514.8	+ 32.4 times
7	Net profit	1 504.8	- 243.3	276.6	- 140.8	- 109.4
8	Viability of activities, %*	143.6	–	27.0	–	–
9	Dividends	752.4	0	138.3	0	–

* Calculated as the ratio of net profit (item 7) to cost price (item 2).
Source: data of the annual accounting statements of RVC JSC in 2016–2018. Available at: https://www.rvc.ru/about/disclosure/ (accessed: August 15, 2020).

Table 10. RVC JSC payroll fund

No.	Indicator	Year				Changes, 2018 to 2015, %
		2015	2016	2017	2018	
1	Personnel number, people	137	168	193	181	+ 32.1
2	Payroll fund, million rubles	383.7	537.1	712.7	595.6	+ 55.2
2.1	Labor costs for the main type of activity, million rubles	298.0	400.0	572.2	473.2	+ 58.8
2.2	Remuneration for executives (executive expenses), million rubles	85.7	137.1	140.5	122.4	+ 42.8
3	Average monthly salary, thousand rubles/ person	233.4	266.4	307.7	274.2	+ 17.5

Source: data of RVC JSC annual reports in 2016–2018. Available at: https://www.rvc.ru/about/disclosure/ (accessed: August 15, 2020).

Analysis of the results of RVC activities showed significant underfunding of the scientific and technological sphere due to the "freezing" of funds on deposits, including foreign currency (more than 9.7 billion rubles at the end of 2018). The formation of such reserves hinders the pace of scientific and technological development and does not help to overcome the accumulated gaps in this area.

The importance of progress in mechanisms for direct and venture capital financing of scientific and technological development was outlined by the President of the Russian Federation in his Address to the Federal Assembly on January 15, 2020. In particular, the need to consolidate the entrepreneur's right to risk is emphasized; an unsuccessful implementation of the idea does not automatically mean misuse of funds with subsequent possible criminal prosecution.

Suggestions

Formation of the regional funds for scientific, scientific-technical, and innovative activities

In our opinion, a network of specialized institutes of resource support for applied research and development should be formed in the regions. As one of the examples, the experience of Germany can be used, where regions (federal states) act as full and active participants in the management of scientific, technological and innovative activities. Thus, "the ability of the lands includes financing of vocational education and fundamental research in universities, as well as regional innovation programs. The federal government is responsible for the strategic course in the

development of R&D, and the system of measures to support at the required level the innovative activity of enterprises, carried out through state banks"[12].

One of the effective and legitimate methods for activating science funding in Russian regions can be the creation of the regional funds to support scientific, scientific-technical, and innovative activities. There are necessary regulatory and legal conditions for the formation of funds in Russia. For example, the article no. 262 of the Internal Revenue Code of the Russian Federation regulates the issues, related to expenditure records of enterprises for R&D. According to the paragraph 2 of the article no. 262, such expenses include deductions for the formation of funds to support scientific, scientific-technical and innovative activities, created in accordance with the Federal Law no. 127-FZ "On science and state scientific-technical policy", dated August 23, 1996, in the amount of no more than 1.5% of income from sales of products.

The article 15.1 of the Federal Law "On science and state scientific-technical policy" states that "... funds may be created by the Russian Federation, entities of the Russian Federation, physical persons and (or) legal persons in the organizational and legal form of the Fund...".

The calculations show that the formation of regional funds to support scientific, scientific-technical and innovative activities at the expense of deductions from the revenue of industrial enterprises will grow the internal volume of expenditures on research and development per person on average in the subjects of the Russian Federation in the amount of up to 6.8 times. The share of corresponding expenditures in the GDP structure can be increased from 0.99 to 2.42% (if 1% of revenue is deducted). The relative volume of research and development expenditures in the structure of GDP will begin to approach the values of the leading countries of the world. Increasing the volume of internal research and development expenditures will help to sharply reduce the level of regional differentiation in this indicator. The gap between territories with the maximum and minimum per capita expenditures can be reduced from 140–150 to 16 times, and between the maximum and average from 16.0 to 5.1 times.

This solution certainly requires additional elaboration. It does not take into account the specific of the territorial development in the processes of creating regional funds in its current form, as not every region can provide a significant level of expertise, etc. to organize the R&D support institute. Moreover, not every entity of the Russian Federation has the necessity for similar structures and funds. This, as well as a number of other aspects, is planning to be investigated and provided at the next research stages.

Increasing the availability of federal funding sources of STSp in the regions

Given the limited resources of the region, targeted support for developers and enterprises requires organizing a system to ensure the availability of federal budget funds for the scientific and technological development of territories. On the one hand, this system should ensure active interaction between regional and federal authorities in order to inform about current and prospective forms of support, terms and conditions for their provision. On the other hand, it is necessary to work directly with the subjects of innovative activity in order to identify promising projects that contribute to the socio-economic development of the regions.

[12] National system of innovation of Germany. *Official website of almanac "Production Management"*. Available at: http://www.up-pro.ru/library/innovations/national_innovative_organizations/nacyonalnaja-inn.html

For effective organization of activities in this direction, an operating algorithm was created for working with manufacturing enterprises which includes five steps:

1) technological audit of enterprises and developers, analysis of their financial condition;

2) selection of support measures that are appropriate for a particular innovation entity, explanation of conditions, possibilities and obligations;

3) formation of the project concept and its "packaging" to the requirements of the financing organization;

4) coordination of the project participations' work during its implementation;

5) support of project implementation at all stages.

The implementation of these directions will allow manufacturing enterprises to attract the necessary resources under the optimal conditions, reduce the project operation time and, as a result, increase the efficiency of their activities and contribute to the economy, and support to the achievement of national goals of scientific and technological development. However, the realization of this initiative requires a separate study which should begin with an examination of the institutional framework and normative and legal regulation which is planned in future work.

Improving the efficiency of venture capital activities in RF

The most important issue should be a strategy approval for the development of the Russian venture market up to 2030 which was started in December 2018. Moreover, it is necessary to legislate the permissible norms of non-return of budgetary funds when financing innovative projects (or proportion of the entire budget of the venture fund to the profit received from the implementation of startups), as well as to define responsibility areas (including criminal) both for developers and infrastructure organizations (funds). The uncertainty of market and technological prospects is taken into account in the implementation of innovative projects that may result in the loss of financial and other resources. It is worth dividing the permissible norms depending on the financing stage of innovative projects; the research and development stage has been carried out, R&D is planned; risks and the non-return rate are higher; laboratory research (R&D) has been carried out; we plan to create an industrial design and test it; the risks are lower, respectively, and the rate of no-return, too, etc. Thus, the norms are not subject to spatial differentiation and should be the same in all entities of the Russian Federation.

Another element of changing the regulatory framework should be the standard establishment for the amount of funds for replacing on the deposits (for example, no more than 0.5–1% of the budget), including securing responsibility for not attracting targeted funds into economic circulation for public and public-private organizations that provide financing (relevant primarily for joint-stock companies with state participation). Determination of the types of responsibility and the mechanism of attracting to it requires additional study of the regulatory legal acts regulating the activities of venture organizations which will be carried out at the next stages of the study.

It is also important to increase the transparency of the activities and financing conditions offered by venture enterprises. Acceleration programs have been actively elaborated in Russia in recent years in which educational intensive is organized for teams for their projects realization, as well as project presentations are held to potential investors. The program conditions are set before the beginning of the project selections and are available to all potential participants. At the same time, financing programs of particular venture funds remain unpublished in open sources, and fund specialists close information

about them. Thus, this market works on the basis of developing financial proposals for a particular project. However, in the authors' opinion, the unavailability of specific and correct information about venture financing programs hinders the venture market evolution (lack of demand).

Conclusion

Summing up, it is worth emphasizing once again that Russia's scientific and technological development which is based on the unified space concept can be the main driver and catalyst for changes in scientific, scientific and technological, and innovative activities in Russian regions that will contribute to improving the competitiveness of the Russian economy in world market and, consequently, sustainable economic growth.

The presented research is complex. Its results contribute to the expansion and systematization of the theoretical foundations of scientific and technological development, and, firstly, in the application of the spatial approach. In addition, applied solutions have been developed to optimize work of financial subsystem of scientific and technological space which can be used both in the authority and administration activities, and while adjusting the "Science" national project and other strategic documents.

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