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Scientific and Technical Potential of Russia as a Factor of Economic Growth in the Knowledge Economy

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ABSTRACT

The relevance of the chosen topic is conditioned by the necessity of recognizing the innovative activities as a real strategic resource of the Russian economy, the major engine of socio-economic development in the conditions of growing competition of national and regional innovation systems. The purpose of this paper is to present the forecast of innovative development of Russia. The paper proves the advantage of the knowledge economy in the transition to a new quality of economic growth in Russian economy. The prospects for the development of the knowledge economy in Russia with the use of scientific and technical potential are considered. On the basis of economic-mathematical modeling a forecast of innovative development of Russia is presented. Materials of the paper present theoretical and practical significance for the development and implementation of Federal and regional programs of innovation development, as well as in the development of the strategy of the state innovation policy.

KEYWORDS
Economic growth, scientific and technical potential, knowledge economy, economic-mathematical modeling

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Introduction

In modern conditions the dynamic sustainable development is possible only on the basis of formation of innovative economy, deployment of key elements of the national innovation system. The transition to a postindustrial society demonstrates the importance of innovation processes as one of the leading factors of economic growth.

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The issue of national innovation systems have been studied by many scientists: W. Kingston (1984), P. Patel & K. Pavitt (1994), S. Metcalfe (1995), Y.V. Yakovec (2004), B.-A. Lundvall, P. Intaracumnerd & J. Vang (2006) и др.

The transition to a new quality of economic growth is carried out in the framework of the model of open innovation, to which are dedicated works of: G. Chesbrough (2007), M. Vanhaverbeke, M. Torkkeli & A. Trifilova (2010), J. West & S. Gallagher (2006), K. Kristensen & E. Skott (2008), M. Torkkeli, K. Kok & I. Savickaya (2009), D.S. Medovnikov & S.D. Rozmirovich (2011), A. Shinkevich & S. Kudryavtseva (2014), S. Kudryavtseva et al, (2015), S. Kudryavtseva et al., (2016a), S. Kudryavtseva et al., (2016b), T. Malysheva et al., (2016) и др.

The most promising from the point of view of ensuring competitive advantages in the modern world is innovation-oriented economy in which the main contribution to growth in gross domestic product is provided by the field of scientific and technical and innovative production. System which is associated with the sixth technological structure often is referred to as economy based on knowledge or like the knowledge economy.

The problem of using scientific and technical potential for achieving sustainable economic growth of a new quality in the knowledge economy is diversified, and it was resolved by many domestic and foreign scholars of various schools and trends.

In the works of scholars a significant attention is paid to such problems as structure-forming factors of human potential and human capital for economic development, the importance of knowledge in the socio-economic development, issues of management of knowledge systems, the introduction of cognitive technologies in production-economic and scientific-technical activity, as well as a number of other issues related to the peculiarities of formation and development of the knowledge economy in modern national economic systems (Kudryavtseva, 2009).

Knowledge economy is the highest stage in the development of modern post-industrial economy, or innovation economy. The main factor of its formation and using is a system of scientific and technological knowledge and human capital as determinants of sustainable economic growth.

The term "knowledge economy" was emerged in the late 90-ies of XX century, introduced into scientific circulation by the Austro-American scientist F. Machlup (1962) in 1962. The main difference of the knowledge economy from an industrial economy is that the development of economic systems is determined not so much by external, how much by internal, intangible factors, the most important of which are knowledge, information and human (intellectual) capital.

The infrastructure of the knowledge economy includes:

- the production of knowledge and high technologies;
- information society
- state effective institutions
- high level of education.

Economy based on knowledge, should be considered from two points of view. First, from the position of the entrance, when the value of investments is estimated in the core sector of the economy, reducing the scientific and technical knowledge, thereby forming a human and scientific-technical potential. Second, from the position of output when the contribution of economic activities is revealed exploiting new scientific and technological knowledge and human potential in the creation of gross value added – as a rule, it is about high-tech sectors of the economy.

At the present stage of the knowledge economy researchers (Toffler, 1999; Machlup, 1962; Drucker, 1969; Bell, 1973; Riesman, 1958; Romer, 1992; Wolfe, 2003; North & Wallis, 1994) distinguish the following main components of a new quality of economic growth: the development of high-tech industries, the use of information and communication technologies, the emergence of the network economy and the creation of a continuous chain of technological innovation. Much attention is paid to the humanitarian dimension of the knowledge economy, such categories as intellectual entrepreneur and worker, intelligent consumer (Kudryavtsev, 2009).

Methodological Framework

Research methods

During research the following methods were used: analysis, synthesis, systems analysis, systematization and generalization of facts, simulation, comparison, description, analogies, factor and component analysis.

Theoretical base of research

The theoretical basis of the research constitute the fundamental and applied works of foreign and domestic scientists who study the category of "knowledge economy", "economic growth", are involved in the development of the management tools of innovative and modernization development of economic.

The stages of the research

The study was conducted in three stages:

1) factors and problems of development of the knowledge economy in Russia are systematized;

2) the advantage of the knowledge economy in the transition to a new quality of economic growth in the Russian economy is proven;

3) the prospects for the development of the knowledge economy in Russia with the use of scientific and technical potential are considered and on the basis of economic-mathematical modeling a forecast of innovative development of Russia is presented.

Results

Systematization of factors of the knowledge economy in Russia

In the knowledge economy a change in the structure of gross value added, with the predominance of the service sector is observed. Dynamics of formation of gross value added in the service sector as a factor of knowledge economy, countries worldwide are shown in table 1.

Table 1. The share of gross value added of service sector in GDP formation (in per cent) (Worldbank, 2016)

Country	2006	2010	2014
China	41,9	44,2	49,9
Russia	**58,2**	**61,4**	**60,0**
Germany	69,1	69,1	69,0
Japan	70,7	71,3	72,6*
Netherlands	73,8	76,0	77,0
USA	76,6	78,5	78,1*
France	77,1	78,6	78,9

*) data for 2013.

The data in table 1 show a tendency of the gap between Russia and the countries in building knowledge economy through increased use of scientific and technical potential in the development of the service sector.

Currently, in research of domestic and foreign authors it is noted that the fundamental factor of the knowledge economy is human capital. Human capital is formed through investments in it. Moreover, the requirements to the quality of human capital in the innovation economy mean the exercise of these investments not one time and not at regular intervals, but throughout a person's life. Continuous investments in human capital contribute to meet growing human needs, and the needs of not only of the physiological level. And if in society there is a growing need for the development of personality, morality, culture, etc., along with the satisfaction of current needs, it speaks about positive socio-economic effect of return from the investments in human capital and about the right vector of development of society (Kudryavtseva et al., 2015).

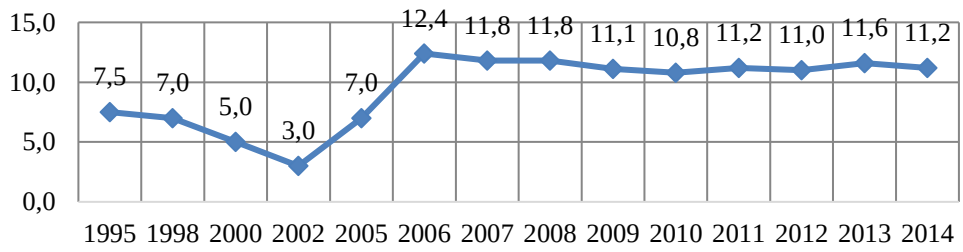
The accumulation of human capital at a certain point, leads to the emergence of new needs, the need to satisfy of which (it comes as both material and spiritual needs) is an incentive for innovation. In the first stage innovations exist in the form of ideas that are the product of the functioning of human capital. Realization phase (implementation) of innovations, along with the product with a significant share of the added value of such a resource as human capital yields the expected economic and social effects. Depending on the magnitude of these effects while implementation of innovations the volume of investments in human capital is formed, i.e. its formation and accumulation (Kudryavtseva et al., 2016a).

Thus, the main structure-forming factors of the knowledge economy are: the system of science and education, information and communication technology and human capital.

The advantage of the knowledge economy is proven in the transition to a new quality of economic growth in the Russian economy

In the knowledge economy the education is the Foundation, the driving force of development. However, in the financing of the scientific sphere, Russia has experienced a negative trend: public spending on education between 1995 and 2002 decreased from 7-8% to 3% of the total expenditure of the consolidated budget of the Russian Federation (Fig. 1), but after 2005 a positive trend of growth of this indicator is observed.

Figure 1. Dynamics of expenditures of the consolidated budget of the Russian Federation on education (percentage of the total expenditure of the consolidated budget of the Russian Federation) (Federal Treasury, 2015)



In General, the statistics indicate that the share of expenditure on education in the consolidated budget of the Russian Federation increased from 7.5% in 1995 to 11.2% in 2014. The maximum value of this indicator was observed in 2006 - 12.4%. From 2011-2014 the average share of expenditure on education was around 11%. Today Russia takes 36th place out of 187 countries on the expenditure on education (Federal Treasury, 2015).

One of the main problems that hinder the development of Russia's knowledge economy and sustainable economic growth of new quality is the ageing of scientific personnel. For example, the average age of the researchers is 47 years old, but according to global research, significant discoveries scientists make before 40-45 years. The average age of doctors increased from 58 years in 1998 to 62 years, in 2014 the average age of PhD– from 49 to 52 years old. This negative dynamics is associated primarily with the outflow of young specialists in the sphere of Commerce and other types of employment that are not related to science (Rosstat, 2015).

One of the main tasks of the knowledge economy is achieving a positive synergetic effect from integration of economic sectors. The integration of education, science and industry is the sharing of scientific, technical and human capacity of educational, scientific and industrial organizations with mutual interests – training, advanced training and retraining of personnel, carrying out joint scientific research, and implementation of innovative projects. In Russia there are processes of integration of science and industry, but to enhance the communication is necessary: effective interaction of universities with employers and the labor market; and support the creation of business incubators, technology parks and other integrated scientific-educational and industrial structures; development of mutually beneficial business partnership of higher education and the industrial sector; training of specialists of cross-functional activities.

In General, the dynamics of the main indicators of scientific and technological development of Russia can be characterized by the following data: the number of research organizations in 2014 relatively to 2000 decreased by 11.5%, the number of employed in R & d – on 47.3%, domestic expenses for R & d - on 42.1%. These trends allow us to speak about contradictory processes of development of scientific-technical potential of Russia and determine the relevance of the study of the subject of research for sustainable growth of the new economy (Rosstat, 2015).

Forms of support and enhance of scientific and technical potential of Russia are enshrined in the "concept of long-term socio-economic development of the Russian Federation for the period until 2020", which is developed in accordance with the instructions of the President following the meeting of the State Council on 21 July 2006. The section "Development of science, the national innovation system and technologies" Concept reflects the following objectives aimed at solving contemporary problems of Russian science and the development of a knowledge-based economy, including:

-ensuring of Russia's participation in global technology projects, international programs and research networks for the purpose of integration into the world scientific and technological space;

-the creation of a mechanism to support the creation and market capitalization of Russian brands in the sphere of high technologies, compensation for the cost of foreign patenting and protection of intellectual property rights abroad; coordination of the issue in foreign economic activity, including in the work of intergovernmental commissions on trade and economic cooperation;

-the involvement of Russian scientists who emigrated abroad, to the development of Russian science and technology, including through their participation in the Russian

scientific-educational projects and teaching activities (Decree of the RF Government, 2008).

For the upcoming period seven priority areas are identified, which largely overlap with the objectives formulated in the Concept of long-term socio-economic development:

- the entering into bilateral and multilateral international agreements to stimulate scientific-technical and innovation collaboration in the priority areas;

- the development of international cooperation between companies with state participation, including in the implementation of programs of innovative development, stimulation of creation in Russia of the international scientific and technical centers, and corporate centers of research and development;

- intensification of Russia's participation in international and regional standardization organizations. Increased support for private sector participation of Russian experts in the development of international and regional standards (Decree of the RF Government, 2011).

Prospects of development of knowledge economy in Russia with using the scientific and technical potential are systematized and on the basis of economic and mathematical modeling a forecast of innovative development of Russia is presented

In order to assess the contribution of Russian scientific and technical potential in the formation of knowledge economy it seems appropriate to carry out the economic and mathematical modeling, where the regression model will be used as an analysis tool. In the construction of the economic and mathematical model the dependent variable is suggested to consider a share offer high-tech sector in the GDP (%), and the independent variables - the share of domestic expenditure on research and development (%), the ratio of inventive activity, the share of investment in fixed assets (%).

Notation of variables are the following:

Y - the share of high-tech sector as a percentage of GDP;

x_1- The share of domestic expenditure on R & D as a percentage of GDP;

x_2 - Coefficient of inventive activity;

x_3 - The proportion of investment in fixed assets as a percentage of GDP.

Dynamic range is represented by figures from 2008-2015. (Rosstat, 2015).The calculated regression coefficients allow us to construct the equation expressing the dependence of the share of high-tech sector in the GDP "y" of factors: «x1» - the proportion of domestic expenditure on research and development, "x2" - inventive activity coefficient, "x3" - the proportion of investment in fixed assets GDP. Linear regression equation is as follows:

$$Y = 6{,}157239 + 8{,}991221x_1 - 1{,}0442x_2 + 0{,}411355x_3$$

Using the theoretical basis of the interpretation of the equation of multiple linear regression, the quality of economic and mathematical models is evaluated.

The significance of the equation for the Fisher criterion. The resulting economic and mathematical model is statistically significant - the significance of the criterion F <0,05 (0,027).

2.) Check of the regression equation coefficients shows that a statistically significant parameter is x_1 (proportion of domestic expenditure on research and

development), its P-value <0.05 (0.046). The indicator "share of investment in fixed assets in GDP" statistically significant at the 10 percent level - its P-value <0.1 (0.06).

The indicator "ratio of inventive activity" is not statistically significant - P-value> 0.05 (0.6), therefore its influence on the formation of the share of high-tech sector in GDP is characterized by a mixed trend that can be explained by the negative trends in the sector of research training and employment of researchers in the scientific field.

The calculation of the elasticity coefficients of the regression model allows obtaining of the following values: x_1=0,44; x_3=0,36.

By increasing the proportion of research and development costs (x_1) on 1% point, the proportion of high-tech sector of GDP will be increased by 0.44% points.

With an increase in the proportion of investment in fixed assets (x_3) on 1% point, the proportion of high-tech sector of GDP will be increased by 0.36% points.

Together, these two factors will increase the GDP by 0.8% points.

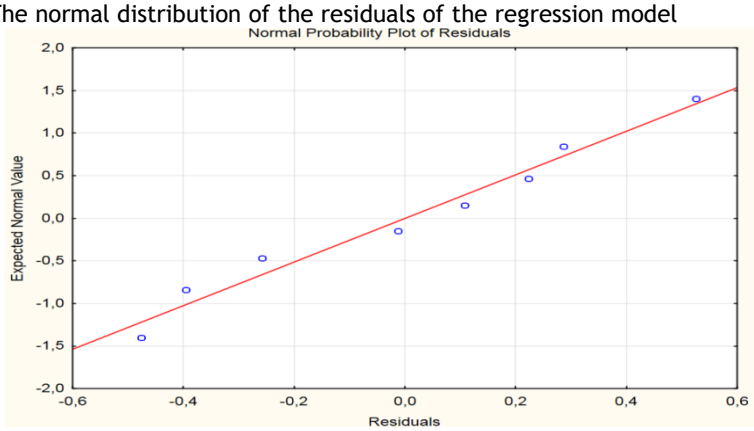
4.) The coefficient of determination (R-squared) for this model was 0.86, thus the selected factors for 86% explain the changes of effective sign - high-tech sector contribution to GDP formation.

5.) The standard error for this model is 2.9% of the average value of the dependent variable, which is a good indicator of the quality of the model

6.) Durbin-Watson criterion for the presence of multicollinearity is 1.5 (standard value close to 2); it shows that the close relationship between the independent factors have not been identified, therefore, the resulting equation is adequate.

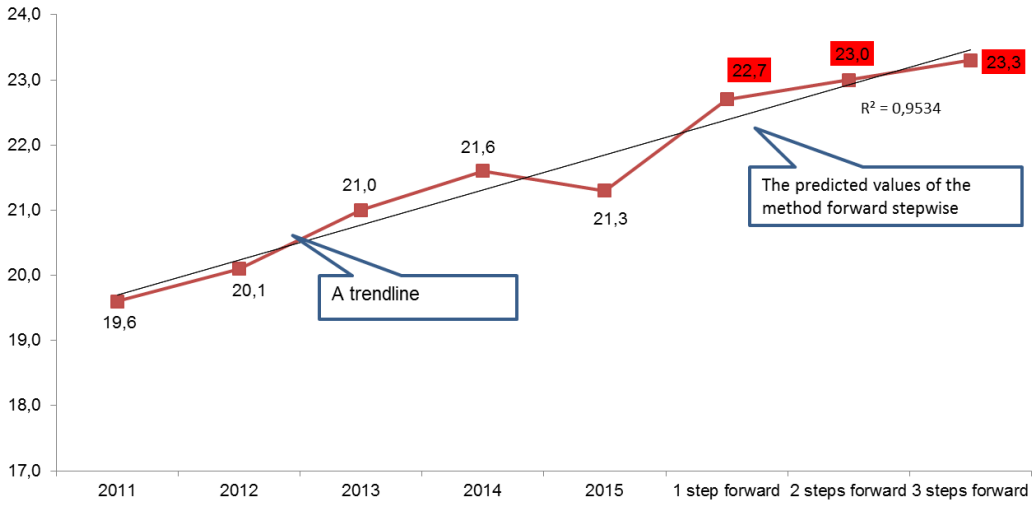
7.) Analysis of the residue shows that their average value tends to zero and the residuals are normally distributed, which also leads to the conclusion about the adequacy of the model (Fig. 2).

Figure 2. The normal distribution of the residuals of the regression model



8.) A forecast of change in the share of high-tech sector in GDP is built by forward stepwise method according to the economic and mathematical model - with an increase in all values to 1% point share of the high-tech sector in GDP is increased to 22.7% (forecast by 1 step forward); with an increase of 2% points, the share of high-tech sector in the GDP will increase to 23% (forecast for 2 steps forward), with an increase of 3% points - the proportion of the high-tech sector in GDP will reach 23.2% (3 steps ahead forecast) (Figure . 3). Achievement of the predicted values includes the possibility in case of observance of a set of measures described above.

Figure 3. Forecast of the share of high-tech sector in GDP (percentage)



Thus, based on the conducted economic and mathematical modeling, we can conclude that the formation of the share of high-tech sector in the GDP is influenced most significantly by the proportion of domestic expenditure on research and development, as well as the proportion of investment in fixed assets in GDP.

Therefore, these controllable factors should be the basis for the implementation of the state scientific-technical and innovation policy that will help develop the knowledge economy.

Discussions and Conclusion

The scientific literature presents multiple research on "knowledge economy" category (Toffler, 1999; Machlup, 1962; Masuda, 1981; Chentsova, 2008 and others.), widely are studied institutional specificity of formation and directions of development of the knowledge economy in Russia (Shelestova, 2013).

However, not enough attention is paid to modeling and forecasting of innovative development in Russia, based on the transition to a new quality of economic growth.

Thus, this study suggests the following conclusions.

To date, the improvement and implementation of scientific and technological potential of the country plays a huge role in the development of public industrial production.

The implementation of scientific and technological potential of the Russian economy will not only solve complex of major socio-economic objectives (improving the quality of life of the population, the implementation of programs of import substitution, increase of competitiveness of the domestic economy, etc.), but also will give a significant multiplier effect of the progressive development of high-tech sectors of the economy in order to build the knowledge economy and to achieve sustainable economic growth in the new quality (Zaidi et al., 2009).

The study produced the following results:

1.) based on a comparative, dynamic and factor analysis the trend of backlog of Russia from the world's economies is revealed in terms of development of the

knowledge economy, including through the development of high-tech sectors of the economy and human capital, on the basis of which it is concluded that at the present time in Russia the transition to formation of a new quality of economic growth is complicated;

2.) economic-mathematical model is proposed, which expresses the dependence of the share of high-tech sector in the GDP from the factors: the proportion of domestic expenditure on R & D, inventive activity ratio, the proportion of investment in fixed assets, and based on it the impact of these factors to achieve a new quality of economic growth is proven and a set of measures that will lead to the transition is developed;

3.) the forecast of innovative development of Russia is prepared in the formation of a new quality of economic growth, demonstrating the achievement of sustainable growth of the economy of knowledge, based on increasing the share of high-tech sector in the GDP.

Disclosure statement

No potential conflict of interest was reported by the authors.

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