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Managing Russian Science-intensive Enterprises in the Emerging New Technological Paradigm

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ABSTRACT

The main purpose of the work was to examine the characteristics and identify the most innovative ways to manage Russian science-intensive enterprises in the emerging new technological paradigm. Fundamental position, works of scientists authoritative in this field, and author's developments served as theoretical and methodological basis of the research. The main methods of the research were the methods of empirical knowledge. As a result of the work, it is proposed to redefine the economic development strategy of the Russian Federation from the established resource-based scenarios to the most progressive ones that imply improvement of scientific and technological development of a number of industries to competitive international levels, to new technological paradigms. The necessity is founded to strengthen the effectiveness of the science-intensive enterprises, which act as a "core" of the production of innovative products, point of formation of a new post-industrial technological paradigm and the foundation of long-term economic growth in Russia. The peculiarities of the activities of science-intensive enterprises in the context of improving the approach to planning and forecasting are revealed. The necessity of harmonization of managing the science-intensive enterprises and the strategies of the state development of scientific and industrial base are methodologically founded. A set of instruments of state support for science-intensive enterprises that allow to bring Russia to the path of sustainable economic growth based on innovation is provided.

Keywords: Science-intensive Enterprises, Science-intensive Industries, Innovations, Technological Paradigms
JEL Classifications: O31, O32, O33, O43

1. INTRODUCTION

Global trends show that high-tech and science-intensive enterprises are the main dominant in the scientific and technological development of the economies of most countries. Playing a vanguard role, most of them materialize the progressive results of research and development and form the demand for advanced science and technology by consumers. The scale of the high-tech and science-intensive sector largely characterizes scientific, technical and economic potentials of the country and is the determining factor in the development of its economy (Pogodina and Medvedeva, 2013). In addition, the state of high-tech industries becomes one of the conditions for the successful integration of a country into the emerging global system of world economic relations.

The economic growth of the country is largely determined by the speed of the spread of innovations (Drucker, 1981) and their implementation in the area of material production. Slow development or inhibition of these processes can have a negative impact on gross domestic product (GDP) growth, reduce the competitiveness of domestic goods and hinder economic development. The state should regulate the area of innovation distribution, develop and improve mechanisms for the integration of science-intensive industries in the global technological space, and stimulate the processes of innovations diffusion. At the same

time, an important condition for strengthening the economic position of Russia on the world stage is a condition for the development of science-intensive sectors and industries, as well as access to world markets for high-tech products.

The state authorities of the Russian Federation should build effective policies to support domestic science-intensive enterprises, using both indirect methods of stimulating innovation enshrined in law and direct methods. The diffusion of innovations or process of a balanced distribution of innovation of scientific and technological, manufacturing, organizational and economic nature plays a special role.

The issues of performance improvement of the science-intensive industrial enterprises are very important in the Russian scientific practice, because being aware of the fact of a powerful resource potential, Russia loses position in the field of innovation development every year. Despite the increase in the number of developments in the various fields of knowledge, the degree of their implementation and widespread distribution remains extremely low. Their secrecy in the defense-industrial complex and the lack of economic and regulatory mechanisms of their introduction in the field of civil applications also slow down the process. Given that the main sources and consumers of innovations in the area of material production are enterprises in science-intensive industries, a reconsideration of their importance to the economy of the country and innovation development, as well as the development of tools to support them are required.

2. METHODOLOGY

Methodological basis of the study included the fundamental assumptions of economic theory, scientific works of domestic and foreign scholars in the field of economics, management, control systems theory, the results of many applied researches on the functioning of science-intensive enterprises and industries and innovative social and economic systems, the dynamics of the development of innovative products and the possibilities of their planning and forecasting.

The authors used the methods of empirical knowledge in the study on the identification of features of state regulation of science-intensive enterprises and industries in terms of its transition to an innovative path of development. They served as a means of collecting scientific facts, which were subjected to theoretical analysis. The theoretical analysis involves the allocation and consideration of individual aspects, features, characteristics of the operation and development of science-intensive enterprises. Individual facts were analyzed, grouped and systematized. Their general patterns were identified. The analysis is accompanied by synthesis, which helped to penetrate the essence of science-intensive technologies, innovations and their impact on the economy as a whole.

The study also contains inductive and deductive methods. Designated logical methods made it possible to generalize the theoretical empirical data on the impact of scientific and technological progress, the cost of R and D and innovation activities on the growth of the Russian economy.

Theoretical methods were necessary to determine the issues of improving the mechanisms of stimulating innovation and support of science-intensive enterprises, formulate the main hypotheses of work and assess the facts collected in the field. These methods have also been associated with the study of a narrow specialized literature and legal acts, which allowed to know what parts and aspects of the issue have already been studied in the designated area, where scientific debate is being held, which are no longer relevant and what issues are still not resolved.

3. RESULTS

3.1. Today's Global Challenges at the Stage of Formation of a New Technological Paradigm

Technological innovations are central to scientific and technological progress, the engine of the world economy. Their quality and scale of distribution and diffusion in various areas of human life determine the productivity growth, degree of modernization of the means of production and speed of the transition to a new technological paradigm. An established trend of deepening the technologizing of the economy at the expense of intellectual resources and innovations led to the development of new areas of research of theoretical and practical orientation.

Many modern scientific schools in the field of innovation and their management are based on the theory of technological paradigms based on the concept of K-cycles or K-waves of the scientist and economist Kondratiev (2002), the concepts of techno-economic changes, diffusion of innovations and technological paradigms. The central element of the designated concepts is the presence of series of successive waves and cycles of technological paradigms, each of which involves the transition of the productive forces to a new, higher level of development.

5 industrial and 1 post-industrial technological cycles are currently defined. Entering the fifth paradigm and mastering its basic features, the world economy is preparing to meet the first post-industrial order. Transition to it, according to a number of theoretical calculations, will occur in 2040 (Dudin et al., 2014), but due to the acceleration of technological progress it can occur earlier. The new wave of Kondratiev (2002) will be based on nano- and biotechnologies.

Currently, we can note a transition of some developed countries to the sixth paradigm (Kirova, 2014a). They include the US, Japan and China. It is too early to speak about the formation of the sixth technological paradigm in Russia. The share of technologies on the market relating to the fifth technological paradigm is about 10%, while 50% belongs to the fourth level, and nearly a third-to the third, prevailing in the developed countries in the 1920s. The gap of the Russian Federation in the economic development to the world's leading countries reaches 45-50 years. The difficulty of the issue faced by the national science and technology is that in order to enter the number of states with the sixth technological paradigm in the

next 10 years, Russia needs to make the maneuver and quickly pass one stage - the fifth technological paradigm.

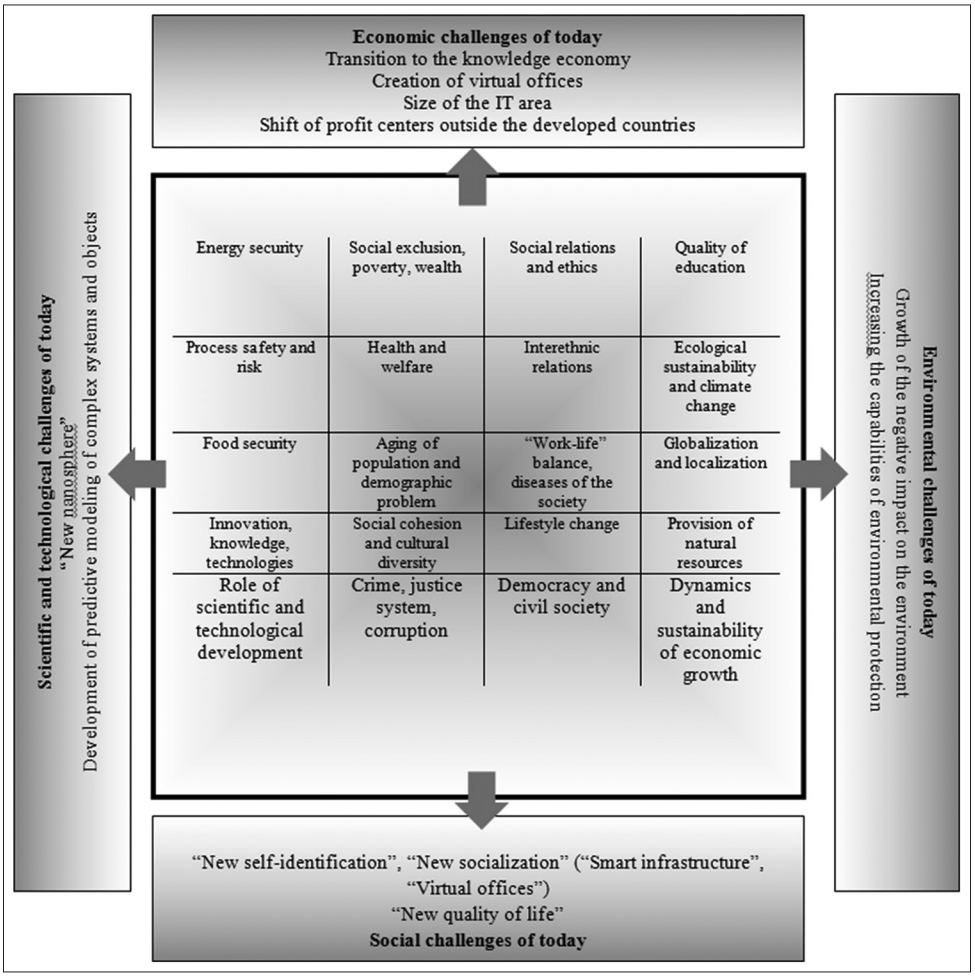
Acknowledging the fact that the economic development of Russia can no longer be carried out in the resource-based environment and with degradation of production and technological potential (Glazyev and Lokosov, 2012), it is required to improve scientific and technological development of a number of industries to competitive international levels, to new technological paradigms. This is confirmed by the experience of a number of Western countries, which shows a high proportion of scientific and technological progress in the filling of economic growth. This requires the creation, development and use of new technologies in the industry that would meet the challenges of today (Figure 1).

The development of the economy and the industry cannot be done without innovations, which also affect non-production area, the area of material production and use of the final products (Kirova, 2014b). The gap in the innovation development to the developed countries can be overcome only on the basis of fundamentally new technologies, changing not only the economic but also social relations (Afonasova, 2008).

Innovations are presented in the form of new technologies, products and solutions of information, financial, economic, industrial or other nature. They are a point of profit in the economic system (Troshin et al., 2014) and lead to positive externalities. This is why those who initially did not enter the number of the innovation consumers also get some positive effects. Being widespread, the innovation ceases to be such and becomes the production of a mass or everyday demand.

Innovation serves as a mechanism of evolution of economic growth, its engine (Pogodina et al., 2015). In order to keep Russia on the path of sustainable economic growth based on innovation, it is necessary to clarify the scientific and technical policy, which would base on a set of measures providing innovative structural and technological developments in the Russian economy. The core of this concept should become the electronic industry, information technology, telecommunications, robotics, etc., The sixth technological paradigm should be mastered in the near future, and the concept should be extended with nanoelectronics, space technology, information and telecommunication technologies, etc. If the final transition to the fifth technological paradigm, and eventually to the sixth, doesn't occur in Russia, this may lead to deceleration of economic growth, decrease in the competitiveness

Figure 1: Macroeconomic aspect of the global challenges of today as a factor of the reorientation of the economy to the path of innovative development. Developed by the authors on the basis of regulation (Forecast of Scientific and Technological Development of the Russian Federation for the period through to 2030 2014)



of domestic products in both domestic and foreign markets, as well as the inadequacy of the prevailing relations of production and consumption structures.

Russia still lags in terms of the use of advanced and explosive technologies of production of civilian goods. Indicators of technology transfer are extremely low (Afonasova, 2014). The efficiency of domestic enterprises is many times lower than that of similar foreign companies, and steady growth has had a negative balance in recent years. Of particular relevance are the tools to support science-intensive sector of the economy, as a high-tech complex of Russia acts as a platform for innovative breakthrough (Shutova and Startseva, 2012), and the competitiveness of innovative products is currently undermined (Afonasova, 2013).

One of the basic causes of the negative changes in the science-intensive sector of the industry was weakening of the innovation factor and reduction in the effectiveness of state corporations (Vilisov et al., 2013). The transition to the innovative development of the Russian Federation requires a sufficient number of personnel able to manage the innovation process and carry out the implementation of innovations. Such a development is impossible without the mass appearance of category of professionals managing technology commercialization, technological innovation and innovative firms, new to Russia.

Activities of science-intensive enterprises and industries are closely connected with the use of high technologies, whose contribution to the total cost of production is a major stake. We can say that science-intensive industries produce mainly high-tech products.

The most severe crisis indexing occurs in the organizational and economic structures with a long production chain and diversified cooperation of production of the technically complex, capital-intensive products. They are more affected by the multiplier effect of recession. On the other hand, the potential of science-intensive enterprises is a stabilizing factor of anti-crisis development. It guarantees the normal rapid economic growth and support of the economic independence of the country. It is well known that the basis of technological development is created by establishing the advanced scientific, technical, engineering, technology and investment backlog, which is an important strategic resource for entering the path of an intense and sustained economic growth.

3.2. Nature and Specific Features of Science-intensive Enterprises and Industries

High-tech enterprises act as the foundation of innovation and economic development of the country, define the vector and speed of scientific and technological progress, are a form of intellectualization of the basic factors of production, contribute to reducing the relative level of consumption and more efficient use of nonrenewable natural resources. Traditionally, this category includes companies with high absolute and relative costs of R and D. Their union at the meso level to "high-tech industries" also implies faster growth of expenditures on science and education in the structure of the material production of the economy.

In accordance with international practice, the assignment of enterprises to science-intensive class is meant to classify them as the "high level" technologies, where the level of R and D spending to output or income is 3.5-8.5% and "leading" science-intensive technologies, where the value of this indicator exceeds 8.5% (Tupikin, 2006). In general, the classification of enterprises as the F-intensive category (time - intensive, resource-intensive, science-intensive, energy-intensive, etc.) is possible if the proportion of the F factor is more than 1.5 times higher than the average share of similar costs of other companies in the economy industries. Along with the concept of F-intensity, you should take into account the performance indicators of the costs incurred for certain articles to the volume of production or sales through the Z-returns indicator (return on assets, on resources, on science, etc.). Currently, the domestic literature has no guideline values in terms of return on science for companies, and their establishment is very difficult. However, you can still establish some criterion of efficiency of return on science, which can be represented as "relatively new high-tech products with high consumer properties on the market compared with the growth of the entire science-intensive market" (Bendikov and Frolov, 2007).

An analysis of several studies (Bendikov and Frolov, 2007) dedicated to science-intensive enterprises, productions and industries allows to identify some other indicators of research intensity, including the number of specialists working in science and scientific services to the industrial and production staff of the enterprise or industry, and the level of R and D costs to the expenditures on industrial personnel and the amount of the basic production assets of the industry. In our opinion, these figures are not the criteria for research intensity, but the result of the criterion of expenditure on science, because increase in funds for its financing involves increasing the number of scientists and their share in the structure of personnel, increasing the cost of their labor remuneration fund. The consequence of research intensity of the industries is also their particular characteristics, including:

1. Growth rate 3-4 times higher than the growth rates of other sectors of the economy/businesses;
2. Large proportion of the value added in the final manufactured products;
3. Higher wages of workers and the availability of scientific personnel;
4. Large volume of exports and quite high innovation potential involved in the operation of not only its own industry, but also in other related industries.

According to official statistics (Official Website of the State Statistics Committee, 2015), the share of production of high-tech and science-intensive industries in the GDP for 2014 is 23.5% (Table 1).

Such high values of this indicator show not the progressive production of high-tech products, but rather the distortion of the official data and methodological inaccuracies, because in the calculation of value-added high-tech and science-intensive activities in the GDP of the Russian Federation, the indicator was defined as the quotient of the sum of gross value added of high-tech, high-level medium-tech and science-intensive economic

Table 1: Share of production of high-tech and science-intensive industries in the GDP

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Share of high-tech production in GDP	21.2	21.4	22.5	22.8	24.4	22.8	21.9	22.1	23.1	23.5

GDP: Gross domestic product

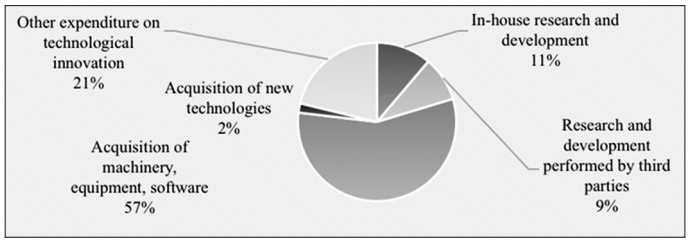
activities in the main current prices and total gross value added of all economic activities. Thus, these calculations include medium-tech productions, the research intensity of which is disputed.

Of particular interest is the structure of expenditure on technological innovation of the organizations in mining and manufacturing, production and distribution of electricity, gas and water supply by type of innovation, according to which more than half of the costs (Figure 2) falls for the acquisition of machinery, equipment and software that is at odds with innovative doctrine of the Russian Federation, the policy of import substitution of high technology, as these items are the most significant in the domestic imports, and the share of machinery and equipment accounts for more than 51%.

Given the nature of the cost approach to definition of the category of high-tech companies, it follows that the higher costs for R and D of individual enterprises, the collectively lower their research intensity at a constant value of production or income. It is suggested that such a situation is unlikely, as it will represent a fiasco and non-return on investment, so the company revenue should still grow, both in the next period and with a shifted time lag. At the same time, the pace of investment in R and D should be lower than the growth rate of the results of these investments. It is difficult to assess this situation on the example of a number of economic entities, and an empirical study based on the 1-2 enterprises in the scale of the country is not representative. It is therefore proposed to give macro assessment of the effect of R and D expenditures at the scale of some countries on the level of their GDP on the basis of correlation and regression analysis. The information base was data from 47 countries on domestic expenditure on research and GDP growth. In result of the construction of the model, the coefficient of determination equal to 5.24%, a free coefficient of 6.32 and the coefficient before the dependent variable equal to −0.05 were obtained. The results of the research showed that the proportion of variance in the dependent variable explained by the model under consideration is not high and the dependence is minimal. Attempts to establish patterns with a lag of 2, 3 and 4 years showed similar results. Despite the intuitive-logical direct connection between these variables, economic and mathematical tools showed the opposite. The reason for this result is likely the lack of the possibility to set the parameters of estimation of GDP growth in the larger time interval in the model, the long duration of the lag from the time of R and D costs recording and bringing their results in materialized form in the form of goods, as well as the crisis in the economy in 2009-2010, which could have an impact on the constructed model. It can be argued that the hypothesis about the direct influence of internal R and D costs on GDP in the short term has not yet been confirmed.

Thus, the stability of science-intensive industrial enterprise is determined by having the ability to respond quickly to changes in the external environment and at the same time save the landmark

Figure 2: Structure of expenditure on technological innovation of the organizations in mining and manufacturing, production and distribution of electricity, gas and water supply by type of innovation



of the planned activities with the production of marketable science-intensive products for a certain period of time. Sustainable development depends largely on external macro environment and the ongoing scientific and technical policy of the state. Therefore, it seems the most appropriate to harmonize the management of science-intensive enterprises and strategies of the state development of scientific and industrial base, as they represent the converging scope of the different levels of the innovation system of the country and have common related goals.

3.3. Harmonization of Managing Science-Intensive Enterprises and the Strategies of State Development of Scientific and Industrial Base in Russia

In the context of an unstable economic growth, the science-intensive companies should be more adapted to the influences of the environment, be able to change their structure and convert the production of new goods in demand. Given the fact that the business must be built according to the needs of the market (Bank and Suglobov, 2014), it is necessary to identify new and update old conceptual approaches to the development strategies of science-intensive enterprises, which should be based on improvement of the functions of planning and forecasting of technical and economic development in the plane of the long-term deterministic manufacturing process and the causality of related processes, corresponding computational and analytical tools and simulation modeling.

The main direction of improving the management of science-intensive enterprises seems to be changing the approaches to planning and forecasting in the following areas:

1. Changing the institutional framework for the functioning of the science-intensive enterprises (personnel, organizational, functional and technological structures, orders system, etc.,), increasing intensification of production.
2. Reducing the asymmetry of production and reproduction processes.
3. Reorientation of the system of goals, incentives and economic relations between economic entities.
4. Availability of policy conditions that need to be adapted to current market conditions.
5. Strategic reorientation of the “backlog” of orders.

Ineffective management of science-intensive enterprises can lead to loss of existing science-intensive technologies, reduction of scientific and industrial potential, and as a consequence, de-industrialization of the economy, degradation of the socioeconomic development of society, departure from the progressive evolutionary replacement of obsolete technologies with new, and increase in irreversible resource consumption. Science-intensive enterprises, being part of the industrial complex of the Russian Federation, are currently experiencing a number of problems, most important of which is a lack of investment, since private financial capital sources are not interested in long-term investment projects in view of the risks and opportunities of investing in faster payback projects with ultra high income. Such, for example, were the operations on the foreign exchange market and in the banking sector at the end of 2014, when the ruble value fluctuations allowed to increase capital at times in just a few days.

Russia has a fairly high intellectual potential accumulated in the period of the planned economy. However, its poor management does not allow to take full advantage of the investment and innovation activity in the real economy. It requires the formation of new technological management both at the micro and macro levels. This issue has become urgent for many developed countries, including the United States, where, in recent years, budgetary allocations for science have been reduced, and the country is actively seeking ways to implement the already developed technologies.

Given the common approaches to support of the science-intensive enterprises in their strategic development, this requires the revision of the concept of development of scientific and industrial base in Russia, preserving and strengthening its capacity as a driving force of science and technology and advanced technological base for economic growth. This requires harmonization of the tools of strategic development of science-intensive enterprises in a number of state strategies, which must conform to the principles of the system and include the adoption of a wide range of measures of state support in the following areas:

1. Stimulation of innovation activity and innovation manufacturing. Requires the promotion of industries and enterprises supplying the market with entirely new and modernized goods (services) with improved consumer and performance characteristics, allowing them to expand the existing position on the commodity markets and win new ones (Kenzhebayeva and Turchekenova, 2014).
2. Optimal diversification of production. Major science-intensive industries have a high specialization of production. The share of profile products in a number of enterprises from the space industry, defense industry, etc., in the total output is 80-90%. International experience shows the need to reduce this figure to 20-40%. The regulatory function of the state can be shown to enhance the growth of high-tech sectors of the economy.
3. Legal regulation and licensing of innovation activity. Since the state management of economic development should be carried out systematically, pragmatically and creatively, without artificial narrowing of the field of possible measures with contrived rules (Glazyev and Fetisov, 2013), it is necessary to improve the national regulatory framework.
4. Tax incentives and fiscal subsidies. Economic incentives to support innovation are more attractive to economic entities. A partial exemption of a number of costs associated with investing in the own technological development from the tax base seems appropriate. Small and medium enterprises can be provided benefits or be fully exempt from income tax, and buyers and consumers of science-intensive products can be ensured with targeted investment loans on the terms of their payback from income.
5. Promotion of import phase-out of science-intensive products. Protectionist policies create prerequisites for the protection of the domestic market of science-intensive products from foreign occupation and allow to fill it with goods produced in Russia.
6. Extension of the fields of application of the results of the defense-oriented research. It is required to choose technologies with a dual purpose from the MIC R and D, fine tune them and implement in the civil area of multiple use. Proposed activities should focus on the priority areas of scientific and technical progress, create favorable climate for innovations, investment inflow in the economy, and contribute to restoring order in the area of protection of intellectual property rights.
7. Clear and consistent implementation of structural reforms and global commercialization of scientific and production activities. Special attention needs to be paid to reformation of the sectoral science, its technological and fundamental sectors in a difficult position, even against the background of the general industry downturn.

These circumstances are fundamental in the formation of the strategy and tactics of development of science-intensive industry at all levels of management. They must be considered by both business entities and state authorities, as well as taken into account in the formation of scientific and industrial policy at the federal level of management.

4. DISCUSSION

This study on identification of the features of the science-intensive sector of the economy in terms of its transition to an innovative path of development and the formation of a new technological paradigm was based on the methods of theoretical and empirical knowledge. In result of the collection and analysis of information about the impact of innovation and R and D expenditures on economic growth, the hypothesis of the need to support science-intensive enterprises in the Russian Federation was confirmed. The high reliability of the results is based on the works of famous Russian and foreign scientists. A distinctive feature of this study is taking into account the specifics of the Russian economy, in particular its current precarious situation, as well as economic and administrative legal regulation of scientific and technical area. During the theoretical analysis, individual aspects, features and characteristics of the regulation were identified and dealt with. The role and influence of science-intensive enterprises on the increase in the number of innovations in the civil area were defined. The work presents the main factors that hinder the development of science and scientific progress, the findings of the threats of external expansion with respect to the domestic market

in the absence of mechanisms of stabilization of the policy in the field of innovation and slowing processes of transition to a new technological paradigm. The validity of the results is confirmed by the data from official statistical institutions in the country published on the site of the State Statistics Committee.

5. CONCLUSION

Proposed measures to harmonize managing science-intensive enterprises in the conditions of formation of innovative economy of the Russian Federation must comply with the strategy of the state development of scientific and industrial base and enhance innovation activity in the economy. It requires activation of the state structures to support science-intensive enterprises, which in the near future should become a driving force of innovation development of the country.

1. State authorities are paying insufficient attention to the issues of scientific and technological development. Review of the tools to support science-intensive enterprises is required.
2. The state owns most of the science-intensive enterprises in the Russian Federation and is the main consumer of their products. Reorientation of the backlog of orders to the area of the civil use and increase in their export orientation are required.
3. Conditions of turbulence and uncertainty of the external environment dictate the conditions of perfection of approaches to planning and forecasting of activities of science-intensive enterprises.
4. Of exceptional value is stable interaction of all the subjects of scientific, technological and production sector, development of a common innovation infrastructure that will take new knowledge production to the assembly line and ensure efficient use of national scientific and technological potentials.
5. The proposed measures of building an effective policy of state regulation of innovative activities should focus on the priority areas of scientific and technological progress and the formation of a new technological paradigm, create favorable climate for innovations, investment inflow in the economy, and contribute to restoring order in the area of protection of intellectual property rights.

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