

Analysis of the Development Prospects for the High-Tech Sector of the Economy in the Context of New Industrialization

Análisis de las perspectivas de desarrollo del sector de alta tecnología de la economía en el contexto de la nueva industrialización

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ABSTRACT:

New industrialization is the central component of the economic development model evolving in Russia. So far, there is no adequate industry in Russia in terms of technological, structural and environmental parameters, corresponding to the requirements of a new wave of technological development. We have systematized the tendencies of the reindustrialization of developed economies, synthesized Russian theoretical and practical studies in the field of new industrialization, examined the opinions of leading experts, and analyzed statistical data on the development of the high-tech sector. As a result, the article identifies modern tendencies in the development of the world economy that will determine its shape in line with the new technological wave. The analysis revealed that the Russian industry does not demonstrate the ability to

RESUMEN:

La nueva industrialización es el componente central del modelo de desarrollo económico que evoluciona en Rusia. Hasta el momento, no existe una industria adecuada en Rusia en términos de parámetros tecnológicos, estructurales y medioambientales, que correspondan a las exigencias de una nueva ola de desarrollo tecnológico. Hemos sistematizado las tendencias de la Reindustrialización de las economías desarrolladas, sintetizamos los estudios teóricos y prácticos rusos en el campo de la nueva industrialización, examinamos las opiniones de los principales expertos y analizamos los datos estadísticos sobre la desarrollo del sector de alta tecnología. Como resultado, el artículo identifica tendencias modernas en el desarrollo de la economía mundial que determinará su forma en consonancia con la nueva ola tecnológica.

follow the global trends. It is substantiated that convergent technologies form an intellectual core of the high-tech sector of its economy; and the new industrialization is impossible without the emergence of national companies in fundamentally new industry markets.

Key words: high-tech sector of economy, new industrialization, convergent technologies, industrial policy

El análisis reveló que la industria rusa no demuestra la capacidad de seguir las tendencias globales. Se fundamenta en que las tecnologías convergentes forman un núcleo intelectual del sector de alta tecnología de su economía; y la nueva industrialización es imposible sin el surgimiento de empresas nacionales en mercados de la industria fundamentalmente nuevos.

Palabras clave: sector de alta tecnología de la economía, nueva industrialización, tecnologías convergentes, política industrial

1. Introduction

The defining characteristic of the second half of the 20th century is the intensive technological development that allowed the leading countries in this area to determine global geopolitical transformations. The lack of clear objectives and priorities for science, technology and innovation policy, along with the low proportion of the high-tech industry in Russia, did not allow our country to form an adequate industry in terms of technological, structural and environmental parameters, corresponding to the requirements of a new wave of technological development.

The formation of an effective economic development model is one of the most important factors in overcoming its current crisis. It is alleged that the central component of such a model is the new industrialization, designed to provide an intensive type of expanded reproduction, new quality of human capital, as well as formation of a high-tech base of the Russian economy as a key factor for increasing its competitiveness and ensuring national security (Gubanov, 2012).

The solution of these problems requires a non-alternative reorientation of various engineering and technological systems to environmentally friendly technologies. In this regard, we are talking not only about the high-tech sector of the economy, but also about traditional industries, the modernization of which is based on the so-called "nature-like" technologies and involves changing the paradigm of resource involvement with an emphasis on natural resource turnover. Transition to a new model of economic development implies transformation of industrial development institutions. We will try to analyze the world tendencies in the development of industry and assess the readiness of Russian industrial enterprises to these challenges.

2. Tendencies of the world industry development

Currently, the idea of achieving global technological parity between Russia and the leading countries in technology is relevant (Volchkova, 2015). Under these circumstances, the Russian economy needs an attempt to develop a number of "horizontal" technologies that play a decisive role in creating new industries. Such a technological breakthrough can help to create a fundamentally new technological environment and alleviate the problem of technological inequality, which is one of the goals of industrial development.

New industrialization is also impossible without the appearance of national companies in fundamentally new industrial markets. According to numerous analysts, with whom we agree, Russian companies can secure a certain niche only in the markets that have not yet been created (Edovina, 2015; Denisov, 2015; Tatarkin, & Romanova, 2013). The strategic vector of the new industrialization of the Russian economy should be formed considering the trends of the global economy that will determine its appearance in accordance with the new technological wave (Tatarkin *et al.*, 2014; Chulok, n.d.).

It seems that among the most important tendencies there is a group of trends related to the growth of markets based on network solutions, which leads to a dramatic change in the value chains. Another group of trends is related to the formation of a network approach in the organization of studies, when, within the framework of large multidisciplinary centers, scientific and production organizations begin to cooperate. The third group of trends is related to the

increasing role of such companies, which solve the arising problems by combining the best available technologies and the variety of demand formats in a comprehensive and cost-effective manner (Lepskii, 2010).

The development of network solutions involves the creation and distribution of a number of technologies in the industry, including the processing of BigData, the "Internet of things", and the automation of data collection and processing. Similar technologies in industry require the use of tools for preliminary forecasting, explaining uncertainties, making the most informed decisions (Lee *et al.*, 2014). Based on *informatization and automation system innovations in production and service are two inevitable trends and problems for manufacturing industries*. The Internet of things involves rapid convergence of the real and virtual worlds. This technology makes it possible to create flexible production tuning, to implement deep integration between customers, companies and suppliers, and to create sustainable production systems (Shrouf *et al.*, 2014).

Trends that determine dramatic changes in the profile of competencies that are in demand in the labor market are no less important. This will lead to significant changes in the structure of employment, as well as to formation of portfolios of competences based on assessment of the expected demand of companies, which predetermines a change in the model of higher education.

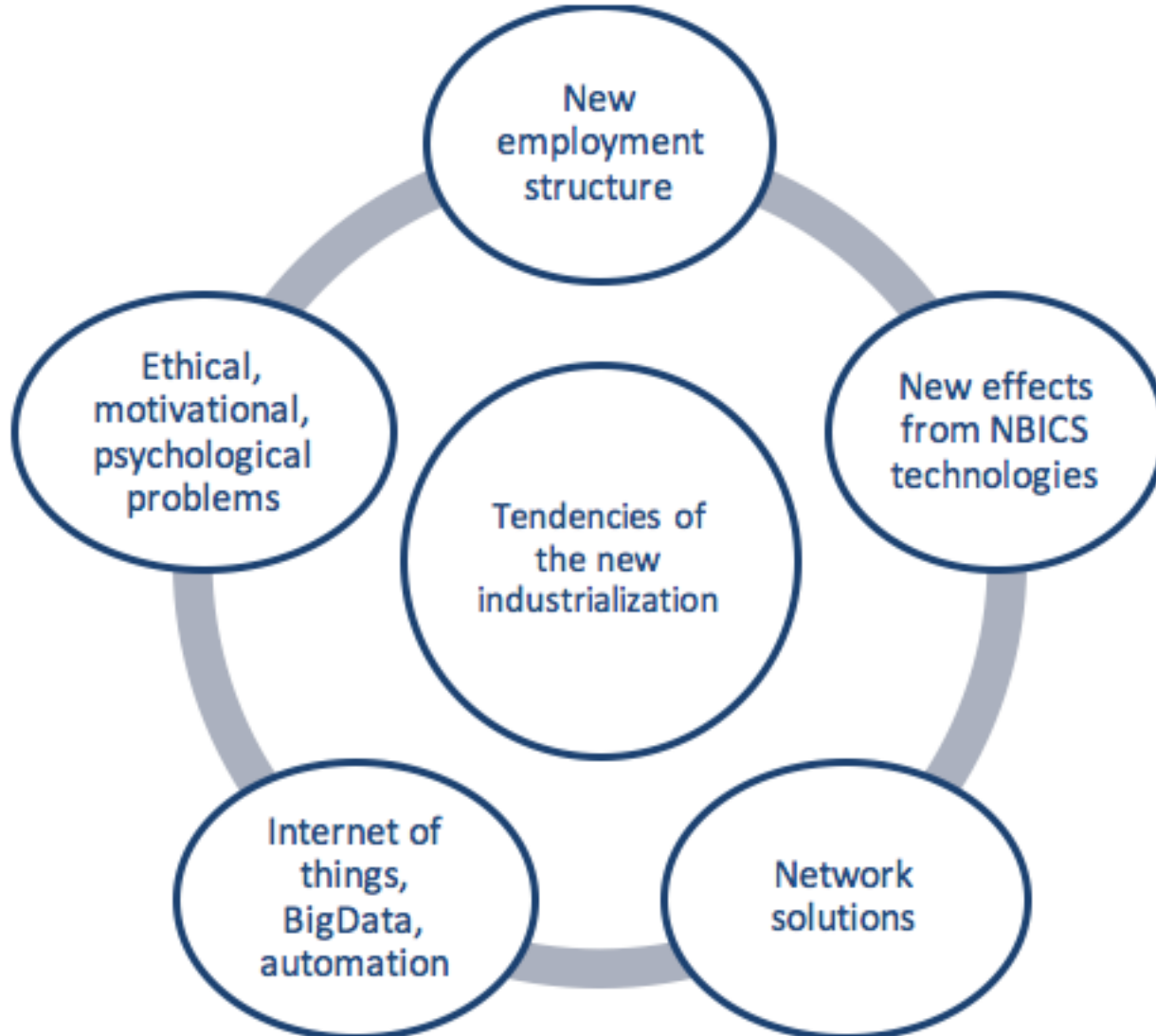
Converged technologies have traditionally been referred to as nanotechnology, biotechnology, information technology, and cognitive technology. Their mutual influence along with their interpenetration is called the "NBIC-convergence". M. Roco and William Bainbridge, who prepared a report "Converging Technologies for Improve Human Performance" in the World Technology Evaluation Center, introduced the term in 2002. However, such important factors as formation of new forms of life and possibility of constructing a social reality remain ignored. They are called social and humanitarian technologies. The importance of these technologies allows talking about the transformed NBICS-technologies. It appears that considering the laws of interaction processes of the technological sphere, human life and society with the development of certain methods and means to influence these processes complements the development features of the new economy. The allegations of the seventh technological order as a socio-humanitarian one have been substantiated (Lepskii, 2010). In view of the above, *convergent technologies are technologies with a high economic potential for practical application, defining a fundamentally new technological base of economy that does not contradict the requirements of environmental protection, and are critical for the country's socioeconomic development and its national security*.

The implementation of the main areas of NBICS-technologies will allow developing non-traditional ways of applying scientific developments, implementing new principles of inter-sectoral technology transfer, as well as their transfer from science to the real sector, to activate ways to manage technological platforms in the sphere of high technologies. The emergence of fundamentally new products and services based on the convergence of technologies will allow forming new industries emerging because of this convergence. A special feature of these processes is the transition to renewable energy sources, as well as resource-saving high technologies, with the release of environmental priority.

With all the positive aspects associated with the use of NBICS-technologies, one cannot ignore the ever-increasing technological threats associated with the consequences of their widespread use, with the ever-increasing detachment of technologies from ethical and civilizational assessments. For instance, while confirming the existence of a dispute about the moral and social acceptability of the use of NBICS technologies, several authors analyze the relevant arguments from the humanistic standpoint (Béland *et al.*, 2012).

Figure 1

The most significant trends in the development of the world industry.



The evaluation of expert opinions identified five most significant trends for the global and domestic industry (Figure 1). The industrial development model is likely to form within these areas.

3. Methods

The study was conducted as part of the author's understanding of the new industrialization as "simultaneous process of creating not only a new high-tech sectors of the economy, but also effective innovative renewal of its traditional sectors with the concerted qualitative changes between the technical, economic, social and institutional areas, implemented through interactive technology, social, political and management changes" (Romanova, 2014). The chosen approach presupposes special attention to such an important process of new industrialization as the development of the high-tech sector of the economy (Bendikov, & Frolov, 2007; Kovalchuk, & Stepnov, 2013; Dementev, 2013).

In a study to identify modern tendencies in the development of industry, in addition to bibliographic analysis, generalization of Russian theoretical and practical research in the field of new industrialization, we have also analyzed opinions of the leading experts on the development of industry, public administration and business involved in science. To assess the actual state of industry and its high-tech sector, we used the methods of structural and dynamic analysis of statistics and the method of comparison. We also used modified indicators characterizing the ratio of the newly developed, acquired and used technologies in the manufacturing industry. The analysis of the support institutions for innovative development and the development of industrial policy measures in Russia presupposed the use of the methods of institutional analysis.

The main objective of the study was to identify tendencies that determine the industry's external environment and assess the readiness of domestic industry for those challenges, assess the capabilities of the emerging institutes and stimulating measures of industrial policy.

4. Results

Assessment of conformity of the industry conditions with the identified tendencies

As we have already stated, new industrialization involves not only innovative development of the traditional industrial sector, but also creation of new high-tech industries. The analysis of statistical information can allow us to draw up a general picture of the state of Russian industry and its readiness for modern challenges. The fragmentation of statistics, even focused on tracking the development of high-tech industries and types of production, does not always allow for a comprehensive evaluation, but it provides an opportunity to form a common opinion and confirm the assumptions in certain areas. We choose processing industries as the main object of statistical analysis, since they create and concentrate core technological capabilities and the concept of the new industrialization will be generally implemented on their basis.

The global trends we have examined suggest an explosive growth in labor productivity, which is not yet traced in the analysis of the Russian industry statistics. The labor productivity index in 2013-14 showed an increase of around 2% and a decrease of 3.1% in 2015 (Figure 2). A significant lag in labor productivity is predetermined by a number of factors, among which are the low level of automation and computerization of production, as evidenced by the data on the specific number of industrial robots per 10 thousand people. While in the leading industrial countries it is on the average at the level of 100 (including in Singapore – 169, in Japan – 295), in Russia, according to the data repeatedly provided by specialists in this field, it is only two industrial robots per 10 thousand people.

Figure 2
Dynamics of productivity and labor saving rate
in the Russian industry in 2003-2016.

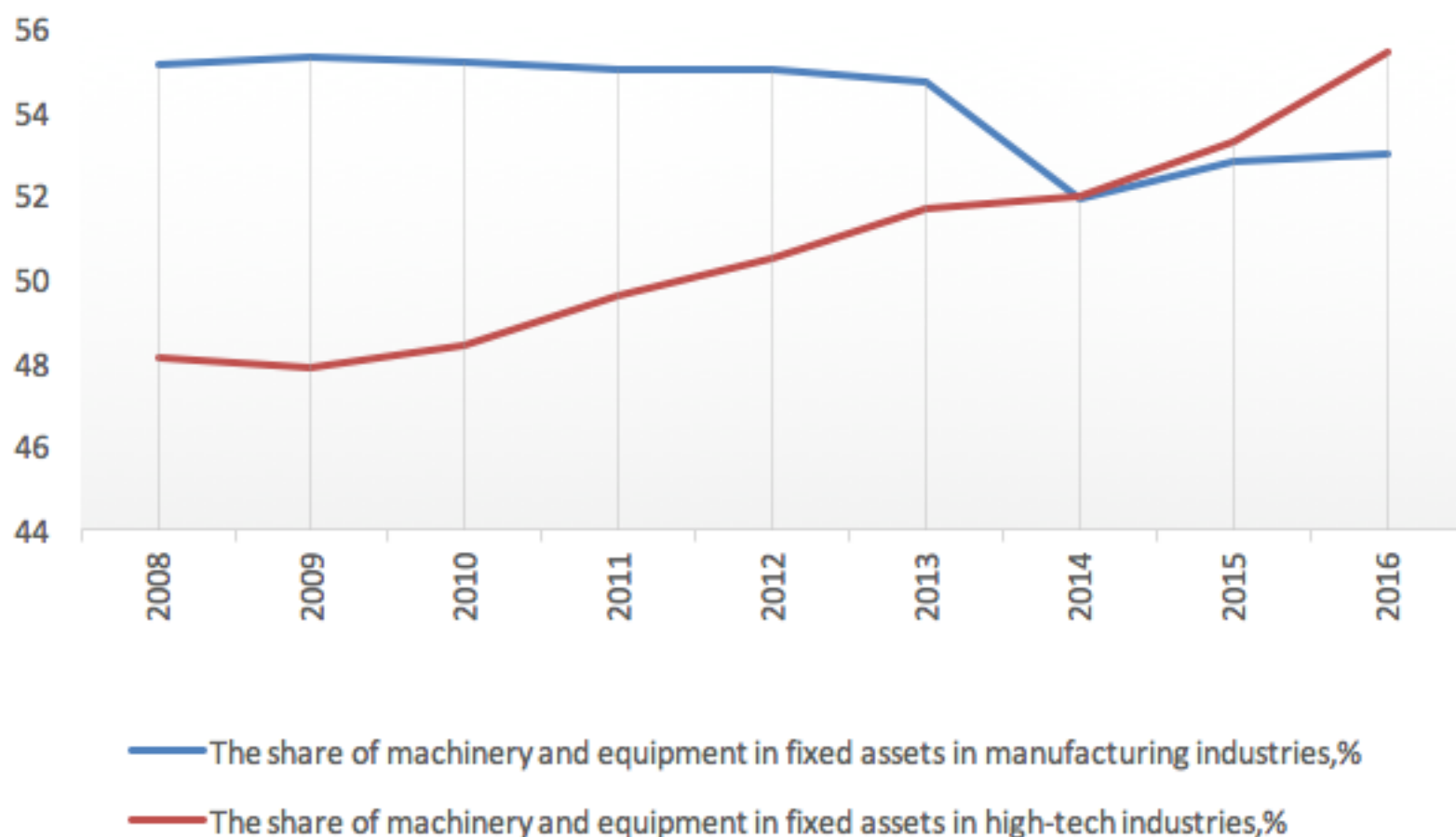


If we assess the indicators of development of traditional industry sectors, we will see some positive structural changes, such as an increase in the share of high-tech products and high-tech industries in GDP from 19.7% in 2011 to 22.4% - in 2016. In 2016, the production index for high-tech industries increased by 3% in relation to the previous year, in 2017 – by 1% (January-June). There are also a number of negative changes. Thus, in the basic industry production assets, the share of machinery and equipment decreased from 55.2 to 52.8% in 2010-2015 (Figure 3). However, the indicator for high-tech activities increased from 48.4 to

53.3%, for high-level medium-technology – from 53.8 to 55.1%, and for low-level medium-technology it decreased from 54.1 to 47.2% (Figure 3). In our opinion, this structural indicator characterizes the share of the most important, actively operating part of fixed assets ensuring the use of production technologies. Its slow growth or even decline indicates that there is no increase in the level of technical armament of labor, which largely determines its productivity.

Figure 3

Dynamics of changes in industrial parameters of Russian industry in 2008-2016.

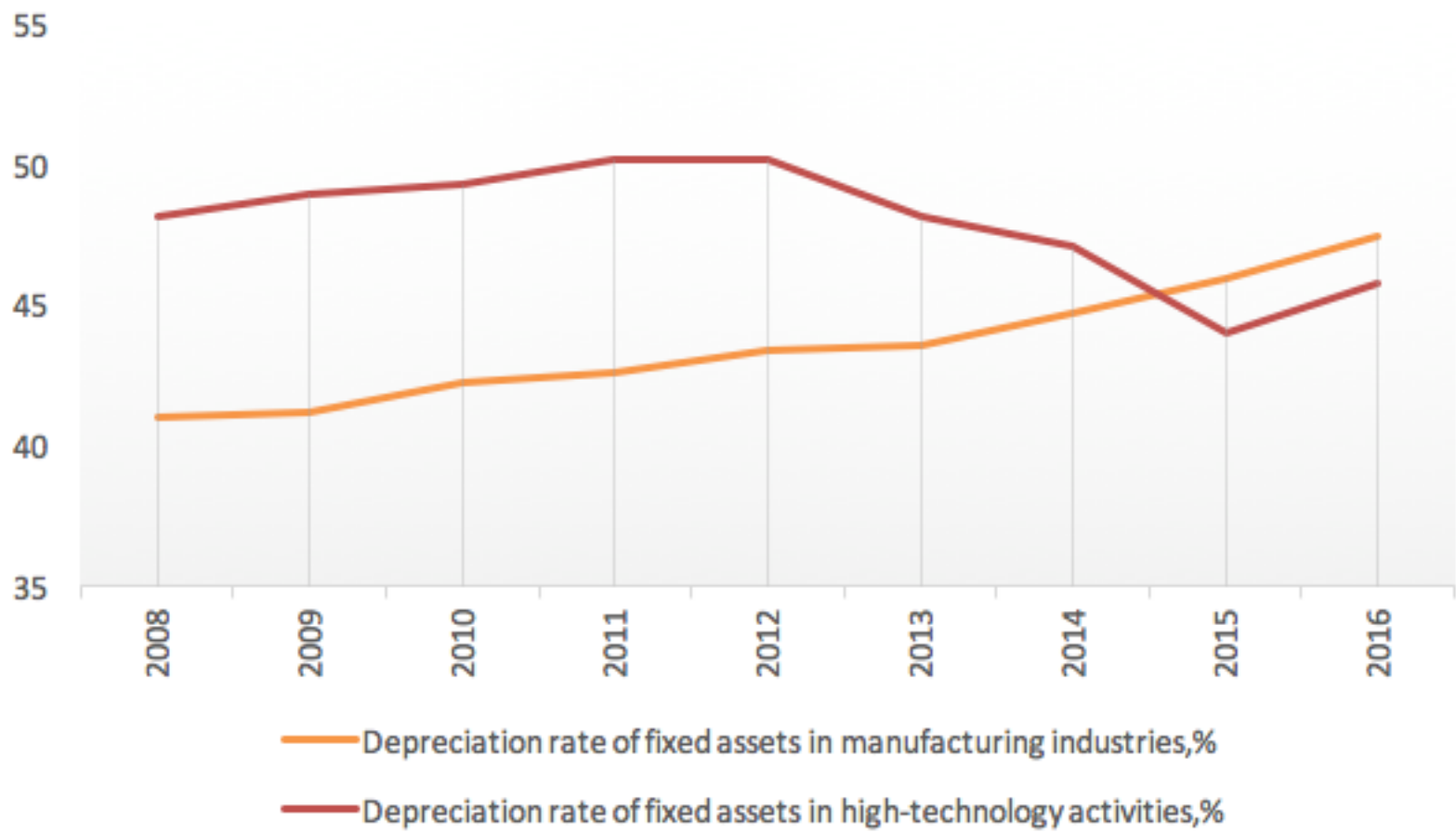


The characteristics of the investment sphere of industry are supplemented by the renewal ratio of fixed assets in manufacturing industries, which in the period from 2010 to 2015 decreased from 12.6 to 11.4, and increased from 9.6 to 17.6 in high-tech activities and from 12.2 to 13.3 in medium-tech activities. This largely determines the growth of depreciation rate of fixed assets up to 48% to the present moment in manufacturing industries and in the high-tech segment (Figure 4).

A negative trend is that the share of investments in machinery, equipment and vehicles in the total volume of investments in fixed assets reduced from 33.1 to 27.9%. At the same time, the same indicator for activities related to the use of computer technology and information technology increased from 17.6 to 11.9, although in 2013 and 2014 it was more than 50%. We consider this indicator important, as it reflects the quality of investments in terms of introducing new technologies and equipment. In general, over the past 10 years the investment activity in the reviewed sector remained at a stable level, which did not significantly reduce the depreciation of fixed assets.

Figure 4

Dynamics of depreciation and industry capital renewals in Russia in 2008-2016.

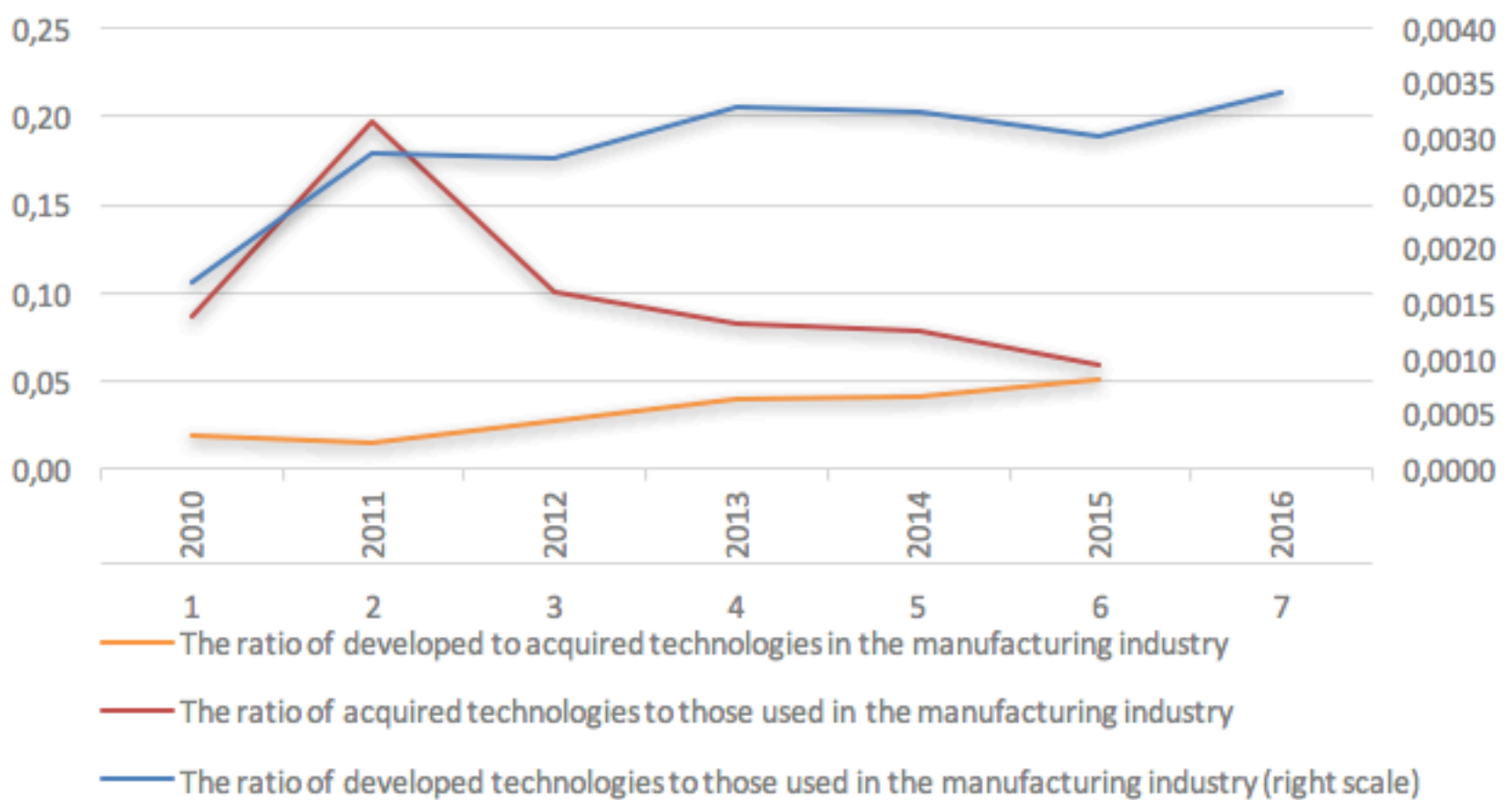


When characterizing the dynamics of innovative development, one should note the lack of growth of one of the most important indicators of innovation development – the share of domestic costs for research and development. In Russia, this indicator has not changed since 2010 and it is now 1.13%. With the observed increase in the ratio of domestic expenditure on research and development, the share of innovation in the total volume of shipped goods in industrial production has increased from 4.9 to 7.9%, while in manufacturing – from 6.7 to 10.6% and in high-tech industries – up to 18.6%. We should note that this figure has repeatedly been subjected to fair criticism of the vagueness of criteria for classification of goods as innovative.

At the same time, the number of advanced manufacturing technologies used in manufacturing has increased from 136,000 in 2010 to almost 150,000 in 2015. To assess the activity of technological development, we propose to look at the dynamics of relative indicators of acquired and developed technologies (Figure 5). The use of relations allows to some extent to normalize the ratio indicators to the total number of technologies used. The ratio of development technologies in the total amount of technologies is small, although they show significant growth. On the other hand, since 2011 the number of acquired technologies has been steadily declining. In our opinion, considering the preservation of the low share of expenditure on research and development in the GDP of the Russian Federation (as mentioned above), it says more about stagnation in technological development, rather than revitalization of studies in the technological sphere.

Figure 5

Dynamics of the ratios of acquired, developed and used technologies in the Russian manufacturing industry in 2010-2016.



If we turn to technologies that constitute the basis of the new technology wave, it is important to consider data on production of high-tech materials for the nanotechnology industry in volume terms in the period of 2013-2016, which has declined by more than 10%, amounting to 304 thousand tons. This happened with a more than twofold increase in the number of nanotechnologies used and developed in Russia.

As a conclusion, it can be noted that currently Russian industry does not demonstrate the ability to follow the world trends. Technical and technological renewal is slow and suggests rather the reproduction of existing technology in the industry structure. As for the newly created high-tech industries, they do not have a noticeable effect on the structural parameters. On the other hand, certain industries (i.e. telecommunications) undergo significant changes. The existing backlog also speaks about significant development potential that can be realized with the support of the government within the framework of the innovation strategy and the emerging new model of industrial development.

5. Discussion

In response to the described challenges, it is planned to improve the complex of industrial policy measures. Industrial policy in the absence of alternatives for the new industrialization is a universal mechanism for formation of a competitive structurally balanced economy. However, the forms and methods of its implementation vary significantly. *Industrial policy acquires a multi-subject nature.* The state thus plays a critical role not in terms of its presence in the economy, but from the position of a "smart state", defining goals and objectives, along with the national development priorities. Today such priority is the formation of the high-tech sector of economy, increasing the overall business and innovation activity. The world practice shows that industrial policy plays the key role in the development of these processes (Bianchi, & Labory, 2006; Altenburg, 2011; Romanova, 2008; Rodrik, 2004). *Therefore, industrial policy is, above all, sectoral policy that creates preference areas.*

In 2015, the Industrial Development Fund was established in Russia, and a special investment contract proposed, which may become an additional factor in accelerating the development of high-tech industry. Given the existing economic structure in Russia, it seems appropriate to develop an innovative strategy based not only on the consumer demand model, but also on the supply model from the technology sector. State structures play a special role within the framework of interacting organizations of the innovation system. It is the state policy that

determines the configuration of the innovative and institutional profile of the economic system. However, today it became a generally accepted fact that the innovation policy in Russia does not yield the expected results (Mekhanik, 2016). The government initiative in compelling state corporations to innovations did not bring the expected results. As a result, without due analysis of the activities of these institutional forms of innovative business, the identification of positive results and obvious failures, a question is posed at the government level about reframing the "mandates" of the existing development institutions (Edovina, 2016).

The "open government" concept proposes to radically revise the governance structure of the development institutions, creating a single state corporation. However, such a proposal seems controversial. The need to establish the Agency for Technological Development in Russia was also actively discussed. It was established in 2016, as a non-profit organization with a clear focus on technology transfer. We believe the Agency for Technological Development can eventually become an effective element of the national innovation system, provided that the functions enforcing the entire chain of successful technology transfer will be assigned to the Agency. It may be noted that now half of the spending is on engineering, which means that Russia imports actually rather mature technologies. The share of purchases of patents, licenses and "know-how" technologies related to the new production processes and technologies amounts only to 10%.

It appears necessary to coordinate the Agency studies with those works that are carried out within the framework of the National Technological Initiative (NTI). Systematic work on STI is built according to the developed NTI matrix. It defines nine new markets. The developed road maps for each of the nine new markets contain a specific schedule for implementation of technology initiatives aimed at developing key market segments. NTI includes system solutions to define key technologies, considering the basic trends of the world development and the need to develop new global markets. A well-developed NTI in fact offers the institutional bases for solving the problems of the new industrialization.

6. Conclusion

The study of the new industrialization in Russia has shown the need to consider the world tendencies. Those tendencies are manifested in the qualitative changes in the technical, economic and socio-institutional spheres. In our opinion, they involve changes in the structure of employment, requirements for the qualification of professionals, the use of a number of fundamentally new technologies, networking solutions in the organization of production and research, automation, informatization, along with ethical, motivational and other social problems accompanying those changes. The identified tendencies will shape the long-term external environment for enterprises and determine the competitive and cooperative opportunities of the high-tech industry sector. It is noted that the new industrialization is impossible without innovative renovation of the traditional sector of industry and the emergence of national companies in fundamentally new industrial markets.

The analysis revealed that the Russian industry does not demonstrate the ability to follow the global trends. The quality of production renewal indicates the reproduction in the industry of the existing technological structure and existing organizational solutions. On the other hand, the situation suggests the existence of willingness and capacity to participate in a new wave of innovation development. A number of traditional activity indicators of technological development of industry were supplemented, which will enhance the understanding of trends.

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