MODESTUM
OPEN ACCESS
Eurasian Journal of Analytical Chemistry
ISSN: 1306-3057
2017 12(7b):1399-1404
DOI: 10.12973/ejac.2017.00266a

Economic Sectors Development Evaluation in Innovations Triple-Helix Model

Alexey I. Shinkevich [1], Svetlana S. Kudryavtseva [1*], Michael N. Kozin [2], Denis A. Shirev [3], Irina A. Fedorova [4], Regina R. Kharisova [5], Vadim A. Zlobin [6]

[1] Kazan National Research Technological University, RUSSIA
[2] Gzhel State University, RUSSIA
[3] RUDN University (Peoples' Friendship University of Russia), RUSSIA
[4] Plekhanov Russian University of Economics, RUSSIA
[5] Kazan State University of Architecture and Engineering, RUSSIA
[6] Ulyanovsk State Agrarian University named after P.A. Stolypin, RUSSIA

Received 17 April 2017 ▪ Revised 14 September 2017 ▪ Accepted 26 September 2017

ABSTRACT

The paper relevance is related to the need to develop new approaches to the innovative economy management. The paper purpose is to develop innovative development analytical model in the economic sectors context based on open innovations' theoretical concepts study and systematization. The paper presents the characteristics for innovative activity system-forming elements, including the innovative infrastructure at the meso-level. An innovation triple helix model is suggested by economic activity types in national innovation systems on economic and mathematical simulation basis. The paper materials can be used to develop innovation activities forecasts of science, business and the state.

Keywords: innovations, economy sector, open innovation, innovations triple helix model, economic and innovative development

INTRODUCTION

The Study Relevance

In recent years, innovative models have become an integral part of the innovation strategies in a number of Russian regions and companies business models. Innovations provide a broader basis for new ideas and technologies, become a strategic tool for exploring new growth opportunities and provide greater flexibility, self-organization and sensitivity to market changes. At the economic development present stage, the science, innovation and new technologies contribution is very significant. Innovative activity implies a complex of scientific, technological, organizational, financial and commercial activities. Innovative and new technologies provide not only the gross regional product growth, but also its qualitative, progressive change.

Innovations are formed within the framework of innovative networks based on the innovation development triple helical model principles, combining the efforts and interests of business, government, science, using the appropriate institutional conditions and innovative infrastructure, organizing innovative interaction to create innovative goods that meet market demands [1].

Particularly topical one in these conditions is questions of economic entities' innovative activity's analysis and accounting. In the Russian Federation, the technique for innovative activity accounting is adapted to the Oslo Guidelines - recommendations for data collection and analysis on innovation (joint development of the

* **Correspondence:** Alexey I. Shinkevich, *Department of Logistics and Management, Kazan National Research Technological University, Kazan, Russia.*
dlogscm@kstu.ru

Organization for Economic Cooperation and Development of the Statistical Office of the European Communities and Eurostat). The Oslo Guide pushes the scope for measuring innovation in two important ways. First, more attention is paid in the innovation process to the relations role with other enterprises and organizations. Secondly, the innovation's importance in less science-intensive sectors, such as services and low-tech industries is recognized. Accordingly, for a service sector better description, some technique aspects (the definitions of innovations and the activities that correspond to them) have been modified.

Many scientists have been involved in the study of national innovation systems: W. Kingston [2], P. Patel & K. Pavitt [3], S. Metcalfe [4], Y. V. Yakovec [5], B. A. Lundvall, P. Intaracumnerd & J. Vang [6] and others.

On the other hand, the innovative development's deterrent factors in the Russian innovation sphere are: the research's high cost, the greater risks, the imperfection of the regulatory framework governing innovation financing, which significantly reduces incentives for innovation. The following authors devoted their works to the investigation of this problem: L. Leydesdorff & Van den Besselaar [7], H. Etzkowitz [8], J. West & S. Gallagher [9], K. Kristensen & E. Skott [10], A. I. Shinkevich et al. [11, 12], A. I. Shinkevich & R. P. Ivanova [13] and others.

At the same time, despite many attempts, the economic sectors development assessment problem taking into account the interests of science, business and the state is not solved.

METHODOLOGICAL FRAMEWORK

The Study Methods

During the study, the following methods were used: analysis, synthesis, system analysis, the facts systematization and generalization, method of comparison, description, analogies, economic and mathematical simulation.

The Study Theoretical Basis

The study theoretical basis is formed by fundamental and applied works of foreign and domestic scientists exploring the categories "innovative economy", "open innovations", "innovations triple helical model" engaged in management tools development for innovative and modern development of modern economic systems.

The Study Stages

The study was conducted in three stages:

1) systematization of the main theoretical provisions of innovation triple-helix model;
2) innovative infrastructure's role analysis in economic development;
3) innovations' triple helix model simulation in the context of economy sectors and their development level's assessment.

RESULTS

The Systematization of Main Theoretical Provisions of Innovation Triple-helix Model

One of the significant problems of Russia's national innovation system development based on the concept of open innovations is the gap between the scientific and business sector, which at the moment has been poorly overcome through the creation of an innovative infrastructure. It should be noted that in most cases, the Russian innovation system existing elements (HEI, research institutes, project centers, etc.) do not have full information about the potential market and the business companies' interests in a particular area on available scientific developments, which is a serious obstacle to the open innovations development.

This problem's solution is seen on the innovative development basis through the dynamics of relations between science, industry and the state. The triple-helix model (Triple Helix Model of Collaboration) is based on the university perspective role as the leader of relations with enterprises and the government and it is organized in accordance with the principles of crossing three sets of relations between the state, business and science. Cooperation's new technologies in innovation field between business, science (universities as innovative communication centers) and the state make it possible to avoid institutional traps (the situation of preserving a closed institutional trajectory which is ineffective from the standpoint of innovative development's sustainability and optimal for two participants - a local optimum) which are natural for innovative development's double-helix models, which acquire a negative character from the standpoint of social utility [14]. This cooperation model contributes to the emergence new forms interaction between industrial consortia, universities and government

institutions, including in the form of scientific - educational - industrial clusters. The existing experience generalization shows that controlled cooperation within the model contributes to overcoming institutional traps, providing a balance between knowledge, positive externalities of innovation for society and for the entrepreneur. Trilateral cooperation activates partners to solve scientific, industrial, personnel problems, as well as national interests through funded educational and research-and-production programs, thereby using human and material resources to create solutions while ensuring the new knowledge generation and processes for the innovations commercialization. In this matter, we hold the view of H. Etzkowitz that "the triple helix grows out of the space of knowledge, consensus and innovation at the level of economic systems" [15]. The knowledge space creates building blocks for innovative growth in the form of a "critical mass", the concentration of scientific and research resources on a particular topic that can generate technological ideas. These resources, having reached a certain level, can influence the innovative development of national systems. Innovative space means the creation, principally, new organizations or the adaptation of old ones in order to fill the gaps in the development of economic systems.

In global competition context, which takes place not only at the national level, but also at the regional level, the emphasis should not be done on creating companies, but on forming a cluster of small innovative enterprises as the fourth institution of this level in the triple helix.

Innovative Infrastructure's Role Analysis in Economic Development

The innovative activity effectiveness largely depends on the innovative infrastructure's state, which is a complex of interrelated structures that serve and ensure the innovative activities implementation.

According to the strategy of scientific and technical development in the Russian Federation, the most significant contribution to the state priorities implementation will be done by such areas as innovative economy and innovation ecosystem. The new efficient economy formation based on knowledge, the development of innovative activities, the economy high-tech sectors, small entrepreneurship as the main driving force for mass innovation are priority areas of innovation policy. The tool of this implementation is a cluster approach to innovation.

A balanced system of public, private and public-private institutions ensures the sustainable development of competitive clusters, entrepreneurship (small and medium business), internal territorial development and external integration.

The cluster approach assumes:

- the innovative clusters creation in conjunction with existing industrial (mainly industrial) clusters; the innovative potential of existing industrial clusters will stimulate the innovative clusters development;
- formation of integrated technological chains that ensure the increase in the share of added value produced in the republic;
- transition from macroeconomic regulation to industrial, technological and cluster policies, using active methods of state intervention in economic development;
- the state assistance in promoting domestic goods in the domestic and foreign markets;
- interregional integration in the process of cluster policy development and the cross-border clusters formation;
- state policy of links development stimulation between universities, research institutes and business and attracting large foreign firms to the centers of knowledge and entrepreneurship;
- formation of competitiveness and high technologies centers, technopolises on the basis and around universities;
- "pulling up" of retarded territories through the clusters formation based on innovative technologies.

As the strategy of the Russian Federation scientific and technical development is defined the following key tasks of innovation policy:

- facilitating the technologies transfer
- stimulating the advanced technologies use applied around the world for less than three years, or technologies that do not exceed 15% in the relevant industry, as well as supporting the commercialization of scientific developments;
- the lean manufacturing principles' introduction stimulation at small and medium-sized enterprises
- a youth innovative techno park creation;
- the innovative entrepreneurship's stimulation; patent holders' and innovative projects' register creation with a view to further their promotion;
- support for business entities innovative projects implementation;
- formation of the clusters key innovations' list; the definition of the clusters innovation projects' portfolio;

– provision continuous interaction within the framework of the "triple helix" business– science -power within the clusters.

Innovations Triple Helix Model Simulation in the Context of Economy Sectors and their Development Level Assessment

Overcoming the system innovative development's limits is expedient to consider in terms of the theory (model) of the Triple Helix. The innovative development model by the "Triple Helix" includes three main elements:

1. the strengthening of universities role in the interaction with industry and government is characteristic of an economy based on scientific knowledge;
2. the economic system three components (University, Business, State) are striving for cooperation, while the innovative component is derived from this interaction, and not at the initiative of the state;
3. in addition to traditional functions, the economic system's each components "partially assumes the role of another."

Thus, the Triple Helix model is adequate to ensure sustainable development as a result of the three spheres balance (business, science, the state).

To simulate the Russian Federation innovation activity according to the "triple helix" model, the factor and component analysis using seems to be appropriate one.

The initial data for the analysis were indicators by types of economic activity according to the form of federal statistical observation No. 4-innovation "Information on the organization's innovation activity" for 2015.

At the analysis preliminary stage, in order to avoid the multi-co-linearity effect, those that had a high correlation dependence (whose correlation coefficient exceeded 0.7 in modules) were excluded from the selected variables. Thus, in the Triple Helix construction for the Russian Federation innovation activity, the following variables reflecting the level of integration of science, business and the state participated:

X - specific weight of innovative goods, works, services in the total volume of shipped goods, works, services,%;

X_1 – share of own funds in expenses for technological innovations, %;

X_2 – the federal budget share in technological innovation's costs, %;

X_3 – the share of RF subjects and municipal budgets funds in costs for technological innovations, %;

X_4 – the number of organizations that are part of organizations group (association (union), holding, consortium (simple partnership agreement, joint activity agreement));

X_5 – the number of organizations that have completed technological innovations during the past three years, mainly by other organizations;

X_6 –the number of organizations that have completed technological innovations during the last three years by their own organization jointly with other organizations;

X_7 – the number of organizations that have completed technological innovations during the last three years by their own organization by changing or modifying products developed by another organization;

X_8 – the number of organizations that have completed technological innovation during the past three years, mainly by their own organization;

X_9 –- the share of organizations that carried out technological innovation, which used the services of other organizations to research and develop new products, services and methods of their production (transfer), new production processes, %.

At the analysis first stage, the principal component method was used to isolate the number of factors. The generalized factors dedicated by the main components method, each of which contains the several variables properties at once, allow, as a result of their interpretation, to explain the regional innovation systems' development trends.

At the analysis this stage, the main components were determined by the Kaiser criterion. The results of the main components allocation are shown in **Table 1**.

As a result of multidimensional statistical analysis, 10 initial indicators were divided into 3 groups of integral factors (the method of the Varimax components' rotation was used), whose economic interpretation shows their qualitative and quantitative contribution to the Russian Federation innovation economy formation in the corresponding component (science, business, the state) (**Table 2**).

Table 1. Results of the selected main components according to the Kaiser criterion

	Eigenvalues	Percentage of total variance	Accumulated eigenvalues	Accumulated percentage of total variance
1	6,4	63,8	6,4	63,8
2	1,9	18,7	8,3	82,5
3	1,1	10,6	9,3	93,1
4	0,4	4,4	9,8	97,5
5	0,1	1,5	9,9	99,0
6	0,1	0,6	10,0	99,6
7	0,0	0,2	10,0	99,9
8	0,0	0,1	10,0	100,0
9	0,0	0,0	10,0	100,0
10	0,0	0,0	10,0	100,0

Table 2. Main results of factor analysis using the principal component method

Variables	Factor 1	Factor 2	Factor 3
	Business	The state	The science
X - specific weight of innovative goods, works, services in the total volume of shipped goods, works, services, %	0,98		
X_1 – the share of own funds in the costs on technological innovation, %	0,85		
X_6 – the number of organizations that have completed technological innovation during the last three years by their own organization jointly with other organizations	0,91		
X_7 – the number of organizations that have completed technological innovation during the last three years by their own organization by changing or modifying products developed by another organization	0,85		
X_8 – the number of organizations that have completed technological innovation during the past three years, mainly by their own organization	0,98		
X_5 – the number of organizations that have completed technological innovation during the past three years, mainly by other organizations		0,96	
X_3 – the share of RF subjects' and municipal budgets' funds in the costs on technological innovation, %		-0,92	
X_2 – the share of federal budget funds in the costs on technological innovation		-0,76	
X_4 – the number of organizations that are part of organizations group (association (union), holding, consortium (simple partnership agreement, joint activity agreement))			0,95
X_9 – the share of organizations that carried out technological innovations, which used the services of other organizations to research and develop new products, services and methods of their production (transfer), new production processes, %			-0,89
The total variance	*4,78*	*3,37*	*1,15*
Share of total variance	*0,47*	*0,33*	*0,11*

DISCUSSIONS AND CONCLUSION

The first integral factor of the Triple Helix model is economically interpreted as "Business" (the share of the factor contributing to the formation of the innovation economy is 47%), the second factor is "State" (33%), the third factor is "Science" (11%).

As a result, the identified factors' total contribution in the Triple Helix model of the Russian Federation innovative economy was 91%.

In the component "Business", the following high-tech economic activities had the greatest burden on the resulting factor: "Production of electronic computers and other equipment for information processing", "Production of ships, aircraft and space vehicles and other vehicles", "Production of aircraft, including space vehicles", "Production of office equipment and computers", "Production of aircraft, including the space vehicles."

In the component "State" the greatest contribution was provided by: "Manufacture of clothing; fur dressing and dyeing", "Production of electronic components, equipment for radio, television and communications", "Production of medical products; instruments for measuring, monitoring, control and testing; optical instruments, photographic and cinematographic equipment; watches", "Ship building and repair", "Scientific research and developments in the field of natural and technical sciences", "Geological, exploration, geophysical and geochemical works in the field of subsoil and reproduction of mineral resources".

In the "Science" component, the following activities were of greatest importance: "Mining", "Production of machinery and equipment (without weapons and ammunition production)", "Production of parts and accessories for cars and their engines", "Research and development" "Activities in the field of architecture; engineering and technical design; geological-prospecting and geophysical works; geodesic and cartographic activity", "Chemical production ".

The previous researches, which were made by J. West & S. Gallagher [9], G. Chesbrough [16], K. Kristensen & E. Skott [10], M. Torkkeli, K. Kok & I. Savickaya [17], A. I. Shinkevich, S. S. Kudryavtseva, G. G. Ivanov, O. N. Korotun, I. I. Ishmuradova, R. R. Gainullina R. R. & S. Sh. Ostanina [12] are devoted to simulation of innovative systems.

However, the scientific works devoted to the integration processes effectiveness assessment in the innovation sphere are of a debatable nature.

For management meso-level, the simulation technique Triple Helix is proposed, which allows you to identify key economic activities for each component of the model - science, business, government. The obtained results represent theoretical and practical significance for the federal and regional innovative development programs development and implementation, as well as in developing a strategy for state innovation policy.

REFERENCES

1. Glazyev, S. Yu. (2017). The crisis and the window of opportunity. *Special Forces of Russia, 8*(250). Direct access: http://www.specnaz.ru/articles/191/1/1681.htm
2. Kingston, W. (1984). *The Political Economy of Innovation (Studies in Industrial Organization)*. London: Springer.
3. Patel, P., & Pavitt, K. (1994). *The Nature and Economic Importance of National Innovation Systems*. Paris: OECD.
4. Metcalfe, S. (1995). *The Economic Foundations of Technology Policy: Equilibrium and Evolutionary Perspectives.* Blackwell Publishers: Cambridge.
5. Yakovec, Y. V. (2004). *Epochal innovations of the XXI century*. Moscow: Economics.
6. Lundvall, B. A., Intaracumnerd, P., & Vang, J. (2006). *Asia'a innovation system in transition*. New York: Edward Elgar.
7. Leydesdorff, L., & Van den Besselaar (1994). *Evolutionary Economics and Chaos Theory: New Directions in*. New York: Springer.
8. Etzkowitz, H. (2002). Incubation of incubators: innovation as a triple helix of university-industrygovernment networks. *Science and Public Policy, 29*(2), 115-128.
9. West, J., & Gallagher, S. (2006). Challenges of open innovation: the paradox of firm investment in open-source software. *R&D Management, 36*(3), 319-331.
10. Kristensen, K., & Skott, E. (2008). *What is the next? Theory of innovation as a tool for the prediction of industry changes.* Moscow: Alpina business book.
11. 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.
12. Shinkevich, A. I., Kudryavtseva, S. S., Ivanov, G. G., Korotun, O. N., Ishmuradova, I. I., Gainullina, R. R., & Ostanina, S. Sh. (2017). Research and Technological Capacity of Russia as an Indicator of Knowledge Economy Growth. *International Journal of Advanced Biotechnology and Research, 1,* 156-163.
13. Shinkevich, A. I., & Ivanova, R. P. (2017). Estimation Technique of Integration Processes in Innovation. *Eurasian Journal of Analytical Chemistry, 12,* 509-520.
14. Zhou, C. (2014). Government-pulled triple helix model for regional innovation in China. *Conference on The Triple Helix Paradigm for Development*, 17-19 Sep., Bristol.
15. Etzkowitz, H. (2011). Triple helix. Universities - enterprises - the state. Innovation in action. *Publishing house of Tomsk state university of Management Systems and radio electronics, 4*, 10-18.
16. Chesbrough, H. (2007). *Open innovation: creating profitable technologies*. Moscow: Generation.
17. Torkkeli, M., Kok, K., & Savickaya, I. (2009). Innovation management in Russia and concept of «Open innovation»: the first results of the study. *Innovations, 11,* 89-95.