

High-tech Industries of Russia: Current Situation and Development Trends

O I Kostromitskaya¹ and I V Somina²

^{1,2} Belgorod state technological University V. G. Shukhov, 46, Kostyukovastreet, Belgorod, 308012, Russia.

¹Orcid id: 0000-0002-0657-5791, ²Orcid id: 0000-0002-4365-9839

Abstract

Within the scope of this work, it was found out that there is no unified methodology for assessing the development of high-tech industries both in foreign and domestic practice, and accepted in the modern literature classification of the industry as highly technological industry is rather conditional. We took under study the most common approaches to the classification of industries according to the level of their manufacturability. The work is based on the classification of high-tech industries, which was adopted by the Rosstat (the Federal State Statistics Service) in 2014 in accordance with the recommendations of the Eurostat and the OECD (the Organization for Economic Cooperation and Development) and the national peculiarities of the functioning of these industries. We have regarded the role of innovations and innovative activity in the effective development of high-tech industries in Russia, as well as the possibility of long-term economic growth. The efficiency of efforts to develop innovations and innovative activity in the Russian Federation, as well as the current state of high-tech branches of domestic industry were estimated. Having analyzed the state of high-tech industries in Russia, we determined strategic problems and formulated the directions of their solution.

INTRODUCTION

At present time the issues of modernization and scientific and technological development of the Russian economy are of exceptional importance. According to a number of scientists [1, 2, etc.], the country has exhausted «extensive» economic growth through capital, quality and quantity of labor. In the current situation, a key role is played by the stimulation of innovations as the only remaining leverage of economic growth with available resources. The experience of such developed countries as South Korea and China confirms the possibility of long-term economic growth through innovations and innovative activity. The ability of the state to create and effectively implement innovations determines the level of the national economy development. The significant scientific-technical and technological potential of the country and the competent designation of scientific and technological guidelines will allow the country to take a leading rank on the world stage, that is especially important now.

At the same time, it should be noted that to date the impact of high-tech industries on the development of the separate states

and regions of the world is constantly increasing. It can be explained by the fact that the change-over of the economy to the production of high-tech products is accompanied by high growth rates, the significant reduction of the energy and material intensity of the national production, the decrease of import dependence, the improving competitiveness of individual enterprises, industries and the whole country's economy. Besides, high-tech industries are characterized by synergistic and multiplicative effects: their functioning contributes to the development of other industries, both related and not related to high technologies.

Stimulating innovations through the support of high-tech industries will allow to give a new impetus to the development of the Russian economy and achieve the effective results of the functioning of the national economy in a short time. Based on the official statistics [3], laws and regulations [4, 5, 6] and the works of economic scientists [2, 7, 8, etc.], we will estimate the current state of domestic high-tech industries and also will identify strategic problems and ways of their solutions.

METHODOLOGICAL APPROACHES TO THE CLASSIFICATION OF INDUSTRIES ACCORDING TO THE LEVEL OF MANUFACTURABILITY

The main innovators are the enterprises of the high-tech sector of the economy, which have breakthrough technologies and high innovative potential and which are carrying out effective innovative activity. As a result, the change-over of the Russian economy to a new technological level is ensured, first of all, by the development of the high-tech sector of the economy, which is considered to be a number of industries, each of which is characterized by high intensity of knowledge and science-intensive production.

For the further analysis of high-tech industries it is necessary to have a clear idea of what industries are considered to be high-tech industries. To this end, we have to study the most common domestic and foreign methodological approaches to the classification of industries.

The undertaken analysis of modern literature [9, 10, 11, etc.] confirmed the fact that neither in the world practice nor in domestic practice there is unified methodology for estimating the level of development of high-tech manufacturing. In most cases, the identification of the level of the development of

high-tech sectors is based on the methodology for classifying industries according to the level of manufacturability, for the evaluation of which they use the indicators of the expenditures for researches and inventions in relation to value added, output volume, indicators of patent activity and the share of researchers in the total number of employees.

The industries classifications of the National Science Foundation of the United States and of the United Nations (trade classification - Standard International Trade Classification (SITS)) (Table 1) enjoy authority.

The criterion for the determination of high-tech industries of the abovementioned classifications is the amount of costs for scientific and technical researches and inventions that exceeds the average level for industry and equals to 2,36% of value added. The production, where the average level of costs for scientific researches and inventions for the industry is more than double, refers to high technologies.

Table 1 Types of high-tech industries according to generally recognized classifications

Nº	National Science Foundation of the US	UN
1	Aviation, rocket and space industry	Air and space vehicles
2	Computers and telecommunications	Electronics and computer technologies, office equipment
3	Electronics	Electronics, equipment for radio, television and communication
4	Nuclear energy technology	Radioactive materials and other chemical products
5	Production of weapons and military equipment	Armament
6	Biotechnology	Pharmaceutical dosages
7	Optoelectronics	Equipment (medical, optical etc.)
8	Development of new materials	Non-electric machines (nuclear reactors, gas turbines, etc.)
9	Computer related manufacturers	Electric machines
10	"Lifesciences"	

At the same time, the classification of high-tech industries, developed by OECD (International Standard Industrial Classification of All Economic Activities (ISIC)), is widely accepted. It is based on the formed composition of high-tech industries of developed countries (Table 2).

Table 2: OECD classification of industries in accordance with the level of manufacturability

Industry	Classification based on ISIC
High-tech industry	Aircraft and spacecraft; pharmaceuticals; office and counting equipment, electronic computing machines; equipment for radio, television and communication; medical, precision and optical instruments.
Medium-tech industry of high level	Electric equipment; motor vehicles, trailers and semi-trailers; chemicals with the exception of medicinal products; equipment for railways and transport equipment; machinery and equipment
Medium-tech industry of low level	Coke, petroleum refinery products and products of nuclear fuel processing; rubber and plastic products; production of other non-metallic mineral products; construction and repair of ships and boats; basic metals; finished metal products except machinery and equipment
Low-tech industry	Production; utilization; wood and wood and corks products; cellulose, paper, paper products, printing and publishing; food, potables, and tobacco; textiles, textile products, leather and footwear

The OECD has two approaches to determining the level of manufacturability of industries: 1) the criterion of classification is the intensity of use of the latest technologies in the production process; 2) the criterion is the science intensity of the final product. This method is traditionally used to classify the production types of economic activity. Those industries, whose criterion of science intensity exceeds 3,5%, are considered to be high-tech industries. If this criterion varies from 3,5 to 8,5%, then the industries refer to the group of "high-level" technologies; if it exceeds 8,5%, then they are defined as "leading" high technology.

For quite long time, the Russian Federation hasn't developed research and information tools that allows to systematize the information about the classification and activities of the enterprises of the high-tech manufacturing sector. Until 2013 there was no officially approved list of industries of this sector in Russia.

In 2014 [5] the list of high-tech industries was improved in accordance with the OECD methodology. It currently includes the production of: 1) pharmaceutical products; 2) office equipment and computers; 3) electronic components, equipment for radio, television and communications; 4) medical products, measuring, monitoring, control and testing

instruments, optical instruments, photo and cinematographic equipment, watches; 5) aircraft. According to [5], the main criterion for the determination of high-tech industries is the high level of technological development, which is calculated through the ratio of the cost for scientific researches to gross added value.

High-tech production facilities are also joined together with the following aggregated market segments: nuclear industry; air, space and rocket complex; radio-electronic complex; sector of the chemical industry; military-oriented industries.

Taking the above mentioned into consideration, we note that the accepted in the modern literature referring of the industries or production facilities to high technology is conditional. This group includes those industries or production facilities, costs for researches and developments (R&D) of which exceed a certain fixed level towards the added value, volume of output (shipped) or towards the main production factors.

EVALUATION OF THE CURRENT STATE OF HIGH-TECH INDUSTRIES IN RUSSIA

High-tech industries make a huge contribution to scientific and technological progress, the development of production and highly qualified personnel of the country. Nevertheless, we have to admit the fact that, due to many factors the high-tech sector in Russia is been developed slowly and yields to the most developed countries of the world.

As it was noted above, in the modern economic conditions the high-tech production is based on innovations and innovative activity. The success of the country's economy is mainly concerned with the availability of innovative capacity and favorable conditions for its implementation. One of the studies, characterizing the innovative development of a particular state, is the Global Innovation Index (GII).

Table 3 contains Russia's rating in the dynamics from 2014 to 2016. Last year, the rating of the countries-innovators of the GII was headed by Switzerland, Sweden, the United Kingdom, the United States and Finland. In turn, Russia took 43 place, having improved its positions by 5 lines against 2015.

Table 3: Russia's rating according to the Global Innovation Index 2014-2016

	GII	Resources of innovations	Results of innovations	Efficiency of innovations
2014	49	56	45	49
2015	48	52	49	60
2016	43	44	47	69

Russia's positions on the innovation resources sub index are improving, that indicates the availability of resources and

favorable conditions for the implementation of innovations. At the same time, the real results of the innovations' implementation have a variable success. Besides, the effectiveness of innovations and innovation activity of Russia is much weaker, it is showed by the low indicators of the results of innovation activities with the existing innovation potential, the insufficiently effective implementation of the available innovative potential.

Over the last few years, the Russian Federation maintains a relatively stable positions among the countries of the world in the rating of GII. Despite the positive dynamics and the presence of competitive advantages - human resources and science, the level of the development of business and technology - the Russian economy demonstrates the backlog in comparison with the benchmarks of the economy and the level of the development of the leading countries [1, 9, 12, 13, etc.]

The development and improvement of high-tech industries, increasing their share in the economy is a key factor of the modernization and establishment of innovative economy in Russia. It is no coincidence that the following priorities of the development of science, technical equipment and technology were legislatively approved in Russia:

- Space technology and telecommunications;
- computer technologies and software;
- nuclear energy technology;
- medical equipment and pharmaceuticals;
- energy efficiency and resource saving, incl. the development of new types of fuel.

Table 4 shows that in the period under study we can see the increase of the share of costs for R&D in GDP and the share of high-tech products in Russia's GDP [3].

Table 4: Main shares of high-tech and science-intensive industries in the GDP of the Russian Federation over the period from 2010 till 2015

	2010	2011	2012	2013	2014	2015
GDP, bln. RUR.	46 308,5	59 698,1	66 926,9	71 016,7	77 945,1	80 804,3
R&D in GDP, %	1,13	1,02	1,05	1,06	1,09	1,13
Inland costs for researches and developments in GDP, %	1,13	1,02	1,05	1,06	1,09	1,13
Production of high-tech industries in GDP, %	–	19,6	20,1	21,0	21,8	21,5

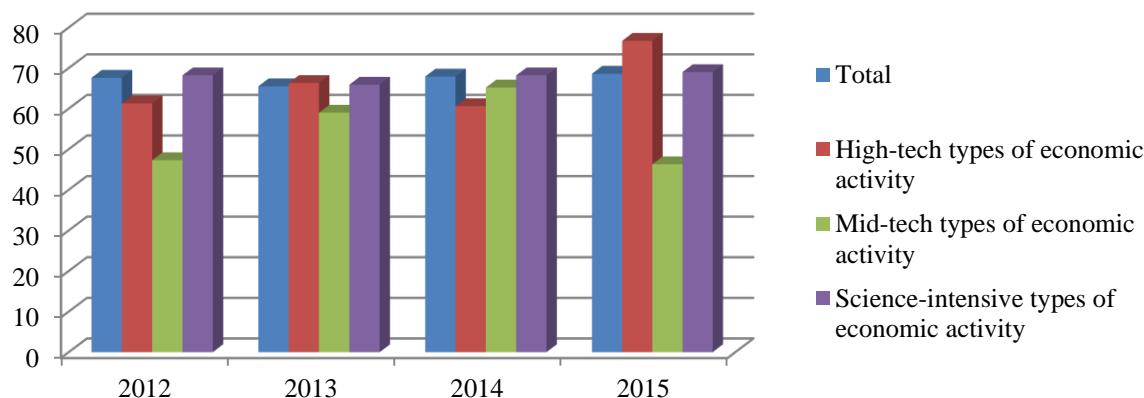


Figure 1: The share of inland costs for researches and inventions for priority areas of development in the total amount of domestic costs in Russia, %

Table 5: Dynamics of used and developed advanced technologies in the high-tech industries in Russia over the period from 2012 till 2016, in pieces

	2012	2013	2014	2015	2016
The number of used advanced manufacturing technologies	22 085	22 571	23 946	32 399	34 307
The number of developed advanced manufacturing technologies	79	116	133	152	134
The number of developed advanced manufacturing technologies that are new for Russia	73	107	123	144	120
The number of radically new developed advanced manufacturing technologies	6	9	10	8	14

The share of inland costs for researches and inventions in Russia's GDP is growing insignificantly, remaining at 1% level, while the leading countries of the world (USA, Great Britain, Germany, etc.) invest in scientific and technical researches to 4% of GDP.

The above priority areas (Figure 1) have significant share in the total amount of inland costs for researches and inventions in Russia. Besides, there is a trend of the increase of the share of the latter in the total amount of internal costs.

The main share of costs for R&D is being taken from the federal budget. Over the past five years the expenditure of the budget for R&D is about 5% of the total budget expenditures with a tendency to increase, that implies the strengthening of the role of the state in creating favorable conditions for the development and stimulation of business.

Table 5 presents analysis of the dynamics of used and developed advanced technologies in high-tech branches of Russian industry.

Increase in the number of developed advanced technologies, incl. fundamentally new technologies, has been observed since 2014, characterized by the introduction of anti-Russian sanctions that have demonstrated the inevitability of creating domestic high-tech industries and reorienting to the national element base in most production segments. One and a half times more advanced technologies were used in 2016

than in the pre-crisis 2014. Despite the decrease in the number of developed technologies in 2016, in the period under study their number doubled. The data speak for the increase of efficiency of R&D against the backdrop of the increase of costs for them.

According to the data [3], the share of enterprises of high-tech industries, developing and implementing technological innovations in the period under study, remained at the level of 31-32%. The volume of shipped innovative goods for the period from 2012 to 2015 has increased almost twice - from 175 318,2 million rubles up to 335 907,9 million rubles, or from 14,3% to 18,6% of the total volume of goods. At the same time the share of goods, that were implemented or significantly changed, increased by 6,92% to 77,51%. The share of innovative products in the production of office equipment and computers has significantly increased: from 2,2% in 2012 to 11,1% in 2015. On the contrary the share of innovative products in the production of pharmaceutical products decreased by 4,5% and amounted to 11,3%.

As for the role of high-tech industries in Russia on the international market, it is insignificant. In the world high-tech exports, the share of Russia's exports is about 1%. For comparison: the shares of China and the US - 25% and 10% respectively. According to [6] by 2020 the value of this indicator should reach 2%. In 2016,

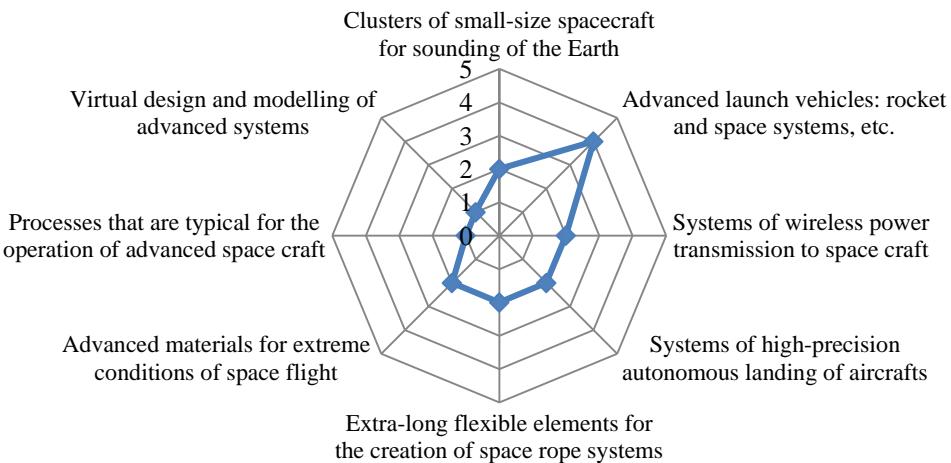


Figure 2: Estimation of the level of Russian available researches in the field of advanced space systems

the share of exports of high-tech goods in the total exports of our country was 14,5%, having increased by 2,3% compared with 2013. Import of high-tech products is characterized by ambiguous dynamics: the share of imported high-tech products decreased from 62,4% in 2013 to 58,7% in 2015, in 2016 it increased by 2,6% and amounted to 61,3%. The given data speak for the continuing import dependence of the industry and a certain increase of Russia's activity in the international market of high-tech products.

Among the competitive and promising directions of Russian applied science in the field of space technologies, in which Russia can succeed, there is the creation of aerospace aircraft for launching suborbital small space satellites, and other areas related to new-generation spacecraft (Figure 2).

The diagram clearly shows which researches of this sphere are worth to be focused on in the first place. The level of Russian researches in the field of advanced launch vehicles (rocket and space systems, space transportation systems, etc.) doesn't yield to the world level (it is 4 on a 5-point scale). There is basic knowledge and infrastructure that can be used to accelerate the development of certain directions (2). Unfortunately, there are researches that significantly yield to the world level (1).

At the same time, the researches that we have studied do not exhaust the system of priorities of the development of the Russian Federation that correspond to the prospects for the development of key markets. The analysis of the state of the high-tech branches of Russian industry also allowed us to make the conclusion that even in the conditions of an unstable political and economic situation, there is positive dynamics of their development on the whole. Despite this, the current achieved level of innovative activity of high-tech industries does not meet the strategic goals of the domestic economy.

DETECTION OF STRATEGIC PROBLEMS AND TRENDS OF THE INNOVATIVE DEVELOPMENT OF HIGH-TECH BRANCHES OF RUSSIAN INDUSTRY

Possessing the latest technologies and demonstrating high investment and innovative activity, the high-tech sector of the economy is called on to play an important strategic role in reducing import dependence and in establishing an innovation economy in the Russian Federation. Namely the presence of a large scientific base in the sphere of high technologies will allow to integrate the latter into global needs, compete in the relevant international markets and also accelerate the change-over of Russian economy to the new scientific and technological level of development.

Effective development of high-tech industries in Russia is possible in case of solving strategic problems, such as:

1. “Brain drain”, as a result of which Russia's investment in intellectual capital contribute to the improving competitiveness of the leading countries' economies, causing significant damage to the domestic economy and forming an “open innovation system”.
2. The lack of effective relations between science and production and, as a result, the insufficient level of the use of Russian scientific and technical researches and developments in the production of high-tech and science-intensive products at enterprises.
3. Low intensity of competition as a specific feature of the domestic economic model, high barriers for the introduction of innovative solutions into production.
4. “Open innovation cycle” (“glass ceilings”) is a situation that is characterized by a barrier between large companies, venture investors and start-ups, when local business projects are not in demand among large companies and the products are being sold to other countries.

5. Low return of costs for R&D: state costs for researches and developments is enough significant, but at the same time they do not lead to the promotion of projects, as a result innovative projects do not turn into necessary and competitive inventions.
6. The low level of open-mindedness of domestic business to advanced technologies, it does not trigger by private investors the demand for innovations as a key factor of production and a source of growth and competitiveness.
7. Low investment attractiveness of high-tech industries due to the insufficient level of the results of the operating activities of enterprises of high-tech sector, etc.

It is advisable to note that there are certain imperatives of the scientific and technological development of the Russian economy, incl. the development of high-tech enterprises, and it is necessary to take them into account. Among them, one can mention the commitment to global competitiveness at all stages of creating knowledge and cost; stimulating demand for scientific and technological achievements; development of mechanisms for prioritizing scientific and technical researches and developments aimed at ensuring long-term sustainable growth; improving the quality of innovation policy, developing the mechanism for assessing the effectiveness of implemented measures, their timely adjustment, etc.

Analysis of contemporary literature [7, 8, 11, etc.] allowed us to determine the following most grounded trends of the development of high-tech industries in Russia:

1. Implementation of the strategy of following the leaders and the orientation of high-tech enterprises, primarily, on the domestic market.
2. The accumulation of the science potential, higher education and high-tech industries through increasing the number of R&D organizations, higher education establishments having authority in the world scientific community, and enterprises using advanced technological innovations.
3. Increasing the R & D effectiveness, expressed through the mobilization of new sources of financing, increasing the volume of manufactured and shipped innovative products, increase in the volume of manufactured and shipped innovative products, increase of exports of high-tech and science-intensive products and increasing the number of patent applications.
4. The increase in the number of employees involved in research and development and working in higher educational institutions, mainly due to the influx of young professionals.
5. Active support of start-ups and venture investors by the state.
6. More intensive involving of large domestic productions it cooperation with the innovative segment will solve the

problem of the so-called "open innovation cycle", or the problem of "glass ceilings".

7. Increase of the contribution of privately owned organizations to the indicators of the sphere of scientific and technical R&D, etc.

According to [8], in general, in the sector of high-tech industries, there is a favorable development outlook with the upcoming growth of the commercialization of scientific developments, namely: 1) growth of the innovative aspect in the country's GDP, the share of high-tech industries in which will increase by 29,6%; 2) increase of the share of innovative organizations by 2,6 times while simultaneously increasing the volume of shipped products produced with the help of nanotechnology by 3,75 times; 3) strengthening of the export-orientation of Russian industry, incl. high-tech industries, with the increase of the share of innovative high-tech products in exports by 1,8 times; 4) recovery and stimulation of the sale of licenses, the number of contracts for which will increase by about 10 times.

So, at the moment, economic growth is possible thanks to the development of new equipment and technology, the manufacturing of high-tech products, increasing costs for advanced innovations, and also stimulating the demand of enterprises for domestic researches and developments. Determined in the course of this study problems and trends of the development of high-tech industries will allow us to use resources in order to eliminate the main factors that impede the development of these industries in the Russian Federation.

CONCLUSION

It can be certainly stated that at the moment, innovations are the determinative factor of long-term economic growth. Unfortunately, despite the positive dynamics and support from the state, according to the indicators of the level of the development and use of innovations Russia's positions in the rating of the developed countries of the world are rather weak, the country's innovative potential is used not enough effectively, there is no explosive growth of innovations. In particular, there are also some positive development trends in the high-tech sector, but the achieved level of innovation activity of the industries in this sector falls behind the world and does not meet the strategic guidelines of the Russian economy. Priority researches in the field of high technologies, which are interdisciplinary and intersectional, will promote in the long term the emergence of new markets, market niches and products, as well as the formation of a technological base of the future economy.

In conclusion, we note that, despite the backwardness of the Russian economy and the demand for radical changes, it is necessary to replace quickly old technologies with new ones, satiate the industrial complex with advanced technologies of

domestic production, carefully think out and coordinate the integration of domestic high technologies with global needs. For this end one has to make deep and comprehensive analysis of science as a productive force, features and trends of the development of high-tech productions and branches of Russian industry. It is necessary to focus on the measures to support and develop high-tech industries, such as opening financing markets for enterprises that develop technological innovations, supporting the export of high-tech and science-intensive products, setting real responsibility for innovation results and analyzing the changing of the situation in the sphere of Russian and world high technologies.

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