

Particularities of forming regional innovation systems in the national economic space

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Abstract. A modern economy requires building effective innovation systems. The formation of national and regional innovation systems should be closely linked. Therefore, it is necessary to deeply understand and take into account the peculiarities of the formation of regional systems in the national economic space. This is especially true for the Russian Federation due to the specificity of the administrative system and existence of significant disparities between the regions. Regional innovation systems are actively being developed, just as in more developed regions and less developed countries. Despite the country's internal conditions, this should be a unified process. Therefore, it is particularly important for the issues of interregional cooperation to eliminate asymmetries and synchronise changes.

1 Introduction

The tasks of developing scientific and technological advances and generating innovation is critical in the modern economy. This requires creating favourable conditions and providing comprehensive support for innovative activities at all levels of the economy.

Modern ideas about the nature of innovation and the innovation process are dominated by the postulate regarding the need for a systematic approach to their security, as embodied in the concept of innovation systems in conditions green economy [1]. The regional innovation system (RIS) has become one of the most important type of such systems. In recent years, there has been increasing attention to the formation of such systems due to the recognition specificity and regions' expanding role in the innovative development of the economy.

In the Russian Federation (RF) a transition to innovative type of economy has been declared at the highest level. This is impossible without creating effective national and regional innovation systems in conditions green economy. Such a system, corresponding to

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modern requirements and the new structure of the national economic space, has taken on a new institutional format in order to support innovation at the regional level, given the specificity of each of them.

The formation of RIS in Russia has specific objective features due to the structure of the national economic space, the large number of regions (subjects of the Federation), and their significant differences. Each region is involved in the process of building an innovative economy and works closely with Central agencies, other regions and actors on the national market. This raises the problem of understanding the formation of RIS within the national economic space. A comprehensive analysis of the use of abstract-logical, structural and institutional methods, as well as statistical methods, are required to resolve this problem. Decision making also requires data, the source of which is the Federal State Statistics Service.

2 Methodology

The theoretical basis for understanding and developing RIS is based on the concept of a national innovation system (NIS), the foundations of which were developed by C. Freeman, B.-A. Lundvall and R. Nelson. C. Freeman emphasised that MDM brings together economic agents, and includes a set of social institutions, participating in the creation of new knowledge and its transformation into new technologies, products and services. C. Freeman considered the network of institutions in the public and private sectors of the economy as being within national borders, which initiate, create, modify, and contribute to the diffusion of innovation [1]. B.-A. Lundvall defines the NIS as a system of organisations and institutions that are included in the search process and innovation (research and technological institutes, universities, and the R&D divisions of private companies). Broadly interpreted, B.-A. Lundvall considers all aspects of the economic structure and the institutional system that affect the search process, research and innovation, covering production, marketing, finance, and special support measures [2]. R. Nelson also considers a broad set of institutional factors that affect innovative activity. He presents innovation as a complex process, involving various actors (firms, producers of new knowledge, technological and research centres), who are connected by many relationships, which ultimately makes up the NIS [3].

In the future, based on the concept of the NIS was used to identify several types of innovation systems, including regional, which has acquired a special significance. Identification of RIS began shortly after the emergence of the concept of NIS. This is confirmed by the work of Ph. Cooke [4], which announced a new approach to regional innovation. Exploring best practices in the field of regional innovation, learning and interaction, the author came to the conclusion about the appropriateness of RIS as a more advanced institutional framework. In the future Ph. Cooke developed the concept of RIS, for example, propose to consider it as a sub-national environment for innovation, including the issues of building infrastructure, universities and small business, the development of production. [5,6].

The concept of RIS covered almost a large range of conditions necessary for the emergence of innovations and their implementation in the economy. RIS was not only a theoretical model but a practical tool that became widely used in regional politics. This resulted in the evolutionary aspect, which made it possible to improve the RIS structure and model for RIS and to expand their influence (E. Uyarra [7]; G. Gunnarsson and T. Wallin [8]).

The creation of the RIS means advancing to a new level of development. H. Etzkowitz and M. Klofsten consider the emergence of the "innovation region" with new structural features that distinguish it from the industrial phase (development, production base, types of clusters, etc.) [9]. This allows us to understand not only the functional effect of a RIS, but its role in the regional economy and various internal processes. H. Etzkowitz and M. Klofsten

also note that a RIS creates a "triple helix" as a form of interaction between the state, companies and universities.

D. Doloreux and S. Parto represent the region as a place for innovation from the point of view of economic organisation. The result of innovation occurs in the institutional, political and social contexts existing in the region and beyond, and is associated with social relations. The authors identify geographical concentration and proximity as a factor of innovation, but also pay attention to the context of the scale of innovation and scope of the region [10].

A RIS is a territorial entity, limited to the boundaries of the region, regional policies and institutions. The spatial approach makes this concept the new basis for analysing economic geography and regional development. It concerns the factor of proximity in generating new knowledge, and implementing and disseminating innovation within the region and beyond. A RIS is presented as a space for interaction between various actors, for the mobility of resources, for building various structures (e.g., B. Asheim, M. Gertler [11,12], and the emergence of special knowledge and innovation networks (W. Powell, S. Glodal [13], Th. Brenner, U. Cantner, D. Fornahl, M. Fromhold-Eisebith, and C. Werker [14]). All this determines the functional organisation of the innovative sector in the region.

Despite the development of the concept and its practical application, the formation and functioning of a RIS in the national economic space has not been awarded sufficient attention. This is especially true for Russia – a country with a federal structure, a large territorial scope, and regions with significant and varied differences.

3 Results

Russia is of great interest when studying processes of building national and regional innovation systems. **You need to make a few comments on this issue.**

A RIS cannot be created in isolation, as this would be insufficient to ensure the full range of conditions and factors, and the regional authorities do not have access to the complete set of necessary tools to support innovation. Therefore, the RIS is formed within the framework of the NIS, localising various factors innovation factors (a set of resources, economic structures, organisations, social institutions), complementing and building them in compliance with regional specifics.

The NIS creates the general conditions for innovation, embracing entrepreneurship, competition, infrastructure, science and education, and creates the external (material, resource, institutional, informational, social, political) environment for each RIS. At the same time, the NIS may not ensure the processes at lower levels and requires additional structures to support innovation that has been achieved by specific subjects. This leads to the importance of RIS for the functionality of the NIS, acting as a spatial element.

Considering the national economic space, this should cover not only elements of the NIS, but also other aspects regarding the functioning of the national market and innovation policies, which significantly affect the regions.

A region is a holistic territorial and economic unit, which is part of the country's economic space. It not only represents certain autonomy in administration, but is also connects the micro and the macro level of the economy. At the regional level, this includes major parts of production cycles, value chains and clusters, and also relations between science and industry emerge. Owing to proximity there is a concentration of resources and interaction between subjects, involving the transfer of knowledge and innovation. Of course, regions have significant specificity in the direction and scale of innovation and, consequently, the formation of RIS. This is due to both natural features (natural and climatic conditions; geographical location; economic structure; market capacity; demographic characteristics) and regional factors (the emergence of new knowledge; intensity of competition; consumer demand; regional innovation policy; the "learning effect"; the quality of social institutions

and their changes; regional issues; orientation of entrepreneurs operating in the region). Innovation can be created for regional, national and global markets. Their scale depends on the innovation potential of a region, as well as accumulated resources and capabilities to create and transform new knowledge. A RIS continuously interacts with both the national and global space, absorbing knowledge, ideas and resources. Cases when a RIS is oriented only toward a regional domestic market should be considered as special.

A RIS needs to understand a few aspects:

- functional, i.e. from the position of its functions in providing a purposeful and regular support for innovation and supporting innovation processes;
- institutional, i.e. as a set of formal and informal institutions of a different nature, ensuring relationships and processes in a region's innovation sector;
- spatial, i.e. as education, which is within a region's boundaries creates the conditions for interaction between actors and implementing innovative activities;
- subject, i.e. as a union of different actors (firms, research institutes, universities, NGOs, infrastructure companies, investors and consumers); the emergence of sustainable relationships between the subjects, whose loyalty is pre-oriented towards relations within the region, is one of the main essential characteristics of RIS.

Within the national economic space, the structure and function of RIS is influenced by a system of a higher order:

- General institutional system of the national economy;
- NIS (special laws, public policies and innovation support, innovation infrastructure);
- national market (including markets for goods and services, labour, knowledge);
- interregional cooperation in R & D and production.

The construction of the institutional framework of a RIS takes place within the overall institutional system to enhance a region's capability for innovation and development. At the same time, at the regional level, national level institutions of the RIS can significantly be supplemented (as a result, the NIS can have quite a diverse institutional landscape). This is partly typical for the Russian Federation, as most regions have adopted their own strategies and programs for innovative development, having their own characteristics. At the same time, in Russia, the NIS significantly affects all the main types of institutional elements of a RIS: constitutive, regulatory institutions, cooperation institutions, and exchange institutions. Informal institutions at the regional level are great, but mostly of local importance for innovation.

One challenging issue is the correlation between national and regional priorities of technological development. The NIS of Russia is characterised by a high level of public participation and regulatory influence and a leading role at a major research and innovation centre. There are priorities concerning technological development, which are enshrined at the national level, and RIS in general are designed to ensure progress of the region within the framework of these national trajectories, which are objective. At the same time, building their strategy and coordinating with national policy, the regions may have additional priorities that are dictated by historically natural conditions, areas of expertise, as well as their own goals.

The functions of the NIS and RIS in Russia are gradually separated and complement each other. The NIS performs a leading function in regulating and supporting innovation, developing science, education, and major centres of innovation infrastructure. The functions of the RIS in Russia are gradually expanding, covering: 1) General economics (the development of innovative entrepreneurship; redistribution of investment; management of innovative activities); 2) functions for organising innovation processes (creating legal and institutional mechanisms; support for sustainable forms of interaction between actors); 3) functions to support innovation activities (implementing various forms of support, established by law); 4) functions for commercialising innovation (creating new markets and channels for commercialising innovation; supporting enterprises when entering the market);

5) functions interact with the external environment (attracting scientists and entrepreneurs to the region, as well as investment capital from the national space and international environment, supporting the absorption of knowledge and collaboration).

An analysis suggests that, during the formation of RIS, at least three basic features under the RIS are manifested: first, implication is constant communication with the national system and its separate changing elements; secondly, implementation of the adoption and implementation of the principles, objectives, priorities and measures established at national level; thirdly, adaptation, which entails the adaptation of regional institutions, structures and policy changes at the national level. A special sphere, in which the functions of the national and regional systems are being implemented in parallel and are intertwined, is supporting innovation. In recent years, this support has intensified in Russia, which has manifested itself in the creation of special federal institutions and structures, as well as the implementation of a package of measures that covered all regions. In addition, the formation of RIS is influenced by different functional systems and the environment diffusion of knowledge, which is the region. Goal setting for the RIS, creates doctrinal documents and state policy in various spheres (Fig. 1).

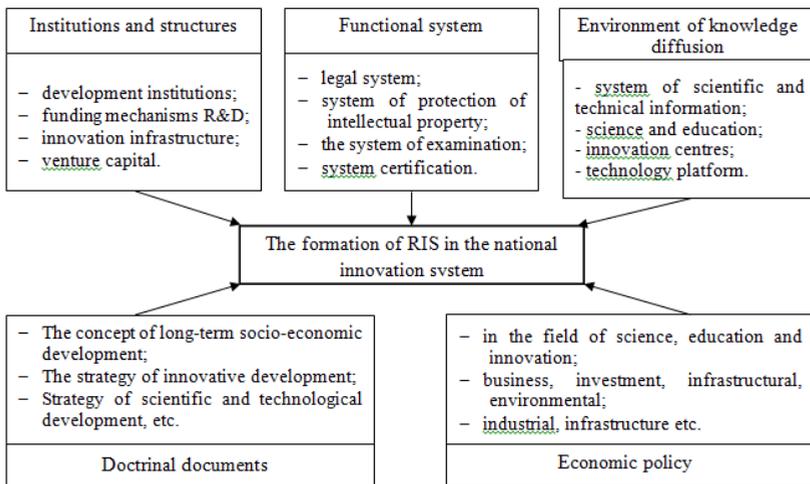


Fig. 1. Main directions of influence on the NIS formation of the RIS.

Conventionally, it is necessary to separate the endogenous and exogenous factors regarding the formation and development of the RIS. In fact, endogenous factors form the RIS, are internal driving forces (e.g. local entrepreneurship and science), develop it, and transform it into a self-replicating system. Exogenous factors are a manifestation of the influence of the NIS and economic space of the country as a whole. Besides the elements of the NIS, they include interaction with the national market and interregional cooperation. The first covers goods, services, capital, labour and knowledge (technology), and reflects the bilateral flows between the region and the rest of the market. Interregional cooperation includes the complex interrelated processes of the various actors on a range of areas, encompassing research, education, investment, innovation, production, and commercialisation of innovation. We should also consider the links between innovation, production and social clusters. In general, interaction with the national market and interregional cooperation constitute the highest level of functioning of the RIS, when the system begins to affect the more complex field of economic and social relations that go beyond the region.

The RIS established in Russia exhibit great variety. However, these differences are relative and the system is convergent; moreover, the ways they are formed and developed are

very similar (based on historical conditions and characteristics of the NIS). At the same time, for a number of reasons, RIS in Russia are complementary, due to, among other things, large variations of formation systems and unsettled specialisation.

In the field of innovation emerges a particular specialisation of regions, which defines the structure, functions and potential of RIS. This specialisation covers the acquisition and use of knowledge, closely linked to production specialisation, which determines the direction of innovation. In contrast to production, "innovative" specialisation is due to only generated and accumulated factor conditions, including the regional knowledge base, research and innovation capacity, and human capital. Such specialisation creates a new area of economic relations between the regions, namely concerning the exchange of knowledge and innovative developments. Also investment capital is accumulated around the sphere of innovations, which can be an important factor in specialisation and the subject of interregional cooperation. To date, in the Russian Federation, "innovative" specialisation is inherent only to the leading regions with strong research potential.

It should be noted that RIS, in general, is created on the principles of competition between regions. However, this does not exclude the possibility for interregional cooperation, coordinating policies, and avoiding duplication. Competition relates primarily to the investment of capital, which forces the regions to improve the RIS. All regions of Russia have significant potential for innovative development, but conditions involving competition for resources very much differs due to the large regional disparities and spatial variations in the concentration of scientific and technology centres.

In Russia, there are clearly separated leading and lagging regions, which is associated with the success of the construction of RIS. The leading regions are characterised by an active and anticipatory strategy, a divergent path of building a RIS, wide specialisation and orientation towards the national market, the fact that it is polycentric, has a high level of institutionalisation, and significant state (national and regional) support for innovation and entrepreneurship. The leading regions are those with the best social and economic conditions, the strongest scientific and technical potential, as confirmed by the rating of constituent entities of the Russian Federation regarding the value of the Russian regional innovation index (RII) 2016. In turn, for outsider regions, interregional cooperation is a more effective factor in building a RIS, which requires identifying areas of cooperation and corresponding mechanisms (Fig. 2).

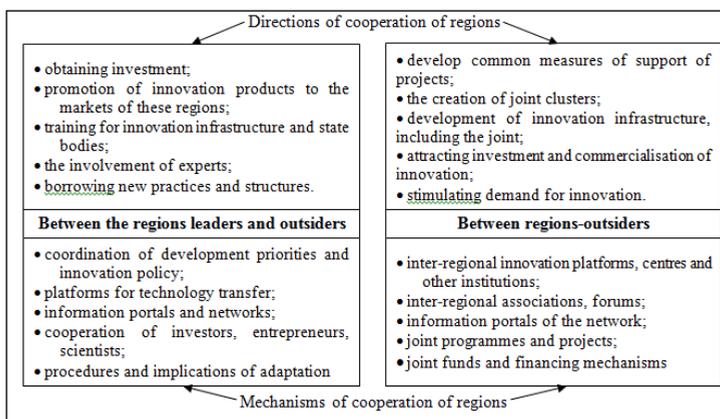


Fig. 2. Directions and mechanisms of cooperation between outsider regions in innovation.

The effective functioning of the NIS requires the consolidation and interaction of RIS, including their interconnection. This is an important prerequisite for achieving the optimal specialisation of RIS.

In Russia, the processes for establishing RIS has been deployed in all regions, including those that are less developed. To consolidate the NIS, this requires minimum asymmetry parameters for the functioning of RIS and maximum synchrony to change them. We will assess the coefficient of RIS parameters for subjects of the Russian Federation using the coefficients of asymmetry and synchronicity.

The asymmetry factor is calculated using the formula:

$$k_a = \left| \frac{n}{(n-1)*(n-2)} * \sum \left(\frac{x_i - \bar{x}}{\delta} \right)^3 \right|, \tag{1}$$

where x_i - is the value of the index of a particular subject of the Federation in the current year;

n - is the number of subjects of the Federation; δ - is the variance of x across the regions. The coefficient of synchrony is calculated using the formula:

$$k_s = \frac{1}{n} |I_{ij} - \bar{I}_i|, \tag{2}$$

where I_{ij} - is the index changes of the i -th indicator of the subject of the Federation j ($j = 1...n$) relative to the previous year; \bar{I}_i - is the average value of the index changes of the i -th compared to the previous year in all regions.

The results of the calculation of the coefficients, covering the three basic parameters in RIS 2010-2015 are presented in Table 1.

Table 1. The coefficients of asymmetry and synchronicity RIS parameters for subjects of the Russian Federation.

	2010	2011	2012	2013	2014	2015
The coefficient of skewedness						
Domestic expenditures on R&D *	6.8965	6.7191	6.6398	6.6374	6.6109	6.6166
The number of personnel involved in R&D*	6.6311	6.5646	6.5250	6.5949	6.6225	6.6395
Used advanced production technologies **	2.9359	2.9134	2.8904	2.4956	2.6926	2.7143
The coefficient of synchronicity (multiplied by 100)						
Domestic expenditures on R&D*	–	0.280	0.183	0.066	0.127	0.033
The number of personnel involved in R&D*	–	0.053	0.107	0.051	0.147	0,283
Used advanced production technologies **	–	0.292	0.671	0.218	0.285	0.036

*excluding the Jewish Autonomous Region, Chukotka Autonomous District, Republic of Crimea and Sevastopol due to the lack of data for the entire period; ** excluding the Republic of Ingushetia, Chukotka Autonomous District, Republic of Crimea and Sevastopol.

The coefficient of skewedness indicates the persistence of significant differences between subjects of the Russian Federation, which may block progress. The reduction of asymmetries in the near future is possible only in terms of funding R&D that demonstrates sustainable positive change. This is proven by the coefficient of synchronicity. However, synchrony may also be related to negative changes.

Calculation of the average index values of the indicators shows a positive change (Table 2). This is confirmed by the calculation of the composite index, covering all indicators, which

amounted to the following: 2011 – 1,6219; 2012 – 1,2631; 2013 – 1,1736; 2014 – of 1.2378; 2015 – 1,2491.

Table 2. Average values of indices of indicators of the subjects of the Russian Federation*.

	2011	2012	2013	2014	2015
Domestic expenditure on scientific R&D	1.2816	1.1868	1.1086	1.1186	1.0929
The number of personnel involved in R&D	1.0625	1.0258	0.9975	1.0359	1.0351
Used advanced production technologies	1.0841	1.0264	1.0550	1.0629	1.1020

*excluding the Republic of Ingushetia, Jewish Autonomous Region, Chukotka Autonomous District, Republic of Crimea and Sevastopol due to the lack of data.

The process of building innovation systems of regions across the country is uneven, but demonstrates a positive trend. Moreover, the rating of constituent entities of the Russian Federation according to the value RRII shows various models of RIS regions. This requires additional measures to consolidate data and integrate regional systems, which involves intensifying interregional cooperation and interaction between the regions to determine their optimal specialisation in the field of innovation.

A new area of cooperation should be to minimise the risks manifested in the framework of the national economic space. To do this, a special mechanism should be created within each RIS (on the basis of innovative infrastructure), which should include analytical, informational, financial components, as well as procedures of cooperation (intra-regional and interregional).

4 Conclusions

The role of regions in ensuring the innovative development of the economy is constantly expanding. The evolution of regions and the transition to new models of the economy requires the creation of RIS. The structure and function of these systems occur under the influence of systems of higher order, and a whole complex of endogenous and exogenous factors in conditions green economy. For effective measures regarding the development of the NIS, the features of formation of RIS in the national economic space should be taken into consideration, which is especially important in countries such as Russia. In Russia, it is expedient to facilitate interregional cooperation in the sphere of innovation and the interaction of RIS in order to ensure increased synchronicity of their development for the consolidation of the NIS.

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