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THE STRUCTURES INTERACTION MODEL OF UNIVERSITIES AND BUSINESS

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Abstract

At the moment, effective interaction between higher schools and business environment in Russia is not built, which undoubtedly prevents the country from moving to a new stage in the development of society and catching up with developed countries in the field of innovative technologies. We have identified the main factor constraining the development of cooperation between universities and business, which is mainly due to the underestimation of university education involvement by high-tech companies. In this paper, we proposed a new interaction model for innovation process actors (universities, business, government) based on the Leydesdorff triple-helix model, the implementation of which is possible provided that the universities fulfill their integration function. In many developed countries, universities already fulfill this function in full, making an incommensurable contribution to the development of the national economy. The integration function of universities can be interpreted as a flow of knowledge created and appropriately supported by the efforts of universities through the activities coordination of all participants. Thus, thanks to the integration function of universities, the most favorable environment for the introduction of innovative activities in general arises and the status of higher schools is increasing. We have also developed a methodology that allows us to select the most priority researches in the transition from the regional level to the district level and from the district level to the national level, thanks to which it is possible to improve the efficiency of the proposed interaction model.

Keywords: Innovations, integration function of universities, knowledge-based society, triple-helix model.

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1. Introduction

The section "Formation of the institutional environment for innovative development", laid down in the Concept of long-term social and economic development of the Russian Federation for the period until 2020, defines such important tasks as the development and further effective use of mechanisms for interaction between the state apparatus, business structures and society; introduction of institutional changes for the development of SME's through business incubators, technology parks and industrial parks; strengthening the role of research institutes responsible for creating an enabling environment in which long-term investment projects are implemented (Mayer-Schoenberger & Cuciere, 2014).

To move to a knowledge-based economy, where any kind of communication are becoming more accessible due to network technologies (Evseeva, Obukhova, & Tanova, 2017; Aladyshkin, Kulik, Michurin, & Anosova, 2017), Russia needs to improve the level of integration of science, education and business, remove existing institutional and legal barriers in the regulation of the intellectual property market, and also take care of the formation of public-private partnership mechanisms.

2. Problem Statement

A group of American scientists, led by the Dutch scientist Loet Leydesdorf, applied an information-theoretical approach based on Shannon's entropy calculations to study the knowledge base of the American economy and calculated the synergy of innovation (Leydesdorff, Wagner, Porto-Gomez, Comins, & Phillipse, 2017), which is expressed in the negative value of entropy (ΔT).

According to the methodology, knowledge-based innovations can arise because of multiple combinations of technological opportunities, market prospects and geographic advantages or limitations.

Russian scientists using this methodology have calculated the knowledge base of the Russian economy. According to the study (Leydesdorff, Perevodchikov, & Uvarov, 2015), the main innovation potential is realized by large companies, while at the small business level, innovation activity is low, despite the high demand for innovation. When the sectors are separated according to the intensity criteria of science, it can be seen that production with high and medium level of technology is not integrated at the regional level (Fig.1 and Fig.2). Companies with an average level of technology make a greater contribution to integration at the district level than at the national level, while high-tech companies influence the innovation process primarily at the national level.

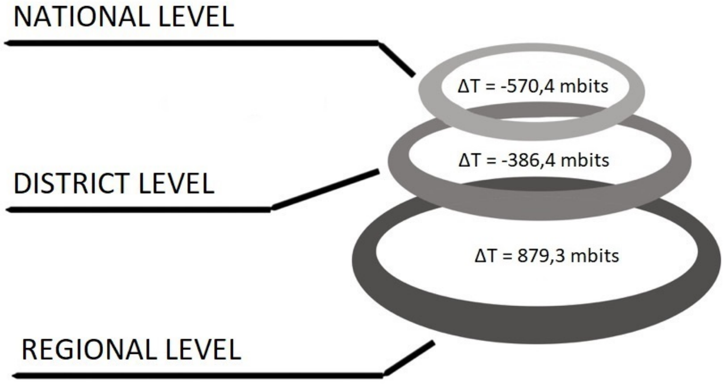

Figure 01. Synergy indicators - the contribution of high-tech industries to Russia's innovation system at three levels (Leydesdorff, Perevodchikov, & Uvarov, 2015)

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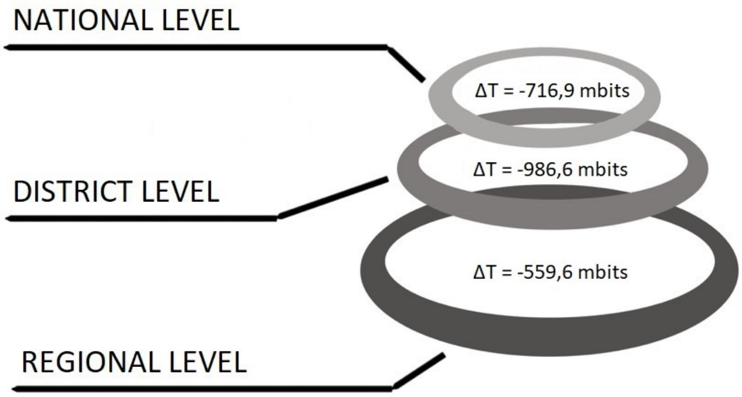

Figure 02. Synergy indicators - the contribution of companies with an average level of technology to the innovation system of Russia at three levels (Leydesdorff, Perevodchikov, & Uvarov, 2015)

Thus, we can assume that the reason for the insufficient integration of technologically advanced companies at the regional level is the incomplete interaction of the academic and business environment, which is explained by the underestimation of university education involvement factor by high-tech companies.

3. Research Questions

American researchers (Unger & Polt, 2017) examined the channels, modes of interaction and policy instruments that provide knowledge exchange between academic institutions, as well as their transfer to business and society. Some ways of interaction are used by outside actors, for example companies, to transform the products of scientific and educational activities of universities into innovations, other ways of interaction have arisen due to the entrepreneurial activity of the universities themselves (the creation of accompanying project solutions – spin-offs, patenting and other activities, often generalized by the term "commercialization"). Often, informal communities become a prerequisite for formal cooperation. To effectively implement this kind of interactions that contribute to the innovative development of society, it is necessary to create an understandable and justified model of interaction between actors in the innovation process, as well as to resolve the issue of choosing priority areas for cooperation. Thus, our research question is: what should be the model of interaction between the state-university-business that is suitable for the Russian market and how can it be possible to solve the problem of choosing the most priority areas of cooperation, thereby increasing the effectiveness of the overall model as a whole?

4. Purpose of the Study

The aim of the study is to develop a model for effective cooperation between universities and business structures, which allows selecting the best joint projects, motivating actors to engage in constant joint research, generating successful innovative developments through the sharing of knowledge and experience, and which is capable of leading the country to a new level of society development.

5. Research Methods

As the main methods of research were the methods of system analysis, forecasting and optimization. The situation has been studied and analyzed in the sphere of interactions between universities, business structures and government bodies in Russia and abroad, and the strengths of existing models of interaction have been revealed and were included in a new proposed by us model.

6. Findings

A new stage in the development of society gives knowledge a great power in public life (Almazova, Baranova, & Khalyapina, 2017; Bylieva, Lobatyuk, & Rubtsova, 2018). Knowledge-creation is a continuous process in which knowledge is generated and then used to generate competitive advantage (Lynch & Jin, 2016). The knowledge creation process itself is not linear, in this connection, it is necessary to create a special universal model of knowledge generation, where universities as the main creators of this knowledge must introduce a new function in modern conditions and act as integrators (Reznik & Kurdova, 2017; Strongin, Maximov, & Groudzinski, 2005).

The study (Perez Vico, Schwaag, Serger, Wise, & Benner, 2017) stated that in order to strengthen ties in the knowledge triangle, Swedish universities perform three key tasks, one of which is directly responsibility for integration processes. By "integration function" we mean the organization of processes of interaction of elements in a complex system to ensure its development (Barykin & Kobicheva, 2018). In a particular case, we consider information interaction, which is a process of joint production, exchange and transfer of knowledge (many universities create knowledge transfer offices (Martín-Rubio & Andina, 2016). The university plays the role of a leading participant and an organizational mediator for the cooperation of the academic environment, business environment and government structures. The main goal of this cooperation is to unite efforts to solve interdisciplinary problems in the educational and scientific spheres, as well as activities aimed at innovation introduction.

According to the American scientist (Etzkowitz, 2008), innovations are formed as follows: the institutional spheres in the triple helix of the model partially overlap each other, people from different spheres meet, and new ideas appear. Thus, such a model becomes balanced. Institutional spheres fulfil their traditional roles, but they also acquire new functions. We, in turn, would like to demonstrate the cumulative role of the university factor in the process of interaction between the entrepreneurial, governmental and research spheres, as at the borders of the intersection of the three spheres the integration function actively enters into operation, ensures management and, as efficiently as possible, allows to generate the maximum amount of new knowledge.

Taking as a basis the model of the triple helix, we propose to build a model of interaction between the actors of the innovation process in the Russian Federation. In our model, the integration function of universities is linked by a common thread of information flow of three dynamic and constantly developing actors of the innovation economy (government - university - business) (Fig. 3). The locus of the function is located in the centre of the model, and the core or "information genome" prompts all drivers to create multi-layered communications, networks and organizations among spirals. Although the spirals of institutional spheres are constantly developing and transforming new information, the integration function does not lag behind, but is modernized and adapted to new conditions, helping to interact with actors at

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each level of their development. Universities in the process of implementing the integration function create innovative knowledge transfer schemes based on digital technologies, new methods for calculating the attractiveness of joint projects with the industry, thereby increasing the return on investment, universities are responsible for management innovations during the integration process, and monitor compliance with intellectual property rights.

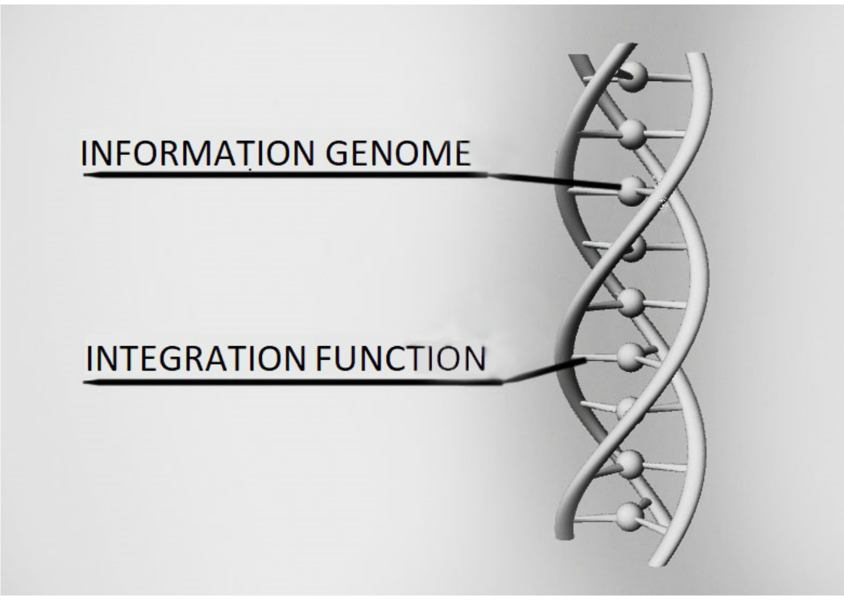

Figure 3. The locus of the integration function in the interaction model of the innovation process actors

In addition, we would like to show that in the model we propose, the flow of new knowledge, projects and researches is controlled and carefully selected in the process of transition from the regional level to the district level, and then from the district level to the highest level - the national level, thus at the federal level there are the most priority and the most significant development (Fig. 4).

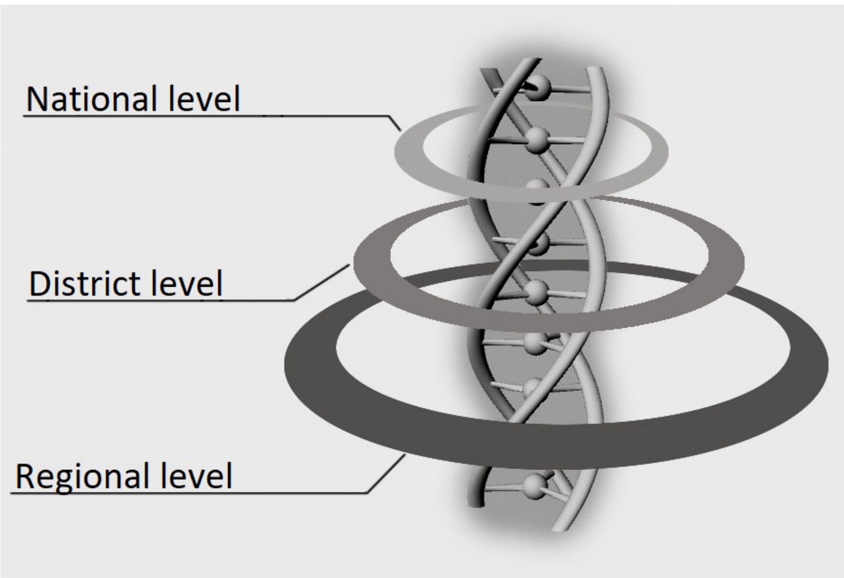

Figure 4. The interaction model of the innovation process actors

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The implementation of this selection is possible on the basis of the following methodology of the investment program formation for joint innovative projects of universities and business structures, which includes seven stages:

Stage 1. Defining the overall goal of the hierarchy - the distribution of projects in accordance with their priorities. The task of selecting a priority innovative project by the university to achieve a set of goals can be represented in the following hierarchy (Fig. 5).

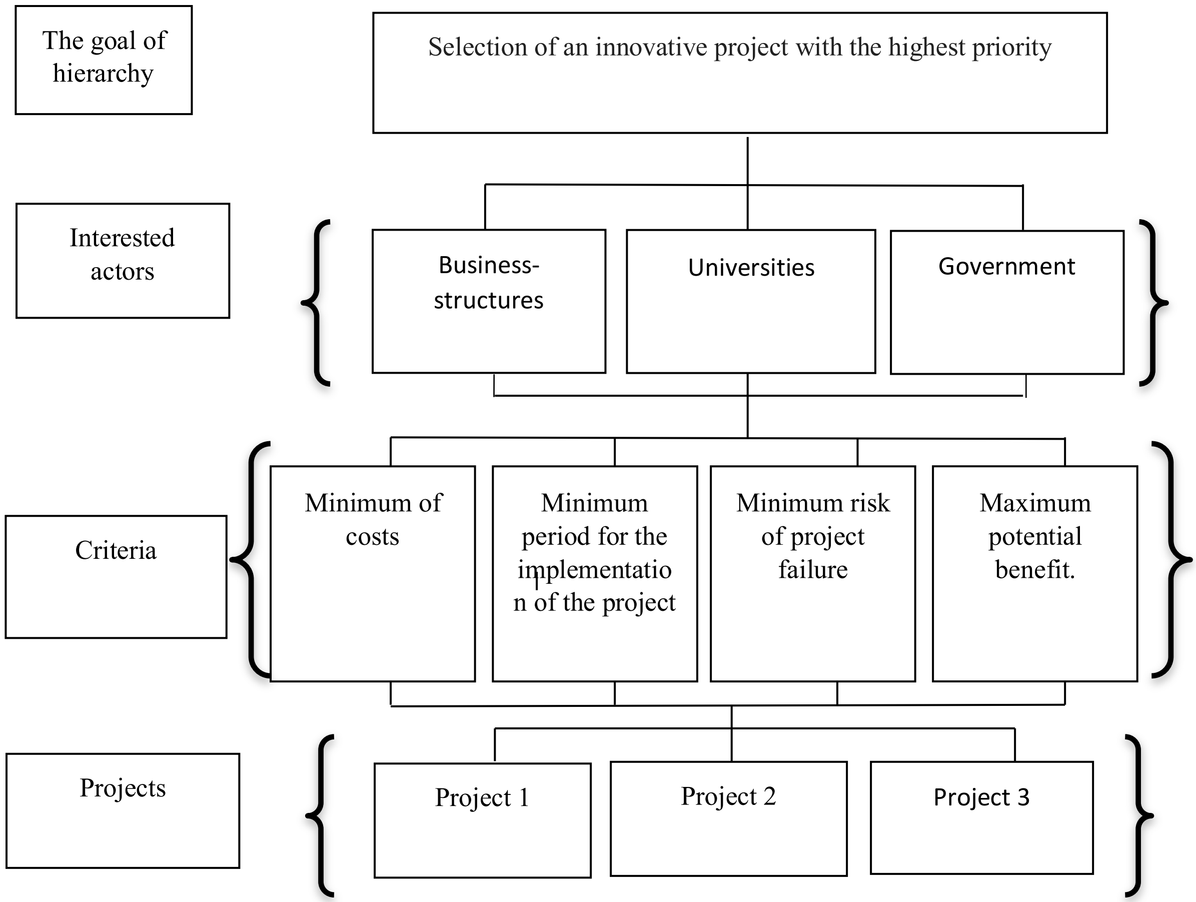

Figure 5. Decomposition of the problem of assessing the project financing priority in a hierarchy

Stage 2. Formation of the level of actors groups who are interested in efficient allocation of resources between projects and achievement of the set goals: 1) university; 2) business structures; 3) the government.

Stage 3. Define the elements of the criteria level in the project selection hierarchy. It is advisable to evaluate innovative projects of the academic and business environment on the following criteria:

1) minimum of costs;

2) minimum period for the implementation of the project;

3) minimum risk of project failure;

4) maximum potential benefit.

Stage 4. Inclusion of projects in the lower level of the hierarchy.

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Stage 5. Calculation of project priorities based on the multiplicative method of analyzing hierarchies.

5.1. The matrix elements of pair comparisons of elements of each hierarchy level are filled. Comparisons are conducted on the basis of expert analysis, using a scale to identify the relative importance of the compared elements (Table 01).

5.2. For each of the obtained matrices of pair comparisons of elements of all hierarchy levels the value a_{rs} is calculated, reflecting the degree of superiority of the compared element r over the element s in accordance with the element comparison scale (the indices r and s refer to the row and column, respectively):

$$a_{rs} = e^{\sigma_{rs}}, \quad (1)$$

where σ_{rs}, – he quantitative value of relative importance in accordance with the scale (Table 01).

Then, the priorities of the compared items are calculated x_r:

$$x_r = \frac{S_r}{\sum_{r=1}^{N} S_r}, \quad (2)$$

where S_r– the geometric mean of the elements $a_{rs}$to N.

Thus, according to formulas (1) and (2), the following values are defined:

1) weight of each interested actor of innovation activities – β_j (influence of the j-th actor on the implementation of the innovative project);

2) criteria weight –z_{jk}(the significance of the k-th criterion for the j-th actor);

3) project priorities for each criterion – ω_{ik} (priority of the project, reflecting the contribution of the i-th project to the achievement of the k-th goal).

Table 01. Scale to identify the relative importance of elements of the same hierarchy level

Quantitative value	Level of relative importance
6	Significant superiority
4	Strong superiority
2	Moderate superiority of one over the other
0	Equal importance
– 2	Moderate subordination of one element to another
– 4	Strong subordination
– 6	Significant subordination

Stage 6. Weighing the criteria for interested actors, and then the project priorities by the weights of the criteria using formulas (3) and (4).

First, the criteria are weighed for each actor:

$$Z_k = \sum_{j=1}^{3} Z_{jk} \quad \beta_j \quad (3)$$

where j = 1, 2, 3 –sequence number of the interested actor; Z_k – weight of the k-th criterion for all groups of persons.

Formula (4) allows us to obtain the normalized weights of the criteria d_k:

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$$d_k = \frac{z_k}{\sum_{k=1}^{4} z_k}. \quad (4)$$

Then the project priorities obtained as a result of decisions (1) and (2) are weighed by the criteria weights.

$$p_i = \sum_{k=1}^{4} \omega_{ik} \quad d_k, \quad (5)$$

where k = 1, 2, 3, 4 – sequence number of the criterion; i = 1, 2, …, n – sequence project number; p_i– priority of the i-th project, showing its contribution to the achievement of the set goals.

Stage 7. Definition of the final project financing priorities (v_i) in accordance with the hierarchy constructed by the formula (6):

$$v_i = \frac{p_i}{\sum_{i=1}^{n} p_i}. \quad (6)$$

Thus, this methodology for selecting a funding program for a priority joint innovation project of the university and business structures is developed on the basis of the multiplicative method of analyzing hierarchies as a multi-criteria approach to the analysis of complex problems proposed by the Dutch scientist Lootsma (Lootsma, 1993). The developed methodology allows to implement the optimal program for financing projects taking into account the interests of the university, business structures, and government, as well as the set goals for the main actors of the innovation process.

7. Conclusion

The model of interaction between universities, business structures and government, based on the integration function of higher schools and the proposed method of choosing the optimal direction of interaction, can lead the Russian economy to a new level of development, increasing the efficiency and effectiveness of all forms of joint cooperation.

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