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Assessment of Performance Indicators of Innovative Activity of Subjects of The Russian Arctic Based on The Triple Helix Model

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Abstract. The article includes the econometric analysis of the key performance indicators of innovative activity, patenting activity, the production of innovative products and state support for innovative activities, state capacity and the implementation of cluster programs in the constituent entities of the Arctic zone of the Russian Federation. The results of the comparative evaluation of key indicators of scientific and educational complex, business and government in the Arctic regions and the rating of the composite index level of innovative development of the subjects is made on the basis of the concept of the Triple Helix Model. It is shown that the key indicators of innovation activity selected for analysis and evaluation reflect the real picture of the current situation of the state innovative development in the Arctic zone of Russia. On the basis of the analysis, it is possible to formulate certain scientific and practical recommendations for the adoption of various management decisions. The above methodology will improve the level and quality of strategic planning and management of the innovative economies in the Arctic Territory.

1. Introduction

The effectiveness of the implementation of innovation policies largely depends on the system of performance indicators, which are the basis for defining innovation activity and monitoring of its development. In this regard, one of the major tasks in this direction is the creation of a set of indicators for assessing the level of innovation development of the region (IDR) considering the necessary capacity and resources. However, there are no universal approaches to the evaluation of innovative level of the regions in managerial practice; that prevents an adequate assessment of the impact of the state innovation policy at federal and regional level, as well as the effectiveness of spending of budgetary funds [1]. There are different views and opinions of Russian researchers on this issue. One of the examples of federal programs that support innovation development of the regions is cluster development. There are about 450 clusters and cluster formations of different types and directions on the territory of the Russian Federation. 25 of them were created in 2012 with the support of state bodies of federal and regional significance [2-3]. In case of successful realization of the pilot program of cluster support, measures and developed tools will be applied to other in-demand regional clusters. In practice, the gaps in assessing the effectiveness of the implementation of the cluster program (namely innovative potential) were identified, and that greatly slowed the program development. The analysis of the literature showed that the main problem is the lack of unified methodological

development on the choice of indicators characterizing innovative capacity. Evaluation of innovation capacity in the region are mostly based on expert survey data, carrying subjectivity indicators, which causes inaccuracies in the results of the evaluation [4].

On the other hand, in a study with a specific purpose of a specific object, even with the use of simple tools and limited information, one can obtain meaningful results, useful for elaboration of elements of economic policy [5]. According to the authors of the work [6], the use of a considerable number of indicators makes the ratings too difficult to verify and too complicated to use as a tool for strategic management. Their simplification and alignment with the target indicators of regional strategies of "smart" specialization is required.

2. Key performance indicators of innovation activity

The regions of the Arctic zone of the Russian Federation (AZRF) have significant innovative capacity, which has not yet been realized. Its effective use involves the concentration of resources on the maintenance of a relatively high level of education, the development of a network of universities, academic institutions and other state public research organizations, and the formation of a new scientific and technological capacity. This should facilitate the creation of a knowledge generation system, the stimulation of business activity, and eventually the organization of the production of goods and services competitive in the global market [7].

To conduct a rapid assessment of the level of innovation development in the region of the Arctic zone the Russian Federation, one can use a simplified system of key performance indicators, characterizing the effectiveness of innovation activity and scientific-educational complex (SEC), business and government (triad).

The Triple Helix concept was proposed in the beginning of the twenty-first century by Professor Henry Etzkowitz, Newcastle University, and Professor Loet Leydesdorff, the University of Amsterdam. It justifies the need for and the usefulness of close cooperation of universities, the state and the business community for a successful implementation of innovative plans to modernize economies [8]. Thus, universities take on the role of the business community, creating new companies on the basis of university infrastructure. The government forms the functions of the business community, providing capital to start-ups (including university-based ones). Business community takes the responsibilities of educational institutions by developing education and research in their own or shared with universities laboratories, sometimes on the same high level as universities. Such cooperation promotes the natural formation of innovation dynamics and creative renovation that occurs in each of the three institutional spheres: academic, industrial, and governmental. The Triple Helix concept gives the key role to science and new entrepreneurial role of universities. The educational institutions become the main driving force behind the formation of the innovation ecosystem, which is a guarantee the development of the clustering in the state economy [9].

Table 1. Classification of knowledge-based (innovative) enterprises taking into consideration the Triple Helix concept of innovation.

Organizational forms of knowledge-based enterprises	The name of the knowledge-based enterprise in the knowledge-based business	Sphere of activity (initial) of knowledge-based enterprises
Small innovation business	Spin-in, spin-out, spin-off	University (scientific) sphere
Medium and large innovation business	Hi-Tech TNCs engaged in foreign direct investment (active and passive) of high technological level	State
	High-tech enterprises of the military-industrial defense sector of the state	Business

Within the Triple Helix concept scientific-educational complex acts as the generator of knowledge and innovative ideas, the owner of the intellectual property, commercialization of which is in the interest of business (profit) on the one hand, and state (innovation support policy) on the other.

Therefore, the ultimate practical results of the SEC activities should be developed innovations that meet demand of innovation business. In this regard, the key (basic) indicator of the impact of the SEC research and development is the number of Russian patents granted on inventions, useful models and industrial designs (labeled I_1). The patent statistics is a unique source of the analysis of the processes associated with technological advances, and, therefore, it should be one of the possible variants of an indicator system in the field of science and innovations in Russian regions [10].

The effectiveness of the innovative activity of the production process (business) is mainly determined by the statistical indicator "the share of innovative products, works, services in the total volume of shipped goods, performed work and services" (I_2), and the effectiveness of state support for innovation activity is "the share of budgetary expenditures on scientific research in expenditures of the consolidated budget of the subject of the Russian Federation" (I_3)

3. Evaluation methodology

Using the considered key performance indicators of the key participants of the innovation process (scientific-educational complex (SEC) – I_1, business I_2 and the state – I_3 (triad)), one can carry out quantitative assessment of the consolidated integral index of the level of the IDR of AZRF based on the Triple Helix concept [11-13]. As noted in the work [14], the concrete application of the Triple Helix model in quantitative estimates was not entirely obvious, primarily because of the complexity of simulated relationships. If in physical environments the measurement of physical quantities does not cause fundamental difficulties, the measurements in complex socio-economic environments are characterized by significant difficulties. Therefore, the actual material - numerical data and their statistical analysis based on all three components of the Triple Helix is of great importance.

Graphically the triad relationship can be represented as a three-dimensional geometric representation of the components of a rectangular parallelepiped. The consolidated integral index of the IDR is determined by the known mathematical formula for determining the radius vector of the three constituents of the rectangular parallelepiped in the form of the following expression [15-17]:

$$\sqrt{I_1^2 + I_2^2 + I_3^2} \qquad (1)$$

where

I_1 *is* the number of Russian patents granted for inventions, useful models and industrial designs per workforce (N, workforce), units;

I_2 – the share of innovative goods, works and services in the total volume of shipped goods, performed works, and services, %;

I_3 – the share of budget expenditures on scientific research in the expenditures of the consolidated budget of the subject of the Russian Federation, %.

It should be noted that the listed names of the indicators are based on the system of indicators of the Russian regional innovation index of the National Research University Higher School of Economics, according to which I_1 is a key indicator of the effectiveness of scientific research and development of the scientific and educational complex. Accordingly, I_2 – effectiveness of business innovation activity, I_3 – state budgetary expenses for science and innovation. Official statistics of Federal State Statistics Service, Rospatent and Federal Treasury are used for calculations.

4. The calculation results

The results of the averaged key indicators of innovation activity of the subjects of the Arctic Zone of the Russian Federation (AZRF) are presented in table 1.

Table 2. The averaged indicator values in subjects of AZRF for the period 2010-2016.

Subjects of AZRF	N, thous. people	I_{1units}	$I_{2,\%}$	$I_{3,\%}$
the Arkhangelsk Region	606.2	0.120	9.4	0.010
the Krasnoyarsk Region	1514.6	0.324	3.2	0.016
the Murmansk Region	465,1	0.118	1.2	0.015
Nenets Autonomous Okrug	22.9	0.025	0.0	0.004
the Komi Republic	489.3	0.083	3.2	0.019
the Republic Of Sakha (Yakutia)	497.8	0.161	1.5	0.159
Chukotka Autonomous Okrug	32.8	0.000	0.6	0.003
Yamalo-Nenets Autonomous Okrug	322.8	0.099	0.6	0.108

The table shows that the patenting activity (I_1) during the considered period is at a relatively high level in the Krasnoyarsk region (0.325) and the Republic of Sakha (Yakutia) (0.16).

According to the business indicator value (I_2), the leading position well ahead of the other subjects occupies the Arkhangelsk region (9.4%), the next places are occupied by the Krasnoyarsk region (3.2%) and the Komi Republic (3.2 %).

According to the share of budget expenses on scientific research in the volume of consolidated budget of a subject of the Russian Arctic (I_3) the first two places are occupied by the Republic of Sakha (Yakutia) (0.159%) and Yamalo-Nenets Autonomous Okrug (0.108%.). It is logical that the main contribution to the overall innovative development of the subject of the Russian Arctic make the above-mentioned leading regions, as evidenced by the following histogram (Fig. 1).

As it can be seen from the figure, the first three places in the rating of innovative development are occupied by the Republic of Sakha (Yakutia), the Arkhangelsk region and the Krasnoyarsk region respectively. The leadership of the Republic of Sakha (Yakutia) is mainly due to the high indicator of "the share of budget expenditure on scientific research in the expenditures of the consolidated budget of a constituent entity of the Russian Federation", the Arkhangelsk region has a high indicator of "the share of innovative goods, works, services in total volume of shipped goods, performed works, services" and in Krasnoyarsk region there is a high level of the indicator of "the number of Russian patents granted for inventions, useful models and industrial designs". In general, this could be explained by the relatively high innovative activity of predominantly resource-oriented organizations in the industrial sector of the Far North regions [18].
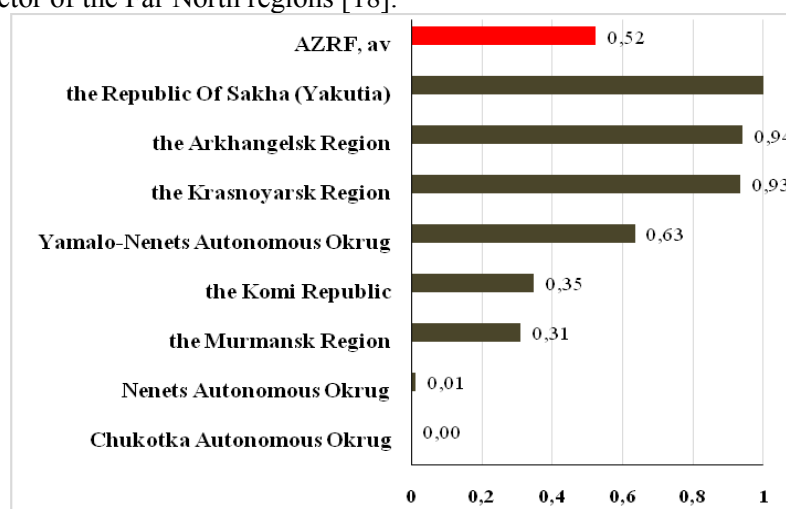
Figure 1. The distribution of the consolidated index of the level of innovative development of subjects of AZRF.

5. Conclusion

In general, the comparative analysis of provided results shows that selected for the analysis and evaluation key indicators of innovative activity adequately reflect the realistic picture of the current state of the innovative development of the subjects of AZRF; based on these results, it is possible to formulate certain scientific and practical recommendations for the adoption of various managerial decisions. The described technique will improve the level and quality of strategic planning and management of innovative economy development of the regions of the Arctic territory.

The results of the work can be useful to the executive bodies of state authorities, business structures, scientific and educational organizations of the Arctic regions in the process of analysis and prediction of the formation and development of an innovative system, strategies and programs of their socio-economic development.

6. References

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