

**Research Article****Research and Technological Capacity of Russia as an Indicator of Knowledge Economy Growth**

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**ABSTRACT**

The paper is aimed at making prognosis for innovative growth in Russia. It justifies the merits of the knowledge economy in the transferring to the efficient way of increase in Russian economy. The perspectives for the growth of the knowledge economy in Russia with application of research and technological capacity are examined. Based on economical-mathematical simulation a prediction of innovative growth of Russia is considered. Paper submissions stress the theoretical and practical importance for the formation and realization of Federal and regional programs of innovative growth, as well as for the formation of the orientation on the public innovative strategy.

**Keywords:** economic development, research and technological capacity, knowledge economy, economical-mathematical simulation.

**INTRODUCTION**

In contemporary environment the dynamic and sustainable growth is available only on the grounds of development of innovative economy, allocation of core components of the public innovative system. The transferring to a postindustrial society shows the significance of innovative procedures as one of the backbone aspects of economic development. The problem of public innovative systems have been considered by a number of researchers: P. Patel & K. Pavitt (1994), S. Metcalfe (1995), Y.V. Yakovec (2004) and others. The transferring to a

new efficient way of economic development is implemented within the model of transparent innovations, to which are the following studies can be referred: J. West & S. Gallagher (2006), M. Torkkeli, K. Kok & I. Savickaya (2009), M. Vanhaverbeke, M. Torkkeli & A. Trifilova (2010), A. Shinkevich & S. Kudryavtseva (2014), S. Kudryavtseva et al. (2015), S. Kudryavtseva et al., (2016), T. Malysheva et al., (2016) and others. The most perspective one in the view of providing competitive merits in the

contemporary environment is innovatively-focused economy in which the major investment to increase in gross domestic product is ensured by the sphere of research and technological innovative products. System which is connected with the sixth technological order often is considered as economy founded on knowledge economy. The issue of application of research and technological capacity to attain sustainable economic increase of a new efficient way in the knowledge economy is varied, and it was studied by a number of Russian and foreign researchers of diversity of schools and directions. In their studies such problems as structure-constructing aspects of human capacity and human potential for economic growth, the significance of knowledge in the socio-economic growth, problems of management of knowledge systems, the realization of cognitive technologies in industrial-economic and research-technological activity, as well as many other challenges connected with the features of development and formation of the knowledge economy in contemporary public economic systems are taken into account (Kudryavtseva, 2009). Knowledge economy is the advanced phase in the formation of contemporary post-industrial economy, or innovative economy. The major aspect of its development and application is a system of research and technological knowledge and human potential as indices of sustainable economic increase. The category "knowledge economy" appeared in the late 90-ies of XX century, presented in by the Austro-American scientist F. Machlup (1962) in 1962. The general peculiarity of the knowledge economy from the production economy is that the formation of economic systems is defined not so much by outer, how much by inner, non-material aspects, the most significant of which are knowledge, information and human potential.

The construction of the knowledge economy involves:

- the production of knowledge and high technologies;
- information society
- public efficient institutions

- upper level of training.

On the one hand, economy founded on knowledge is seen from the standpoint of the entrance, when the contribution is evaluated in the key segment of the economy, consisting in research and technological knowledge, in this connection developing a human and research and technological capacity. On the other side, from the standpoint of exit when the investments of economical activities is found implementing new research and technological knowledge and human capacity in the making of gross value added in high-tech economical segments. The knowledge economy researchers (Machlup, 1962; North & Wallis, 1994; Toffler, 1999; Wolfe, 2003) identify the following major parts of a new efficient way of economic increase: the formation of high-tech production, the application of information and communication technologies, the network economy and the formation of a constant chain of technological innovations. Humanitarian aspect of the knowledge economy with such concepts as intellectual entrepreneur and intelligent consumer are taken into account (Kudryavtsev, 2009).

## **METHODOLOGY OF THE STUDY**

### **Study methods**

The study involved the following methods: analysis, synthesis, systematization and generalization of facts, systems analysis, comparison, description, analogies, factor and component analysis, simulation.

### **Theoretical base of the study**

The theoretical basis of the study included the basic and applied studies of foreign and Russian researchers who investigated the concept "knowledge economy", "economic development", "constructing of managerial instruments of innovation and economic modernization".

### **The study stages**

The study was included three phases:

- 1) Contributing to and blocking factors and challenges of formation of the knowledge economy in Russia are identified;
- 2) the merits of the knowledge economy in the transferring to a new efficient way of

economic development in the domestic economy is justified;

- 3) the perspectives for the formation of the knowledge economy in Russia with the implementation of research and technological capacity are taken into consideration and founded on economic-mathematical modeling a prediction of innovation growth of Russia is shown.

### Study Results

#### Factors' systematization of domestic knowledge economy

In the knowledge economy a changed structure of gross value added, with the prevalence of the service segment is watched. Dynamics of development of gross value added in the service segment as a factor of knowledge economy in different countries are presented in table 1.

**Table 1.** The share of gross value added of service segment in GDP development (in per cent) (Worldbank, 2016)

Countries	2006	2010	2014
China	41,9	44,2	49,9
<b>Russia</b>	<b>58,2</b>	<b>61,4</b>	<b>60,0</b>
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 table 1 demonstrates a gap between Russia and the countries in formation knowledge economy via improved application of research and technological capacity in the formation of the service segment.

The studies of Russian and foreign researchers state that the basic tendency of the knowledge economy is human potential. Human potential is developed by contributions. Besides, the demands to the efficiency of human potential in the innovative economy imply the application of those contributions not once and not with breaks, but during the whole life of the person. Constant investments in human potential contribute to growing human needs, and not only physiological needs. And if there is an increased need in society for the formation of personality, culture, morality, etc., besides the meeting of current needs, it denotes on positive socio-economic efficiency of return from the contributions in human potential and about the correct direction of social development (Kudryavtseva et al., 2015).

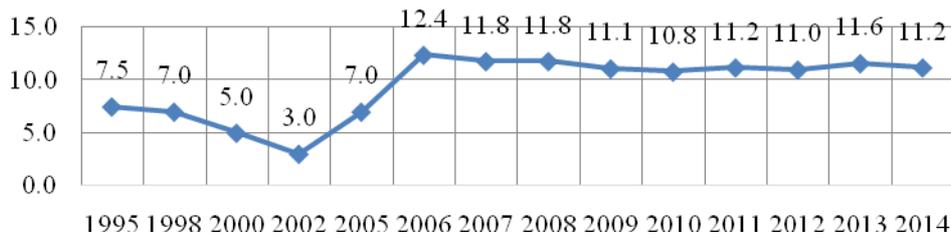
The stockpiling of human potential at a definite level, results to the appearance of new needs, the necessity to meet which is a stimulus for innovations. In the first phase innovation exists

in the form of ideas that are the result of the operation of human potential. Implementation stage of innovation, besides the product with a big share of the added value of such a source as human potential yields the anticipated economic and social efficiency. Taking into account the values of these efficiencies while realization of innovation the amounts of contribution in human potential are made, i.e. its development and stockpiling (Kudryavtseva et al., 2016a).

So, the major structure-constructing components of the knowledge economy are: the system of research and training, information and communication technology and human potential.

#### The merits of the knowledge economy in the transferring to a new efficient way of economic development in the domestic economy

In the knowledge economy the training is the basis, the engine of improvement. But, in the financing of the research field, Russia has had a negative tendency: national expenses on training in 1995 - 2002 reduced from 7-8% to 3% of the total expenses of the combined budget of Russia (Fig. 1), but after 2005 a positive tendency of increase of this index is watched.



**Figure 1.** Dynamics of expenses of the combined budget of Russia on training (percentage of the total expenses of the combined budget of Russia) (Federal Treasury, 2015)

In the whole, the statistics points out that the share of expenses on training in the combined budget of the Russia grew from 7.5% in 1995 to 11.2% in 2014. The biggest value of this index was watched in 2006 - 12.4%. From 2011-2014 the medium share of expenses on training was approximately 11%. Today Russian Federation takes the 36th place out of 187 states on the expenses on training (Federal Treasury, 2015). One of the major issues that prevent the formation of Russia's knowledge economy and sustainable economic development of new efficient way is the ageing of research staff. For example, the medium age of the researchers is 47 years old, but by to world research, important discoveries researchers carry out before 40-45 years. The medium age of Ph.D increased from 58 years in 1998 to 62 years, in 2014 the medium age of candidates – from 49 to 52 years old. This decreased dynamics is connected originally with the escape of young experts in the field of Commerce and other kinds of employment that are not connected with research (Rosstat, 2015). One of the major objectives of the knowledge economy is attaining positive synergetic effect from integration of economic segments. The integration of training, research and production is the exchange of research, technological and human potential of training, research and industrial organizations with mutual interests – training, advanced training and retraining of staff, realization of joint scientific research, and fulfillment of innovation projects. In Russian Federation there are integration processes of research and industry, but to improve the connection is necessary: efficient interrelation between institutions and employers and the labor market; and maintenance in the formation of business

incubators, technology parks and other integrated research-training and production structures; formation of mutually profitable business partnership of higher education and the production segment; training of specialists with cross-operational activities. In the whole, the dynamics of the major indices of research and technological growth of Russian Federation can be illustrated by the following data: the number of research organizations in 2014 in comparative with 2000 reduced on 11.5%, the number of employed in R & d – on 47.3%, domestic expenditures for R & d - on 42.1%. These tendencies enable to speak about discrepant events of formation of research-technological capacity of Russian Federation and identify the actuality of the study subject for sustainable economical development (Rosstat, 2015).

Support forms for improvement of domestic research and technological capacity are retained in the "concept of long-term socio-economic development of the Russian Federation for the period until 2020", which is carried out in compliance with the orders of the President based the meeting of the State Council on 21 July 2006. The chapter "Development of research, the national innovative system and technologies" reflects the tasks directed on the solution of modern challenges of Russian science and the formation of a knowledge-based economy, involving:

- providing of Russia's involvement in world technological projects, international programs and research networks aimed at integrating into the global research and technological environment;
- the construction of an instrument to maintain the formation and market capitalization of Russian structures in the field of high technologies,

reimbursement for the expense of foreign patenting and defending of intellectual property rights abroad; consolidation of the problem in foreign economic activity, involving in the activity of intergovernmental commissions on trade and cooperation in economy;

-the participation of domestic researchers who emigrated abroad, in the formation of Russian research and technology, taking into account their involvement in the domestic research-training projects and educational activities (Decree of the RF Government, 2008).

There are some major sectors, which significantly correspond to the targets presented in the Concept of long-term socio-economic development:

- the entering into bilateral and multilateral world arrangements to contribute to research-technological and innovative cooperation in the major spheres;

- the formation of world collaboration of enterprises with public involvement, taking into account the realization of programs for innovation development, contributing to the development in Russia of the global research and technological centers, and industrial centers of research and development;

- strengthening of Russia's involvement in world and regional standardization institutions. Improvement of maintenance for private sector involvement of Russian experts in the formation of world and regional standards (Decree of the RF Government, 2011).

Prospects of formation of domestic knowledge economy with application of research and technological capacity are systematized and on the basis of economic and mathematical modeling a prediction of innovation development of Russia is presented

To estimate the investment of domestic research and technological capacity in the development of knowledge economy it seems reasonable to fulfill the economic and mathematical modeling, where the regression model will be applied as an analysis instrument. In the building of the economic and mathematical model the dependent variable is offered to consider a share of high-tech segment in the GDP (%), and the

independent variables - the share of domestic expenses on research and development (%), the ratio of inventions activity, the share of contribution in fixed assets (%).

There is the following notation of variables:

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

- the share of domestic expenses on R & D as a percentage of GDP;

- coefficient of invention activity;

- the proportion of contribution in fixed assets as a percentage of GDP.

Dynamic range is illustrated by figures from 2008-2015. (Rosstat, 2015). The calculated regression coefficients enable to build the equation showing the dependence of the share of high-tech segment in the GDP "y" of factors: «x1» - the proportion of domestic expenses on research and development, "x2" - invention activity coefficient, "x3" - the proportion of contribution in fixed assets GDP. Linear regression equation is the following:

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

Applying the theoretical base of the interpretation of the equation of multiple linear regression, the efficiency of economic and mathematical models is estimated.

The importance of the equation for the Fisher criterion. The outcomes of economic and mathematical model is statistically significant - the significance of the criterion  $F < 0,05$  (0,027). 2.) testing of the regression equation coefficients demonstrates that a statistically significant parameter is (proportion of Russia's expenses on research and development), its P-value  $< 0,05$  (0,046). The index "share of contribution in fixed assets in GDP" statistically significant at the 10 percent level - its P-value  $< 0,1$  (0,06).

The index "ratio of invention activity" is not statistically significant - P-value  $> 0,05$  (0,6), so its impact on the development of the share of high-tech segment in GDP is described by a mixed tendency that can be understood for the negative tendencies in the segment of research training and employment of researchers in the scientific sphere.

The computation of the elasticity coefficients of the regression model enable to get of the values:

$$=0,44; \quad =0,36.$$

By improving the proportion of research and development costs ( ) on 1% point, the proportion of high-tech segment of GDP will be raised by 0.44% points.

With the growth in the proportion of contribution in fixed assets ( ) on 1% point, the proportion of high-tech segment of GDP will be improved by 0.36% points.

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

4.) The coefficient of determination (R-squared) for this model was 0.86, so the selected factors for 86% illustrate the changes of efficiency - high-tech segment investment to GDP development.

5.) The standard mistake for this model is 2.9% of the medium value of the dependent variable, which is a good index of the quality of the model

6.) Durbin-Watson criterion for the availability of multicollinearity is 1.5 (standard value close to 2); it demonstrates that the close interaction between the independent factors have not been defined, so, the equation is adequate.

7.) Analysis of the balance illustrates that their medium value tends to zero and the residuals are normally delivered, which also result to the concluding about the adequacy of the model (Fig. 2).

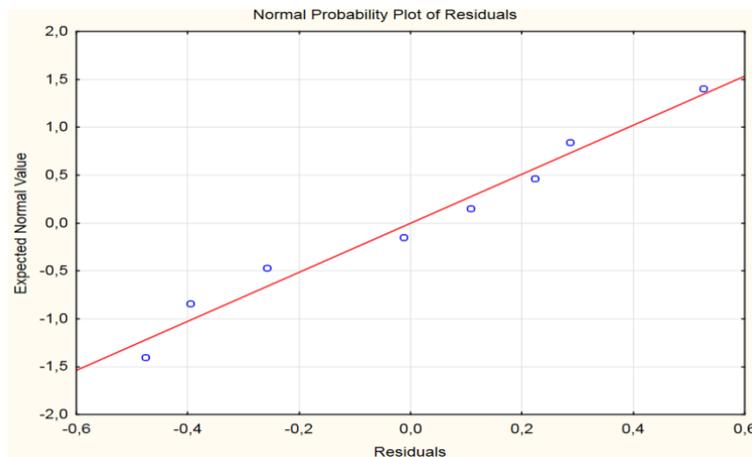


Figure 2. The normal delivery of the residuals of the regression model

8.) A prediction of change in the share of high-tech segment in GDP is constructed by forward stepwise way in compliance with the economic and mathematical model - with the growth in all values to 1% point share of the high-tech segment in GDP is raised to 22.7% (forecast by 1 step forward); with an improvement of 2% points, the share of high-tech segment in the GDP will be raised to 23% (forecast for 2 steps forward), with an improvement of 3% points - the proportion of the high-tech segment in GDP will attain 23.2% (3 steps ahead prediction) (Figure . 3). Attaining of the forecasted values involves the opportunity in condition of keeping of a complex of procedures illustrated above.

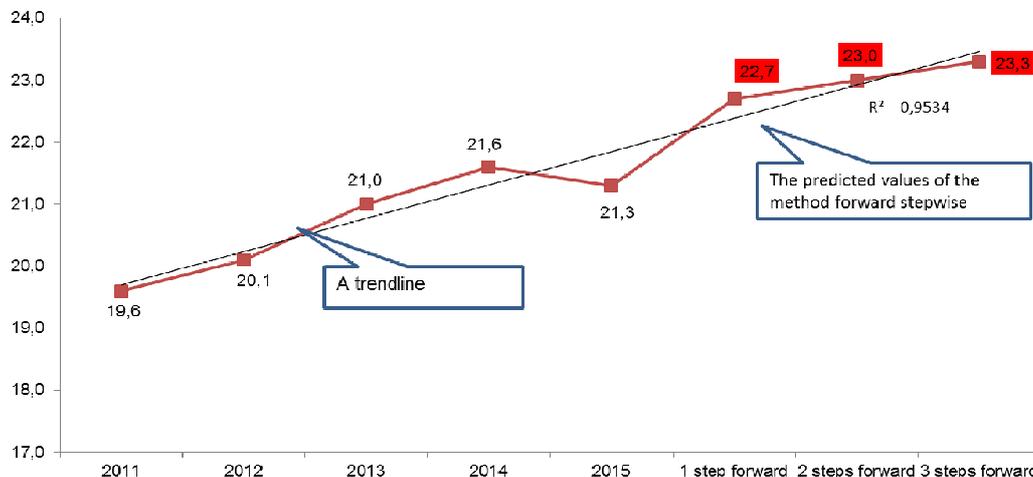


Figure 3. Prediction of the share of high-tech segment in GDP (percentage)

So, founded on the constructed economic and mathematical modeling, it is possible to make conclusion that the development of the share of high-tech segment in the GDP is impacted mostly by the proportion of domestic expenses on research and development, as well as the proportion of contribution in fixed assets in GDP. That is why, these manageable factors should be the foundation for the realization of the public research-technological and innovative policy that will contribute to the development of the knowledge economy.

## DISCUSSIONS AND CONCLUSION

The scientific literature suggests many studies on "knowledge economy" concept (Machlup, 1962; Toffler, 1999 and others.), which broadly investigate institutional specificity of development and its vectors: the knowledge economy in Russia (Shelestova, 2013). But, attention is not given enough to simulation and predicting of innovation formation in Russia, founded on the transferring to a new efficient way of economic development. So, this study presents some conclusions. The growth and realization of research and technological capacity of the country plays a significant role in the formation of national industry. The realization of research and technological capacity of domestic economy will not only solve set of main socio-economic tasks (raising the efficiency of life of the population, the realization of programs of import substitution, improve competitiveness of the Russian economy, etc.), but also will contribute to multiplier effect of the perspective formation of high-tech segments of the economy to build the knowledge economy and to attain sustainable economic development of the new efficient way (Zaidi et al., 2009).

The study presents the following outcomes:

- 1.) founded on a comparative, dynamic and factor analysis the tendency of lag of Russia from the economies of the world is found in conditions of formation of the knowledge economy, involving through the growth of high-tech segments of the economy and human potential, on the base of which it is stated that nowadays in Russia the transferring to the development of a new efficient way of economic growth is difficult;
- 2.) economic-mathematical model is suggested, which shows the dependence of the share of high-tech segment in the GDP from the following factors: the proportion of domestic expenses on R & D, innovation activity ratio, the proportion of contribution in fixed assets, and founded on it the influence of these factors to attain a new efficient way of economic development is justified and a complex of procedures that will result to the transferring is formed;
- 3.) the prediction of innovation growth of Russia is given in the development of a new efficient way of economic growth, illustrating the attaining of sustainable development of the economy of knowledge, founded on the raising of the share of high-tech segment in the GDP.

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