Modeling the Spatial Organization of the Higher Education System in the Regional Economy

E. V. Bolgova and M. V. Kurnikova

Abstract The innovative strategic scenario of Russian regions requires new models for the territorial distribution of resources, key ones to this type of development. The development of these models is especially important for higher education, which is a basic condition for building innovative subsystems, creating poles and growth centers, a factor in reducing development differentiation in regions. The spatial organization was not in the focus of higher education reforms for a long time, despite the innovative agenda, the deep theoretical basis and the successful world experience of its modeling as a management tool. In this regard, the objective of the study is to substantiate the methodology for managing the development of the higher education system on the basis of spatial organization models that have been effective in countries with similar territorial conditions, trends and problems of the university network development. Within the framework of the research, the following tasks should be solved: to study theoretical foundations of modeling the spatial organization of the higher education system and to develop models; to determine the factors for the successful application of a model in Russia that has proved effective in the results of econometric analysis; to generalize foreign experience and suggest schemes for implementing a priority model in the economy of Russian regions. The scientific novelty of the study is to develop a methodology for managing the development of the higher education system with the possible implementation of spatial modeling tools. The methods of the research are theoretical-empirical, systemic and comparative analysis. Special methods of economic and statistical analysis, ranking techniques, general and special purpose software tools (Microsoft Excel, Statistica 8.0) are used for observing and grouping data, building generalizing indicators, in assessing the connection of phenomena, for comparing facts and determining the characteristics of the priority model of the spatial organization of the higher education system, the conditions for its application in the economy of Russian regions. The main conclusions and results can be used for the research in the spatial distribution of economic

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resources in the innovative economy, in the practice of targeted programming for the development of vocational education, taking into account the characteristics of the subjects of the Russian Federation.

1 Introduction

The key to the innovation strategy of the Russian Federation is education, which is inseparable from the goals of the Economy-2030, defined as the economy of the intellect. The urgency of searching for new, effective ways to modernize education is determined by the tasks of expanding the segment occupied by the country in the world market of high-tech products to 10%, bringing the volume of the gross added value of the innovation sector in the country's GDP to 20%, which is expected to be solved solely through the growth of intellectual potential—one of the main competitive advantages of Russia.

The transition of the country's economy to the innovative development is impossible without the implementation of innovative scenarios in Russian regions, which requires significantly improving the rationality of the spatial distribution of resources that provide this type of regional progress.

In resource support of the innovative development, education is considered a pole and growth center, a factor of smoothing the regional differentiation and spatial polarization, an important condition for building a competitive economy that is resistant to crisis phenomena and capable of ensuring high rates of social development. Only the localized education system, spatially integrated into the economy of Russian regions, can solve such problems.

A special role in these processes is assigned to higher education, which, in the strategic perspective, will focus on a significant increase of its contribution to the social and economic development of Russian regions, and on building the competencies necessary for the region to implement the innovative scenario without alternative (Khasaev et al. 2015, 2016; Ashmarina et al. 2017).

Priorities of the innovative development impose organizational and content directions to modernize higher education, which are not just to adapt to changing conditions of the labor market, but to evolve as a system with innovative ideas, breakthrough solutions, and technologies that take into account the characteristics of Russian regions.

The obstacle to such development is management practice, where the functioning of universities located in the region is considered in isolation from the spatial and socio-economic characteristics of the region, selected regional strategies and scenarios for their implementation. In the territorial administration, this gap creates the insufficient contribution of higher education to the development of the regional economy in the innovative scenario. The management of the public service sector leads to the persistence of unsatisfactory performance characteristics of the university network.

The current management practice is based on scientific views of Russian scientists exploring the role of higher education in factors of the socio-economic development and territorial mechanisms for its implementation.

Fundamental provisions of the impact of education on the socio-economic development of the country are formulated in the framework of the knowledge-based economy theory by Makarov (2003), Lvov et al. (2004) and Kolesov (2008) on the basis of the works of Bell, Inozemtsev (1999).

Organizational-economic models that determined the ways to modernize Russian higher education were formed by Volkov et al. (2009) and Mau (2012).

Theoretical and methodological provisions for assessing the contribution of vocational education to macroeconomics were developed by Belyakov and Klyachko (2016).

The authors who formed scientific views on space as the economic phenomenon pointed to the causal relationship of the higher education system and spatial development: Kolosovsky (1969), Artobolevsky et al. (2011) and Granberg (2012).

Structural aspects of the impact of education on spatial socio-economic systems, including production clusters in the region, made it possible to comprehend the results of the studies of Tsihan (2005), Bazhutkina (2005), Kozlova (2013) and the territorial structure of higher education in Russia of Katrovsky (2003).

Highly appreciating the contribution of domestic scientists to the problems, we note that the studies conducted do not sufficiently take into account possibilities of modeling as a tool for managing the spatial development of the higher education system and the positive experience of foreign countries accumulated in the use of these tools.

A number of these countries in similar territorial and socio-economic conditions to Russian ones, as well as related processes in the evolution of the university sector, equally related to large-scale complexities, were able to develop models for the spatial organization of the higher education system and on its basis to form an effective university network in regions.

France, of course, belongs to such countries, higher education is one of the basic priorities of both the state policy and the policy of regions, and the multi-leveled territorial structure and the multistructure of the economy are successfully combined with benchmarks of the innovative development.

2 Materials and Methods

2.1 Theoretical and Methodological Foundations for Modeling the Spatial Organization of the Higher Education System

Theoretical Foundations of Modeling

By the beginning of the third millennium, the spatial aspect of reforming the higher education system has become part of the priority agenda in many European and Asian countries pursuing an active policy of the innovative development of their territories.

In connection with these processes, theoretical foundations of the spatial development of the higher education system, defined by provisions of the "new economic geography," were formed. Perru, Budvil, Lazuen, Potier (1950–2010) and other representatives of the modern French school of spatial economics proposed to combine large and small enterprises, research and education institutions to work together in a particular region, to develop synergies and joint efforts around common tasks.

The views of many scientists, who researched and identified trends in the development of higher education, substantiated their causes by a number of interrelated challenges of the global economy.

The modern challenges such as demographic changes and the growth of the number of students, internal and external migration processes, academic mobility, the expansion of the world market for higher education, the growth of heterogeneity of trainees in terms of socio-cultural characteristics, changes in the labor market increasing the share of employed people having higher education fundamentally change substantive and organizational foundations of higher education (Sinelnikov-Murylev et al. 2017).

Earlier, Bauman (2002) noted that the global context for the development of higher education, the formation of the information economy have made universities rethink their own role, including the territorial one, as the world "which no longer needs their traditional services, sets new rules for prestige and influence, and looks at the values that universities stand for with increasing suspicion."

Goldstein and Drucker (2006) pointed to a shift in the traditional—educational and research—functions of higher education. In the opinion of these authors, the development of technologies leads to the fact that the university begins to fulfill the "entrepreneurial function, the function of commercializing innovation, involving network interactions between higher education organizations, business and the state within individual territories, thereby strengthening the role of higher education in the territorial development."

The territorial interaction is described by the triple helix model proposed by Etzkowitz and Leydesdorff (1997) and Etzkowitz (2002a, b), which assumes the equality of universities, enterprises and authorities in the innovation system. The main content of the model is that in addition to the task of developing innovation by universities through the generation of new knowledge, production tasks of enterprises localized within the boundaries of a certain territory, as well as socio-economic tasks of the development of this territory are being solved in parallel.

The innovation form of higher education, a new model of the university, evolving on the basis of a wide range of approaches, from the "knowledge economy" (Goddard et al. 1999) to the cluster approach to the university as an educational and scientific center, is becoming an answer to challenges of competition in the international market of education services and the factor of the regional development (Etzkowitz 2002a, b; Chatterton and Goddard 2000).

Modeling Methodology

Based on the presented theoretical concepts, as well as on numerous empirical studies conducted and published by foreign scientists in the last twenty years, the Organization for Economic Cooperation and Development (OECD) has proposed four new—possible—models of the higher education system that effectively implement scenarios of the innovative development. The content of these models is determined by options for university interaction with enterprises and forecasts for the development of university education ("Four future scenarios for higher education" http://www.oecd.org/education/skills-beyond-school/42241931.pdf):

- Open international network;
- University—a new responsibility of the state;
- University "Higher education Inc (corporate university)";
- "University on duty of regions and municipalities."

The latter model contains characteristics of the spatial organization of the higher education system, which implies the concentration of universities on national, regional and local goals, tasks and development priorities. Within the framework of the "university on duty of regions and municipalities" model, the functions of universities in education and research strategically coordinate with the needs of the region and municipalities.

3 Results

Conditions and Experience of Using the "University on Duty of Regions and Municipalities" Model in the Economic Space of Russian Regions. Factors for Successful Application of the Model

The increased practical interest in understanding the impact of the higher education system on the regional development in Russia is due to significant changes in conditions both at the global and national levels, which include the weakening of the role of the traditional production sector in economies of many countries and the creation of progressive forms of economic space. Such conditions predetermined the innovative development of regions within countries, the desire to create a knowledge-based economy on their territory, both through the development of knowledge-intensive industries and innovative enterprises, and through an active policy of clustering and retention of qualified personnel with competencies that meet the needs of the innovation economy and rapidly changing clusters' preferences.

To build the "university on duty of regions and municipalities" model of the higher education system in the economic space of the region, two theoretical approaches characterizing the impact of universities on the development of adjacent territories and a number of empirical arguments, substantiated in the works of European scientists, should be singled out.

The first approach regards the university as a provider of basic scientific knowledge for the needs of production, primarily agriculture and manufacturing. Within the framework of this approach, the role of knowledge in the production system is secondary and therefore the exogenous one. The process of the knowledge dissemination and development is considered linearly and is described as a "science push model," in which knowledge is created within the walls of the university or research laboratory of a large firm outside the production system and then transferred to production (Guston 2000).

In the second approach, the role of higher education, fulfilling its research and education function, is: (a) to ensure the development of regions; (b) in the long term —to keep local cultural norms (Smith 1990; Freeman 1995, 2000).

Clusters—innovative spatial systems—united universities and production, created dynamic complexes of interaction between higher education, economics, authorities, business development institutions, labor markets, capital and products, and predetermined the second approach. In the cluster system of interaction, universities perform eight basic functions: creating knowledge, building human capital, transferring existing know-how, creating technological innovations, investing in fixed assets, regional leadership, influencing the regional habitat and producing knowledge infrastructure (Lundwal et al.). The level of importance of higher education within a particular region depends on its ability to meet the needs of production clusters in specialized professional competencies, as well as from a number of factors presented in Table 1, compiled by the authors according to

Table 1 Impact of the higher education system on the socio-economic development of the region

Factor name	Content of the factor
Accounting university specialization of the regional economy	Availability of higher education programs that take into account the needs of territorial production
Development of links between the university and region	History of main interactions between the university and society living in this territory, the university and territorial authorities
Conformity of scientific research to the regional industrial needs	Focus of research activities on meeting production needs of the territory
Institutes of interaction between higher education and the region	Presence of territorial and production associations that include higher education, as well as the existence of institutions that provide interaction between elements of such a system
Regional specialization in the country's economic space	Availability of territorial specialization, as well as the needs of main enterprises in knowledge
Political and economic conditions	Degree of dependence of higher education on major policy decisions and changes in economic conditions

Source
1. Smith et al. (1998)
2. Goldstein et al. (1995)
3. Gunasekara (2004)
4. Kohoutek et al. (2017)
5. Trippl et al. (2004)

Lawton et al. (2001), Goldstein et al. (1995), Gunasekara (2004), Kohoutek et al. (2017) and Trippl et al. (2004).

Econometric Analysis of Model Efficiency

In foreign publications, empirically obtained evidence is provided that the higher education system stimulates the development of less developed regions, such as Wales (Pugh 2016), peripheral regions of southern Italy (Harrison and Turok 2017), rural Israel (Johnston and Huggins 2016; Frenkel and Leck 2017).

In this connection, the econometric analysis of dependence of the economic welfare of regions on universities' activity is of particular interest. Researchers use the multiple regression models, in which the average annual income of workers in the analyzed region is the dependent variable adjusted for the consumer price index. Explaining variables are the amount of expenditure on research activities; the total number of scientific degrees awarded in the region, including the bachelor's and master's degrees; proportion of Ph.D. awarded in the field of science and technology, in the total number of graduates of universities; the number of patents received by universities in the region. The study is based on data on 313 US agglomerations, and the time period covers the interval 1986–2001. The results of the research show that all four variables of the regression equation are significant in explaining changes in the average income level, with the greatest impact on the socio-economic development of the region being spent on R&D. In a relative assessment, they show that every additional 10 million $ increase the average income level of the regional population by 2.3% (Goldstein and Drucker 2006).

Foreign Experience in Applying the Model

The empirical arguments for using the "university on duty of regions and municipalities" model include the positive experience of France, a country in which the significant role of higher education in the regional development is realized by authorities.

At the beginning of the twenty-first century, the task was set to transform higher education institutions into structures that would ensure the development of high-tech industries and the development of new technologies in regions of that country. A number of key reforms and institutional reforms aimed at modernizing the higher education system and creating new institutions providing cooperation between universities, research centers, enterprises and territorial communities were undertaken.

In 2004, the French government decided to create poles of competitiveness (pôles de compétitivité), a tool for a new state and industrial policy. The poles of competitiveness are associations of enterprises, research organizations and education centers located on the same territory. Later, in 2006, a project was launched to create new structures in the field of education and science—the poles of research and higher education (pôles de recherche et d'enseignement supérieur)—designed to foster cooperation between universities, "big schools" and research structures located on the same territory. The poles were adapted to the specifics of regions and local labor markets, and they facilitated the implementation of territorial projects in

the field of education and research, territorial development projects. The policy pursued has optimized the spatial distribution of the higher education system in France, although it has criticized the possible risks of creating an elite education by concentrating the best universities and research centers in several regions, violating the principle of equal access to higher education.

In 2013, the next step was taken to build the "university on duty of regions and municipalities" model, aimed to develop education clusters in the framework of "Initiatives d'Excellence-Idex." The reform at this stage included three priorities: the formation of education clusters within the framework, the reduction and consolidation of the number of universities, the construction of a new model of the university. Already in 2015, 25 territories were selected for the formation of new types of universities in the country, and the main characteristics of universities within the framework of the new model were work at the level of the territory, attraction of private structures and regional management to technologies, solving issues of scientific-technical and regional development, infrastructure for new technopolises. In essence, universities become multidisciplinary centers of research, and they are responsible for the implementation of their results in the practice of the territorial development. Thus, the program "Initiatives d'Excellence-Idex" has achieved its goal of turning the university into an innovation center for scientific, education and regional development (Analytical Interim Report on the Implementation of the Future Investment Program 2016).

The successful introduction of the "university on duty of regions and municipalities" model in France is confirmed by the fact that the top 500 rating of the QS represented about 60% of Parisian universities, and more than 40% of the list were universities operating in the "non-metropolitan" region (the assessment was carried out by the authors according to the Web site https://www.topuniversities.com/qs-world-university-rankings/). This feature of the rating is the result of a conscious modeling of the spatial organization of the higher education system that solves the problem on the uniform placement of universities across France in order to provide the entire population with equal access to quality higher education, and for large, small and medium-sized businesses equal access to the results of scientific research conducted by universities and higher schools.

They prove the high efficiency of the "university on duty of regions and municipalities" model of the spatial organization of the higher education system in France and the results of national ratings. The French national Eduniversal rating is today the only one that assesses the results of higher education in accordance with the market criteria. With the help of their own approach and methodology, based on the criteria of university fame and prestige in the eyes of employers, the size of the average salary of graduates, the students' satisfaction with the results of education, higher education programs are ranked in the bachelor's, master's and doctoral studies. The rating uses a score of programs, conducted on the basis of their own polls and expert opinions, according to which the majority of programs implemented in France are ranked. The popularity of the Eduniversal rating in France is ensured by the transparency of this methodology, high reliability and relevance of the assessment (grades are updated at the beginning of each academic year or cycle,

for programs implemented during 18 months of training or 2 times a year), and an obvious practical benefit.

The classification of the three best master's degree programs, performed in the context of the university or the higher school location in which it is implemented, proves that the principle of uniformity remains a priority in the spatial organization of the higher education system in France.

Out of 189 master's degree programs, MSC and MBA, which are included in TOP-3 in Paris, 88 or 47% are implemented. In the group of three best programs in each area of training, 101 programs or 53% are implemented by universities and higher schools outside the capital. Obviously, the presented classification is a result of high quality of higher education not only in large cities and recognized university centers such as Grenoble, Bordeaux and Lyon, but also in cities whose importance as territories with a developed higher education system in the global aspect has not been universally recognized yet (the assessment was carried out by the authors according to the data from the site http://www.meilleurs-masters.com).

The uniformity of placement on the territory of the country is also demonstrated by the distribution of the number of students by large territorial units—macroregions of France, presented in Table 2.

In departments located outside Paris and the capital of the Ile-de-France district, 62% of undergraduate students, 60% of master's degree programs and 55% of doctorates are trained. The number of students is distributed evenly and is in the range from 7 to 11% in each of macroregions with a high uniformity of the distribution by the region. It is obvious that France managed to avoid excessive concentration of the higher education system in the capital or central regions, to ensure a high uniformity of the distribution and territorial balance.

Author's Schemes for Implementing the "University on Duty of Regions and Municipalities" Model in the Economic Space of Russian Regions

The conclusion, which confirms the successful proposed model of the spatial organization of the higher education system, leads to the conclusion that the dissemination of the accumulated experience can become an example for Russia and those countries that seek to implement an innovation scenario in the regional development and consider the higher education system as a factor of such development.

The network scheme to implement the model proposed by the authors is determined by the content of education programs and research works for individual universities in the regional university network and is formed by two interrelated parameters defined by the UNESCO International Standard Classification of Education (ISCED): the area of education and the level of education (Fig. 1, Appendix 1).

The field of education forms a professional profile of the graduate, and education programs of higher education institutions are oriented toward the specific type of their employment/occupational employment in the cluster of enterprises, determined by its industry specialization. The stage of education establishes graduate's

Table 2 Distribution of the number of students by region in France in 2016

Regions of France	Number of students-bachelor's degree, people	Ratio (%)	Number of students—master's degree, people	Ratio (%)	Number of students-Ph.D., people	Ratio (%)
France—total	*1,025,434*	*100.0*	*890,359*	*100.0*	*67,679*	*100.0*
1. Ile-de-France	*269,788*	*26.3*	*254,581*	*28.6*	*25,162*	*37.2*
2. Regions around Paris	*120,112*	*11.7*	*97,136*	*10.9*	*5209*	*7.7*
Champagne-Ardennes	16,532	1.6	15,500	1.7	630	0.9
Picardy	18,855	1.8	15,598	1.8	687	1.0
Upper Normandy	22,497	2.2	23,411	2.6	1153	1.7
Center-Loire Valley	27,809	2.7	15,496	1.7	1069	1.6
Lower Normandy	16,658	1.6	13,082	1.5	670	1.0
Burgundy	17,761	1.8	14,049	1.6	1000	1.5
3. North-Nord-Pas-de-Calais	*65,839*	*6.4*	*58,869*	*6.7*	*2351*	*3.5*
4. East	*75,741*	*7.4*	*66,575*	*7.5*	*4986*	*7.4*
Lorraine	33,086	3.2	28,249	3.2	1609	2.4
Alsace	29,466	2.9	27,046	3.0	2568	3.8
Franche-Comte	13,189	1.3	11,280	1.3	791	1.2
5. West	*120,072*	*11.7*	*99,309*	*11.1*	*5935*	*8.7*
Pen-de-la-Loire	49,275	4.8	41,874	4.7	2226	3.3
Brittany	49,919	4.9	40,779	4.6	2670	3.9
Poitou-Charentes	20,878	2.0	16,656	1.8	1039	1.5
6. South-West	*109,623*	*10.7*	*97,602*	*11.0*	*7218*	*10.7*
Aquitaine	47,740	4.6	45,051	5.0	2875	4.3
Midi-Pyrenees	53,024	5.2	46,061	5.2	3824	5.6

(continued)

Table 2 (continued)

Regions of France	Number of students-bachelor's degree, people	Ratio (%)	Number of students—master's degree, people	Ratio (%)	Number of students-Ph.D., people	Ratio (%)
Limousin	8859	0.9	6490	0.8	519	0.8
7. Center-East	*125,774*	*12.3*	*114,002*	*12.8*	*8707*	*12.9*
Rhône-Alpes	106,354	10.4	100,330	11.3	7802	11.5
Auvergne	19,420	1.9	13,672	1.5	905	1.4
8. Mediterranean	*116,389*	*11.3*	*93,372*	*10.4*	*7536*	*11.1*
Languedoc-Roussillon	45,306	4.4	35,464	3.9	2735	4.0
Provence-Alpes-Côte d'Azur	68,348	6.6	56,785	6.4	4666	6.9
Corsica	2735	0.3	1123	0.1	135	0.2
9. Overseas Territories	*22,096*	*2.2*	*8913*	*1.0*	*575*	*0.8*
Guadeloupe	4491	0.4	2256	0.3	278	0.4
Martinique	3582	0.3	2026	0.2	0	–
Guyana	1914	0.2	819	0.1	0	–
Reunion	10,888	1.2	3812	0.4	297	0.4
Mayotte	1221	0.1	0	–	0	–

Source http://ec.europa.eu/eurostat, Accessed 1 April 2018

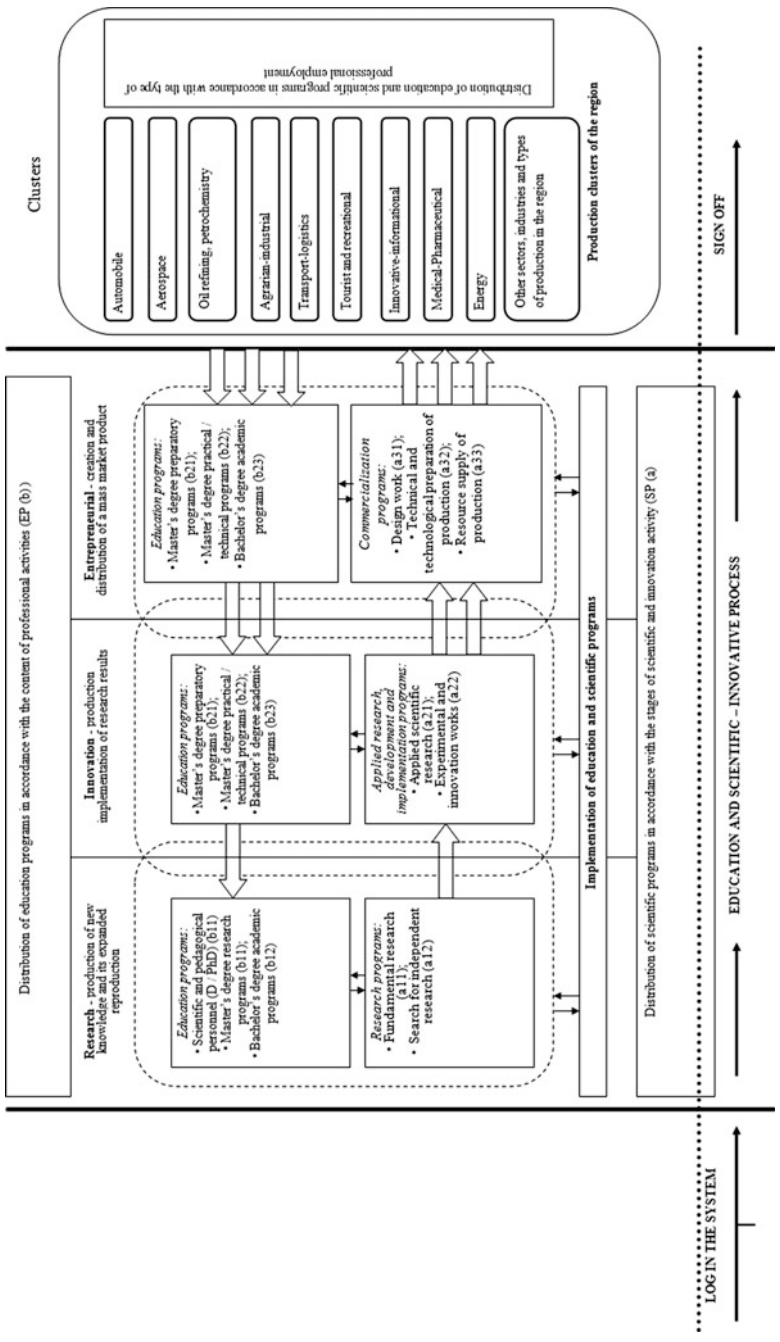

Fig. 1 Regional university network in the "university on duty of regions and municipalities" model. *Source* Authors

qualifications, and the content of education programs is formed on the place in the professional hierarchy, which the graduates will apply to.

The position in the professional hierarchy determines the sequence of innovation stages: participation in initial stages (entrepreneurial activity) means the availability of the first stage of higher education and the bachelor' degree; to participate in the next stage (innovation activity), it is necessary to master the programs of the second stage and the master's degree program; research and development require training in advanced (academic) research programs that correspond to master's degree programs, and programs of original research corresponding to the doctor's degree (Doctorate/Ph.D.) (research activity).

Areas and levels of education form the content of the individual university's activity in the form of a complex of education and research programs, and the spatial configuration of the regional university network develops links with production clusters of the region. Frame and focal intracluster links as a result of their evolution led to the possibility of implementing two schemes of interaction between higher education institutions and cluster enterprises: "equal coalition" (Fig. 2, Appendix 2) and "center-periphery" (Fig. 3, Appendix 3).

The "equal coalition" scheme is used as a variant of interaction between a particular cluster and a number of universities in the region, and the "center-periphery" scheme as a variant of cooperation with a profile university, if it is formed in the region and is able to be the "core" of the cluster.

The proposed interaction schemes are based on "orders" performed by the regional university network for clusters localized in the region. In essence, the "order" is a multivariate complex of programs in the field of training personnel and developing innovative products. Individual programs of the complex are implemented by specialized universities in the course of research and education activities. In interaction with clusters, the "cell" of the higher education system is not a separate institution, but a sector of this system that can solve the task of the innovative development of the individual cluster or groups of clusters with the help of the individualized program complex. These sectors are groups of universities that realize complexes of research (R), innovation (IN), entrepreneurial (E) programs, in the field of research (SP) and education activity (EP), oriented to the needs of a specific customer cluster.

The level of the research program (fundamental or applied research, development, commercialization—(a)) and education program (bachelor, master, doctorate —(b)) is also selected in accordance with the requirements of the cluster.

The need to perform a multitude of research and education programs for a separate cluster predetermines the development of matrix links between higher education institutions with each other and with clusters of the region ($Cluster_i$), which gives a network view to the spatial organization of both schemes.

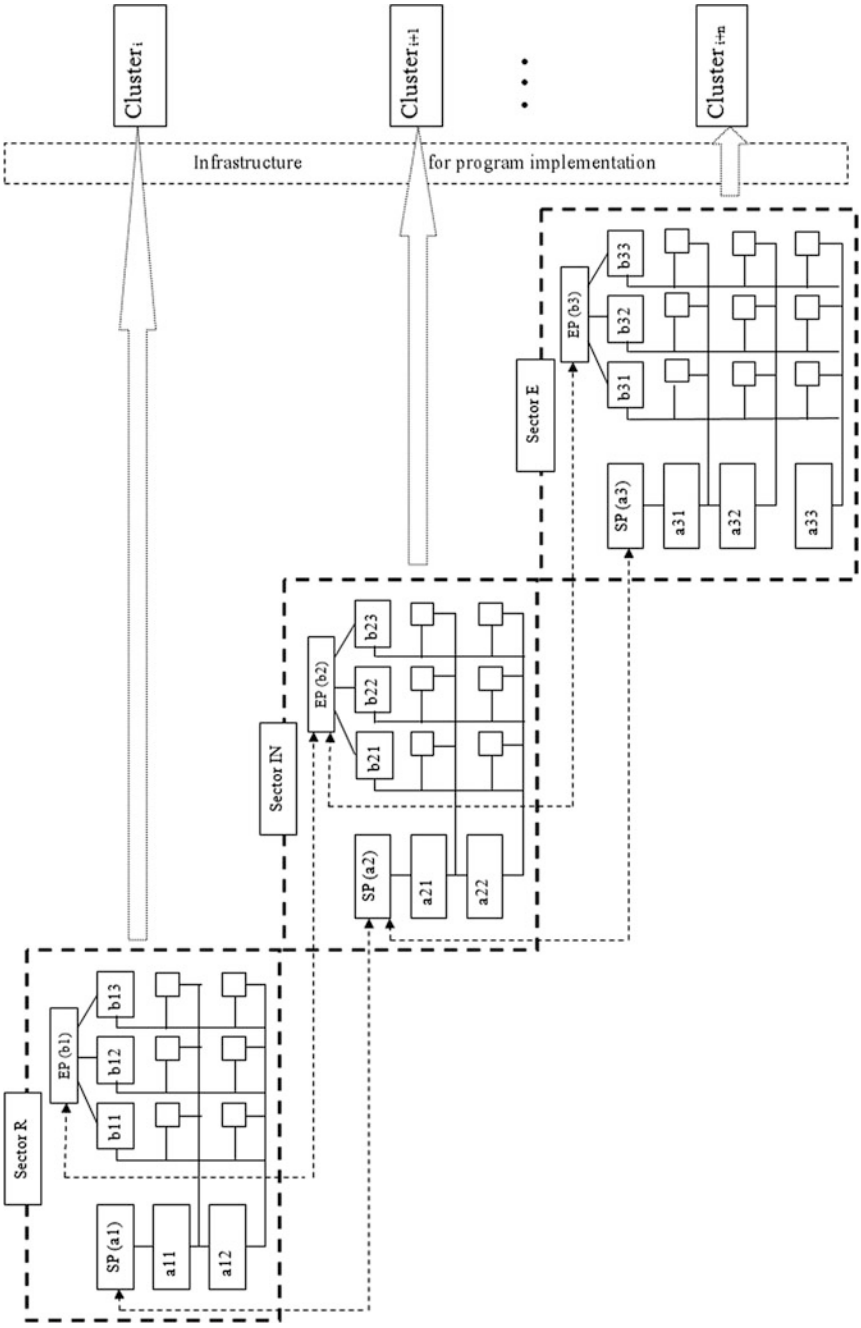

Fig. 2 Interaction of the higher education system and clusters of the region in the "equal coalition" scheme. *Source* Authors

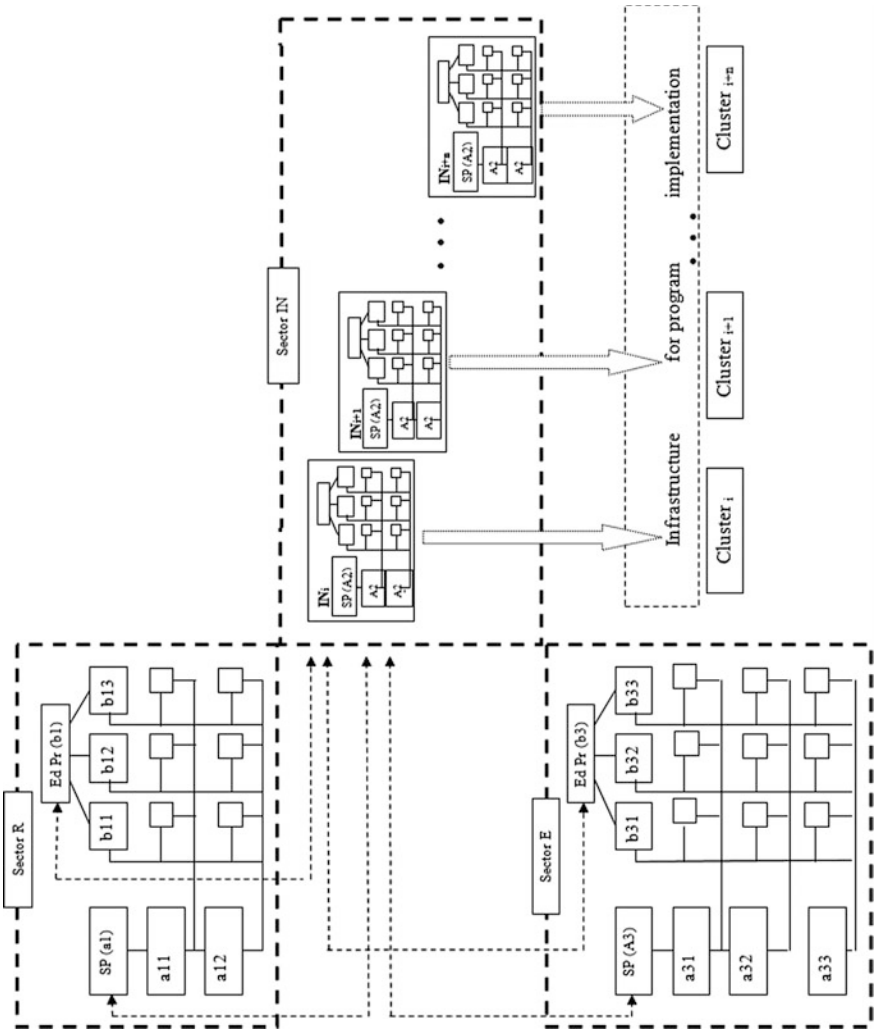

Fig. 3 Interaction of the higher education system and clusters of the region in the "center-periphery" scheme. *Source* Authors

4 Discussion

Thus, the models of the spatial organization of the higher education system and the author's network schemes for their implementation in Russian regions are constructed on the basis of theoretical provisions of the "new economic geography," in accordance with the methodology of modeling the OECD higher education system and the practical implementation of the "university on duty of regions and municipalities" model in the economy of France. The efficiency of this model, confirmed empirically in a number of scientific papers, as well as the results of the authors' own analysis makes it possible to bring the university network in the region closer to the ideal "learning" system that is widely used for organizations working in the field of innovation. The advantages of the proposed network schemes for implementing the "university on duty of regions and municipalities" model; in the economic space of Russian regions include: (a) adaptability—ability of the higher education system to adapt to changes in demand for research program results and graduate competences through the selection of programs, corresponding to the needs of a separate cluster; (b) targeting—ability of higher education institutions to solve innovation tasks specific for a particular cluster; (c) profitability, which is created as a result of conducting research at the same time for several sectoral clusters; (d) motivation—use of market mechanisms in the formation of orders for research and education programs, which increases the interest of universities in the final results of their activities.

5 Conclusions

In accordance with the urgency of the innovative development in Russian regions and the role of higher education in ensuring this development, the authors studied the theoretical foundations and foreign experience in developing spatial models of the university network. Based on the provisions of the "new economic geography," the OECD modeling methodology and the analysis of foreign experience, a hypothesis was advanced about the high efficiency of modeling spatial organization as a tool for managing the development of the higher education system. The methodology of management, the proposed spatial model: "university on duty of regions and municipalities" and the developed schemes for its implementation, substantiated by the authors, firstly take into full account the processes of clustering that are actively taking place in the economy of Russian regions; secondly, they make it possible to bring the university network closer to the ideal innovative "learning" subsystem; in the third, this subsystem is oriented to contribute to the social and economic development of regions, as one of the main criteria for the development of the university network.

Appendix 1

See Fig 1.

Appendix 2

See Fig. 2.

Appendix 3

See Fig. 3.

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