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Scientific and Technological Development of the Russian Economy in the Transition to a New Technological Order*

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Abstract. In modern developed countries, an active search for new sources of growth has begun. One of them is the scientific and technological potential (STP), implemented through new informational, digital, and industrial technologies. Its development leads to the formation of a new technological structure and the acceleration of labor productivity growth. STP accounts for up to 90% of the total contribution of all factors to the growth of these countries' gross domestic product. The formation of a new order is a modern global trend, which is important to follow in order to maintain the economy's competitiveness. The orientation of the Russian economy toward the export of energy resources poses threats to the economic and technological security of the national economy. Thus, within fundamental technological and structural changes of the world economic system, the task of Russia's transition to a new technological order becomes particularly relevant. Important areas of its solution are the creation of qualitatively new production relations, a favorable regulatory environment and its alignment with the requirements of the new technological order, the formation of appropriate informational and material equipment for the implementation of new technologies and activities. The purpose of this article is to analyze the scientific and technological development of the Russian Federation in the process of transition to the new technological order. The article summarizes the theoretical foundations of the essence of technological changes in the economy in the process of the transition to the new technological order; it studies domestic and foreign experience of implementing national plans and strategies in the sphere of scientific, technical, and

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innovative development; it analyzes the status and trends of the scientific and technological development of the Russian Federation according to key indicators of a new technological revolution; it reveals issues of the economic development in the process of the transition to the new technological order; it develops a set of measures for the activization of processes of the scientific and technological development of the Russian Federation in a new environment.

Key words: scientific and technological development, new technological way of living, problems, state, trends, development areas.

Introduction

The country's position on the world market and the national economy growth is determined by its competitiveness, the increase of which is achieved through the success and speed of progress in the socio-economic system of the state and its regions on the path of scientific and technological development.

Over the last one hundred years, this country has been experiencing evolutionary and revolutionary change of development targets of the national economy and its constituent subsystems. For example, since the 1990s, the transition to the market economy, overcoming the structural crisis effects and combating the global financial crisis were considered the targets of economic development. In the last decade, the issue of overcoming country's commodity dependence, ensuring high rates of economic growth on this basis, and the country's becoming one of the world leaders was brought to the forefront. The solution of this problem partly depends on the creation of conditions for innovative development of the economic system, the formation of organizational-economic structure appropriate for the knowledge economy (innovation economy, cognitive economy, knowledge-based economy, innovative model of development).

In this regard, the problem of ensuring the long-term scientific and technological development of the economy is in the center of researchers, the executive bodies of the state authority, and public organizations' attention [1, 2]. However, it is early to speak about a significant progress in this area. The problem remains unresolved and, therefore, relevant, which is evidenced by the fact that Russia is far behind the innovative leaders (Switzerland, UK, and Sweden) in all key indicators in the international rankings from the point of view of the resource potential of science (intellectual capacity, infrastructure, financing, regulation)

Table 1. The Russian Federation rating according to basic indicators of the Global innovation index

Indicator	Rating position		
	2013	2016	2017
The Global innovation index	**62**	**43**	**46**
Institutions	87	73	73
Human capital and science	33	23	23
Infrastructure	49	60	62
IT	28	35	36
The development of the internal market	74	63	60
Business development	52	37	33
The development of technology and the knowledge economy	48	40	45
The development of creative activities	101	66	62
Source: Global Innovation Index: official website. Available at: https://www.globalinnovationindex.org/			

and the relevance of scientific results. Thus, by the end of 2017, Russia has been ranked 46th in the Global innovation index; 45th in terms of technology development; 36th by information and communication technologies; 62nd in creative activities (*Tab. 1*).

Russia's substantial lag in the innovation development is the result of its economy orientation toward the export of raw resources. The presence of rich natural resources forms so-called "resource curse" syndrome which does not allow the national economy to develop its high-tech sector [3], and considerable differentiation of the country's territories is not conducive to the formation of regional innovation systems and, consequently, of the state as a whole. This, in turn, hinders the transition of the economy to the innovative path, and it does not ensure high growth rates and national competitiveness.

However, the technological development becomes the determining factor of economic leadership. The growth of technology-based competition requires the formation of advanced technological structures of the economy to be set as the major priority of the country. One of the main tasks of the Russian state is the transition to a new technological order. Therefore, it is necessary to determine the priority directions of science and technology development, to form an effective infrastructure provision, to encourage businesses to the creation and implementation of new technologies. The solution of this problem will allow Russia not only to participate in shaping the markets of the future, but also to take a worthy place in the global technological chains.

In this context, the aim of the research is the analysis of scientific and technological development of Russia in the conditions of transition to the new technological order.

To achieve this aim the following tasks should be resolved:

1) the study of the essence of technological change of the economy in the transition to a new technological order;

2) the synthesis of domestic and foreign experience of national plans and strategies realization in the field of scientific-technological and innovation development;

3) the analysis of the state and the definition of trends of scientific and technological development of the Russian Federation according to the key indicators and the reveal of the problems hindering the transition of the economy to the new technological order;

4) the substantiation of a complex of measures for enhancing the processes of scientific and technological development of the Russian Federation.

Theoretical aspects of the research

Domestic and foreign scientists have been concerned with the problem of the economic growth for decades. Currently, the level of the technological development has priority among the main factors of the economic growth [4]. This is evidenced by the fact that countries with high technological level are among world leaders. As a rule, these are industrialized countries which have reached a high level of technical and technological development and qualification of labor resources [5]. In other words, the high-tech industry provides a higher growth rate of the economy as a whole. This thesis is fundamental in the theory of stages of economic growth by Walt Rostow [6], the theory of a single industrial society by Raymond Aron [7] and the new industrial society by John Galbraith [8], the theory of postindustrial society by Daniel Bell [9], and others [10–14]. The thesis is practically confirmed by the USA which are very actively engaged in the process of re-industrialization, i.e. they

"return" manufacturing enterprises from the developing countries. Moreover, this return is largely associated with greater labor-saving generated by intensive automation of modern industrial production and the usage of robotics in the developed countries [15].

An integral part of the theoretical platform of the study of industrialization and new industrialization is the theory of long-term economic development explaining the regularities in technology dynamics. The main idea of the theory is the "technological order", the phenomenon studied in the works of many Russian and foreign economists (among them are D. Ricardo, K. Marx, Th. Schumpeter, D.S. L'vov, S.Yu. Glazyev, Yu.V. Yakovets, A.A. Sytnik, etc.).

The founder of the modern view of technological order is N.D. Kondrat'ev. According to him, the main cause of cyclicity is the need to update basic production assets. He assigned the scientific and technological innovations a major part in the development of civilization [16]. He believed that, before the upward wave of a long cycle, there is a serious transformation in various spheres of life that relate to the changes in science and technology.

In the Russian economic science, the model of technological order has become a major analytical tool for the analysis of technological revolutions [17, 18, 19]. Technological order is understood as a "large complex of technology conjugate industries" regularly replaced by another complex which is more modern in composition of the used technology.

Leading domestic scientists [20] define technological order as a certain combination of technologically interrelated industries that are close in terms of the quality technology, resources and products. Most Russian scientists, who carried out their researches in the 1990s–early 2000s, have a similar point of view.

The analysis of domestic and foreign literature on studied issues enabled us to identify three main approaches to the essence of the category of the "technological order". Technical and technological approach is followed by S. Glazyev, Yu.V. Yakovets, R.M. Nizhegorodtsev, T.P. Nikolaeva, J. Dosi, etc.

Table 2. Main research directions of the essence of "technological order" category [21–25]

Name of the approach	Representatives	Definition
Technical and technological	S.Yu. Glazyev, Yu.V. Yakovets, R.M. Nizhegorodtsev, T.P. Nikolaeva, J. Dosi	1. A set of technologically conjugate industries, preserving the integrity in the process of its development, "a certain set of units close in terms of quality characteristics of resources technology and products". 2. Techno-economic paradigm – a set of technologically conjugate "clusters of technologies" based on radical innovation.
Evolutionary	V.I. Maevsky, V.V. Ivanov, R.I. Tsvylev	1. A combination of evolutionary developing technological trends. 2. Technological order allows to study the regularities of economic and technological development in the form of structural changes, economy development is considered in terms of its advanced informatization and distribution of material processes in the economy.
Institutional	K. Perez, V.V. Kiseleva, A.G. Fonotov, O.S. Sukharev, B. Karlsson, R. Stankevich	1. Techno-economic paradigm is a complex of industrial sectors, the appropriate institutional structure, infrastructure, financial structure, and socio-economic climate and a specific system of relations between labor and capital formed on the basis of the embedded in the phase of depression of the beam of the base technological innovation and mediating the development of a new technological style. 2. Technological system is a network of agents interacting in a specific economic (e.g., industry) sphere, with appropriate institutional infrastructure and involved in the development, diffusion and use of new technologies, the emphasis is on radical innovation, i.e. on new technologies leading to the displacement of obsolete ones.

Evolutionary approach to the technological order is defended by V.I. Maevskiy, V.V. Ivanov, R.I. Tsvylev, etc. Institutional approach is advocated by K. Perez, B. Carlsson, R. Stankievich, N.I. Ivanova, V.V. Kiselev, O.S. Sukharev, A.G. Fonotov, etc. (*Tab. 2*).

Critically approaching the definitions of "techno-economic paradigm" and "technological order" ("technological system"), we may conclude that these concepts are very similar. The fundamental difference is that foreign researchers adhere to the institutional approach and take into account the dynamics of technological and economic development while interpreting the first term. In the works of domestic scientists, the attention is mainly concentrated on the technical and technological side, and changes are ignored.

Global trends currently indicate a transition to the new, sixth technological order, the main trends of which are [26]: the transition to customized production, the growth of engineering companies large-scale use of additive technologies, 3D printers; simulation; the erase of geographical barriers and the disappearance of intermediaries.

The study of theoretical and methodological approaches and the best foreign experience allows concluding that information technologies and digital transformation are the main drivers of the technological change, which ensure competitiveness at the level of individual enterprises and at the level of countries and supranational unions, leading to a restructuring of all economic and production processes, radical productivity improvement, the increase of quality and the reduction of the cost of goods and services [27]. The most important rapidly developing technologies are robotics, 3D printing, artificial intelligence, Internet of things and connection of objects to the Internet, computer-aided design, new sensors, the usage of intelligent networks in energy, the creation of materials with desired properties. In general, these technologies allow creating and using cyber-physical systems in industry, i.e. programs controlled production using sophisticated sensors where there is no need for people to participate. This is manifested in the total automation of technological and business processes, the maximum horizontal and vertical information integration [28, 29, 30].

These trends reduce the material consumption, increase the productivity and the "intellect" share in the cost, and the geographic availability of goods, which is highly relevant for Russia.

Materials and methods of the research

The author of the research used a set of methodological approaches providing the necessary complexity of assessing the possibility of strengthening the role of the new industrial revolution in the development of production, improving the efficiency and competitiveness of the Russian economy in conditions of transition to the new technological order.

The assessment of the level of the scientific and technological development of the industrial sector of the Russian Federation and the degree of its readiness for the development in the transition to a new technological order was based on the amount of statistical information, covering, firstly, the indicators of innovative development of the economy, and, secondly, the indicators characterizing the socio-economic potential of the Russian Federation, the performance of economic and social policies; thirdly, the performance of the real sector of the Russian economy and the market of information and communication technologies. Methods of the analysis are comparative analysis, methods of cognition, content analysis, methods of dialectical logic, method of synthesis of the theory basis, and empirical experience.

Scientific novelty of the research is the development of methodical approaches to the definition of innovative transformations of scientific-technological sector of Russia in the context of transition to the new technological order and development of the economy focusing on the implementation in the production of digital technology making up the technological basis for the economic growth of the Russian economy.

Main results of the research

Low growth rates of the Russian economy allow asserting that possibilities of the economic growth at the cost of resource factors are largely exhausted. Russia faces the challenge of achieving qualitative growth which can only be ensured on the basis of the scientific and technological development, i.e. the transition to the new technological order.

These tasks are also caused by global "big challenges" faced by all countries of the world. These challenges include the exhaustion of potential for further productivity growth in most developed countries: since 2011, the value of this index has not exceeded 1% per year [31].

Industrialized countries (USA, Germany, UK, Japan, China, South Korea, etc.) responded to this challenge with the scientific-technological and innovation policy aimed at the development stimulation and the introduction of advanced technologies providing high performance and, as a consequence, the technological and economic growth. At the same time, the emphasis is on the development of the industrial sector.

This is reflected in the implementation of various strategies, countries' plans and programs that stimulate building up of the scientific-technological and industrial potential, the improvement of innovation systems, the update of technical base of the industry (*Tab. 3*).

Table 3. National plans and strategies in the sphere of scientific and technical and innovation development, adopted in some developed and rapidly developing countries

Country	Document	Period
France	The national research plan	2013–2018
	The plan for industry restoration	Since 2013
	Innovation–2030	2013–2030
	National strategy for higher education	2014–2018
Germany	Industry 4.0	2011–2020
	Enhanced strategy for the development of high technology	in development
Italy	Industry 2015	2006–2025
	The Destiny of Italy	Since 2013
Japan	A comprehensive strategy of science, technology and innovation	2013–2030
UK	The strategy of innovative development and research	Since 2011
	Industrial development strategy	Since 2012
USA	The strategy of innovative development	Since 2009
EU	European innovative initiatives	2012
	For the European industrial Renaissance	2014
	European framework program for research and innovation "Horizon 2020"	2014–2020
India	A decade of innovation	2010–2020
China	Medium and long-term National plan for the development of science and technology	2006–2020
	13th five-year plan for the development of science and technology	2016–2020

Sources: OECD Science, Technology and Industry Outlook 2014. OECD, 2014. 480 p. Available at: http://www.keepeek.com/Digital-Asset-Management/oecd/science-and-technology/oecd-science-technology-and-industry-outlook-2014_sti_outlook-2014-en#page114; OECD Science, Technology and Industry Outlook 2016. OECD, 2016. 196 p. Available at: https://read.oecd-ilibrary.org/science-and-technology/oecd-science-technology-and-innovation-outlook-2016_sti_in_outlook-2016-en#page1

The possible prospects of the new technologies usage are also actively discussed Russia. In 2016, the Strategy of Scientific and Technological Development of the Russian Federation until 2035 was adopted [36], which codified the following priority development directions of national science, technology and innovation:

1. Conducting research, promoting the provision of the country with technologies of the new industrial revolution.

2. Creating an interactive environment of intellectual digital production. The development of "green" energy.

3. Maintaining the society's resource balance in conditions of limited natural resources for industry.

4. Developing the country's food security.

5. Adapting the state to the risks associated with future demographic changes and the complexity of socio-technological systems.

In 2017, the program "Digital economy" was adopted (now, it is the national program "Digital Economy of the Russian Federation"). Programs of the regional level are also being developed. Such documents usually include aims and a work plan for the modernization of existing production facilities based on new digital technologies including the creation and the development of enterprises in IT sector, the creation of relevant infrastructure, and legal framework in the country.

In addition to the state program of 2017, Russia adopted a number of strategic documents which significantly influence the application of digital technologies in the domestic economy. They were founded in 1996 after the adoption of the Recommendation legislative act "On Protection of High Technologies", which was aimed at the creation of conditions for the development of information technologies (*Fig. 1*).

Thus, by adapting to "big challenges" and main trends of the global economy, the Russian Federation sets the task of the transition to the new technological order, the core of which includes the computerization and digitalization of economic processes in all spheres of economic activity.

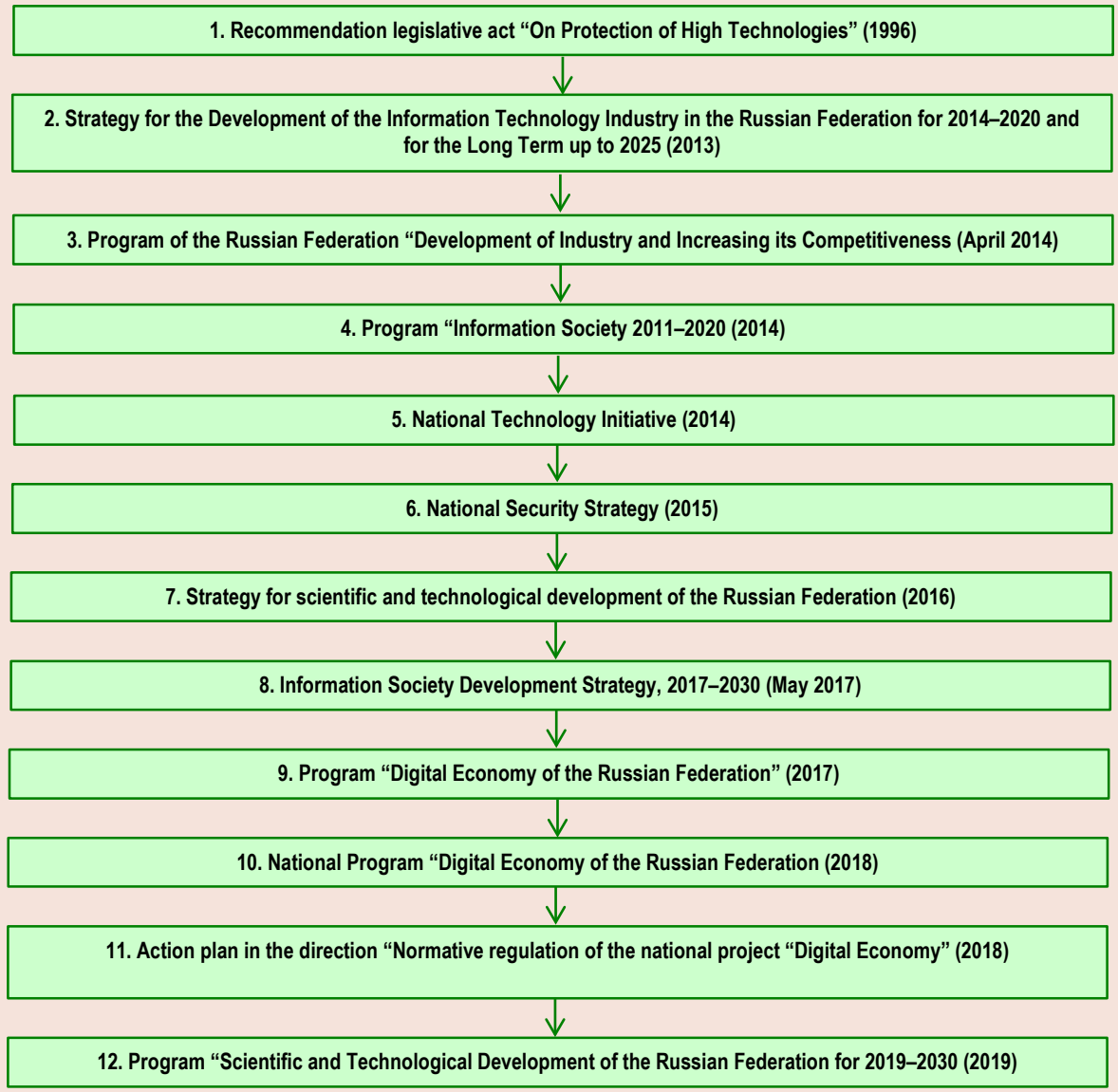
However, a major obstacle in resolving this problem is the low share of domestic expenditure on information and communication technologies in the gross domestic product of the country (*Tab. 4*). Our analysis showed that, over the period from 2010 to 2017, this figure did not change significantly.

For this period, enterprises' expenditures on information and communication technologies have increased more than 6 times: from 160 up to 1012 billion rubles, respectively. However, their share in GDP decreased.

Currently, there is no detailed information on the annual dynamics of the enterprises' expenditures on information and communication technologies in GDP in foreign countries in the statistics. However, the study of publications on the subject leads to the conclusion that, in developed countries, particularly in Germany, the value of this indicator in GDP ranged from 3 to 4% in recent years (i.e. four times higher than in Russia).

As we already mentioned, the main reason for the deployment of the new industrial and technology policy in advanced countries was the need to overcome the slowdown of productivity growth. Between 2000 and 2015, the sustainable growth of this indicator was preserved in these countries (*Fig. 2*). In relation to Russia, we can say that it still lags behind leading countries: its index is 2–2.5 times lower than in Germany, France, and the United States. As the presented data shows, Russia has not even reached the level of productivity, which was in developed countries 10–20 years ago.

Fig. 1. Legal framework regulating the development of high-tech industries based on the development of information technologies



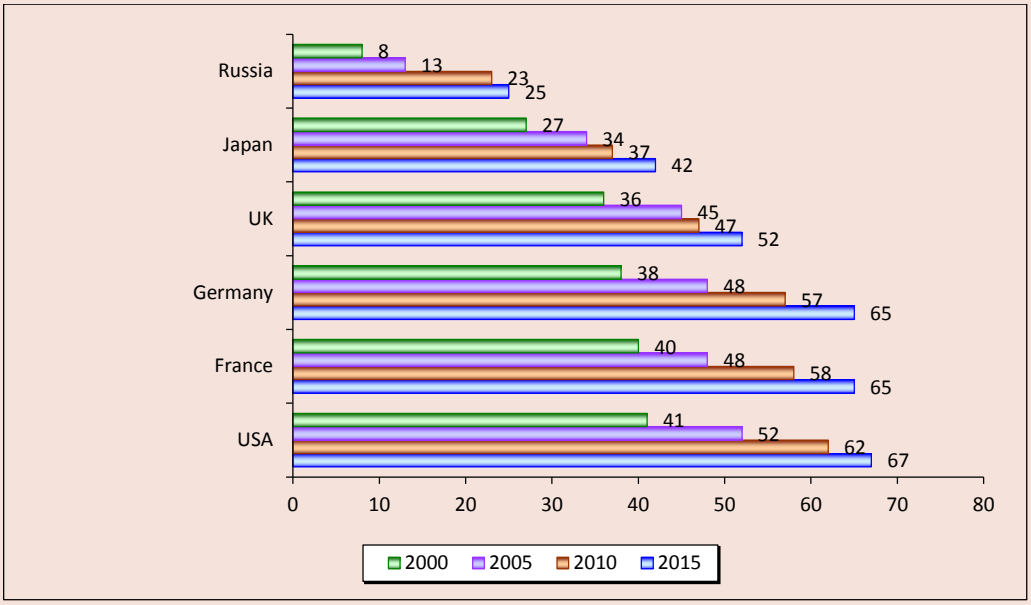
Source: own compilation.

Table 4. The expenditure on information and communication technologies in GDP for the period from 2010 to 2017

Figure	2010	2012	2014	2015	2016	2017	2010–2017, %
Expenditure on IT, billion rubles	516	843	1175	1153	1249	1012	196.1
GDP, billion rubles	46309	68164	79199	83387	86010	92000	198.7
Expenditure on IT in GDP, %	1.11	1.24	1.48	1.38	1.45	1.10	-0.01

Source: Regiony Rossii. Sotsial'no-ekonomicheskie pokazateli, 2003–2018 gg. Available at: http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/publications/catalog/doc_1138623506156 (In Russian).

Figure 2. Labor productivity countrywise (per one employed person, USA dollars)



Source: *Novaya tekhnologicheskaya revolyutsiya: vyzovy i vozmozhnosti dlya Rossii: ekspertno-analiticheskiy doklad*. Moscow, 2017. 136 p. (In Russian).

Thus, Russia faces the challenge of ensuring sustainable growth of labor productivity for the full potential realization of the national economy. It requires technological modernization of production including commissioning of new equipment, upgrading of basic production assets, primarily equipment, complex automation of production, etc. In the opinion of the absolute majority of Russian industrial companies' CEOs (84%), the internal key condition for productivity growth is the increase of the technical level of production1.

Technological upgrade should be reflected in the growth of investment in fixed capital, which is hardly seen in Russia today: according to Rosstat, the degree of fixed assets depreciation in the manufacturing industry has been increasing steadily since 2005 (47.1%) till 2018 (50.6%). Similar dynamics is also traced in the mining industry and in enterprises for the distribution of electricity, gas, and water (*Fig. 3*).

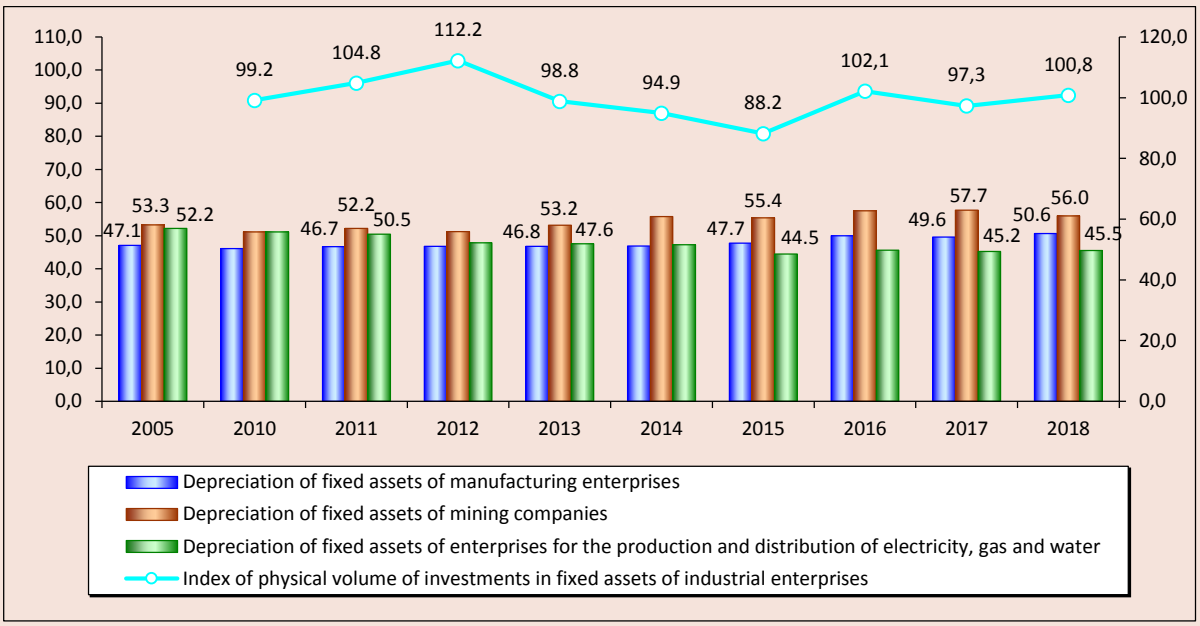
The analysis of the dynamics of the index of physical volume of investments in fixed assets suggests that, despite the increasing degree of fixed assets depreciation, the volume of investment in Russian industry, especially in high-tech industry, does not grow substantially.

Russia lags behind in other key indicators of the technological development too.

First, the level of innovation activity of industrial organizations remains very low (about 10%). In recent decades, the share of innovative products in total volume of shipped goods on a national scale did not exceed 10%. Industrial enterprises' expenditures on R&D are very low: in 2015, only 0.3% of GDP according to the OECD. For comparison, the similar indicator was 1.54% of China's GDP, 1.79% of the United States' GDP, 2.72% in Japan's GDP (*Fig. 4*).

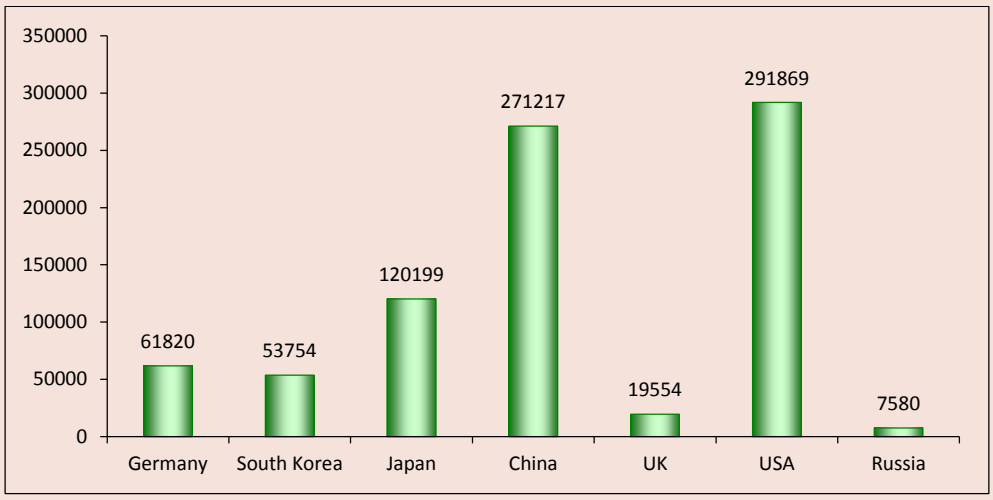
[1] Labor productivity. Results of a survey of 500 managers of industrial enterprises. The Ministry of Industry and Trade of Russia, the Center for Strategic Development Foundation, the Center for Monitoring Industry Development, the Agency for Technological Development. 2017.

Fig. 3. The degree of industrial enterprises' fixed assets depreciation and the index of physical volume of investments in fixed assets of industrial enterprises of the Russian Federation



Sources: Effektivnost' ekonomiki Rossii. Available at: https://www.gks.ru/folder/11186; Tehnologicheskoe razvitie otrasley ekonomiki. Available at: https://www.gks.ru/folder/11189 (In Russian).

Figure 4. R&D expenditures of industrial enterprises in 2015, mil. USA dollars (in permanent prices)

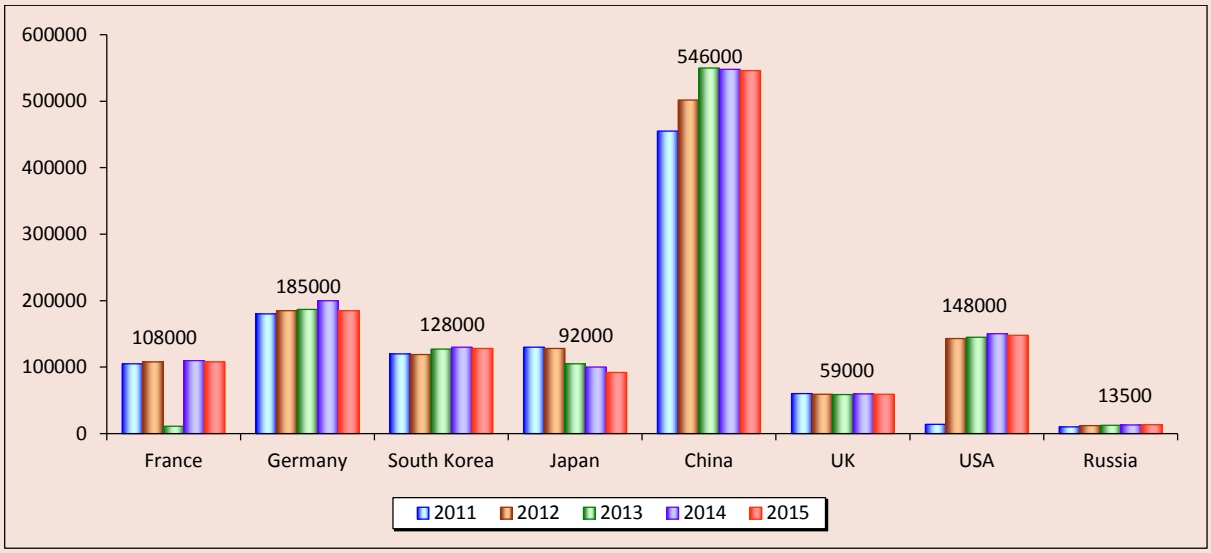


Source: *The Global Competitiveness Report 2017–2018*. Geneva: World Economic Forum. 2017. P. 249.

Second, the level of products diversification is being reduced, resulting in the displacement of the Russian export structure toward the products of low complexity (about 80% in the export structure) with a simultaneously low level of manufacturing industry export (*Fig. 5*).

Third, there is a lag in creating new industries and markets of the unfolding technological revolution. Despite the gradual recovery of the economy, the share of high-tech and knowledge-intensive industries' production in Russia's GDP remains low (*Tab. 5*).

Figure 5. The volume of high-tech export by individual countries, mil. USA dollars



Source: based on the data from the World Bank. Available at: https://data.worldbank.org/indicator/TX.VAL.TECH.MF.ZS

Table 5. Dynamics of knowledge-intensive industries' contribution to GDP

Indicator	The value by years						
	2010	2011	2012	2013	2014	2016	2016 to 2010, %
The volume of GDP, billion rubles	39763.2	41457.8	42869.6	43444.4	43722.7	43855.4	110.3
The share of high-tech industries products in GDP, %	22.8	21.9	22.1	23.1	23.5	23.7	0.9
The volume of high-tech products in in constant prices, billion rubles	9066	9079	9474.2	10036	10275	10316	113.8
The growth of high-tech products in GDP relatively to 2010, %	–	0.14	4.50	10.70	13.34	13.52	13.4*
Source: Federal State Statistics Service. Available at: http://www.gks.ru/ * 2016 to 2011.							

All these facts suggest that Russian economy is characterized by innovative stagnation, there is no mass redistribution of resources in favor of progressive technological orders, and the strong technological inferiority has developed in the industrial sector.

At the same time, judging by the dynamics of growth rates of GDP physical volume, return on assets, return on sales, and specific values of the volume of innovative goods, works, services, prevailing in the Russian industry, the technological orders III and IV reached the limits of economic growth (*Tab. 6*).

Fourth, the gap between Russia and leading countries in some of registered patents in areas such as robotics, new materials, additive technology, industrial Internet of things, etc., is measured by the times. According the All-Russian Scientific Research Institute of Aviation Materials, Russia's share in the global additive manufacturing market amounted to almost 1.7% in 2016 [31].

Fifth, an extremely low level of R&D funding: approximately 1.10% of GDP is allocated on research and development nationwide, while in countries, which are

Table 6. Dynamics of GDP rates, the profitability of organizations in the Russian Federation for the 2000–2016 period

Indicator	2000	2005	2010	2012	2014	2015	2016
Index of GRP, growth rate, %	10.6	7.6	4.6	3.1	1.3	-0.6	0.8
Return on assets, %	7.6	8.8	6.7	6.1	2.5	3.9	4.9
Return of sales, %	18.9	13.5	10	8.6	7.3	8.1	8.7
The volume of innovative goods, works and services, %	4.4	5.0	4.8	8	8.7	7.9	8.4
Source: Rossiya v tsifrakh. 2017: krat. stat. sb. *Rosstat*, M., 2017, 511 p. (In Russian).							

technological leaders, the figure is 3–4% of their GDP [28, 31].

Sixth, the rates of the economy digitalization and platforming remain low. According to the study [31], the Russian Federation takes is placed 41st according to its readiness for the digital economy (ten leading countries are Singapore, Finland, Sweden, Norway, United States of America, the Netherlands, Switzerland, UK, Luxembourg, and Japan). Russia is 38th in the rating of economic and innovation results of digital technologies usage, which is significantly lower than Finland, Switzerland, Sweden, Israel, Singapore, Netherlands, USA, Norway, Luxembourg, Germany, etc. Such position of Russia is the result of low elaboration of the regulatory framework and the lack of favorable conditions for the application of digital technology and innovation in businesses. It should be noted that, in 2016, the International Digital Economy and Society Index (I-DESI) was 0.47 for Russia. For comparison, the EU average value of this indicator was 0.54; the leaders in terms of digitization are Denmark (0.67), Finland (0.66), Sweden (0.65), and the Netherlands (0.64) [31].

The result of Russia's noticeable lag, according to key indicators of technological development, is a very low percentage of high-tech products and products with high value added in exports.

Thus, our analysis allows drawing a conclusion on the low level of scientific and technological development in Russia which prevents the country from the solution of the issue of improving the productivity and including the country into global trends. In this context, it seems that the state policy in scientific, technological, and industrial spheres requires significant adjustments.

Suggestions and conclusions

One of possible solutions of abovementioned problems and the response to challenges, currently facing the Russian economy in conditions of transition to the new technological order, is primarily the promotion of scientific and technological development of the industrial sector.

The formation of the new technological order is based on the social system processes including innovation, intensive investment in information, digital technologies. Knowledge economy is characterized by close links between science and technology, the high importance of innovation for economic growth and competitiveness, and the importance of education, lifelong learning, increasing investment in intangible assets: R&D, software, education. Therefore, the successful development of knowledge economy and active growth of innovative industries are closely interconnected. From this perspective, we should emphasize the special importance of creating effective institutions for scientific and technological development [5, 14]. In order to complete set goals, appropriate activities are required. First, it refers to the creation of

enabling legal and regulatory environment and bringing it in line with the requirements of the digital economy as the new way of life and qualitatively new production relations. Second, the appropriate information, material, and technical equipment is necessary for the implementation of new technologies and activities. Third, it is important to make changes in the system of specialists training and retraining including advanced training in new specialties. In addition, the appropriate mechanisms for the support of domestic companies, which are the most advanced in terms of new technologies, should be developed [37].

It should be remembered that the regulation of the economy in the period of the new order formation requires a careful approach from the state apparatus. The emergence of the new type of economics is impossible without innovation, and the large-scale marketing is impossible without constant race for increasing products' competitiveness.

The nature and methods of state regulation should be associated with the policy in the investment sector, funding of basic sciences, and risky projects.

For scientific and technological development of the industrial sector, a state policy of re-industrialization in the context of globalization and structural transformation of the national economy should be formed, and its effective implementation should be started. The creation of high-tech industries and innovative enterprises will improve the competitiveness of industries, their innovation potential [17; 24], and the socio-economic development of Russia and its regions [31; 34].

Industrial policy of the state should be aimed at encouraging technological modernization of industrial enterprises; the modernization of main production funds; the creation of conditions for realization of results of intellectual activities in industrial production; the expansion of innovative production; the development of production and innovative capacities of enterprises.

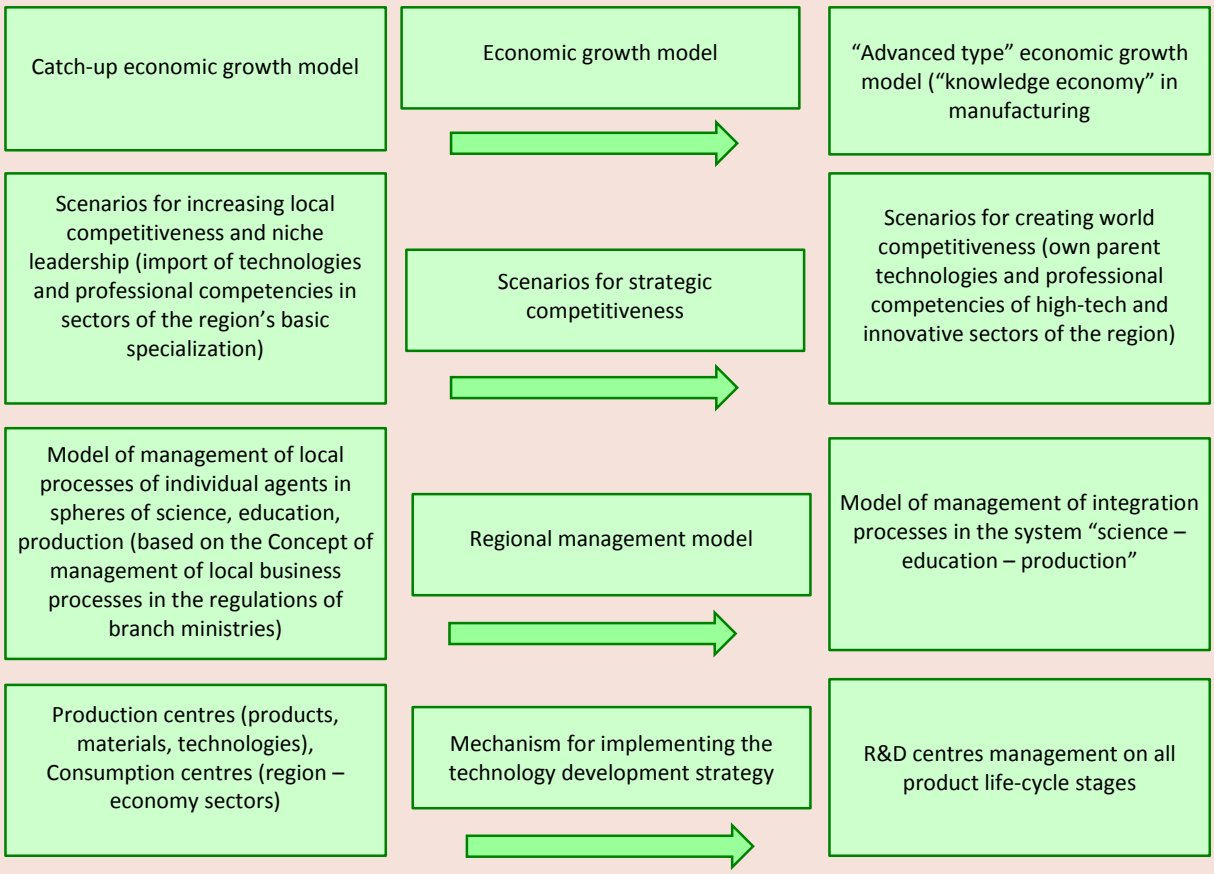
For the formation and implementation of state policy in the field of scientific and technological development, various methods and approaches may be used (*Tab. 7*).

The change of management formats of scientific and technological development in the transition to the new technological order should be based on the conceptual framework of the change of economic growth pattern, scenarios for the formation of technological leadership, the management model of the processes of scientific and technical changes, methods of implementation of technological development strategies (*Fig. 6*).

Table 7. Methods of implementation of the mechanism of state scientific and technological development in the transition to the new technological order [38]

Direct methods	Indirect methods
R&D financing from federal and regional budgets	Tax credits and benefits
Control of technology and innovation procurement abroad	Stimulation of businesses through changes of price and customs policy
Insurance against innovation-related risks	Accelerated depreciation
Subsidizing scientific and technical developments	Foundation of innovative scientific and technological centers in leading universities of the country
Subsidized financing of individual innovation projects and the allocation of funds for creating platforms for their interaction	Improvement of legislation in matters of patent law, intellectual property
Partial government guarantees the attraction of funds of different types of investors to the project: banks, investment companies, etc.	Creation of legal mechanism of purchase or entry into the capital of small innovative companies of large business
Institute of Special Investment Contracts.	

Fig. 6. Conceptual basis of changing management formats of the scientific-technological and innovative development



Sources: own compilation on the basis of: Korovin G., Chenchevich S., Krokhina E.O. On the role of regional institutions of innovative development. *Problemy teorii i praktiki upravleniya=Management Theory and Practice*, 2018, no. 12, p. 84. (In Russian); Lenchuk E.B., Vlaskin, G.A. The emergence of digital economy in Russia: Problems, risks, prospects. *Vestnik Instituta ekonomiki Rossiyskoy akademii nauk=Bulletin of the Institute of Economics of the Russian Academy of Sciences*, 2018, no. 5, p. 9.

The mechanisms of management of the system of scientific and technological transformation should be aimed, on the one hand, at the reduction of terms for the development and commercialization of breakthrough techno-logical solutions, ensuring the region's strategic positioning, and, on the other hand, at the readjustment of the mechanisms of interaction of all subjects of integration processes of the system "science – education – production" in order to ensure the uniform distribution of innovative technological solutions.

This approach, in turn, allows determining the basic parameters of international positioning of the technological development for innovation-technological and market capabilities based on technological development strategies, formed on the basis of the ratio of knowledge sources (technologies/professional skills):

– global technological competitiveness (new sectors of the economy in the regions: high-tech; "knowledge economy" sector);

– local technological competitiveness (basic sectors of the economy: resource, infrastructure);

– niche leadership in new sectors of the regional economy and the core sectors of the economy.

In our opinion, in order to accelerate technological transformation, large, medium, and small businesses should be supported only on the condition of the compliance of innovative technological solutions with the following requirements:

– a new quality of the region's economic growth (new product markets and labor markets; the share of production with high value added; intellectual capacity; new professional competences);

– a new quality of life of the population (accessibility; efficiency; health safety);

– a new quality of consumption (energy efficiency; cost effectiveness; productivity; performance).

The institutional support for changing management formats may be provided by the "institutions of professional customers" for innovative technological solutions (ITS) necessary for the transition to the technology of the VI technological order. In our opinion, to perform the functions of "professional customers" for ITS, formats of regional technological platforms, combining the interaction of actors of the integration system "science–education–production", may be used.

Conclusions

Thus, the implementation of the course of scientific and technological development of economy in conditions of transition to the new order includes the establishment of economic and scientific-technical development priorities, increased R&D funding, investments in industrial-technological complexes of the new order, the formation of an appropriate institutional environment. The taken decisions, including growth and development priorities, should be connected, first, with objects of innovation transformation, second, with preferences of main economic agents, and, third, with external and internal conditions, factors, and the dynamics of change within the country.

In this regard, the selection of priority directions of forces and means expenditures should be preceded by a systematic analysis of the socio-economic system potential in the context of its all subsystems, taking into account the history, experience, state of technology, resource base, and intellectual capacity.

High-tech industries' development in the framework of the new order formation implies a broader and deeper analysis of national economy sectors. The pace of the country's development in this direction is related to extensive growth of electronic market segments. Relatively modest advantages in most areas of modern scientific progress cast doubt on the ability to radically change the balance of power in the global scientific and technological arena and to develop high growth rates of competitive industries on the basis of digital technologies. The application of systemic principles for justifying the strategic priorities and methods of influence involves co-measurement of the targets of digital technology, at the expense of certain sources, with the available intellectual and technological potential of the economy.

To ensure the growth of high-tech industries in the digital transformation of the country's industrial sector, a systemic paradigm for the economy and society is required. It serves as the only adequate methodological basis of the innovative-technological development of the socio-economic system and its components during radical changes.

The results of the research might be used for analytical and predictive studies of regional and national macro-systems' dynamics, for making recommendations on the creation of prerequisites for boosting economic growth in the transition to the new technological order. It will allow improving the quality of implemented economic policy.

References

1. Uskova T.V., Chekavinsky A.N. The Law on Strategic Planning in the Russian Federation: Advantages and Unresolved Issues (peer review). *Ekonomicheskie i sotsial'nye peremeny: Fakty, tendentsii, prognoz=Economic and Social Changes: Facts, Trends, Forecast*, 2014, no. 4, p. 63. (In Russian).
2. Gulin K.A., Mazilov E.A., Ermolov A.P. Import substitution as a tool to enhance territories' socio-economic development. *Problemy razvitiya territorii=Problems of Territory's Development*, 2015 no. 3, p. 7. (In Russian).
3. Uskova T.V., Lukin E.V., Vorontsova T.V., Smirnova T.G. *Problemy ekonomicheskogo rosta territorii*. Vologda: ISERT RAN, 2013. 170 p.
4. Ilyin V.A., Povarova A.I. Problems of regional development as a reflection of the state management efficiency. *Ekonomika regiona=Economy of Region,* 2014, no. 3, p. 48. (In Russian).
5. Korovin G.B. Theoretical aspects of the new industrialization of Russia. *Sovremennye issledovaniya sotsial'nykh problem=Modern Studies of Social Issues*. Available at: http://journal-s.org/index.php/sisp/article/view/2803/0 (In Russian).
6. Rostow Walt. *The Stages of Economic Growth: A Non-Communist Manifesto*. Cambridge University Press, 1960. 173 p.
7. Aron R. *Etapy razvitiya sotsiologicheskoy mysli*. Moscow: Progress-Politika, 1993. 608 p. (Transl. of: Aron R. *Main Currents in Sociological Thought*. London: Weidenfeld & Nicolson, 1965).
8. Galbraith J. *Novoye industrial'noye obshchestvo*. Moscow: AST, 2004. 602 p. (Transl. of: Galbraith J. *The New Industrial State. Houghton Mifflin, 1967)*.
9. Bell D. *The Coming of Post-Industrial Society: A Venture in Social Forecasting*. New York: Basic Books, 1999.
10. Toffler A. *Tret'ya volna*. Moscow, 1999. (Transl. of: Toffler A. *The Third Wave*. Bantam Books, 1980).
11. Glazyev S.Yu. *Strategiya operezhayushchego razvitiya Rossii v usloviyakh global'nogo krizisa*. Moscow: Ekonomika, 2010. 255 p.
12. Rifkin J. *Tret'ya promyshlennaya revolyutsiya: kak gorizontal'nye vzaimodeystviya menyayut energetiku, ekonomiku i mir v celo*. Moscow, 2014. (Transl. of: Rifkin J. *The Third Industrial Revolution: How Lateral Power Is Transforming Energy, the Economy, and the World*. Palgrave MacMillan, 2011).
13. Jenike M., Jakob K. Dritte Industriele Revolution. *Internationale Politik,* 2008, no. 5, pp. 38–39.
14. Shvab K. *Chetvertaya promyshlennaya revolyutsiya*. Moscow, 2017. P. 27. (Transl. of: Shvab K. *The Fourth Industrial Revolution*, Currency, 2017. 192 p.).
15. The Reindustrialization of the United States. Euler Hermes Economic Outlook. *Special Report*, 2013, January, no. 1187. Available at: http://www.eulerhermes.us/reindustrialization.pdf.
16. Kondrat'ev N.D. *Bol'shie tsykly konyunktury i teoriya predvideniya*. Moscow: Ekonomika, 2002. 768 p.
17. Glazyev S.Yu., Kharitonov V.V. *Nanotehnologii kak klyuchevoy faktor novogo tehnologicheskogo uklada v ekonomike*. Moscow: Trovant, 2009. 304 p.
18. Glazyev S.Yu. World economic structures in global economic development. *Ekonomika i matematicheskiye metody=Economics and Mathematical Methods,* 2016, vol. 52, no. 2, pp. 3–29. (in Russian).
19. Perez C. Unleashing a golden age after the financial collapse: Drawing lessons from history. *Environmental Innovation and Societal Transitions,* 2013, March, vol.6. pp. 9–23.
20. Glazyev S.Yu., L'vov D.S., Fetisov G.G. *Evolyutsiya tehkniko-ekonomicheskikh sistem: vozmozhnosti i granitsy tsentralizovannogo regulirovaniya*. Moscow: Nauka, 1992. 207 p.

21. Yakovets Yu.V. *Global'nye ekonomicheskie transformatsii XXI veka*. Moscow: Ekonomika, 2011. 377 p.
22. Loginov V.P., Kornyshev I.R., Sokolov Yu.I., etc. *Vozrozhdenie ekonomiki Rossii: put' v XXI vek*. Moscow: Nauka, 2000. 268 p.
23. Mayevskiy V. Economic evolution and economic genetics. *Voprosy ekonomiki*, 1994, no. 5, pp. 58–66. (In Russian).
24. Ivanov V.V. Promising technological order: Opportunities, risks, threats. *Ekonomicheskiye strategii=Economic strategies,* 2013, no. 4, pp. 2–5. (In Russian).
25. Perez K. *Tekhnologicheskie revolyutsii i finansoviy kapital. Dinamika puzyrey i periodov protsvetaniya*. Moscow: Delo, 2011. 232 p. (Transl. of: Perez K. *Technological revolutions and financial capital. The dynamics of bubbles and periods of prosperity*, Edward Elgar Pub, 2003. 224 p.).
26. *Innovatsii i ekonomicheskyi rost*. Moscow: Nauka, 2002. 377 p.
27. Freeman C., Soete L. *The economics of Industrial Innovation: A Study of Long Waves and Economic Development*. Pinter: London, 1997. P. 19.
28. Uskov V.S. Trends of formation and problems of development of the digital economy in Russia. *Problemy razvitiya territorii=Problems of Territory's Development*, 2019, no. 2, p. 53. (In Russian).
29. Koreponov E.N. The paradoxes in science and innovations. *Vestnik Instituta ekonomiki Rossiyskoy akademii nauk=Bulletin of the Institute of Economics of the Russian Academy of Sciences*, 2019, no. 1, p. 47. (In Russian).
30. *Rossiya online? Dognat' nel'zya otstat': otchet*. The Boston Consulting Group, June, 2016.
31. *Novaya tekhnologicheskaya revoljutsiya: vyzovy i vozmozhnosti dlja Rossii: ekspertno-analiticheskiy doklad*. Moscow, 2017. 136 p.
32. *Eurostat – New Cronos, metadata on high-tech industries and knowledgeintensive services. Eurostat.* Available at: http://ec.europa.eu/eurostat/cache/metadata/FR/htec_esms.htm
33. Kuznetsova S. B. The fourth industrial revolution as a result of innovative-technological development of production systems. *Sovremennye nauchnye issledovanija i innovacii=Modern Scientific Researches and Innovations,* 2016, no. 3. Available at: http://web.snauka.ru/issues/2016/03/65792 (In Russian).
34. Lenchuk E. B. Orienting to the new industrialization, the global trend of economic development. *Problemy prognozirovanija=Studies on Russian Economic Development,* 2016, no. 3, pp. 132–143. (In Russian).
35. *Strategy for Scientific and Technological Development of the Russian Federation (approved by the Decree of the President of the Russian Federation no. 642, dated December 1, 2016)*. Available at: http://docs.cntd.ru/document/420384257 (In Russian).
36. Polterovich V.M. Institutions of Catching-up Development (On the Project of a New Model for Economic Development of Russia). *Ekonomicheskie i sotsial'nye peremeny: Fakty, tendentsii, prognoz=Economic and Social Changes: Facts, Trends, Forecast*, 2016, no. 5, p. 34–56. DOI: 10.15838/esc/2016.5.47.2 (In Russian).
37. Lenchuk E.B., Vlaskin G.A. The emergence of digital economy in Russia: Problems, risks, prospects. *Vestnik Instituta ekonomiki Rossiyskoy akademii nauk=Vestnik Institute of Economics of the Russian Academy of Sciences,* 2018, no. 5, p. 9. (In Russian).

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