ISSN 0798 1015

REVISTA ESPACIOS

HOME Revista ESPACIOS ÍNDICES A LOS AUTORES

GERENCIA • GESTÃO • MANAGEMENT Vol. 39 (N°22) Year 2018. Page 4

Industrial sector development of Economy in conditions of new technological mode formation: interrelation modeling

El desarrollo del sector industrial de la economía en el contexto de la formación de un nuevo orden tecnológico: la simulacion de la relación

Andrey V. BYSTROV 1; Ekaterina L. VODOLAZHSKAYA 2

Received: 02/03/2018 • Approved: 02/04/2018

Contents

ABSTRACT:
The urgency of the problem stated in the paper is due to the fact that in the conditions of transition to a new technological order, there is a need to improve national innovation systems by measures of innovative activity's state stimulation in the industrial sector. The purpose of the paper is to analyze the measures of innovation activity's state stimulation in industry in the context of national innovation systems of the world's countries for developing a common doctrine of innovative development in a new technological order. A factor model of state incentive measures and the quality of its effectiveness in national innovation systems is proposed, comparison and analysis with the Russian economy are given. The materials of the paper are of theoretical and practical importance for the development of models for the management of Russia's national innovation system in the context of transition to a new technological order and the improvement of state scientific, technical and industrial policy.
Keywords: innovation, technological order, industry, national innovation system, innovation activity,

RESUMEN:
La actualidad del tópico se deriva de la necesidad de mejorar los sistemas nacionales de innovación por estimulaciónes estatales para la actividad innovadora en el sector industrial en las condiciones de transición a un nuevo orden tecnológico. El objetivo del artículo es analizar las medidas de estimulación estatal de la actividad innovadora de la industria en el contexto de los sistemas nacionales de innovación de los países del mundo para desarrollar una doctrina común del desarrollo innovador en un nuevo orden tecnológico. Se propone un modelo factorial de las medidas de incentivos estatales y la evaluación de su eficacia en los sistemas nacionales de innovación; se ofrecen la comparacion análitica con la economía rusa. Los materiales del artículo tienen la importancia teórica y práctica para el desarrollo de modelos para la gestión del sistema nacional de innovación de Rusia en condiciones de transición a un nuevo orden tecnológico y para mejorar la política científica, técnica e industrial del estado.
Palabras clave: innovación, orden tecnológico, industria, sistema nacional de innovación, actividad

modeling, cluster analysis, stimulation of innovation activity, R&D.

innovadora, simulación, análisis claster, estimulación de la actividad innovadora.

1. The Relevance of Research

The national innovation system is an important subsystem of the state and is the area of a new technological order formation. The study of the category of the national innovation system is not an independent task of this work, in its understanding we adhere to the studies of modern and foreign researchers. National innovation strategy in its effective format (state strategy, supported by the strategies of meso- and microeconomic innovation-active systems) is the basis of scientific and technological progress, structural changes in the economy, and the introduction of breakthrough (basic) innovations. B In the work of S.A. Dyatlov (2011) an important idea is provided on the evolution of NIS activities' content in the process of interaction of scientific and technological capabilities with the place of their development (market space), development, the introduction of innovations from activities related to basic innovations that provide a push in development (technology push), to demand-driven activities, pulling out innovations by the real sector (demand challenge). As a hypothesis it is dominance in the Russian conditions of the first kind of activity of the innovation system. One can note the evolution of ideas about the definition of NIS essence and content, in particular, the classical definition of NIS proposed by K. C. Freeman (1995), according to which NIS is considered as "a set of organizations and enterprises whose activities are aimed at the generation and diffusion of innovations" (Freeman, 1995). This definition was transformed under the influence of a change in the content of creative activity in the studies and normative documents of the following representatives and organizations. In the definition of B.A. Lundvall (1992) the characteristics of the NIS are described as a system, with an emphasis not only on the elements of the system, but also on the links between them, and about the limitations of the system by state borders is said, which is important within the factors of reality. Representatives of the evolutionary trend of economic science, in particular R. Nelson (1993), in the work devoted to national innovation systems, under the NIS understands the set of institutions that determine the characteristics of national micro-level economic agents. Such a view gradually becomes dominant, the NIS characteristics emphasize efficiency parameters-the system's tasks (low transaction costs, incentives, competence centers and agent training, business activity) (Patel & Pavitt, 1994). It is interesting to define the NIS according to J.S. Metcalfe, who, as a government task, denotes taking into account the previous development of the macroeconomics, its "artifacts" for the creation of new technologies. Within this research we are interested in: the current and relevant model of NIS in Russia, the priorities of the system's impact on production (innovative push) and, conversely, the request of the real sector of the economy, relevant in the face of crisis phenomena in the economy and in the transition to a new technological order.

In particular, an interesting approach to the analysis of the national innovation system was proposed by domestic researchers S.A. Dyatlov & V.P. Marianenko (2012). This approach continues as a matter of fact the trend in the development of technological paradigms through the activity of economic agents of a network nature, which means attracting as a criterion for the efficiency of the system not only local but global optima, with the emergence of synergy in the process of cooperative links between the subjects of the system. The authors emphasize a clear distribution of the role between the state and the market in stimulating innovation, although there is a fairly large number of self-organization and self-development facts within the private sector (a vivid example of I. Mask, Google and others). At the same time, the "invisible hand" of the innovation market will represent the emergence of a network effect between research organizations, industrial enterprises and their networks. However, it must be clearly understood that the network effect can be both positive and negative from the point of view of scientific and technological progress, and institutional innovations are not an end in themselves, but a means, in particular, the situation can be justly called a situation in which not only obsolete technological, but also institutional innovations (Shinkevich et al. 2016). In this regard, the issues of modeling the relationship between the level of the national innovation system development and the

transition to a new technological order in modern conditions of management become especially urgent.

2. Methodological Framework

2.1. Methods of Research

During the research, the following methods were used: analysis, synthesis, system analysis, systematization and generalization of facts, modeling, comparison method, descriptions, analogies, factor analysis and correlation analysis.

2.2.Theoretical Basis of the Research

The theoretical basis of the research is the fundamental and applied works of foreign and domestic scientists studying the development of national innovation systems, the transition to a new technological order, and the relationship between these phenomena.

2.3. Stages of Research

The study was conducted in three stages:

- At the first stage - the preparatory stage - the current state of the problem was analyzed in the theory and practice of managing national innovation systems; a program of research methodology was developed;

- At the second stage - the main stage - the comparative analysis of the level of national innovation systems' development was conducted, the regularities of transition to a new technological structure were identified, the factor model of innovation activity's state stimulation was developed in the context of companies' size by countries of the world;

- At the third stage - the final stage - the systematization, comprehension and generalization of the research results were carried out; theoretical conclusions were refined; processing and registration of the research's results were carried out.

3. Results

3.1. The R & D role in the Russian National Innovation System's development: a Comparative Aspect

The national innovation system is a complex system that includes mainly 3 institutional groups: the state, business and science. In this regard, the problem of the Russian and not only the innovation system is to ensure the systematic interaction of the listed elements.

In the Russian national innovation system, one can see the low efficiency of state innovation projects' implementation, even intensified in a crisis. It is caused by the initial systemic factors that impede stability. The current state of state intervention in stimulating the country's innovative development is characterized by the following data. According to the results of the study, published in the collection "Science and Engineering Indicators 2016" (from Science and Engineering Indicators 2016, from https://www.nsf.gov), Russia has the highest share of government participation in R & D financing among economically developed countries (Table 1). At the same time, the effectiveness of the intervention is not so high, with other things being equal.

Table 1
The ratio of state and private sector participation in R & D financing by country in 2013 (as% of gross domestic expenditure on R & D)

A country	Business Expenses	Expenses of the state

South Korea	78,5	11,2
China	76,6	16,2
Japan	76,1	9,2
USA	70,6	11,2
Germany	67,8	14,7
France	64,8	13,2
Russia	60,6	30,3

The large-scale intervention of the state in the Russian innovation system can be explained by the previous development of the institutional environment on the one hand, the low activity of business in the field of commercialization of innovations, on the other. The key reasons preventing the growth of the demand for innovations from the private sector are the inadequacy of own financial resources, high level of taxation, a high percentage of commercial credit, low predictability of business conditions, etc.

Within the framework of the model of sustainable development, but rather a subsidized model, the state is forced to substitute the demand for innovations from the industry. State support is provided at all stages of the innovation process, from basic research to diffusion of innovations. At the stage of fundamental and applied research, state support is provided in the form of grants from the President of Russia, various scientific foundations, and through the Federal Targeted Program "Research and Development in Priority Areas for the Development of the Russian Science and Technology Complex" for 2014-2020, which provides for 234.43 billion rubles on competitive applied research and development. The qualitative development of the scientific and pedagogical staff provides for the Federal Target Program "Scientific and Pedagogical Staff of Innovative Russia" for 2014-2020, with the volume of financing 201.02 billion rubles. At these stages of the innovation process, the problem of public funds' dispersal arises, because the state is compelled to finance both fundamental science and applied technology at the expense of budgetary funds, while the private sector does not invest enough in research and development. As a result, financing of the first stage of the innovation process is being reduced and the state finances mostly the applied research (Table 2).

Table 2
Financing of science in Russia from the federal budget (million rubles)
(Federal State of Statistics Service (2018), from http://www.gks.ru)

Type of research	2010	2011	2012	2013	2014	2015
basic research	82173,8	92305,3	85691,9	112230,9	121599,5	120203,8
as a percentage of the total	34,6%	28,9%	26,1%	26,4%	27,8%	27,4%
applied research	155482,8	226970,2	242491,2	313070,8	315673,8	319188,9
as a percentage of the total	65,4%	71,1%	73,9%	73,6%	72,2%	72,6%

Because of untimely investment of resources, the quality of R & D is falling, the innovative

development of the country lags behind, the efficiency of using funds is decreasing and their shortage is increasing in the short term. This trap hinders the scientific and technological development of the country. In Russia, by the end of 2015, the level of funding for applied research is more than twice that of the basic science. At the stage of commercialization and diffusion of innovations, the state provides support to science through the Skolkovo Foundation and the Foundation for Assistance to Small Innovative Enterprises in the scientific and technical sphere. It should be noted that in the Russian legislation there are no tools that regulate the stage of designing developments, which aggravates the problem of cooperation between business and science.

3.2. Measures of State Stimulation of Innovative Activity in National Innovation Systems

In addition to the noted leadership role of government intervention in the economy, a shortage at the country level is a small amount of incentive measures. More precisely, tax incentives for innovation activity of enterprises can be estimated on the basis of the formula (1 - B-index) - the indicator of tax subsidies for innovation activity. The higher the value of the indicator of tax subsidies, the more incentives the state provides for innovation (Table 3).

Table 3
The level of tax subsidies for innovation activities (1-B-Index) (OECD (2018) Data and Statistics on R & D Tax Incentives, from https://www.oecd.org)

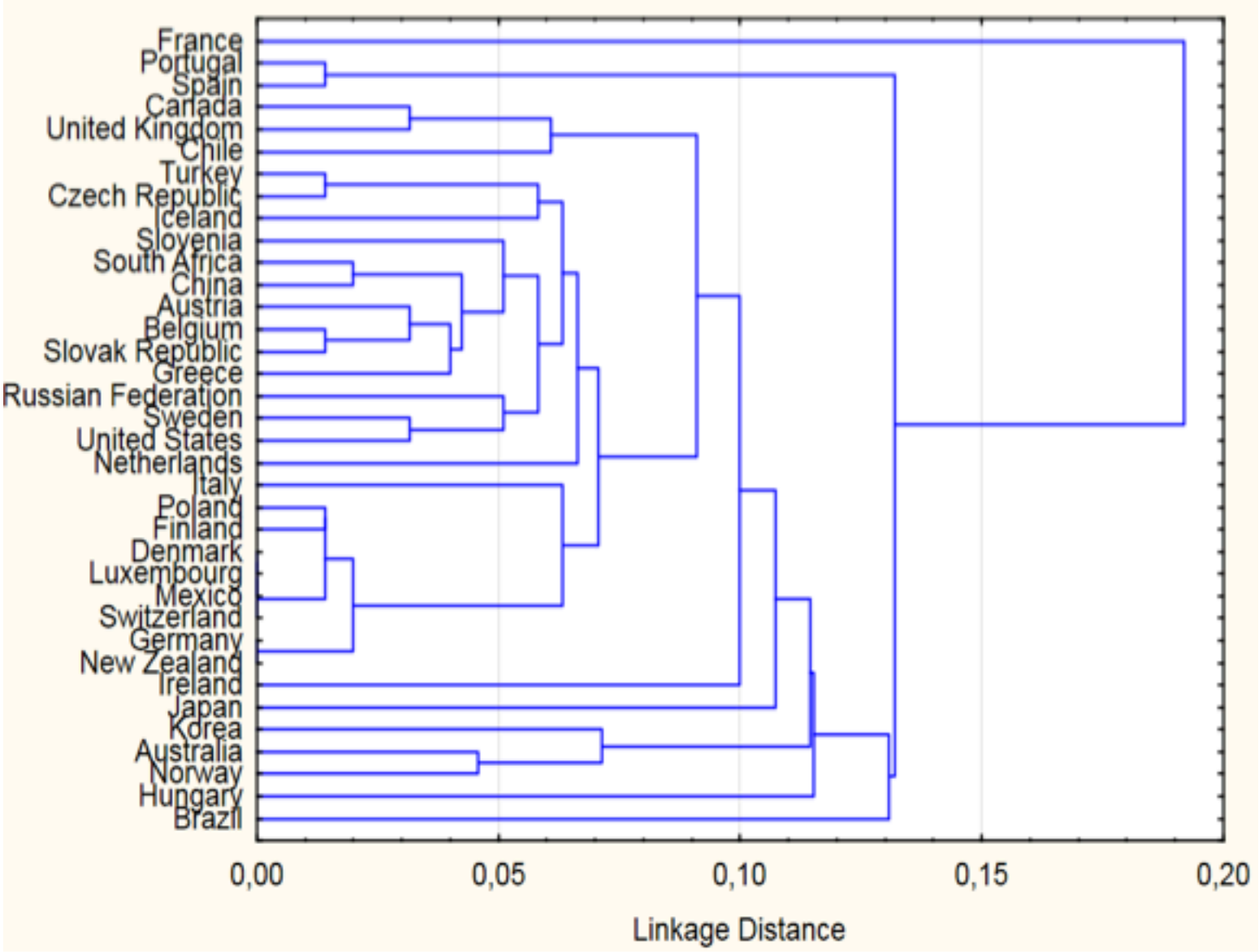
A country	Large, profitable companies	Small and medium profitable firms	Large unprofitable companies	Small and medium loss-making firms
France	0,26	0,43	0,22	0,43
Portugal	0,36	0,37	0,28	0,29
Spain	0,37	0,37	0,29	0,29
Canada	0,13	0,30	0,10	0,29
United Kingdom	0,10	0,29	0,10	0,29
Ireland	0,29	0,29	0,23	0,23
Chile	0,13	0,29	0,10	0,23
South Korea	0,04	0,26	0,03	0,21
Turkey	0,23	0,23	0,18	0,18
Czech Republic	0,23	0,23	0,17	0,17
Iceland	0,22	0,22	0,22	0,22
Netherlands	0,16	0,22	0,14	0,20
Greece	0,09	0,09	0,07	0,07
Russian Federation	0,08	0,08	0,03	0,03

Sweden	0,05	0,05	0,05	0,05
United States	0,04	0,04	0,03	0,03
Italy	0,04	0,04	-0,02	-0,02
Poland	0,00	0,00	0,00	0,00
Finland	-0,01	-0,01	0,00	0,00
Denmark	-0,01	-0,01	-0,01	-0,01
Luxembourg	-0,01	-0,01	-0,01	-0,01

3.3. Cluster Analysis of Tax Incentives for Innovation in the Transition to a New Technological Order

Using the cluster analysis technique made it possible to group the states according to the level of tax subsidies for innovation activity according to four analyzed indicators (Large, profitable companies, Small and medium profitable firms, Large loss-making companies, Small and medium loss-making firms) into three clusters. At the first stage of the analysis, a dendrogram was constructed demonstrating that it is more preferable to be clustered in 3 groups (Figure 1). *The first cluster (the "average level of tax incentives")* is characterized by averages for sampling values for both loss-making and profitable companies in terms of the level of tax subsidies for innovative activities. At the same time, the spread of indicators' average values in this cluster is the largest, which allows speaking about the highest instability and unpredictability of financial results of companies operating in these countries. The middle-level cluster is represented by 18 states: Canada, Great Britain, Korea, Norway, China and others.

Figure 1
Dendrogram "tree of clusters"



The descriptive statistics for each cluster are given in Table 4.

Table 4
Descriptive statistics for clusters

Indicators	**Average meaning**	**Standard deviation**
	1 cluster "average index level"	
Large, profitable companies	0,15	0,07
Large unprofitable companies	0,11	0,06
Small and medium profitable firms	0,20	0,06
Small and medium loss-making firms	0,17	0,07
	2 cluster "high index level"	
Large, profitable companies	0,32	0,05
Large unprofitable companies	0,26	0,04
Small and medium profitable firms	0,37	0,06
Small and medium loss-making firms	0,31	0,08
	3 cluster "low index level "	

Large, profitable companies	0,02	0,05
Large unprofitable companies	0,00	0,03
Small and medium profitable firms	0,03	0,05
Small and medium loss-making firms	0,01	0,03

The second cluster ("high") is formed by four states: France, Portugal, Spain and Ireland. This cluster is conditionally called a cluster with a "high level of tax benefits". The countries of this cluster were dominated by high (compared to other national economies) values (1-B-Index). The high value of tax subsidies' level for innovative activities for lucrative enterprises was combined with the high level of tax subsidies for innovative activities for unprofitable enterprises, that is, there is a clear inefficiency of incentives. So, a cluster with a high level of tax incentive index numbers contains the largest values for the analyzed indicator of large, medium, small, profitable and unprofitable companies.

The third cluster ("low") is represented by 14 states: Japan, Greece, Russia, Italy, Germany, etc. In this cluster, there are lower values of the indicators compared with the "high" and "medium" cluster. Therefore, a cluster with a low level of tax incentive index contains the lowest values for the analyzed indicator of large, medium, small profitable and unprofitable companies.

3.4. Evaluation of the Results of Cluster Analysis

Cluster analysis of tax incentives' index for innovation is considered appropriate to complement by the ratio of R & D costs as a percentage to GDP (Table 5).

Table 5

Expenditure on R & D as a percentage to GDP by cluster

States	**Expenditure on R & D as a % to GDP**	**States**	**Expenditure on R & D as a % to GDP**
	1 cluster "medium"		**2 cluster "high"**
Canada	1,6	France	2,3
United Kingdom	1,7	Portugal	1,3
Chile	0,4	Spain	1,2
South Korea	4,3	Ireland	1,6
		Total for cluster 2 average	**1,6**
Turkey	1,0		**3 cluster "low"**
Czech Republic	2,0	Japan	3,6
Iceland	1,9	Greece	0,8
Netherlands	2,0	Russia	1,2

Australia	2,2	Sweden	3,2
Norway	1,7	USA	2,7
Slovenia	2,4	Italy	1,3
Hungary	1,4	Poland	0,9
South Africa	…	Finland	3,2
Brazil	1,2	Denmark	3,1
China	2,0	Luxembourg	1,3
Austria	3,0	Mexico	0,5
Belgium	2,5	Switzerland	…
Slovakia	0,9	Germany	2,9
Total for cluster 1 average	**1,9**	New Zealand	1,2
		Total for cluster 3 average	**2,0**

Thus, the largest share of R & D expenditures in GDP is recorded in the third cluster with a low level of the tax incentive index for innovation (the cluster average was 2%), the smallest in the second cluster with a high level of tax incentive index (1.6%).

4. Discussions

In order to identify the dependence of the tax stimulus index of innovation activity (1-B-index) and expenditure on R & D in GDP, a pairwise correlation analysis was performed separately for profitable and unprofitable enterprises. The results of the research confirmed the hypothesis of cluster analysis that the amount of tax benefits in the implementation of innovations does not depend on the results of enterprises' economic activities (profit or loss) (Table 6).

Table 6

Results of pairwise correlation analysis 1 - B-index and R & D expenditures in GDP

Enterprises	**Pearson's correlation coefficient**	**The level of statistical significance of the correlation coefficient (p-value)**
Large, profitable companies	-0,21	0,2
Small and medium profitable firms	-0,08	0,6
Large unprofitable companies	-0,16	0,3
Small and medium loss-making firms	-0,06	0,7

Thus, none of the correlation coefficients obtained showed the interdependence of tax

incentives' index for innovation activity (1-B-index) and R & D expenditures in GDP for both profitable and unprofitable enterprises.

Thus, the results of clustering have shown the presence of tax incentives' country models, a high level of tax subsidies for innovative activities for profitable enterprises is correlated with a high level of tax subsidies for innovative activities for unprofitable enterprises. The analysis shows that the use of the tax stimulus for innovation has no targeted approach - the greater the proportion of profitable and unprofitable enterprises, the higher the value of the tax incentive index, respectively, the reverse is true, the smaller the share of profitable and unprofitable enterprises, the lower the value of the index tax incentives. Therefore, the distribution of tax incentives for innovation can be considered the same for both profitable and unprofitable enterprises. This reserve should be considered underutilized.

5. Conclusions

The model of the national innovation system, adequate for the domestic economy presupposes the consideration of the previous development and the use of "windows of opportunities" with an emphasis on increasing the sustainability and innovation of the 4-th technological order. It is impossible to ensure the transition to a new technological order without significant efforts, without the development of an institutional environment at the meso level for the microsystem. There is no shortest path to development without mastering technology in the simple sense of social, technical and economic know-how embedded in people. Violation of this axiom can be observed in the context of import substitution policies, which for a time allowed many countries to achieve impressive growth rates by investing in mature plants and equipment without intensive training efforts.

In Russia, this model is declared for several years, just at the peak of crises, but its full potential has not been realized. A characteristic feature of the Russian economy is the high dependence on foreign technologies.

In Russia, in our opinion, the supply and incentive system continues to exist, which requires the transition to an interactive network with producers. It is about understanding the national innovation system as a social rather than a public institution (North & Wallis, 1994). It includes an environment in which innovation is stimulated and maintained; quality of relationships between suppliers, producers and users; system of education and training; various public and private organizations that promote technical change; laws, rules and even ideas and attitude to technologies and changes.

A separate modernization task is the restructuring of the economy's public sector, the activation of privatization, as well as the reform of the budget network, but taking into account the previous development model.

The issue of Russia's current development model and the participation of the state in it presuppose the solution of the system task of spreading the logic and practice of business models within the framework of a new technological order at all levels of management. Accelerating of growth or preventing a recession in a crisis, the sustainability of a request for innovation depends on the technological potential and the appropriate form of production organization. Formulating Russia's current model for managing the transition to a new technological structure in addition to the known solutions, we believe that this should be a modernized concept of sustainable economic development based on the involvement of endogenous factors and growth reserves. The materials of the article are of theoretical and practical importance for the development of models for the management of Russia's national innovation system in the context of transition to a new technological order and the improvement of state scientific and technical policy. Taking into account the obtained results of this research, it is possible to single out a number of scientific problems and promising directions that require further consideration: the deepening and expansion of certain provisions set forth in the paper related to the transition to a new technological order and Russia's role in the innovation economy.

Bibliographic references

Dyatlov, S. A. & Marianenko, V. P. (2012). System-network approach to the analysis of the national innovation system. *Economics of education, 2,* 180-186.

Dyatlov, S. A. (2011). Essence, principles and forms of state innovation policy. St. Petersburg: SPbSEEU.

Federal State of Statistics Service. (2018). Retrieved from: http://www.gks.ru

Freeman, C. (1995). The National System of Innovation in Historical Perspective. *Cambridge Journal of Economics, 19*(1), 5-24.

Lundvall, B. A. (1992). National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning. London: Pinter Publishers.

Metcalfe, J. S. (1995). The Economic Foundations of Technology Policy: Equilibrium and Evolutionary Perspectives. Oxford: Oxford University Press.

Nelson, R. (1993). National Innovation Systems. A Comparative Analysis. Oxford: Oxford University Press.

North, D. & Wallis, J. (1994). Integrating institutional change and technological change in economic history: a transaction cost approach. *Journal of Institutional and Theoretical Economics, 150*(4), 609-624.

OECD Data and Statistics on R&D Tax Incentives. (2018). Retrieved from: https://www.oecd.org/sti/RDTaxIncentives-Data-Statistics-Scoreboard.pdf

Patel, P. & Pavitt, K. (1994). The Nature and Economic Importance of National Innovation Systems. *STI Science Technology Industry Review, 14,* 353-364.

Science and Engineering Indicators. (2016). Chapter 4. Research and Development: National Trends and International Comparisons. Retrieved from: https://www.nsf.gov/statistics/2016/nsb20161/ up-loads/1/7/chapter-4.pdf.

Shinkevich, A. I., Kudryavtseva, S. S., Razdrokov, E. N., Lushchik, I. V., Vodolazhskaya, E. L., Ostanina, S. Sh. & Sharafutdinova, M. M. (2016). Method for Assessing of the Level of National Innovation Systems Openness from the Institutional Approach Perspective. *International Journal of Environmental and Science Education, 9,* 10505-10515.

---

1. Plekhanov Russian University of Economics, Moscow, Russia.
2. Kazan National Research Technological University, Kazan, Russia. *Contact e-mail: vodolazhskaya86@bk.ru*

Revista ESPACIOS. ISSN 0798 1015
Vol. 39 (Nº 22) Year 2018

[Índice]

[In case you find any errors on this site, please send e-mail to webmaster]