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Assessing the Efficiency of Regional Innovation Systems When Choosing a Business Model

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Abstract:- **This paper aims to assess the efficiency of regional innovative systems from the point of view of innovative business models. Innovative business models in Russia and around the world are reviewed with a description of the key features of regional innovative systems. Research was conducted for 86 regions of the Russian Federation using data from the period of 2013 to 2016.**

Key words: Business model, innovative business model, innovations, regional innovation systems, efficiency assessment, Data Envelopment Analysis

INTRODUCTION

One of the main principles of market economy is free enterprise and the various forms of ownership. In these conditions, companies strive not only to occupy a market niche, but also to ensure a sustainable competitive advantage. Every year, new players arrive on the market scene who change the rules of the game, use new business models, and develop innovative technology. Companies work to find a solution which will provide them with flexibility and sustainability, as well as the opportunity to react quickly to new challenges and stay competitive in market conditions. In this paper, we will look at Russia's experience with innovative business and the regional innovation systems (RIS). The paper is made up of three sections. The first section is devoted to defining innovative business models and examining examples of innovative business models around the world and in Russia. In the second section of the paper, the definition and key characteristics of regional innovation systems are given as one of the business models. The third part of the work describes methods for assessing the efficiency of regional innovation systems as well as the analysis results on the efficiency of RIS in Russia.

1. INNOVATIVE BUSINESS MODELS

1.1 Definition of a business model

A business model is a particular company's concept which is focused on generating income. The definition of a business model includes the potential of enterprises and commercial partners, which are necessary to create, promote, and supply the end product to the company's target audience, as well as consumer relations and investments, which are necessary to establish a steady cashflow [9].

Currently, the long-term success of a company depends on its ability to create an innovative business model. Research shows [5] that business model renovation carries with itself a much greater potential for a company to succeed than product or process renovation does. In the past five years, the use of innovative business models has earned companies 6% more profits compared to product and process improvement. Innovative business models are becoming the key to stable and successful development.

1.2 Experience around the world

Researchers and economists from around the whole world study the formation and successful use of business models. In an article written in 1994, the American researcher Peter Drucker describes the theory of business as a set of assumptions about the activities of the company: issues of identifying the market and competitors, determining the company's strengths and weaknesses. By using some firms as an example, the researcher shows how changes in the environment motivate the company to search for new business models [7].

Paul Timmers conducted research of new business models in electronic markets. He distinguished the following models: online store, e-procurement, online auction, virtual communities, platforms for collaboration, and many more [6].

Joan Magretta describes a business model as a system which shows how individual components of business work together. The author also divides business models into two parts: the creative part, describing the development, purchase, or production of a product or

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service, and the part dedicated to the sale, how to identify and find clients, how to organize sales and distribution of a product and a service. Therefore, the formation of a new business model can occur by creating a new product and service, or by changing the business processes [3].
Karan Girotra describes the fourth step in the innovation of a business model. In the author's opinion, a company must decide what exactly needs to be changed, when changes should take place, who should make the decisions and why. Successful changes in these areas are able to improve the structure of the company's revenues, costs, and risks [4].

1.3 Experience in the Russian Federation

In the current economic conditions in Russia, the introduction of business innovations is becoming an extremely important tool for the majority of market participators, and in particular for those who are competing globally, when conquering new markets and maintaining leading positions [8].
Innovative business models help Russian companies reduce prices on manufactured goods, and therefore perfect manufactured products or start the production of new ones. All of this affects first and foremost the growth of sale and, subsequently, the increase of the proportion of innovative products across the country as a whole. This has been one of the key focuses of the government's economic policy in recent years.
In comparison to European countries, the organizational innovations (innovations as a business model) being implemented in Russia are significantly less common. From 2013 to 2016, the proportion of organizational innovations dropped from 2.9% to 2.4%. Furthermore, the innovation share as a whole decreased from 10.1% to 8.4%. The majority of innovations conducted by Russian companies have to do with changes in production process and technology, on average 8% for the examined period.
If we look at the structure of organizations, conducting scientific research and development, then we can ascertain that an overwhelming majority of innovations are carried out by government organizations, followed by the business sector in second place, and institutions of higher education in third. Likewise, it is worth noting the substantial growth in numbers of the latter from 2013 to 2016.
The result of a decrease in the amount of innovations carried out in business is the decrease in the proportion of innovative goods, work, and services. For the examined period of 2013 to 2016, we observe the negative dynamics of the value of this indicator: the volume of innovative products dropped from 9.2% in 2013 to 8.5% in 2016.
Over the past years, the Russian government has been supporting a policy of creating regional innovation systems which not only unite the manufacturing companies of products and services, but also research centers, conducting scientific research and development, and institutes, leading the training of personnel.
Regional innovation systems act as a company business model in Russia, but at the regional level, representing a symbiosis of the integration model and the model of conducting.

2.REGIONAL INNOVATION SYSTEM AS AN INNOVATIVE BUSINESS MODEL

The development of an innovation system in a region involves the creation of conditions for innovative adaptations in the real economic sector and social sphere, impetus for the development of innovative enterprise, coordination of innovative stakeholders to ensure the unity of goals for innovative development in the region, as well as the formation and development of interaction mechanisms of the private and government economic sectors in the implementation of the innovation policy of the region.
Regional innovation systems act as a business model at the regional level. Here the issues of function are no longer resolved by a single company, but by a combination of manufacturers, research centers, and institutes. The final product is an innovation product, work, or service, which is of value to the manufacturer itself, the region, and the state as a whole. Every RIS is equipped with a certain set of competitive advantages depending on the location and available resources. Therefore, some regional innovation systems can specialize in the production of electric appliances, while others can specialize in chemical and pharmaceutical products. As with the formation of a company business model, the formation of a regional innovation system also addresses financing the RIS, initial creation costs, current costs, and future earnings.
Measuring the efficiency of regional innovation systems is extremely important. However, due to a lack of common approach in literature to defining RIS, there is no single, generally accepted approach to evaluating the efficiency of their function.
Traditionally, the efficiency is determined by the relation of the result to the costs incurred to achieve this result. It is accepted in scientific literature to separate efficiency into technical and price (allocative). Together, these two types of efficiency form the general economic efficiency [10]. The indicators of allocative efficiency reflect information about whether production factors are used in the proportions able to ensure maximum output at established (set) prices. The indicators of technical efficiency are the efficiency of using available resources to produce a certain number of the final product. Furthermore, the results of assessing the technical efficiency allow us to answer

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the following: whether or not the maximum output volume is achievable when using a given set of production factors [11].

3. EVALUATING THE EFFICIENCY OF REGIONAL INNOVATION SYSTEMS

3.1 Methodology

The most widespread method for assessing allocative efficiency is by constructing a production function with the subsequent analysis of the value of marginal products (VMP).

Both parametric (Stochastic Frontier Approach, Distribution Free Approach, Thick Frontier Approach) and nonparametric methods (Data Envelopment Analysis, Free Disposal Hull) are used to analyze and evaluate the technical efficiency [12].

The nonparametric DEA method was chosen to evaluate the functional efficiency of RIS in Russia. According to this approach, the organization, region, or economic system whose efficiency is being evaluated in the analysis, is referred to as the decision-making unit (DMU).

W. Cooper [2] distinguished two types of models: one focused on resources and one focused on results. All the indicators characterizing the activities of the organization/ region/economic system, are divided into two groups: resources and results.

There is a set of resources x_i and obtained results y_r, which is reduced to a common indicator by weights:

$$Input = v_1 x_{10} + \cdots + v_m x_{m0}$$
$$Output = u_1 y_{10} + \cdots + u_s y_{s0}$$

where v_i, i=[1, m]; u_r, r=[1, s] is the weight of every resource and obtained result in the common indicator. The weight of the resources is not initially specified, but is determined by linear programming so that the maximum correspondence of results to resources is achieved.

Since the weight values are not set in advance but are taken from actual data, resource and result vectors of unique weight are obtained for each DMU. In this way, the efficiency of the DMU is measured and a decision is made to optimize it. The efficiency of the DMU is denoted as θ^*, with the most optimal value equal to 1 (at 1, the DMU is considered technically efficient).

Solving the problem is a task for linear programming, while the optimal solution is the solution (θ^*, v^*, u^*): the efficiency and weight for each resource and result.

In this study, a model focused on resources (input) was used, which calculates efficiency by decreasing costs and isolating unused resources. With this in mind, a regional innovation system will be considered efficient if there is no other RIS whose costs for a given output are less.

Furthermore, the two-stage DEA model was also used in this work. The difference between this model and the previously described model is that two stages of the innovation process are examined: the first to be analyzed is the stage of creating knowledge and technology, followed by the stage of their commercialization. The model is based on the fact that the results obtained in the first stage become the resources for the second stage of the innovation process. An innovation system is considered technically efficient if total efficiency, i.e. efficiency at each stage of the innovation process, is achieved.

3.2 Data used

According to the method used for evaluating the technical efficiency of a regional innovation system, it is necessary to collect information about the RIS resources. For the purposes of our study, these resources were:

- the amount of researchers,
- internal costs for research and development,
- proportion of investments in GRP.

Given the time lag between the time of resource development and obtaining results for innovation activities, indicator values for 2014 were used. The dynamics of the values of these indicators in the years 2013-2014 are for Russia as a whole. We can observe a growth in the number of researchers and an increase in the internal costs for research and development. However, at the same time we observe a decrease in the proportion of investments in GRP for 2014. This could be due to the period of sanctions and the increased economic difficulties in the country.

The resulting indicators for the purposes of the research are:

- the amount of advanced production technology developed in a region;
- the amount of advanced production technology used;
- the coefficient of innovative activity;
- the proportion of innovative production in total output;
- the proportion of high-tech production in GRP.

For research purposes, we analyzed data from 2016. However, for the reviewed period there was an increase in the amount of developed and used advanced production technology, while the number of innovation-active enterprises decreased, and the coefficient value dropped from 9.3% in 2015 to 8.4% in 2016. In spite of this, the proportion of innovation production grew.

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The Excel: DEA Frontier Solver software was used to calculate the efficiency coefficient.

For the two-stage model, we use a set of data, presented in Figure 1. First, we analyze the resources of the first stage of the innovation process, the stage of creating knowledge and technology, then we assess the results of this stage. The results of the first stage become the resources for the second stage, the stage of commercialization. Considering the presence of a time lag between using the resources and obtaining results, we analyzed the resource values of the stage of creating knowledge and technology for 2012, the results of the first stage for 2014, the results of commercialization for 2016. To calculate the efficiency coefficient, we also used the software Excel: DEA Frontier Solver.

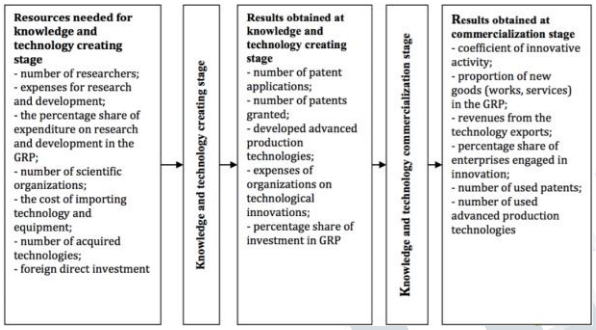

Figure 1 – DEA model for a two-stage innovation process

3.3 Results obtained

The nonparametric evaluation method Data Envelopment Analysis allows the efficiency of a regional innovation system to be determined in relation to the region leader. The results of the assessment give an idea of which region uses the available resources with maximum efficiency.

The results presented in figure 9 were obtained based on the conducted calculations. The value of the efficiency coefficient equaled 1 for 49 regions of Russia in 2016 and 52 regions in 2015. Therefore, we can note, that the number of technically efficient regional innovation systems was not significantly reduced.

A characterization of the technically efficient regions is presented in appendix 1 with regard to their score in the ranking by the Association of Innovative Regions of Russia (AIRR) and in the ranking of innovative development of Russian subjects (RRII). According to the data obtained, it can be noted that over a long period of time the efficient regions were not those at the top of the ranking, but rather the "trailing" regions. We can see that a large number of technically efficient regions using the DEA method are "average strong", "average", and sometimes also "weak" innovators according to the AIRR ranking. They also belong to groups I and II according to RRII. The low values of the technical efficiency coefficients of the leaders of these rankings speak to the fact that the regions have a reserve of increased efficiency of innovative activities without a significant increase in investment, as well as to the need of implementing new management processes and improving cooperation among participants of the innovation process.

CONCLUCIONS

An evaluation of the technical efficiency of regional innovation systems as one of the innovative business models has been conducted in this work. In the first section of the paper, the author characterized innovative business models, examined examples of its practice from around the world and in Russia. Based on the conducted research, we can conclude that issues of forming, dispersing, and implementing innovative business models are relevant and have been studied around the whole world over the last years. All innovative business models are divided into three large groups: integration models, models of conducting, and licensing models. Each company chooses a type of model based on the particularities of its activities. In Russia, regional innovation systems are used along with global business models.

The author examines the key characteristics and particularities of regional innovation systems in the second part of the paper. The development of regional innovation systems is based on the formation of an innovative infrastructure, providing the interaction of innovative processes with all processes of territorial development. As of today, there is no unified approach or method to assess the efficiency of regional innovation systems.

In the third section of the paper, the author examines the parametric and nonparametric approaches to analyzing the technical efficiency of a RIS. For the purposes of this research, the DEA method - Data Envelopment Analysis - was chosen. According to the method used, a region can be recognized as efficient if no other region (RIS) can produce more innovative results for a given amount of resources. Research was carried out in 86 regions of Russia. The following indicators of resource were assessed: the number of innovators, internal costs for research and development, proportion of investment in GRP. The following were chosen as the resulting indicators: the amount of advanced production technology developed in the region; the amount of advanced production technology used; the coefficient of innovative activity; the proportion of innovative products in total output; the proportion of high-tech production in GRP. According to this method, the value of the technical efficiency indicator was equal to 1 for 49 regions of Russia. This attests to the complete efficient use of

resources. However, the number of efficient RIS decreased in comparison to 2015.

Furthermore, the author uses a two-stage DEA model for a more detailed analysis of the innovation process with consideration of the time lag and nonlinear form of the results of innovative activity. The two stages are examined: the stage of innovation creation and the stage of its commercialization. The resources of the first stage were: the number of researchers, internal costs for research and development, the number of science organizations, the proportion of research and development costs in GRP, the cost of purchasing technology and import costs for technology and equipment. The results of the first stage, which also served as the resources for the second stage, were: the number of patent applications, the number of patents received, advanced production technology developed, costs for technological innovation, and proportion of investments in GRP. The final result indicators of the stage of commercialization were: the coefficient of innovation activity, the advanced production technology used, the number of patents used, the proportion of organizations carrying out technology innovations, the proportion of innovative and high-tech production in output, and income from technology imports.

As a result of the two-stage analysis of the efficiency of regional innovation systems, 43 technically efficient regions were revealed, less than by the one-stage analysis. Furthermore, the obtained results were compared to the results of the rankings done by AIRR and RRII. Taking into account the obtained results, we can conclude that over a long period of time the efficient regions were not those at the top of the ranking, but rather the "trailing" regions. We can see that a large number of technically efficient regions using the DEA method are "average strong", "average", and sometimes also "weak" innovators according to the AIRR ranking. They also belong to groups I and II according to RRII. The low values of the technical efficiency coefficients of the leaders of these rankings speak to the fact that the regions have a reserve of increased efficiency of innovative activities without a significant increase in investment, as well as to the need of implementing new management processes and improving cooperation among participants of the innovation process.

Therefore, from the example of the experience in Russia, we can conclude that a regional innovation system is an efficient innovative business model.

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