Evaluation of innovation activity science-intensive and high-tech of enterprises

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Abstract. The innovative development of individual enterprises and industries determines the competitiveness of the regional and national economies through modern business technologies for sustainable urban development. The article presents the analysis of categories "science intensive", "high technology", "innovative". The analysis of official data of the Federal Statistical Agency on key indicators of the effectiveness of innovation activities of enterprises is given and their aggregated estimate is given. The dynamics of such indicators as: innovative activity of organizations (specific weight of organizations that carried out technological, organizational, marketing innovations in the reporting year) was revealed; the share of innovative goods, works, services in the total volume of goods shipped, works performed, services; costs for technological innovation; specific weight of expenses for technological innovations in the total volume of shipped goods, works performed, services, etc. In the course of the research, recommendations were developed to increase the efficiency of innovation activities of enterprises based on assessing innovation activity and identifying innovative capacity, as well as applying the necessary economic and mathematical tools for the assessment and modelling of innovative projects and enterprise programs.

1 Introduction

At the macro- and meso- levels, innovation activity determines the level of competitiveness of industries and the entire Russian economy. Innovative activity at the micro level can be defined as an indicator that reflects the pace, scale and duration of the development and implementation of innovations based on the use of scientific and technological progress and best practices at a particular enterprise.

The purpose of the study is to analyze retrospective and current indicators of innovation activity.

The object of the study are enterprises that carry out economic activities in the territory of the Russian Federation.

The subject of the study is the innovative development of the Russian economy.

To achieve this goal, the following research objectives have been formulated and solved:

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- analysis of the theoretical and methodological base on the categories and forms of presentation of performance indicators of high-tech and high-tech enterprises;

- collection and analysis of data on the results of high-tech and high-tech enterprises;

- a description of trends and the identification of patterns of changes in the indicators of innovation activity of enterprises;

- the formation of recommendations aimed at increasing the innovative activity of high technology and high-tech enterprises.

2 Materials and Methods

In the course of studying knowledge-and-intensive categories and solving the problems posed, such theoretical methods of investigation as: axiomatic method; method of formalization; general method.

Formation of the category apparatus in the study is based on the use of normative legal documents and the works of authoritative scientists.

A correct representation and comparison requires the genesis of science-like concepts.

First of all, it should be noted the work of the American scientist of Austrian origin J. Schumpeter's Theory of Economic Development, which first defined the concept of "innovation" for various cases [1]. J. Schumpeter combined his work on the role of the entrepreneur in the process of economic development and the theory of long-term fluctuations in Kondratiev's economic dynamics. Thus, he created the theory of innovation cycles, in which long-wave oscillations defined as one of the forms of manifestation of the economic dynamics generated by the innovation process.

Imagine the tools used to analyze statistical data. Currently, three international organizations are engaged in the development of a methodology for the statistics of science and innovation: the Organization for Economic Cooperation and Development (OECD), UNESCO and Eurostat [2, 3, 4]. With the purpose of clarifying the international concept, the information "Manual Frascati" is given, which became in 1963 the first document devoted to the methodology of statistics of science and innovation. It was developed and is constantly supplemented by the Group of National Experts on Science and Technology Indicators within the OECD [5]. At the national level, the data of the federal statistical agency are used [6].

A significant part of the study of statistical data includes data that are disclosed at the time of the first quarter of 2018 in the annual federal statistical collection of 2017, as well as data on the macroeconomic performance indicators of the Russian economy [7,8]. Accordingly, the most relevant open information is disclosed for the period up to 2016, inclusive.

For the comparative analysis of the "high-tech" and "science-intensive" type of activity, the modern Methodology for calculating the indicators "The share of high-tech and high-tech industries in the gross domestic product" and "The share of high-tech and high technology products in the gross regional product of the subject of the Russian Federation" approved by the Order of Rosstat # 21 from 14/01/2014 [9]. The Russian grouping of industries on the basis of technological development and science intensity is developed on the basis of the recommendations of Eurostat and OECD on the basis of NACE Rev.1.1, taking into account the national characteristics of the development of industries [4, 9].

The list of high-technology products, works and services, taking into account the priority of the directions of economic development oriented towards modernization, was approved by the Ministry of Industry and Trade of the Russian Federation [10].

To collect and analyze data on the results of high-tech and high-tech enterprises, as well as the description of trends and the identification of regularities, statistical research methods were used: correlation and regression analysis.

The formation of recommendations aimed at increasing the innovative activity of high technology and high-tech enterprises is based on the methods of the experimental-theoretical level: analysis, modeling, hypothetical method.

3 Results

We present an analysis of the theoretical and methodological base for the categories of the subject area of the study.

For the first time the concept of "innovation" in the scientific context was introduced in 1911. This was done by the American scientist of Austrian origin J. Schumpeter in his work "The Theory of Economic Development" [1]. He defined innovation as "the implementation of new combinations." In his opinion, this concept of "innovation" covers the following five cases:

1. Making a new one, i.e. still unknown to consumers, benefits or the creation of a new quality of this or that good; 2. The introduction of a new the method of production, which does not necessarily have as its basis a new scientific discovery, and which can also consist in a new way of commercial use of the corresponding product; 3. Development of a new market, i.e. a market in which the industry of this country has not yet been represented, regardless of whether the market existed before or not; 4. Receiving a new source of raw materials or semi-finished products, likewise, whether this source existed before, or simply was not taken into account, or was considered inaccessible, or it was yet to be created; 5. Conducting an appropriate reorganization, for example securing a monopoly position (through the creation of a trust) or undermining the monopoly position of another enterprise.

In accordance with international standards, innovation is the end result of innovation, embodied in the form of a new or improved product introduced on the market, a new or improved technological process used in practice, or a new approach to social services [5].

Before revealing the dynamic indicators of high-tech and knowledge-based enterprises, we will consider the importance of the categories used and their relationship to the above-mentioned concept of "innovation".

The concepts of "high technology" and "science intensive" are used in different contexts: for enterprises, economic sectors, types of economic activity, and also for the results of activity - products and services.

In the most general sense, the category of "high technology" correlates with the criteria for high and new technologies (using high-tech production). The level of the technology used is determined by the main technical characteristics of the produced products in terms of such parameters as: energy intensity, reliability, material consumption, safety, durability, etc .; or the absence of substitute goods on the market.

High-tech goods, works, services, characterized by the following features: 1) the goods and work is produced or the service is provided by enterprises related to knowledge-based industries; 2) the goods and work is produced or the service is provided with the use of modern equipment, the latest technologies and technological processes; 3) the goods and work are produced or the service is provided with the participation of highly qualified personnel. High-tech products, works and services are considered that correspond to one of the listed characteristics or several. Also high-tech and medium-technological types of economic activity are distinguished, which are characterized by a high level of technological development. The composition of these groups includes production types of economic activity.

For the science intensity category, various definitions are used in the Russian economic literature, for example: modern industries are engaged in the production of products using the latest achievements in science and technology, in which the share of expenditure on R

& D aimed at improving production technology and final products is more 40-50% of all costs, and the number of scientific and technical personnel exceeds 30-40% of all employees. In the Soviet economy, in the general structure of the national economy, three groups of sectors were distinguished in terms of their level of science: branches with high, medium and low science intensity. The first group of industries (with a high level of high science) included: machine building, oriented to small-scale production and manufacturing technically complex products. The second group of industries (with an average level of high science) included: mass machine building and the chemical industry. The third group of industries (with a low level of knowledge intensity) included: traditional industries, such as the production of building materials, light, food, and meat and dairy industries [10, 11]. Thus, in science-intensive industries, scientists refer to such industries as are distinguished by advanced scientific and technical programs and development strategies, highly qualified personnel, significant financial expenses for R & D, use and manufacture of technologically advanced products.

The level of sectoral science intensity can be defined as follows:

- the ratio of expenditure on R & D and the volume of gross national product (GNP), gross domestic product (GDP) or volume of shipped products;

- the ratio of the number of specialists engaged in R & D and industrial and production personnel in the industry;

- the ratio of costs for R & D and the costs of the FOT of industrial production personnel, as well as the basic production assets of the industry.

The most common method for assessing knowledge intensity is the first of these, where the main factor is the cost of R & D.

In science-intensive branches of the economy, there are a number of distinctive features:

1) rates of growth of productivity of high technology enterprises in 3-4 times exceeding rates of growth of the enterprises of other branches of an economy;

2) the share of added value in the final output produced at science-intensive enterprises is much higher than in products produced by enterprises of other branches of the economy;

3) higher wages of personnel working in high-technology industries;

4) significant volumes of exported products;

5) high innovative potential.

When considering data from international and national statistical agencies, the difference between "science-intensive activities" and "high-tech activities" corresponds to the industry affiliation of the enterprise. This difference consists in the following types of services in statistics: knowledge-based in statistics: in the field of transport, finance, healthcare, scientific research, information technology, etc., and only types of products can be high-tech.

Based on the official data of Rosstat, will present the dynamics of performance indicators of high technology and high-tech industries (Figure 1) [7]
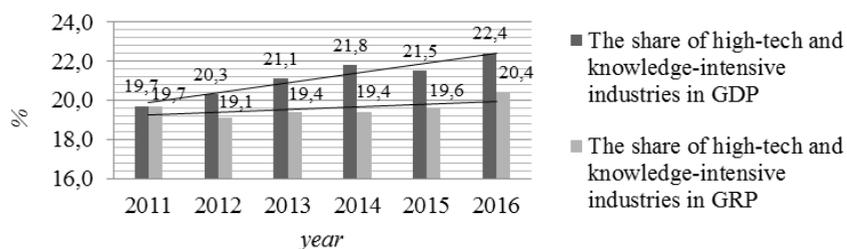

Fig. 1. Dynamics of indicators "Shares of high-tech and high-tech industries in GDP" and "Shares of high-tech and high-tech industries in GRP".

The presented data show that there are no sharp changes in the market of high-tech and knowledge-intensive industries. This is also evidenced by data on the specific weight of organizations that in the reporting year carried out technological, organizational, marketing innovations in the total number of organizations surveyed (Figure 2) [7].
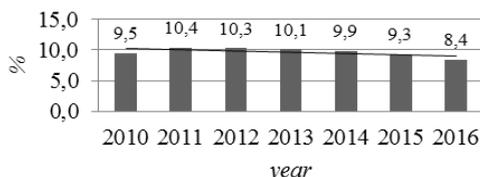
**Fig. 2.** Dynamics of the level of innovation activity of organizations.

The following is an analysis the indicators of innovative activity of enterprises engaged in economic activity in high-tech industries (extracting, processing industries, production and distribution of electricity, gas) and science-intensive industries (communications, activities related to the use of computer technology and information technology, research, and other services) (Figure 3) [7, 8].
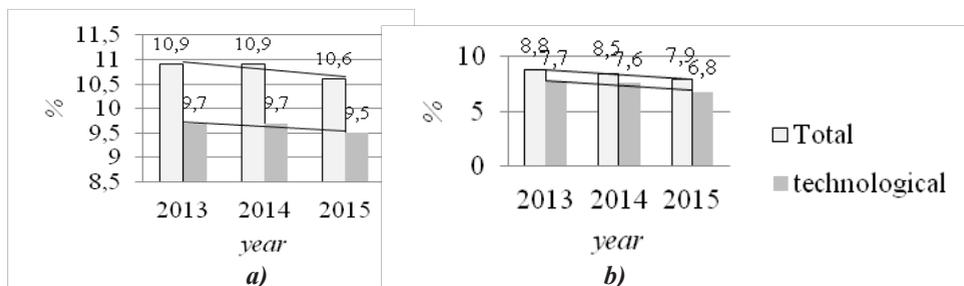
Fig. 3. Dynamics of the ratio of the proportion of organizations that carried out innovations (*a* - on extracting, processing industries, production and distribution of electricity, gas; *b* - on communication, activities related to the use of computers and information technology, R & D, the provision of other types of services).

There is a general tendency to reduce the level of innovative activity of enterprises, the economic efficiency of which depends to a large extent on the technologies used. For such knowledge-intensive types of economic activity as communication, activities related to the use of computer technology and information technology, research and development, other types of services, there is also a negative trend in the level of innovation activity.

Further will consider dynamics of the index of production by the hi-tech processing types of economic activity (Figure 4) [7, 8].
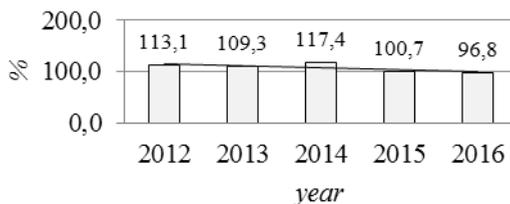
Fig. 4. Dynamics of the production index for high-technology processing activities of economic activity.

The production index for high-technology processing activities indicates the ratio of the current production volume to the volume produced for the previous period. Thus, in terms of high-technology processing types of economic activity, there has been a decline in production over the last reporting periods.

The analysis of the indicators reflecting the ratio of the volume of innovative goods, works and services and their total volume has an unstable dynamics in the last three years: a decrease in the share of high technology production facilities and fluctuations in the specific value of high-tech products in their absolute value (Figure 5) [7, 8].
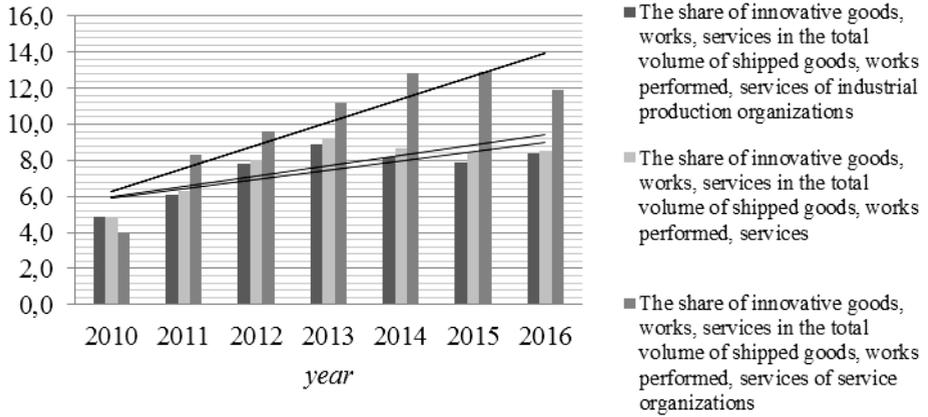
Fig. 5. Dynamics of the share of innovative goods, works, services in the total volume of shipped goods, works performed services for 2010-2016.

To determine the effectiveness of innovation, in addition to analyzing the results, it is necessary to estimate the costs for them. On the basis of statistical data, let us present the dynamics of investment costs for technological innovation in the Russian Federation (Figure 6) [7, 8].
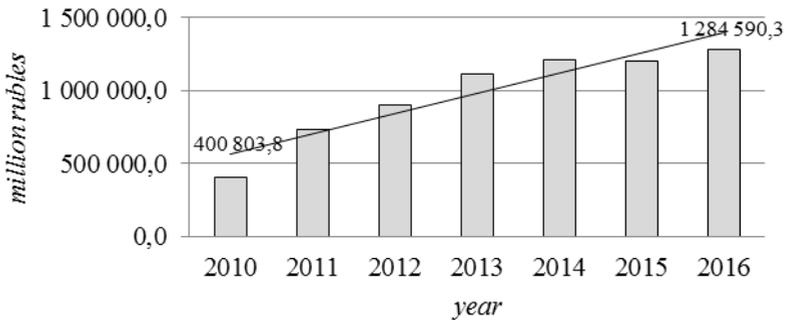
Fig. 7. Dynamics of investment costs for technological innovation in the Russian Federation.

For a long time, the total investment activity in innovative areas has grown, but in the last three financial years the relative increase is insignificant.

Let's present a pie chart of the types of economic activity that have the greatest value of costs for technological innovation in the Russian Federation (Figure 7) [7].

1) 574,154.1 million rubles. (45%) - processing industries;
2) 416,730.1 million rubles. (33%) - Research
3) 136 702, 1 million rubles. (11%) - extraction of minerals;
4) 66 663.4 million rubles. (5%) - production and distribution of electricity, gas and water;
5) 40 874, 3 million rubles. (3%) - communication;
6) 22 638.4 million rubles. (2%) - provision of other types of services;
7) 11 859.3 million rubles. (1%) - activities related to the use of computer technology and information technology

Fig. 7. Costs for technological innovation in Russia in 2016.

The analysis of statistical data shows that the most significant amount of investments in innovative development are highly technological processing activities. In the second place are knowledge-intensive research directions.

4 Discussion

The obtained data, resulting from the analysis of information from official statistical databases, shows that, despite the high importance of the issue of innovative development of the Russian economy, there is a low efficiency of the measures taken to increase the competitiveness of the results of high-tech activities (manufactured products) and knowledge-intensive activities types of services, including research).

The latest international statistics, dating back to 2015, show that the costs of research in the Russian economy are well below the costs of world leaders (USA, China, Japan, Germany) - Table 1 [12].

Table 1. International comparisons of GERD (gross domestic expenditures on R & D) and R & D share of gross domestic product (by country, with the highest R & D costs).

Country	GERD, $millions	GERD/GDP, %
USA	496585	2.74
China	408829	2.07
Japan	170003	3.29
Germany	114778.1	2.93
South Korea	74051.5	4.23
France	60818.7	2.22
India	50269.4	0.63
United Kingdom	46259.8	1.7
Russian Federation	38135.5	1.1

When considering the indicator of equal ratio of incomes and expenditures in the GDP indicator, it becomes obvious confirmation of the low effectiveness of innovation in Russia.

To increase the efficiency of innovation activities of enterprises and economies in general, it is necessary to identify the main problems that impede innovation development and the development of an innovative development program for macro- (for the country), mezzo- (for industries and regions) and micro levels (for each science-intensive or high-tech enterprise) taking into account provisions of regulatory legal documents, such as: the Strategy for Innovative Development of the Russian Federation for the Period to 2020 and the Decree of the President of the Russian Federation of December 1, 2016 No. 642 "On the Strategy of Scientific and Technological development of the Russian Federation " [13, 14 15].

To obtain intermediate results, which contribute to the development of innovative development programs, in the course methodical approach. Designing programs should be based on the principles of hierarchy, systemic, deductive and inductive methods of research. The key issues in the development of an innovative program are:

1) Formation of investment conditions and tendencies of innovative activity of enterprises. The program should include an investment subprogram, which describes: the objectives of investment activities of a high-tech or knowledge-based enterprise; the necessary resources to achieve the goals; possible sources of investment; a set of potential investment projects, their indicators and evaluation criteria; composition of participants in investment activities [16, 17, 18]. A separate problem is the development of economic and mathematical tools for the evaluation and modeling of innovative projects and enterprise programs. At the moment there is no single approach, which allows unifying the calculations to determine the effectiveness of whole programs and individual projects. The most active for the evaluation of projects use such quantitative economic indicators as: NPV - the net present value of investments; IRR - internal rate of return; PP - the payback period of investments. For programs use expert methods, methods of analyzing hierarchies, etc. [19, 20, 21]. These indicators are sometimes supplemented by methods from mathematical statistics. The Toolkit should be a Guide to the evaluation and modeling of innovative projects and programs of enterprises with universal approaches to multi-criteria evaluation.

2) Improving the methodology for assessing the effectiveness of innovation activities of enterprises, industries, regions, countries. At the moment, the main indicators characterizing the effectiveness of innovation activity are reflected in Form No. 4-innovation "Information on the innovation activity of the organization" only for the industry level (in accordance with Russian Classification of Economic Activities - OKVED codes). Official data shows that this form will be updated for odd years, beginning in 2016 (that is, in 2018, information will be provided for 2017, and further: in 2020, information will be provided for 2019, etc.).). The current methodology has many shortcomings, the main of which are: - statistical observations should be conducted at least once a year, to understand the actual situation and to conduct successful preventive measures to achieve the forecast indicators; - the list of evaluation criteria is incomplete. It is important to take into account a number of criteria, including the comparison of Russian and foreign results (for example, the assessment of the organization that carried out research and development, the evaluation of the coefficient of inventive activity, the evaluation of innovative activity of organizations, the share of domestic expenditure on research and development in GDP, etc.) . All these evaluation criteria are available in collections and statistical data on macroeconomic indicators. Thus, there are many disparate statistical databases that need to be integrated into the overall assessment model and supplemented with international indicators in accordance with the Russian Administrative-Territorial Division Classification - OKATO codes and OKVED codes.

5 Conclusions

Through the process of accelerated growth of the world market of high technology and high-tech goods and services, the Russian economy opens new opportunities for technological breakthrough. To overcome existing problems, it is necessary to identify areas that can provide a high-quality jump in the Russian economy. According to the forecast of scientific and technological development, the most important condition for expanding the Russian economy on the world market is to ensure the growth rate of exports of science-intensive and high-tech products at the level of 15-20% per year. Observance of this condition by 2020 will allow Russia to reach the level of 1% of the world market of science-intensive and high-tech products, and by 2030 this figure may amount to 2.5%.

At the moment, despite considerable efforts on the part of the country's leadership, the tendency of the enormous technological backwardness of the Russian economy from the leading countries continues, which is primarily caused by a strong dependence on the extractive and processing industries. The level of development of the domestic economy is inferior to a large number of countries, among them: the countries of Western Europe, the United States, a number of Asian countries and even Latin America. Exports of high technology in Russia is about 3.7% of US exports, 1.2% of China's exports, 4.3% of Japan's exports. World Bank data show that the volume of exports of high-tech products by enterprises in Thailand is 6 times, and that of Switzerland is 10 times higher than that of Russian enterprises. There is also a significant lag in the rate of growth of finished science-intensive products. Russian enterprises still can not refuse to purchase imported technologies and equipment in the absence of quality analogues for the enterprise of most types of economic activity, which does not allow to ensure the competitiveness of domestic products.

Based on the foregoing, it can be concluded that there is a general negative dynamics of the country's innovative development and that key strategic decisions on high-technology and science-intensive activities, capable of providing necessary and sufficient autonomy, and a high level of competitiveness of the Russian economy on the world arena have not yet been formed.

The results of the research show that it is necessary to adjust the processes of organization of innovative development, through appropriate programs and projects at various levels (at the country level, at the industry level, at the regional level). For an objective analysis of actual indicators for innovation in the Russian Federation, existing statistical databases should be integrated and supplemented with international assessment criteria.

Continuation of the study may be the development of a system for assessing innovation activities of high-tech and knowledge-based enterprises. The new direction of the research will increase the predictability of projects and increase the scope of innovation, as it will increase the interest of commercial organizations, individual entrepreneurs, venture investors and other entities that can participate in the implementation of research and the production of innovative products.

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