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Identification of Characteristic Features of Structural Change in the Research and Innovation Process

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Abstract. The paper substantiates and identifies the characteristics and emerging trends of structural change in the research and innovation process in the conditions of formation of post-industrial economy and transition to post-industrial technology. The characteristics and developments concern the structure of the research and innovation process, research and development quality, the role of basic science and high technology, the place of services in research and innovation products, and the spatial context of the structure. The evolution of the concept and content (structure) of the research and innovation process determines the initial trend in the specific features of structural change in the research and innovation process. The authors of the article investigate the dynamics of the main indicators of innovation activity as an integrated result of boosting the efficiency of the research and innovation process, the indicators of development of high-tech industries with special emphasis on nanotechnology and information and communication technology, the indicators of dissemination of post-industrial economic services, in the spatial context as well. The article reveals a tendency towards the implementation of the research and innovation process in the spatial dimension. The authors reveal characteristic features of structural change in the research and

innovation process and several emerging shifts in the structure of the process; this helps to outline certain specific requirements to the organizational-economic mechanism, the feasibility of changing institutional conditions and institutions for the purpose of strengthening the promising trends of development of post-industrial technology and acceleration of innovation development.

Key words: characteristics, structural change, research and innovation process, post-industrial technologies, services, spatial context.

The current structure of the research and innovation process in Russia cannot respond effectively to the global challenges and perspective trends of innovation development. For instance, the disadvantages of the research and innovation process include the following:

– at the beginning of the 21st century, the production output in science-intensive industries grew by 11% per year – four times faster than in other industries [2];

– Russia is lagging far behind world's leading countries in the share of medium- and high-tech industries in its industrial production structure [27];

– Russia is falling back in its innovation economic features such as patent activity, especially in high-tech industries (rapid increase in the number of patents is caused by technological innovation mainly in information technology and biotechnology); the volume of export and import of technology on the world market [3]; the volume of high-tech products and their share in the economy; the level of technological development, lagging several-fold [17; 18; 20; 24];

– the G7 nations possess 46 out of the world's 50 macro-technologies, which include a set of technological processes (R&D, preproduction, production and service support of the project). Russia currently maintains control over one or three macro-technologies and still preserves the capacity to develop several other macro-technologies that can help it catch up with developed countries. That is, the country retains competitiveness in a small number of macro-technologies that require major fundamental results: in the field of nuclear energy, weapons, nuclear engines, bio-nano-, information and cognitive technology, etc.

Any significant changes for the better have not been observed over a long period (more than 10 years) [14, pp. 110, 112, 131, 133].

Not enough attention is paid to the analysis of structural changes in the field of scientific innovation. We can mention the relevant works of A.L. Gaponenko, G. Vechkanov, S. Glazyev, B.M. Grinchel, K. Gulin, V.A. Inozemtsev, V. Karacharovskii, S.V. Terebova, S.Yu. Shevchenko.

The innovation type of development requires widespread and purposeful cultivation of those development factors that are based on innovation. We are talking about different types of innovation – technological, business, marketing, socio-cultural, social; and they are most often based on or entail technological change. Innovation development goes on as an integration interactive process that involves innovation, technology, and economic and social change. *Innovation development has its own specific manifestation in the post-industrial economy*, where information resources become most important, services and consumption

come to the fore, and individuals determine their place in production with the help of new technology of information communication.

The transition *to innovation development in the post-industrial era* leads to unavoidable new significant changes in the structure of the research and innovation process and its characteristics. It becomes very important to identify these trends, both established and outlined; the trends that are hypothetical and preferable for Russia and its regions, but quite real and visible in the countries that have achieved success in their innovation development. Meanwhile, there emerges an issue of inconsistency between the institutional conditions of realization of innovation strategy and developments in the research and innovation process. Identifying these trends will help substantiate a change in innovation development and innovation strategy and establish the necessary institutions to support positive trends and eliminate negative ones, and, ultimately, for successful economic modernization. It should be emphasized that we are talking about *long-lasting qualitative changes* that alter or affect the necessity to introduce new forms and economic mechanisms.

Thus, the novelty of the study consists in the fact that it identifies the characteristics and emerging trends of structural change in the research and innovation process in the formation of post-industrial economy over a long period (1995–2015). *Characteristics and shifts in the postindustrial era affect the structure of the research and innovation process, the quality of research and development, the role of basic science and high technology, the place of services in the research and innovation output, the spatial context of the structure.*

Typical features of the evolution of the content of the research and innovation process

Significant evolution of the concept and content of the research and innovation process sets *the initial trend* in the typical structural change of the research and innovation process. In this case we consider a broad concept of the research and innovation process, close to the idea of the research and innovation development. The research and innovation process is a process of creating, producing and distributing new products and technologies with the aim of increasing the degree of innovation development of enterprises, regions and countries.

Earlier, the research and innovation process was objectively presented as the sequence of stages – research, development, mastering of new technologies in production – distributed in time.

The modern research and innovation process is fundamentally different from this view. The process is gradually becoming more and more "quantized", i.e. these stages are fulfilled not in direct connection with each other, but according to the need to create the final product – novelty and then innovation. The results of each stage can be ordered, and in some cases – selected with specific revision. This occurs because in a knowledge-based economy there is an opportunity of free access to knowledge (scientific knowledge, developments) on the part of interested persons, primarily, entrepreneurs. At present, the latter can develop innovations on their own. On the other hand, the functions of the subjects can change as the research and innovation process is carried out. All this demonstrates the overwhelming nature of innovation activity.

In order to break the research and innovation process into stages, a feature that characterizes the process as a whole was selected. The content of each stage should reflect a certain step of modeling of production of machines or product – the ultimate goal of the process. The update of the models of machinery is the unified process that involves changes in major decisions, in samples production and in models of machinery, and changes in technology and expansion of its application field as well. This requires that each stage go in strict sequence. Therefore, *the goal of execution of the stages* can be considered as the most appropriate basis for classification. This feature determines the appropriate means and ways of stages implementation, the system of the organizations in which they are conducted, and the ways of using their results. The objectivity of this classification feature has not changed.

There remains a trend in the production of the research and innovation process on the basis of different forms of knowledge – science, invention and experience, *with the strengthening of the role of mutual relationship* between fundamental scientific research and invention activity.

For example, since the 16th century, science and instrument-making have been interdependent, as well as science and craftsmanship: Galileo Galilei made a telescope on his own, for this purpose he polished the glass made by craftsmen. World trade predetermined the demand for telescopes used to watch ships. Invention of the printing press facilitated the spread of Galileo's idea that planets move along their orbits, and only then did the scientific community accept his idea. Two hundred years later, entrepreneur John Hooker gave money to scientist Edwin Hubble for the purpose of building a telescope; with the help of several inventions (the spectrograph, in particular), the scientist discovered the effect of recession of galaxies.

Meanwhile, the ground was prepared for the development of science as a direct productive force, and an impetus was given to the organization of scientific and innovation activity as the structure relatively independent from the production, with its own organization and management mechanisms.

At present, the interaction between research and invention is developing much faster, especially in high-tech industries.

The goals of basic and applied research remain different; there is a boundary between them. However, *there is an objective tendency towards levelling the boundaries* between these types of research in some high-tech industries where it is otherwise impossible to obtain a practical result, a new product. With the help of specific examples, scientists have shown that in the field of nanotechnology it is fundamentally impossible to separate the implementation of applied research and the production of nanoproducts from fundamental research, because "experiment merges with engineering, and nanoindustry becomes inseparable from scientific experiment" [5]. And then the authors explain: based on the structuralist concept, a theory consists of a core and a set of applications, which is meaningful for modern high-tech science, unlike conventional science.

Breakthrough technologies start to play a leading role in the high-tech economy in the post-industrial era in all branches of production

of goods and services. These are principally new technologies that stem from fundamental scientific research and the consequent further research and innovation process.

It should be emphasized that the dominance of breakthrough technologies in postindustrial economic development can be possible only after *significant enhancement of the role of basic science*, expansion of space of science and that of basic science in particular. Intensified creation of key innovations leads to the inevitability of more frequent and radical technological leaps. For example, according to Academician E.P. Velikhov, all supercomputers today have less power than the brain of one individual, and in five years one new supercomputer will have the power of the brain of the whole mankind. The distribution of major innovations for the realization of prospective efficiency in the wide field of demands significantly complicates commercialization without losing a high degree of novelty and balance in the industries in which they are applied.

In the future, all this will require changing the ratio of the share of persons employed in science and innovation, the structure of demand in the specializations in the sphere of education associated with this trend, etc.

Objective changes take place along with subjective changes such as *lagging behind in the quality of the research and innovation process and the quality of research and development.*

The following main structural trends can be highlighted from the standpoint of post-industrial economy:

1. Slow change of research areas that are considered priority in accordance with global trends (marked according to indicators [11, pp. 61–67; 14, p. 115, 119, 133–135; 15; 19; 23]: absence of changes in the employment structure of the research and innovation process, absence of changes in the fields of knowledge in which patents are issued, absence of changes in the commodity structure of export of innovation goods and services); moreover, it has been going for the last 10–15 years;

2. There is a balance of export and import of technology: however, export in the field of science and scientific services accounts for approximately 70% of the total number of agreements and its cost is 30%, while import is less than 10% both by number of agreements and cost [12, pp. 52–54; 13; 14, pp. 127–131]. Thus, what is sold is (at best) a pilot technology, or, more specifically, apparently, the result of the development. Therefore, first, trading in technologies with foreign countries does not contribute to scientific and innovative reproduction in the country so far; and second, good scientific and technological results are not included in innovations and in production. The structure of the trade in technology according to all indicators – patents for inventions, utility models, know-how, etc. – is dominated by imports. Other authors (see, e.g. [26]) put forward similar conclusions in this regard. Moreover, the situation has stabilized, and it has not changed for the past 10 years or more;

3. Lack of coordination between the stages of the innovation process and its insufficient focus on the final result, especially in the phases of engineering and manufacturing of new equipment, – applications for utility models and advanced production technologies created and utilized, the share of

commercialized patents, etc. which makes the use of imported equipment inevitable [1; 21].

Our calculations, along with the research carried out by other scientists, show that the costs of technological innovation per worker (thousand rubles) are growing significantly faster compared with the volume of innovation products per worker (thousand rubles) in several manufacturing industries. This indicates either a decrease in the efficiency of scientific and technological developments, or an increase in the cost of knowledge "production" or a reduction in the number of operations per workplace a month in the field of innovative products, and the relative increase in the cost of development per unit of output.

Direct evidence of the absence of a quality improvement is the fact that enterprises produce few fundamentally new or just new products, and their share continues to grow slowly (see, e.g. a relevant detailed study [11, pp. 59–64]); besides, innovation development indicators remain low. This reflects the implementation of the *strategy of borrowing* over a long period and the backwardness in creation of high-tech products, the focus on the acquisition of ready-made technologies, industries and enterprises.

Thus, the above-mentioned specific features in the understanding of the research and innovation process in the post-industrial economy and the lack of any shifts in the structure and quality of the process produce certain **specific requirements** to the organizational-economic mechanism, the appropriateness of altering the existing institutional framework and institutions for effective implementation of the research and innovation process, for innovation development.

Apparently, it is necessary to increase the direct funding of fundamental science, as well as other means, forms and methods of support for fundamental research and promotion of its results, i.e. the creation of a special **institutional environment**. In addition, it is essential to work out special measures to increase the production of fundamental scientific ideas, to carry out exploratory research based on inventive activity in priority areas, as well as an integral research and innovation process in a number of high-tech sectors. The focus on **business venture** that has been recently developing in Russia, including the organization of dozens of venture capital funds and technology companies, can become one of the most important measures for this purpose [4; 25].

Specific development features of high-tech industries and production of services

In the long run, post-industrial economy is clearly expected to develop two major trends: **the priority development of the role (and, consequently, the share) of high-tech industries, and the expansion of the space (which means – in all the spheres) of production of services**.

Post-industrial technological basis is implemented in the 5th and the 6th technological modes. Knowledge, education and science, information and science-intensive technology, emerging technologies: information technology, nanotechnology, biotechnology, and cognitive science become leading technologies. Science-intensive, resource-saving and information technologies

("high technologies") are developing rapidly. Informatization penetrates all spheres of society: not only the production of goods and services, but also household, culture and art.

The study of the dynamics of the main indicators of innovation activity – as an integrated result of boosting the research and innovation process – in the manufacturing sector for the period from 1995 to 2013 [7, pp. 16–25; 8, pp. 16–25], unfortunately, shows the *lack of significant change*; all the indicators of innovation activity experience multidirectional fluctuations, and there is no substantial increase in the volume of innovative goods, works, services per ruble of expenditure on technological innovations.

Still, it is necessary to mention that there is an important development in the last 4 years: the share of innovative goods, works and services in the total exports of goods, works and services increased more than 2.5 times in 2013 since 2010, as well as the share of export of innovative goods, works and services in the total amount of sales of goods, works and services.

On the background of fluctuations and insignificant growth of the overall indicators of development of scientific-innovation activity in recent years, and according to the results of the analysis, it is possible to draw a conclusion about the following changes **in high-tech industries**.

The share of organizations that implement technological, marketing and organizational innovation in manufacturing (and they constitute over 80% of the total number of such organizations) in all the groups of industries by level of technology for the period of 2010–2013 [7, pp. 57-58; 8, pp. 55-56] varies insignificantly and is as follows: from 13.6 to 14.4% for high-tech industries, from 24.3 to 25.3% for medium-tech industries of the high level, from 17.0 to 17.5% for medium-tech industries of the low level, from 25.4 to 23.1% for low-tech industries. It can be noted that the situation is similar with regard to the industries associated with the so-called **NBIC technologies,** there are small fluctuations in the share of these industries in the total number of organizations: 1.5–1.9% for pharmaceutical production, 3.9–4.1% for the production of electronic components, radio, television and communication equipment, 1.9–2.0% for the production of air- and spacecraft.

In other words, there is *no significant growth in the number of high-tech organizations (excluding pharmaceutical industries)*, including that in comparison with the changes in innovation activity in general.

Other trends – though within a short period of formation – are defined as typical **of the sector of nanotechnology**.

The volume of innovation products in nanotechnology, and the number of industrial production companies engaged in technological innovations in 2009–2011 [14, p. 199, 201] in general by type of economic activities (in fact, these are manufacturing industries) *increased* approximately 60-fold, out of which the volume of new products for the global market grew somewhat less, and amounted to 11–215 million rubles. Moreover, for one of high-tech industries – manufacture of electrical, electronic and optical equipment – the growth is the same, but the volume is relatively small: in 2011 – 3,585.5 million rubles, for the global market – 1.4 million rubles (the figure in 2010 was 65.0 million rubles).

Nanotechnology industry is growing along the increase in the number of researchers at organizations that perform research and development in the field of nanotechnology: during the period under consideration – from 14,500 to 21,166 people, i.e. in 1.5 times given the fact that the number of these organizations remained practically the same (an increase was from 465 to 485 units).

It should be emphasized that nanotechnology as an industry is in the stage of formation: the number of nanotechnologies created in 2009, 2010 and 2011 increased from 108 to 258, and the number of nanotechnologies that were implemented increased from 284 to 526. The number of nanotechnologies created in manufacturing increased from four to 28, and the number of these technologies that were implemented increased from 37 to 146. Meanwhile, the industry has considerable *capacity for growth*, because the majority of nanotechnologies are created and used in scientific research and development (approximately 90%) and in higher professional education (approximately 60%).

According to the results of generalization made by the author, the specific features of **information and communication technologies** (ICT) sector are as follows [9; 10, p. 21, 25; 12, p. 69; 14, p. 152, 154].

The number of people employed in ICT sector in 2005–2010 ***decreased*** quite significantly – by more than 13% – including that in the activities related to the production of ICT equipment. Regarding the share of ICT in the business sector, our country is lagging behind leading countries in two times. The indicators of innovation activity of ICT organizations also *decreased by a third* or more in 2003–2013, although since 2007 the dynamics has been aligning; the number of ICT organizations engaged in technological innovation in 2013 amounted to 10–13% of the total number of ICT organizations **in federal districts of the Russian Federation**, which is the same as in other industries.

At the same time, the number of personal computers (PCs) per 100 employees increased in all types of activities in 2005–2011 from 22 to 39, i.e. almost twofold, and in manufacturing industries – from 13 to 24, apparently *due to the imports of PCs*. There has been some *saturation with computers*: the number of organizations that use them (as a percentage of the total number of organizations) was 91.1% in 2005 and 94.0%. in 2013. Apparently, therefore, the updating of personal computers in the organizations as a percentage of the total number of PCs is reducing and it was 17.1% in 2005, and 12.6% in 2011 on average for all the types of economic activity (and this is important for post-industrial society); as for manufacturing industries, the figure was 14.7% in 2005 and 11.6% in 2011.

In general, it can be noted that *there are no significant changes* that could distinguish this sector from other high-tech industries.

However, *changes in ICT sector are possible in the near future,* because when the volume of capital investments of ICT sector reduced by 32% in 2005–2010, the investments in ICT production increased by 20% and the investments in ICT services increased in 2.4 times, i.e., apparently, the investments in the production potential and in infrastructural potential.

In general, there are no significant positive structural changes in high-tech industries; therefore, it is **necessary** to take major organizational and economic measures to **promote** high-tech industries, support the employees of the high-tech sector and provide government support in this regard.

It is necessary to emphasize the importance of a new prerequisite for the formation of potential breakthrough technologies, namely, the transition from the production of goods **to the production of services** in postindustrial economy.

The services sector occupies a considerable part of world economy and its share is continuously growing; the same applies to innovation component in the service sector. The distribution of services is a new trend; moreover, fundamentally new post-industrial services are distributed, they include new forms of information and communication technologies, intellectual services, and comprehensive services in the so-called smart cities.

Statistics collections on research and innovation activities place the services sector on a permanent basis during the last 10–15 years in the sections – by types of economic activity – as a subsection of "the services sector" with three types of services – communications, activities related to the use of computers and information technology, and other. According to all the indicators of innovation activity in the services sector, their values fluctuate, changes occur even *less clearly* than in the manufacturing sector, and there are no sustainable changes there. The volume of shipped innovation products produced by innovation-active organizations in the services sector that implement technological innovations was up to 10% of the total industrial production in this period [14, p. 175, 176, 179].

Meanwhile, according to the results of the analysis, it is concluded that *accelerated development and dissemination of post-industrial services*, primarily in ICT sector, becomes a characteristic feature of the services sector [9; 10, pp. 90–96; 12, p. 69; 14, p. 157, 158]. For instance, the number of organizations that use local networks, on average, in the organizations of all types of economic activities increased by one third in 2005–2011, and almost twice – with regard to global networks. As for manufacturing organizations, the growth in their case is somewhat smaller – in 1.2 times. The number of manufacturing organizations that use networking technology as a percentage of the total number of surveyed organizations in 2011 reached 84.2% for local networks and 94.3% for global networks, and for the organizations of all types of activities – on average a bit less – 71.3% and 85.6%, respectively. Moreover, *the growth was regular* and quite even. The extent of using ICT services in Russia's federal districts and constituent entities approaches 90–100% (see, for example, the regions of the Northwestern Federal District [6]).

It should be noted that a characteristic feature of "post-industrial time" is the emergence of new indicators of the services sector: the speed of data transmission, broadband Internet, mobile Internet, websites, etc., the range of their application expands – from the sphere of production to households.

Significant growth and change is also observed according to these fundamental indicators: the number of organizations that use the Internet (as a percentage of the total number of organizations in all types of economic activity) increased from 53.3 to 88.1% in 2005–2013, and the number of organizations that use websites – from 14.8 to 41.3%, respectively, while the coverage of the population with the services of "postindustrial society" is 50% and more.

Meanwhile, there are no fundamental differences between federal districts according to all the indicators of information society development, which is certainly *a positive feature and a step forward in the development of post-industrial society*.

Services broaden the scope of using advanced technologies, ensuring their promotion to the consumer and, in many respects, their economic efficiency. The extension of innovations in the service sector is, in our opinion, has its drawbacks, namely, a decrease in the attention that society and state pay to basic research and its support, and also the exhaustion of the capacity of the *set of basic innovations*, i.e., in fact, *the exhaustion of the potential of the 4th and 5th technological modes*. It is therefore advisable, probably, to move to an economy based on priority development of fundamental science and the development of new industries and **related intellectual services** such as advisory support in the field of information technology, engineering, design services, etc.

With the advancement and wide dissemination of information services, development of their creativity, diversity, and integration in education increases, *the nature of the research and innovation process becomes more complex*. The complexity of high-tech services in postindustrial economy is manifested especially in the concept of the smart city, when special measures are developed in order to support and promote the comprehensiveness of services in the spatial organization of cities; these services include the automation of city emergency services, the implementation of automated models of social and healthcare services and much more [28].

The accurate reflection of specific features of the services sector in post-industrial economy requires adjustments in the structure of the research and innovation process, especially the personnel component of the potential, corresponding changes in statistical indicators, the anticipatory forecast of specializations in the field of higher education.

Characteristic features of structural changes in the research and innovation process in the spatial aspect

Trends in structural changes in the research and innovation process in spatial context are reflected in the difference in the extent and specifics of *innovation development of regions*. Moreover, the *growth of innovativeness* in virtually all the federal districts and in Russia as a whole is registered during the last four years. Thus, the share of organizations that implement technological innovations in the total number of organizations increased approximately by 15–20% in 2010–2013 (in several districts – somewhat less) [7, pp. 320-324; 8, pp. 243-246].

High-tech industries, services, etc. in the regions have the potential for growth, as it was shown above. However, according to the author of the article, one can note *significant*

differences in the rates of creation and use of nanotechnology in Russia's macro-regions [14, p. 197, 199-202].

It should be noted that in 2009–2011 half of the organizations that carry out research and development in nanotechnology, and half of the people employed in such organizations were concentrated in the Central Federal District, and almost half – in the Northwestern, Volga and Siberian federal districts. Moreover, in spite of the fact that the number of organizations remained virtually the same, the number of employees increased during these three years by 10% in the Siberian Federal District, by 20% in the Volga Federal District and twofold in the Central Federal District.

The development of nanotechnologies during the same period increased *in 2.5 times* in the Central and Siberian federal districts, and in 5 times – in the Volga Federal District. The use of nanotechnology increased in *about 1.7 times* in general and in the Central Federal District, in 2.5 times – in the Northwestern Federal District, twofold – in the Siberian Federal District, and in 1.5 times – in the Volga Federal District.

The *greatest increase* in the volume of innovation products in the sphere of nanotechnology, and the growth of industrial production companies performing technological innovations (mainly in manufacturing) in the short period under consideration took place in the *Volga Federal District* – from 449.7 million rubles to 47,134.6 million rubles, i.e. in 100 times, thus providing the entire growth in the amount of goods for global market.

The regions' capacity to carry out the research and innovation process changes, the innovative activity of the regions also changes; therefore, it is necessary to take into account the dynamics of innovation development. Previously, the analysis revealed a trend of *innovation shift* in the spatial context [16; 22]. This trend consists in the acceleration of innovation activity and performance efficiency in several macro-regions in which scientific and scientific-technological potential is not so strong. At the same time, according to the analysis, the last decade did not face any significant spatial transformations in the structure of the research and innovation process and in innovation development, the situation stabilized.

Thus, the study of structural changes in the research and innovation process has shown that in the conditions of formation of post-industrial economy, and in the transition to post-industrial technologies, there are very few qualitative changes of a long-term nature; there are no **sustainable shifts**, and there are certain multidirectional fluctuations in all the indicators of innovation activity. This also applies to the internal structure of the research and innovation process, to the quality of research and development, and to the enhancement of the role of fundamental science and high technology in innovation development.

We can distinguish only *individual characteristics* and emerging trends: a tendency toward growth is noted in some high-tech industries, such as pharmaceutics, and some areas of the military-industrial complex; there is the potential of growth in nanotechnology

due to the ongoing research and development in this sector; ICT sector is also developing due to specific investments in technology infrastructure. The information and communication services of post-industrial economy are being created and widely spread, **in the spatial context as well**, the range of high-tech services is expanding, but mainly through the use of imported technologies and devices.

Taking into account the exhaustion of the potential of the fourth and fifth technological modes, it is, apparently, more reasonable to move to an economy based on priority development of fundamental science and the development of new industries and related intellectual services, to enhance the **integrated nature of the research and innovation process** and high-tech services implemented in the smart city concept.

Due to the identification of characteristic structural changes in the research and innovation process and emerging shifts in the structure of the process, there arise certain **specific requirements** to the organizational-economic mechanism, to the feasibility of altering the institutional conditions and institutions for the purpose of promoting the promising trends of development of post-industrial technologies and accelerating innovation development.

Thus, the research is based on the author's own theoretical and methodological approach to the formation of the institutional environment and corresponding institutions of innovation modernization. The approach takes into account the dependence of the institutional environment on the essence of the research and innovation process and its task steps, the trends of structural changes in the research and innovation process in the post-industrial economy, and on the existing or emerging structural changes or characteristic features of the research and innovation process.

This approach makes it possible to propose conditions for the modernization of research and innovative development with recommendations on the development of institutions for implementing research findings. The key terms of the mechanism for promotion of the innovation process are as follows: institutional support for comprehensive execution of the research and innovation process and transfer of its results; selection of institutions for individual stages, particularly important in the post-industrial economy; selection of institutions for accounting characteristic features and trends in the research and innovation process of the post-industrial era; institutional support for the interaction between the subjects of scientific-innovative sphere; allocation of institutions to account for trends in the spatial aspect; institutional provision of equal access to resources for all the subjects of scientific-innovative sphere.

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