Diagnosis of Conditions for the Formation of Innovation Clusters in Russian Regions: Mathematical and Statistical Approach

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Abstract The methodical approach to the analysis of the spatial differentiation of conditions and factors in the development of innovative mesoeconomic systems (clusters) based on multi-dimensional classification of the resulting indicators in subspaces of overall economic efficiency of development of regions of the Russian Federation, the effectiveness of individual activities, the degree of development of small business and innovation indicators for regional development. The system of informative indicators for grouping regions on the resulting system gauges. In the resulting typologies tested the hypothesis of statistical significance of differences of quality characteristics of the institutional environment, the influence of factors of urbanization, etc.

Keywords: innovation cluster, institutional environment, multidimensional classification, statistical hypothesis testing

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1. Introduction

Taking an approach of institutional economics, clusters of small and medium-sized enterprises are seen as a way of industrial organization, covering both geographical and sectoral specialization, and competing with large companies. They are geographical concentration of enterprises in one or several related industries competing, but at the same time cooperating with each other, thus gaining the benefits of co-location and social embeddedness. Among the principal characteristics of these mesoeconomic systems are: specialization (the unity of the market, processes, etc.), innovativeness, the multiplicity of actors (companies, research institutions, financial institutions, universities, governments, non-governmental organizations), the presence of a life cycle (stagewise development).

Since the 90-ies of the XX century, the scientific literature dedicated to clusters is actively discussing the issues of cluster identification and cluster formation via an effective cluster policy. Without going into a detailed review of individual sources, we note some of the recent studies in which these issues are well represented [3; 4]. Back in 1995, at a national conference on clusters in Arizona (i.e. The North American Cluster Conference, Sedona, June 1995) a formula for determining the dominant clusters was proposed, the so-called "index cluster of power". According to this formula, the concentration of production in the cluster must not be less than 40%, the economic growth - not less than 10%, the cooperation ties among enterprises participating in the cluster - not less than 10%. This made it possible to identify the 380 largest US clusters in the fields of high technology, consumer goods, service industry, and the extraction of natural resources. These clusters incorporated up to 57% of the labor potential of the country, producing 61% of GDP.

Nevertheless, the problem of identifying clusters has not lost its relevance up to date. It should be noted that there is no uniform methodology for the identification and mapping of clusters based on the key indicators and procedures that can be used to determine the geographical boundaries of clusters and their specific parameters (e.g. cluster efficiency, competitiveness, innovativeness, etc.). Different countries and regions tend to define clusters using many special ways, via a wide variety of research techniques and criteria [2]. Existing approaches are mainly empirical and vary considerably.

Most of the known methods are essentially based on two main approaches to the allocation of clusters. In the first, which can be called "top-down", the principle of cluster identification is based on the industry sector of its participants and is used to detect regional clusters, i.e. a nationwide sample that is defined by spatial localization of production, which is focused on a specific type of economic activity. The second approach uses a technique, which is conventionally called a "bottom-up" approach, where clusters are being identified at a specifically selected area, based on the presence of local industry leaders. All other approaches to the identification of

economic clusters, in one way or another, vary between the two approaches mentioned above.

The first approach relates to the meso-level and is applicable in a situation when, for example, the regions want to identify not yet clearly formed mechanisms of interaction and potential alliances between the well-known major industries and sectors that are still underdeveloped. These techniques tend to be useful in situations of almost full uncertainty.

The second, micro-level approach is suitable for situations where the leading industry in the region is being allocated, but the mechanisms that allow individual firms to strengthen their competitive advantage through collaboration with other companies within these industries are left unclear. However, the micro-level approach is unproductive when it is required to detect an industrial clustering at the regional level, since it does not allow forming a holistic view of the development of the regional economy due to its laboriousness [1].

The purpose of this paper is to develop an approach capable of identifying the conditions conducive the formation of innovation clusters, which is an integral part of an overall methodology for their identification within the lack of information on not only the clusters, but also considerable uncertainty in the possibility of their occurrence in the prevailing socio-economic and institutional conditions. The need for such macro-level analysis of the Russian economy is defined by the fact that the long-term strategies for socio-economic development of the Russian Federation consist the proposals for the creation of regional clusters in different sectors of the economy, sometimes without proper justification.

Since information on the activity of clusters (as well as on officially registered clusters) is virtually absent in the Russian economy, the study of the impact of economic, infrastructural, institutional, and socio-cultural conditions on their activities without conducting a special survey is not possible. However, it is possible to conduct such research at the regional level based on official statistics. Regional statistics reflects the conditions listed above, which are external to the economic systems operating in the region. Moreover, during the transition from one region to another there is a certain variation of these conditions, caused by intra-regional specifics. The impact of these external factors on the regional economic systems leads to variation of functional efficiency of the region's economy and the development of innovative processes in it. This approach does not allow to take into account internal factors of individual economies, being no less important than the external ones. However, it allows to answer the question about the general favorability of the "regional background" for the development of innovation and improvement of the competitiveness of regional economies.

2. Research Methodology

The proposed methodological approach to the analysis of spatial differentiation of conditions and factors affecting the development of innovative mesoeconomic systems (i.e. clusters) is based on a multivariate classification of resulting indicators in the subspaces of the: a) overall economic efficiency of the development of Russian regions, b) the effectiveness of certain types of activities, c) the degree of development of small business, d) and the innovation indicators of regional development. Thus in the study is designed to test the statistical hypotheses about the impact of regional infrastructure, institutional, socio-cultural and other conditions on the heterogeneity of economic and innovative development of the territories (Figure 1).
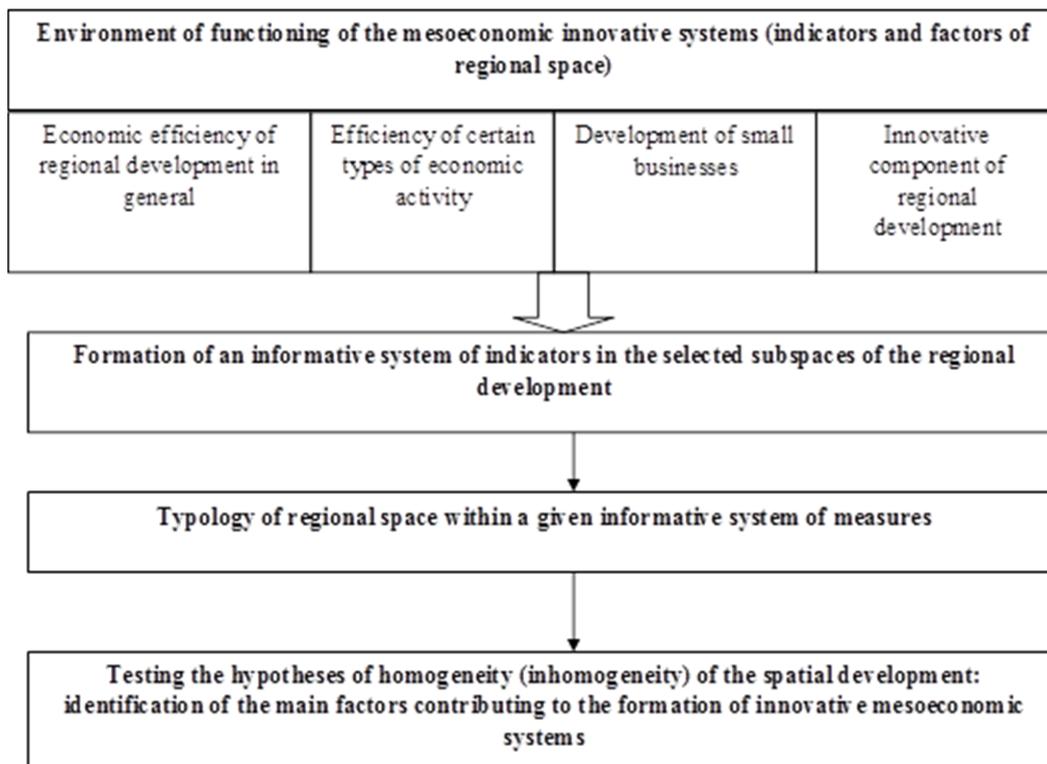
Figure 1. Framework for the analysis of spatial differentiation of the meso-economic systems

The applicability of this method is defined by the objective inhomogeneous development of the set of regions of Russia, characterizing the investigated sampling frame, the direct and indirect effects of infrastructure, socio-cultural factors, the institutional environment on the economic and innovative activity of the regions.

The method is based on two main blocks: 1) classification (typology) of the regional space in the scorecard "economic efficiency - innovativeness - the development of small businesses - the structure and productivity of certain economic activities" and 2) search for statistically significant factors causing regional differences in the resulting typologies.

The use of a multivariate classification of the regional space in the selected system of indicators follows the results obtained in [4]. Research results of the regional aggregate for the period of 1995 – 2006, drawn in the context of innovation indicators, have shown a significant statistical difference between the regions of the Russian Federation according to their respective industrial structure and productivity of various types of economic activity, the overall economic efficiency of the regional economy, the development of small business in the regions and others. The expansion of the quotient space and the use of statistical data for the year 2007 has allowed to verify the validity of previously obtained conclusions as well as to obtain new results on the effect of external "regional background" on the efficiency and innovative development of the regions of Russia.

3. Analysis of Obtained Results

The testing ground for the proposed methodological approach was the data of Rosstat on the development of 80 regions of the Russian Federation for the year 2007 [5]. The choice of the study period caused by the fact that it was characterized by the general growth of the Russian economy and due to the lack of effect of force majeure crises. A total number of 205 regional development indicators were investigated, including indicators reflecting the efficiency of the economy (e.g. specific indicators of GRP, its dynamics, per capita income and its dynamics, the performance of certain economic activities, etc.), indicators reflecting the demographic processes in the given region (e.g. population change, life expectancy, migration processes, the relationship between urban and rural population, etc.), employment rates for certain types of economic activities. Authors considered a large block of indicators of the innovation development of the territories (e.g. the volume of innovative products, employment in the research sector, the share of the costs at the various stages of the innovation cycle, etc.). Particular attention was paid to the indicators of small businesses development (e.g. turnover of small business, employment in small businesses, etc.), serving as indicators of entrepreneurial activity in the region, as well as contributing to the creation of innovative products.

Since one of the main objectives of the study was to investigate the influence of the institutional environment on the development of innovative regional clusters, regional differentiation of such indicators as the presence of social, religious, and political organizations, as well as their structural composition was investigated.

An investigation also involved the comparative contradistinction of factors of regional infrastructure (e.g. transport links, communications, etc.), and factors of social infrastructure - education, health, culture.

3.1. Interrelation of Classifications of Regions in Individual Subspaces

We shall briefly discuss the classification of individual subspaces. Classification of regions by their economic efficiency was carried out using the index of GRP per capita. In order to obtain the classification in the space of productivity of the types of economic activity parameters, authors used indicators of per capita production in the sections of the following types of economic activities: A, C (CA, CB), D (DA, DB, DC, DD, DE, DG, DH, DI, DJ, DL, DM, DN), F, G, H, I, J, K, L, M, N, O, E. In this case, in order to isolate the informative subsystem of indicator for a specific types of economic activities, authors have previously used a statistical factor analysis.

Classification of regions in the subspace of small business development was carried out using indicators of small business turnover per capita, the share of small enterprises in national and regional scale, employment in small business, and small business performance in terms of turnover.

Innovativeness of the territory was characterized by the production of innovative products in the total volume of output, indicators of scientific and educational complex, statistics on the use of advanced technologies, the intensity of patenting activity, and others.

Analysis of the interrelation between the typologies in individual subspaces revealed an impact of the productivity of individual economic activities (such as manufacturing and mining), as well as small businesses on the region-wide cost-effectiveness. As for the factor of innovativeness, its significant impact on the efficiency of the economy has not been established. However, with regard to the productivity growth of certain types of economic activity the influence of this factor is rather significant (e.g. chemical and petrochemical plants, metallurgy, machine building).

Following the logic of the methodological approach used (Figure 1), a unified informative scorecard classification was formed, provided by the generalized system of orthogonal factors resulting from the application of multivariate factor analysis to the original system of the studied variables characterizing regional economic efficiency, productivity of economic types of activities, the development of small business and innovative development of the territories. In the framework of this system a classification was carried out, the results of which are presented across the regions of Russia (Table 1).

In the first type of regions fell the subjects of the federation, that have the highest GRP per capita, per capita income and per capita income concentration index (Gini index) (corresponding to the average values - 214, 8 thous.rubles, 13,6 thous.rubles, 0,42). We shall note a specific feature of the obtained classification as a significant difference for most types by innovation indicators. For instance, the first type of regions reflects the totality of the subjects of the federation, differing by the rates of innovation activity, being higher than the national average level (Table 2).

Table 1. Distribution of regions of the Russian Federation in accordance with the typology in the joint space of indicators

Type 1	Type 2	Type 3
Belgorod region, Moscow, St. Petersburg, Kaliningrad region, Kemerovo region, Krasnoyarsk region, Leningrad region, Lipetsk region, Magadan region, Moscow region, Murmansk region, Nizhny Novgorod region, Orenburg region, Perm Krai, Republic of Bashkortostan, Republic of Komi, Republic of Sakha (Yakutia), Republic of Tatarstan, Samara region, Sverdlovsk region, Tomsk region, Chelyabinsk region	Altai Krai, Amur region, Bryansk region, Vladimir region, Volgograd region, Jewish Autonomous Region, Irkutsk region, Kaluga region, Kirov region, Krasnodar Krai, Kursk region, Novgorod region, Novosibirsk region, Omsk region, Penza region, PrimorskyKrai, Republic of Buryatia, Republic of Karelia, Republic of Khakassia, Saratov region, Tambov region, Tver region, Tula region, Udmurtia, Khabarovsk Territory, Republic of Chuvashia, Yaroslavl region	Arkhangelsk region, Astrakhan region, Voronezh region, Trans-Baikal region, Ivanovo region, Kabardino-Balkar Republic, Kamchatka Krai, Karachay-Cherkess Republic, Kostroma region, Kurgan купшщт, Orel купшщт, Pskov region, Republic of Adygea, Republic of Altai, Republic of Dagestan, Republic of Mari El, Republic of Mordovia, the Republic of North Ossetia - Alania, Tuva Republic, Rostov region, Ryazan region, Sakhalin region, Smolensk region, Stavropol Krai, Ulyanovsk region, Chukotka Autonomous Okrug

Table 2. Significantly distinct mean values of innovation activity indicators, 2007

Type	Share of enterprises engaged in technological innovation, %	Current domestic expenditure on R&D as % of GRP	Share of current expenditure on applied research in the internal current expenditure on R&D, %	Number of organizations involved in research, units	Number of personnel engaged in R&D per 10,000 employees in the economy	Number of researchers with academic degrees, per 10,000 people employed in the economy of the region	Number of advanced technologies created
1	10,30	1,22	0,23	109,36	111,68	13,65	27,75
2	7,69	0,85	0,14	33,59	58,11	7,15	8,95
3	5,85	0,54	0,24	21,12	36,73	4,72	5,38
Total sample	7,82	0,85	0,20	51,49	66,41	8,21	14,45

The statistical significance of deviations less than 0,05.

The second type - the regions with the indicators of innovative activity being close to the national average. Finally, the third type - regions with innovation indicators being below the national average.

The most represented in the type 1 are the regions of the North-West and Volga federal districts. They represent the most regions of the country, which successfully carry out innovative activity - 7 and 8 percent, respectively. It represents almost half of the most successful regions of Russia. Attention is drawn to the Southern Federal District, where during the research period of 2007 not a single region fell into this group.

3.2. The Difference of Typology by Factors not Taken Part in the Classification

One of the important factors that could significantly affect the processes of modernization of regional economies, as well as the country as a whole, is the quality of the habitat. This is due to the fact that modernization is possible only with the qualitative growth of personnel, a significant increase in the proportion of scientific, technical and other personnel with demanding conditions of vital activity. In other words, it means a radical change in the conditions of reproduction of labor power and the general public that enhance the human development index in accordance with the new socio-economic realities. Typically, this is done in regions with a high level of urbanization, i.e. a high proportion of the urban population and a higher share of the cities. Thus, type 1 in the classification in question is the most populated regions with a predominance of the urban population (the average percentage of the population of these regions in the general population of the Russian Federation - 2%, the average share of urban population - 77%).

Favorable is considered to be such a city environment, which primarily meets the highest standards of the housing quality, of a set of cultural facilities, educational complex, of the ecological status, and criminal situation. The presence of such an environment has become one of the most important factors in the formation of collective intellectual capacity, capable of ensuring the development and implementation of scientific and technological breakthrough achievements. Creation of a similar environment was beneficial to the development of such research centers as the Novosibirsk Akademgorodok, Obninsk, and many others. At the same time, it should be noted that an enabling environment is an important factor in attracting investments.

Implementation of territorial interests is reflected mainly in the functioning of economic institutions through which the regulation of important types of activities in the major subsystems of the economy in the given area is held (e.g. production, income distribution, exchange, consumption of goods and services). In addition, important institutions, along with economic, are political, ensuring the establishment and maintenance of legitimate power (at the local level - local public institutions), and socio-cultural (education, healthcare, law, recreation, etc.).

These institutions are basic and form the institutional core through which the survival and development of one or another social community as a unified whole is ensured. Manifestation of the essence of social institutions and their properties is their function. The function of economic institutions is reproduction of the vital functions for members of the community. The effect of political institutions aimed at consolidating social forces, while the social and cultural institutions ensure the integration of the members of the society - perceived or latent - on the basis of common values and norms of behavior. Table 3 presents significantly distinct components of the institutional environment in the typology of regions.

An indirect confirmation of the feasibility of the proposed approach for the analysis of the possible formation of regional innovation clusters is a published list of 25 regional innovation clusters (Order of the President of the Russian Federation dated 28.08.2012, №DM-P8-5060), fifteen of which receive subsidies from the federal budget for the implementation of activities under their respective development programs.

Table 3. Significantly distinct average indicators of the institutional environment of typologies, 2007

Type	Number of non-governmental organizations in the region	Number of commercial and enterprise organizations	Number of political organizations	Number of professional organizations	Number of trade unions	Number of other public organizations, not included in other categories	Number of religious organizations	Rating of regions by the presence of self-regulatory organizations, score
1	601,45	110,36	103,19	392,59	1 191,09	1 495,23	447,45	32,85
2	206,89	33,96	53,59	119,33	655,04	773,33	251,70	39,65
3	134,96	22,65	44,08	68,23	494,15	456,00	196,00	48,71
Total sample	297,69	52,45	64,32	181,77	756,51	875,08	289,81	40,80

The statistical significance of deviations less than 0,05.

Table 4. Innovative territorial clusters

№	Subject of Russia	Cluster title	Specialization	Typology number
1	2	3	4	5
Central Federal District				
1	Kaluga region	Pharmaceutical, biotechnology and biomedicine cluster (Obninsk)	Medicine and pharmaceuticals, radiation technology	2
2	Moscow	Cluster "Zelenograd"	Information and communication technology, electronics	1
3	Moscow	New materials, laser and radiation technology	New materials, nuclear technology	1
4	Moscow region	Cluster of nuclear physics and nanotechnology in Dubna	Nuclear technology, new materials	1
5	Moscow region	Biotechnological innovative territorial cluster Pushchino	Medicine and Life Sciences	1
6	Moscow region	Cluster "Phystech XXI" (Dolgoprudny, Khimki)	New materials, medicine and pharmaceuticals, information and communication technologies	1
Northwestern Federal District				
7	Arkhangelsk region	Shipbuilding innovative territorial cluster of Arkhangelsk region	Shipbuilding	3
8	St. Petersburg	Development of information technology, electronics, instrumentation, communications, and infotelecommunications of St. Petersburg	Information and communication technology, electronics, instrumentation	1
9	St. Petersburg	Cluster of medical, pharmaceutical, radiation technologies of St. Petersburg	Radiation technology, medicine and pharmaceuticals	1
Volga Federal District				
10	Nizhny Novgorod region	Nizhny Novgorod industrial innovation cluster in the automotive and petrochemical industry	Oil and gas refining and petrochemicals, automotive	1
11	Nizhny Novgorod region	Sarov Innovation Cluster	Nuclear technology, supercomputing technology, laser technology	1
12	Perm Krai	Innovative territorial cluster of rocket engine	Manufacture of aircraft and spacecraft, engine manufacturing, new materials	1
13	Republic of Bashkortostan	Petrochemical territorial cluster	Oil Refining and petrochemicals	1
14	Republic of Mordovia	Energy-efficient lighting and intelligent lighting control systems	Instrumentation	3
15	Republic of Tatarstan	Kamsky innovative regional production cluster of the Republic of Tatarstan	Oil Refining and petrochemicals, automotive	1
16	Samara region	Innovative regional aerospace cluster of Samara Region	Manufacture of aircraft and spacecraft	1
17	Ulyanovsk region	Consortium "Scientific-educational and industrial clusters" Ulyanovsk-Avia"	Manufacture of aircraft and spacecraft, new materials	3
18	Ulyanovsk region	Nuclear Innovation Cluster of Dimitrovgrad, Ulyanovsk region	Nuclear technology, radiation technology, new materials	3
Ural federal district				
19	Sverdlovsk region	Titanium Cluster of Sverdlovsk region	New materials	1
Siberian Federal District				
20	Altai Krai	Altai biopharmaceutical cluster	Medicine and pharmaceutics	2
21	Kemerovo region	Complex processing of coal and industrial waste in the Kemerovo region	Chemicals, energy	1
22	Krasnoyarsk Krai	Cluster of innovative technologies ZATO in Zheleznogorsk	Nuclear technology, aircraft and spacecraftproduction	1
23	Novosibirsk region	Innovative cluster of information and biopharmaceutical technologies of Novosibirsk region	Information and communication technology, medicine and pharmaceuticals	2
24	Tomsk region	Pharmaceuticals, medical equipment and information technology of Tomsk region	Medicine and pharmaceuticals, information and communication technology, electronics	1
Far Eastern Federal District				
25	Khabarovsk Krai	Innovative territorial cluster of aircraft building and space vehicles, shipbuilding	Manufacture of aircraft and spacecraft, shipbuilding	2

Source: Based on the data of the Ministry of Economic Development of Russia and author calculations. Highlighted are the clusters subsidized by the federal budget.

Table 4 shows the data on the clusters indicating their typological belonging determined by the method described in this article.

Of the total number of innovative cluster projects being subsidized by the federal budget more than 70 percent, belong to the regions within the most promising group 1, selected according to data as of the year 2007, which indicates an acceptable predictive ability of the proposed method.

4. Conclusion

The study produced the following results:

1. The regional differentiation of territories of the Russian Federation was identified in the context of individual subjects of the federation and the federal districts by three main types – territories being more favorable for the development of innovative processes, the territories in which the development of innovative processes corresponds to the Russian average trends, and territories, which exhibit slowed innovation processes.

2. Demographically, the most favorable for the development of innovative processes are the heavily populated territories with predominantly urban population (an average of 77%). These areas are very attractive for migrants (33% of the population of these places according to the 2002 census were not born in the given area).

3. Innovative activity of the territory corresponds to the more developed educational complex in both quantitative and qualitative respect, and more demanded institutions of culture, sport and recreation.

4. With regard to per capita output of production by the type of economic activity, the products of engineering, chemical, metallurgical complexes dominate in the more developed regions, from an innovative point of view.

There are no statistically significant differences in the agricultural output per capita.

5. In most innovatively and economically developed regions the level of institutional development is significantly higher in comparison with other subjects of the Russian Federation: more public and political organizations, trade unions, religious organizations (by 2 - 3 times).

Support

References

[1] Bergman, E.M. and E.J. Feser, *Industrial and Regional Clusters: Concepts and Comparative Applications*, Regional Research Institute, WVU. 1999. [Online].

[2] Available:http://rri.wvu.edu/WebBook/Bergman-Feser/contents.htm[Accessed March. 15, 2014].

[3] Doeringer, P. and D. Terkla. Business Strategy and Cross-Industry Clusters. *Economic Development Quarterly,* 9 (3). 225-237. 1995.

[4] Kutcenko, E.S.,*The cluster approach to the development of innovative economy in the region*. Thesis for the degree of candidate of economic sciences. Moscow, Federal State research institution "Council for the Study of Productive Forces" Russian Economic Development Ministry and the Russian Academy of Sciences, 2012. 235 p.

[5] Markov, L.S., Yagolnitser, M.A.,"*Clusters: formalizing the relationship in nonformalized structures*". Publishing IEIE SB RAS, Novosibirsk. 2006. 195 p.

[6] *Regions of Russia*. The main characteristics of subjects of the Russian Federation by 2008. Statistical Yearbook, Moscow, 2008.