CROSS-REGIONAL INTERACTIONS AS A SOURCE FOR INNOVATIVE REFORMATION (THE CASE OF RUSSIA)

Elena V. Kozonogova

Perm National Research Polytechnic University, Perm, Russia

The processes of Soviet Union disintegration back in the 1990s have negatively influenced the Russian Federation's economic environment. According to some experts, the total volume of cross-regional economic relations became 4 times lower. There was practically a split of the economy into the export sector and the sector working for the domestic market solely. Under such developmental conditions, achievement of sustainable economic growth, the rise of the country's competitiveness and its transfer to the innovative model of development directly depends on successful overcoming of the current autarkic tendencies. This requires the reform of cross-regional relations' system aimed at efficient use of territories' competitive advantages, in the interests of both standalone regions and the state as a whole. Solution of all the related problems belongs to the competence of federal and regional authorities interested in transition of Russian industries into the truly innovative ones.

Keywords: cross-regional interaction; cluster; innovative development; Russian Federation

Introduction

Innovative development today belongs to the most topical problems, both for science and for public authorities in any country. This, relatively new, type of development is impossible without territorial integration which is to provide free movement of production, investment and labour resources between regions of a country.

In Russia, formation of the full-fledged cross-regional integration is complicated by significant distances between the administrative territories and insufficient development of transport communications inside the country. This leads to serious cross-regional differences in terms of production, scientific and natural potentials. Besides, a significant share of the already formed production and trade relations inside the country and also with the former republics of the USSR have been distorted during the 1990s as a result of rapid and not always thought through transition to market economy.

Elena V. Kozonogova

Post graduate student of Perm National Research Polytechnic University, Perm, Russia (since 2014). Her scientific interests are mathematical modelling in economics, clusters, innovative development. Since 2011 she published more than 20 articles in Russian federal and international journals; participated in more than 10 International scientific – practical conferences.

E-mail: elenaa.semenovaa@gmail.com

CROSS-REGIONAL INTERACTIONS AS A SOURCE FOR

Consequently, Russian economy is characterized by rather distinct interregional heterogeneity and disbalances in its spacial development, both socioeconomic and innovative. This conclusion is additionally proved by vast empirical data, available from both Russian and foreign studies.

Most of the researchers in this field are unanimous in the statement that cross-regional differentiation in Russia does not only exist – it actually leads to a range of rather negative externalities. Agreeing with most of the ideas of the “new economic geography” here, we think that inequality in the territories’ development levels within market economy would be impossible to smooth fully. At the same time, artificial smoothing of per capita incomes between the regions as performed by federal authorities through resources redistribution may lead to lower rates of economic development of the country as a whole.

Therefore, externalities from cross-regional differentiation should be more positive. And this would be possible provided cross-regional cooperation effects dominate over the effects from cross-regional competition. This would enable the widening of spacial borders for economic activity in some regions by means of the others. In this case, cross-regional differentiation will become not only the resource increasing the welfare level in particular regions, but would also be the catalyst of innovative development for the national economy overall.

Theoretical and practical importance of reforming the cross-regional relations’ system which is an integral element of innovative development of the regions and the country has determined our choice of the objective and the subject matter for this research.

Background

The means of cross-regional economic interaction were formed during a long period of time, in parallel to social division of labour and the development of production and trade relations. Therefore, considerable attention of scientists, since Adam Smith with his theory of absolute and relative advantages to the present time, is paid to the problems of studying the nature, forms, advantages and effects of cross-territorial interaction and cooperation of economic subjects. Analysis of the contemporary academic literature on this subject matter has revealed that the problems of cross-regional interaction are considered by analysts either in the context of globalization when economic subjects cooperate with each other with the aim to win in the international competition (Torre et al., 2005; Ovcharenko, 2001; Etzioni, 1965) or in the light of inequality observed in regional development (Pyke & Sengenberger, 1992; Song, 2007; Plikhun & Kiselev, 2009). These problems are also often examined in the frames of “center-periphery” theory, the theory of growth poles and development centers, and the theory of territorial industrial engineering.

A great number of published works concerning this problem are studying the levels’ correlation between the cross-regional interaction and the innovative activity (Audretsch, 1999; Fritsch, 2003; Grotz & Braun, 1997). Thereupon, it should be mentioned that as the development of new directions and instruments of innovative policy realization progresses, research on such directions in the cross-regional interaction starts to cover also the theory of production localization (Krugman, 1993; Moreno et al., 2005; Woodward Douglas, 2012), the benchmarking of territories (Atkinson & Andex, 2008; Groenendijk, 2010; Huggins, 2008), territories’ intelligent specialization (Reid & Miedzinski, 2014; McCann & Ortega-Argilés, 2011).

Despite the obvious research results already achieved in the field of cross-regional interaction and its influence on economic development, scientific achievements connected with evaluation of such interaction effects have been still incomplete.

It is necessary to mention here that in scientific works the description of cross-regional interaction effects is presented, as a rule, on the basis of interdisciplinary analysis: the institutional economic theory, the theory of communication, theory of complex systems, synergetics and even logistics. For example, Russian sociologist A.E Shastitko (2009) considers cross-regional interaction, namely clusters, following the logics of contemporary institutional economic theory. This author notes that special interdependence which allows deriving particular rent appears between the participants of a cluster when technical independence is combined with the factual one.

L. Leidsdorf (2008) describes the effects of three agents of development interaction (representatives of science, business and government) from the standpoint of the theory of communication. In his opinion, interaction of these three agents lowers the level of uncertainty in the process of decision-making and allows creating new knowledge right along.

A.A. Bogdanov (2003) examines the effects of interaction from the standpoint of system analysis. When several components are combined into an organized system, it happens so that the addition of their activities (the so-called “positive demonstration”) is providing a considerable effect while “the opposition” (the negative impacts from the opposing activities of the combined components) is not yet formed.

After the analysis of Russian and foreign scientists’ results, the authors have concluded that the considered approaches to the evaluation of cross-regional clusters’ efficiency do not fully adequately take into account the influence of clusters on territories’ development. Moreover, the existing methods do not allow applying these indicators as universal ones with regard to the economic systems’ differences in the levels of their development.

Theoretical and methodological grounds for this study have been shaped by numerous works in the fields of geopolitics, production forces allocation, network economy, industrial regions’ development and clusters. The information and empirical basis for this research consists of Russian legislation and regulatory acts; information & analytical databases available online on the site of the Federal Service for Public Statistics of Russian Federation; the results of the sociological surveys; other materials published in Russian and foreign research sources; media sources.

Several key approaches are suggested for application in this study.

First of all, the methodology developed within institutional evolutionary economic theory. It would enable defining the regularities in formation and development of the institutes needed for the functioning of cluster structures as the leading form of cooperation between economic subjects.

The second approach is based on the ideology of hierarchical analysis of territorial economic systems. Within the framework of the hierarchical approach we study the processes taking place at various levels of the economy. This approach also includes the analysis of the hierarchical structure of the participants and their interconnection within particular regions. It also covers the determination of opportunities for their cross-regional efficient cooperation.

Thirdly, we aim at application of mathematical statistics methods (including correlation and regression analysis, grouping/clustering method and cluster analysis).

CROSS-REGIONAL INTERACTIONS AS A SOURCE FOR

Applying these three methodological approaches to the analysis of the effectiveness of cross-regional clusters would increase the soundness of our conclusions and would also provide a chance to pay attention to those aspects which remain uncovered/understudied in case if only one of these approaches is applied.

Importance of Cross-regional Interaction

Economic development of any country would be impossible without inter-territorial integration. The latter concerns both inter-state integration and integration of the regions within one country. It is the integration realized through interaction and cooperation of economic subjects that provides free migration of manufacturing, investment and labour resources.

Inter-regional cooperation allows strengthening cultural and business connections and optimizing infrastructure placement on the basis of regional cooperation. It makes possible to eliminate excessive financial expenditures connected with creation and functioning of the regional duplicating economic structures and unjustified inter-regional competition; to pool resources and needs of territories aimed at realization of large-scale investment projects, and to distribute effective experience in the field of innovative development.

Formation of regional interaction in the RF is complicated by considerable distances between territories and by poor development of transport infrastructure. Due to these factors, Russian economy is characterized by great inequality of spatial development, both socioeconomic and innovative one (Akhmetova, 2014). Extensive empirical data confirms this conclusion. Thus, according to the National Bureau of Economic Research results, the difference between GRP level per head in the richest and the poorest regions of Russia is 25-fold (Gennaioli, 2013).

According to the state statistics, at the end of 2014 only five regions in Russia provided about 40% of the country's GRP. Sharp inter-regional differentiation in the socio-economic and innovative development inevitably leads to continuous increase in the number of regions where the income level per head is lower than the country's average.

Mass concentration of resources in the developed territories and stagnation of poor ones have become the result of such a situation. Returning to the problem of inter-state integration it should be noted that development of foreign economic relations of Russian regions does not always promote the growth of inter-regional relations. It is preconditioned by commodity composition of Russian imports and exports. As A.G. Granberg (2004) mentioned, "The growth of the world market influence on Russian economy has become one of the main reasons of inter-regional relations' weakening. Domestic commodity producers were intensively driven out of the home market by imports. And this process was promoted by the reduction of customs tariffs and cancellation of the most nontariff import restrictions. As Russian export primarily consists of initial processing stage products (fuel, raw materials) while import consists of highly processed products (first of all, consumer goods), foreign trade growth hardly concerns domestic inter-branch industrial communication, and, consequently, inter-regional relations".

For these and other reasons, the structure of regional economies is a significant factor of inter-regional cooperation. Therefore, development of inter-regional cooperation acts as an important factor of enhancement and quality of economic growth in the light of transition to the innovative model of the RF development.

Following the logic of the Triple Helix model, the representatives of industrial enterprises, scientific community and public authorities are believed to be the subjects of cooperation in economic systems. Taking into account this classification, it is necessary to also mention that the same subjects are considered to be the participants of inter-regional cooperation. The exclusive distinction is that these subjects belong to different territories. At the same time, they have common interests and needs.

The following general directions of inter-regional cooperation are distinguished by scientists:

- motivation of business connections between economic organizations;
- development of advanced technologies in the sphere of national security;
- association of production and research aimed at conducting research and development activities;
- founding of the objects for the development industrial and social infrastructure;
- education of engineering and technical manpower;
- mobilization of investment and commercialization of research.

The so-called “innovative landscape” appears in the process of economic subjects’ cooperation. Its specific character makes it possible to reduce every participant’s costs directed on such operations as information interchange, the search for contractors and/or partners, funding of the project, products and services promotion, etc. (Basov & Minina, 2014).

Hierarchy establishment and innovative landscape localization lead to formation of a production complex denominated as a cluster.

Clusters as the Instrument of Interaction

The term “cluster” involves such meanings as swarm, bunch, accumulation, group, and is used in many fields of science and technology.

Clusters are known as geographic agglomerations of companies, suppliers, service providers, and associated institutions in a particular field (Porter, 2007).

It should be mentioned that only in the 1990s clusters started being treated as “applied key factors”. To a large extent this happened thanks to the works of Michael Porter. But the very idea of enterprises’ cooperation aimed at cost reduction and competitiveness improvement was originated back in the middle of the 19th century. It became the basis for localization theory presented by I. von Thünen (1896) in 1826. Later, it was developed further by A. Marshall (1920) in his description of industrial regions of the Great Britain in 1850, as well as by A. Weber (1929), in his industrial location theory in 1929.

All over the world scientists made profound analysis of economic relations in the frames of producers’ cooperation. At that, despite different denominations, such as clusters, blocks of development, industrial units, territorial-production complexes, scientific-production associations, etc., in the frames of these formations economic subjects act as the elements of the single territorial innovative system.

Cluster structures are convenient for the state as the required element of any cluster is a special management company responsible for the joint results. Federal state structures cooperate according to the “one window” principle: firstly, with this managing company regarding organizational issues; secondly, with regional authorities with respect to legal problems; thirdly, with organizations regarding financial matters. Thus, the realization of

CROSS-REGIONAL INTERACTIONS AS A SOURCE FOR

national innovation and industrial policy on every level of economy, from macrolevel to microlevel, is provided.

In theory, cluster structures can be formed on the different levels of economy (Tab. 1).

Table 1 - Value chain approach at different levels of analysis
(Source: Soshnikova, L.A., 1999)

Level of analysis	Cluster concept	Focus of analysis
National (macro)	Industry groups' linkages in overall economic structure	Patterns of specialization in national/regional economy Innovation and technology upgrade needs in mega-clusters
Branch or industry (meso)	Inter- and intra-industry linkages at different stages of production chain of a single end product	Industry benchmarking and SWOT (strengths, weaknesses, opportunities, threats) analysis Innovation needs
Firm (micro)	Specialized suppliers around one or a few core enterprises (inter-firm) linkages	Strategic business development needs Value chain analysis and chain management Need for collaborative innovation projects

It is necessary to mention that industrial clusters in the USA, Australia, and also in some states of Europe and Asia have already served as the instruments of regional and local development for more than 30 years (Faskhutdinov, 2014).

M. Porter argued that clusters tend to be geographically concentrated. At that, E. Feser (1998) noted the possibility of developing interaction and cooperation between the enterprises located far from each other. He defines two core dimensions of the cluster concept: economic and geographic one.

Geographical proximity of actors becomes an insignificant condition for efficient functioning of clusters. Moreover, estimating alternative variants of cost reduction through saving on different types of expenses (transport, production, experimental stage, etc.), enterprises will cooperate but not necessarily with the actors located next door.

Still, at present, cluster initiatives are realized in most countries, including Russia, in the borders of certain regions.

The history of innovative clusters' formation in Russia started relatively late, back in 2012, when the Ministry of Economic Development announced the first competition of pilot programs aimed at development of innovative territorial clusters. According to the results of double-step estimation, 25 regional programs were then selected from the total number of 94 tenders, and the List of innovative territorial clusters was approved (Gokhberg & Shadrin, 2013). According to the RF Government Regulation as of 31.07.2015 No 779 "On industrial clusters and specialized organizations of industrial clusters", these clusters became the pilot ones. Mechanisms and principles of governmental support for cluster initiatives were practised on their example; standard requirements to clusters and the systems of their management were then developed.

At the moment, 26 territorial innovative and 17 industrial clusters situated in 22 regions of the country have financial support in Russia.

The following specific features of Russian clusters should be mentioned here. First of all, Russian innovative systems are defined by scientists as highly closed ones. It means that

principally non-public knowledge is used by organizations in creating innovations. Such an approach was peculiar to the earliest models of innovative development (Akerman, 2011).

Indeed, the majority of the currently existing clusters in Russia are not expected to disseminate information on their activities and/or to use online instruments for involving new members, to inform about the results of conducted research and prospects for future development. Besides, territorial innovative clusters are usually based on the already existing relations between science and business. As a rule, such cooperation takes place when they develop certain technologies for production of goods meeting well-marked demands of the industry.

Thereby, cluster structures often act as an instrument for attracting government financing for complex long-range cost-based and science-intensive projects.

The circle of participants, their functions and expected results are clearly determined by the program of the government support of clusters in Russia which forms the institutional base of cluster cooperation. Modification of the behaviour, from regions' competition to regions' cooperation, along with the change of institutional environment for inter-regional cooperation depends, in the first place, on the state authorities.

We accept the widespread opinion that "combination of cooperation and competition is the characteristic feature of industrial-innovative clusters' development" (Kucherenko, 2013).

However, while competition is the result of opposition between the actors' interests, cooperation appears as a result of combination and coincidence in the needs and actions.

If we single out the key industries (they form "the core" of a cluster), the related branches (they are denominated as additional with respect to the key industries) and then the servicing industries, we will see that cooperation is more typical for the first ones while the second and the third industries are usually facing strong competition and minimal cooperation.

The Concept of Competitiveness Growth through Cross-Regional Clusters

In the field of cross-regional interaction, regions participating in tenders for federal financing compete with each other. This is preconditioned by the lack of common interests which brings every region to stand apart from the projects of other contenders. This tendency leads to the situation in which state financial support for cluster development is given to the territories with the highest level of industrial and scientific-and-technical potential. This fact has been already confirmed in our previous research (Yolokhova et al., 2016).

Because industry clusters, by definition, are not ubiquitous, the industry cluster policy would seem to imply at least the acceptance of a potential worsening of regional economic disparities (Feser, 1998).

Everything mentioned above is the reason for the existing differentiation between Russia's regions. For instance, according to the Rosstat data, in December 2016 the most developed region (Tyumen region) was doing 25 times better than the poorest region (the Ingush Republic) by GRP per head and the purchasing power parity. In 2014 this gap reduced to 9.2. The problem of asymmetric development in the regions of Russia is still very acute and it is still explained, firstly, by the dynamics of outstripping development in some regions and, secondly, by the phenomenon of preferential regime (Akhmetova, 2016;

CROSS-REGIONAL INTERACTIONS AS A SOURCE FOR

Mironov, 2010). Establishment of such a regime is principally connected with power policy. It is practically impossible for some regions to switch to another group without a cardinal change in the existing conditions.

However, there are still examples of successful cooperation between the regions in realization of joint initiatives and external funding for the regional level projects. Such experience makes it possible to expand the scope of territories in realization of the government programs supporting innovative projects. The example of this is the competition announced by the Ministry of Education of Russia with the aim to give government support for developing cooperation between Russian higher schools and the organizations that implement high-tech projects. Many participants of this competition have been offered cross-regional projects in 2015. Such projects determine the special character of mutual relations among economic subjects located in different regions.

Special character of classic cluster relations consists in territorial proximity of partners, and this fact is the reason for objective restrictions. Producers are in need of new customers as well as suppliers of equipment, materials and technologies outside their own region. Scientific and education establishments are in need of new scientific instruments, advanced research knowledge, joint projects and exchange of experience. And the fact that researchers are in need of new, potential customers and of service promotion is no less important. Regional authorities should go beyond the limits of territorial clusters as well, though to a lesser extent. This often depends on the demands of a federal supervising body which determines the format of financed projects.

The listed above factors predetermine the necessity of transition from cluster projects' realization in the frames of one region to cross-regional clusters.

Under cross-regional clusters we mean such mutual relations which take place among economic subjects from different territories in the frames of realizing such joint projects which could not be realized by any of these participants individually.

On the one hand, emergence of cross-regional clusters can be explained by the deficit of local knowledge, scientific and manufacturing equipment, raw material and goods in the frames of one territory. On the other hand, such clusters boost the potential of every actor in the process of their innovative projects' realization. One of the key features of cross-regional clusters is wide application of ICT, including international communication which fully meets the principle of "open innovations". Introduction of the latest technologies in communication and information exchange intensifies the interaction of economic relations' subjects in real-time mode.

Thus appears the necessity for creating the appropriate institutional and legal conditions for coordination of cross-regional innovative projects. It should be mentioned that there are general institutional problems in the development of cross-regional interaction among the subjects of cluster structures in Russia:

- the lack of structural reconstruction algorithm for the Russian industrial sector;
- problems with innovative activity results' application, including the problems of external economic marketing;
- problems of public involvement in discussion and achievement of expert consensus, first of all, in the most sophisticated fields (robotics, artificial intelligence, progressive biomaterials, additive technologies);
- problems of long-term investments' mobilization into innovative infrastructure and projects.

Solutions of the problems listed above may expand the boundaries of clusters' activity through stimulation of cross-regional association and cooperation. But development of such interaction is complicated by the lack of integrated legislative and methodological approaches to the regulation of innovative processes in the regions. Besides, research in the field of cross-regional clusters' efficiency has been incomplete and mostly local so far. As a result, the positive influence of cross-regional clusters on the territories' development is often underestimated.

Standardized Analysis of Cross-Regional Clusters' Efficiency

On the basis of generalization and classification of the methods used for analyzing clusters' efficiency in the process of their operation we propose the standardized analysis of cross-regional clusters' efficiency.

Under the efficiency of cross-regional clusters we understand here qualitative and quantitative changes in the regions' activity indicators, the indicators of branch operation as well as of target groups in cross-regional clusters (entrepreneurial structures, power bodies, social organizations and population).

The proposed procedure of determination and analysis for the efficiency of cross-regional clusters' operation includes 7 stages divided into three groups as follows:

1st group (Stages 1 and 2) – Algorithm of clusters' identification;

2nd group (Stages 3-5) – Algorithm of clusters' analysis;

3rd group (Stages 6-7) – Algorithm of clusters' efficiency evaluation.

Stage 1. Grouping of territories according to the level of their clusterization potential

In the previous works (Yolokhova et al., 2016) the authors have already developed the algorithm of cluster potential calculation for revealing the types of regions, stemming from Etzkowitz-Leydesdorff (2000) "triple helix" concept. This concept was used for calculating the regions' cluster potential on the basis of three indices: "Index of quality of life and infrastructure development" (X), "Index of industrial development" (Y), "Index of education level and technological development" (Z). The suggested system is correlated with the elements of "triple helix" in the following way: "Index of quality of life and infrastructure development" – "Power", "Index of industrial development" – "Business", "Index of education level and technological development" – "Science". These indices demonstrate whether the region is ready for clusterization, i.e., how efficient is the budget funding of cluster structures' development on a territory.

Every index is calculated on the basis of relevant statistical data. Selection of indicators' group for every index and further calculation of the integral indices is carried out in 5 steps.

Step 1. Groups of indicators are singled out to fully characterize each of the three indices and their multicollinearity control is carried out.

Appraisal of the calculation algorithm was made by the authors for the regions of Russia on basis of 2013 statistics. There were four indicators selected characterizing index X, one indicator for index Y and then five indicators for index Z (Tab. 2). All of them were recommended for the calculation of the integral indices.

CROSS-REGIONAL INTERACTIONS AS A SOURCE FOR

Table 2 - System of indices characterizing the cluster potential
(Source: authors calculations)

Integral Indices	Statistical indicators
1. Index of the quality of life and infrastructure (X)	Total area of living space per head on average
	Population size per one hospital bed
	Density of public hard-surface roads
	Pollutant emissions from stationary sources
2. Index of production potential (Y)	Volume of factory shipments (works, services) by type of economic activity “Processing production”
3. Index of scientific, technical and educational potential (Z)	Headcount of staff involved in research and development activities
	Number of students enrolled for undergraduate studies
	Internal research and development costs
	Number of university teachers
	Volume of innovative goods, works and services in the total volume of performed work

Step 2. Evaluation of the asymmetry characterizing the degree of distribution asymmetry with respect to the county's average value of indicator is carried out for every indicator.

At that, if the resulting distribution is asymmetric (the value of asymmetry indicator is more than 0,5), in order to flatten the influence of “spikes” (extreme values) on the value of the calculated index, the value of the indicator is transformed according to the formula:

$$\bar{x}_{ij} = \sqrt[k]{x_{ij}},$$

where $\bar{x}_{ij}$ – the transformed value of i-indicator in j-region;

x_{ij} – the datum value of i-indicator in j-region;

k – the degree of asymmetry (takes on values from 2 to 4 against the asymmetry ratio).

Step 3. For uniformity and comparability all the indicators are normalized by means of linear transformation:

$$\bar{\bar{x}}_{ij} = \frac{\bar{x}_{ij} - \bar{x}_{i_min}}{\bar{x}_{i_max} - \bar{x}_{i_min}},$$

where $\bar{\bar{x}}_{ij}$ – the normalized value of i-indicator in j-region;

$\bar{x}_{i_min}$ – the minimum value of i-indicator in Russia;

$\bar{x}_{i_max}$ – the maximum value of i-indicator in Russia.

Step 4. For every region we have then calculated the indices, characterizing cluster potential of a region as the arithmetic mean of normalized values for the corresponding groups of indicators.

Cluster potential (CP) of a region is calculated using the formula:

$$CP = \frac{X + Y + Z}{3}$$

Thus, for every region three indices are being calculated. These indices characterize the level of power, science and business development, and on the basis of their values we can later calculate the value of the region's cluster potential.

		Quality of life and infrastructure (X)								
		L			M			H		
Production potential (Y)	L	LLL	LLM	LLH	MLL	MLM	MLH	HLLN	HLM	HLH
	M	LML	LMM	LMH	MML	MMM	MMH	HML	HMM	HMH
	H	LHL	LHM	LHH	MHL	MHM	MHH	HHL	HHM	HHH
		L	M	H	L	M	H	L	M	H
		Scientific, technical and education potential (Z)								

Figure 1 - Matrix of maturity degree of the territory's clusterization potential
(Source: author's own suggestion)

The obtained indices could be applied in two directions. Firstly, they may be used for grouping territories according to the level of their clusterization potential. Well-known algorithms of mathematical clusterization (hierarchical clusterization, the algorithms of squared error, selection of connected components, Kohonen maps, etc.) are used for grouping. Secondly, they may be used for comparison of territories in terms of life quality and infrastructure development, industrial potential, technological and educational potential and then also for determination of the vectors for their further growth. Every territory is assessed in its X-Y-Z dimensions of maturity, arranged in a matrix form (see Fig. 2). For example, a territory under the number N has high level of quality life but low level of production, and also low technological and education potentials. Thus, this territory N is located on the HLL point.

In the process of results' interpretation, we can define the set of vectors for further development and interaction of territories. Thus, for the territory N in the example above the natural line of development would be to increase its production and also to strengthen its technological and education potentials. Such an increase would be possible to achieve in the process of integration with the territory located at HMM. It should be mentioned here that when territories are chosen for cooperation, the intensity of the already existing cross-regional flows of goods and services, funds, cash assets, etc are first of all evaluated.

CROSS-REGIONAL INTERACTIONS AS A SOURCE FOR

Thus, the first stage defines the territories' strongest advantages needed for the creation of cross-regional clusters.

Stage 2. Determination of specialization capacities of enterprises-participants in the cross-regional clusters

Step 1. Determination of the top-priority branches and types of activity in the studied territories.

These are defined on the basis of territories' strategic documents, including long-term development strategies and medium-term development forecasts.

Step 2. Analysis of specialization in the corresponding branches and types of activity on every territory.

To determine the degree of specialization for any branch or type of activity, it is necessary to calculate the rate of specialization, LQ. Branches interrelated in a cluster are usually using the common labour market where special skills are formed. The rate of specialization (LQ) is determined as the ratio of employment: the share of the employed in the territory's industry (E_{ij}) in the total volume of employment on the studied territory (E_i) in comparison with the share of employed in the same branch of the national industry (E_j) and the total volume of national employment (E):

$$LQ_{ij} = \frac{E_{ij} / E_i}{E_j / E}.$$

Table 3 - Matrix of coefficients for branches' specialization on territories

(Sources: author's own suggestion)

Branch	Territory 1	Territory 2	...	Territory N
Branch 1	LQ11	LQ12	...	LQ1N
Branch 2	LQ21	LQ22	...	LQ2N
...	...	...	...	...
Branch K	LQM1	LQM2	...	LQMN

The value of $LQ > 1$ shows higher (than the national average) level of a region's specialization in this branch. This can be interpreted as the indicator of the existing competitive advantages in the examined branch. If in this situation the average annual job growth rate is positive, the examined branch shows dynamic progress and thus is able to attract new human resources (IPA, 1997).

Thus, according to the calculation results, the matrix of the coefficients of branches' specialization can be filled (Tab. 3).

Step 3. Definition of specialization branch for further cross-regional cluster creation

Tab. 4 presents the total information about the existing branches of specialization in the priority-driven spheres of economy on the analyzed territories. The table is being filled in the following way:

if $LQ_{ij} > 1$, then in the appropriate cell of table we put “+”, in the opposite situation we input “-”.

Table 4 - Priority-driven spheres of economy by the types of activity on the analyzed territories

(Sources: author’s own suggestion)

Branch	Territory 1	Territory 2	...	Territory N
Branch 1	+	+	...	-
Branch 2	+	+	...	+
...	...	...	...	...
Branch K	-	-	...	+

Further, on the basis of expert appraisal, we can define the branch of specialization for a newly created cross-regional cluster. There could be several branches of specialization in one cluster, actually. In this case, there appears the opportunity to create a cross-regional cluster including several branches of specialization — or several clusters.

Stage 3. Definition of target groups in a cross-regional cluster

Definition of target groups in a cluster will be carried out according to the procedure developed by M. Porter (2000). Firstly, the core of a cluster is defined, from which technological chains of interrelated enterprises are driven in a vertical direction. On a horizontal direction, industries which use common with the core production factors, technologies and deliveries are identified. Secondly, special groups within the cluster are determined to provide specialized practices, technology, information, capital and infrastructure — everything that would later form the competitive advantages of a cluster. Thirdly, governmental and other legal structures influencing the behaviour of cluster’s participants are identified. They would be responsible for formulating rules, principles and incentives which influence the character and the intensity of local competition.

Stage 4. Definition of key parameters and of the integral indicator of cluster’s efficient functioning on the basis of expert appraisal

Experts who are representing the local scientific community, business managers and the official authorities are the important source of information about prospects and problems of regional industrial development.

The very first step in the process of experts’ polling is deciding on the set of parameters characterizing the efficiency of cross-regional cluster functioning. On the second step, these parameters are grouped into blocks and then the selected experts are asked to range this collection of parameters by blocks. At the third step the most significant indicators in every block are selected. On the fourth step the numerical score is applied: the experts assign weights to all the indicators in every block and estimate the degree of their influence on the success of cluster’s functioning.

On the fifth step, the integral index for every block of indicators is calculated by means of summation of all the weighted estimates. On the sixth step the integral indicator of cross-

CROSS-REGIONAL INTERACTIONS AS A SOURCE FOR

regional cluster functioning is determined as the root of corresponding degree from the product of integral indices for every block of indicators.

Considering the subjectivity of expert appraisal as such and in order to analyze the results in more detail, we can then also apply such methods of mathematical statistics as generalized estimator, analysis of hierarchies and the method of experts' consensus degree determination.

Stage 5. Identification of key parameters and of the integral indicator of efficient cluster functioning on the basis of statistics and legal documents

Step 1. Determining the combination of indicators for evaluation of cross-regional cluster's efficiency.

The problem of indicators combination for evaluation of clusters' effectiveness in a continuous way is rather debatable. Andersson singles out such indicators as: the number of firms in a cluster, employment, production rate (efficiency), export volume, the number of innovative projects in a cluster, profits and also changes of these indicators in the course of time.

Naumov V.A. (2006), Kostyukevich D.V. (2009) propose to use the following characteristics as the key criteria: production structure of a cluster, its resource potential, investment activity, economic indices.

T.V. Zadorova (2009) applies only four indicators for evaluation of clusters' efficiency: cluster's share in industrial production of a region, cluster's share in the total number of employed people, the index of labour productivity at the enterprises of a cluster, cluster's share in the export structure of its region.

To evaluate the efficiency of a cross-regional cluster the authors propose the system of factors and indicators developed on the basis of factor analysis application (Soshnikova, 1999).

Table 5 - Factors and indicators of cross-regional cluster's efficiency evaluation

(Sources: author's own suggestion)

Name of the factor	Indicators
Factor of cross-regional cluster significance (S)	1. Indicators "coefficient of localization", "size", "focus" calculated on the basis of employment statistics 2. Indicators "coefficient of localization", "size", "focus" calculated on the basis of factory shipments statistics (the volume of executed works and rendered services) 3. The indicator of uniqueness
Factor of interdependence of cross-regional cluster's participants (I)	1. Number of connections among cluster's participants 2. Indicator of cross-regional cluster's localization potential
Factor of economic effectiveness of a cross-regional cluster (EE)	1. Average monthly wage of personnel in the cross-regional cluster 2. Profits 3. Investment in fixed assets

Tab. 5 presents these factors and indicators in detail.

Before the beginning of this factor analysis all the indicators are standardized.

Step 2. Calculation of the integral indicator of cross-regional cluster effectiveness.

The integral indicator of cross-regional cluster effectiveness (CCE – further for cross-regional cluster effectiveness) is equal to the cube root of the product of estimation factors' value (Table 5). The factors' values are calculated in the process of factor analysis:

$$CCE = \sqrt[3]{S * I * EE}$$

Stage 6. Analytical estimation of effectiveness of cross-regional cluster's functioning

The integral indicators obtained at the 5th stage show the effectiveness of cross-regional functioning. The level of integral indicator is estimated by experts. Also, its value is compared with the calculated value of the previous period, and then the effectiveness growth is estimated. The indicator of effectiveness could be also compared with the industry's average one.

Estimation of the influence of cross-regional cluster's operation on the indicators of territories' development (GRP, GRP growth, the index of industrial production, investment in fixed capital, etc.) could be carried out by means of mathematical statistics, namely, correlation-regressive analysis and variance analysis.

Stage 7. Monitoring of corrective actions' implementation and receiving feedback from cluster participants

Among the advantages of the proposed procedure we could mention the following ones:

- this procedure may be used for both for the cluster located on the territory of one particular region and also the one on the territory of several regions;
- the set of indicators used for calculating the integral indicator takes into account special features of regions' activity, specific industries and those directly of cluster's participants.

Solutions and Recommendations

As it has been shown in our research, in cross-regional clusters there arise unformalized situations which are difficult to define by means of mathematics. Application of analytical methods is also insufficient for their description. Besides, processes taking place in clusters are usually long-continued ones. Therefore, methods of system dynamics are essential for cluster modeling. They make it possible to create simulation models of cross-regional clusters aimed at predicting effects of managerial decisions directed at region's development. Analysis of output data for cross-regional cluster simulation modeling allows, first of all, making qualitative conclusions which describe the dynamics of its development and then quantitative conclusions which make it possible to predict the changes in economic, social and financial indicators of regional development.

The general directions of cross-regional relations' development could be the following:

- development of innovative infrastructure;
- conducting market studies aimed at defining the potential and the prospects of cross-regional exports;
- creation of the system of goods marketing in the regions of the Russian Federation by intensification of fair trade representation;
- creation of a data ware system for the subjects of cross-regional markets.

CROSS-REGIONAL INTERACTIONS AS A SOURCE FOR

Future Research Directions

At the next stage of research the authors are planning to simulate the cross-regional interaction on the basis of statistics on Russian regions. The methods of system dynamics will be used as the main instrument of this simulation. Cross-regional clusters will be considered as complex dynamic systems. Computer modeling would help with behaviour simulation of cross-regional clusters as complex dynamic systems. Such modeling methods will make it possible to visualize the specific problems and prospects of development. Variation of simulation model parameters will allow estimating results and effects generated in the process of managerial decision-making in the specific periods of time as well as revealing promptly critical situations and suggesting necessary corrections.

Experiments with the models of cross-regional clusters will make it possible not only to reveal the influence of its functioning on social and economic conditions of different territories but also to predict the possible negative effects and to choose appropriate managerial decisions.

Conclusion

Cross-regional cooperation and interaction would always lead to some competitive advantages, and this, in turn, will create incentives for economic activity growth on the territories of other, related subjects.

The conducted research shows that high cross-regional differentiation inevitably leads to the enlarged number of decelerating territories and intensification of cross-regional contradictions. This fact makes it considerably difficult to pursue a common policy of social-economic transformations in the majority of developing countries including Russia.

In Russia, one of the general directions of reformation in the field of innovative development is the support for clusters' establishment. However, regulatory control carried out by Russia's public authorities does not provide the requirements for the development of mutual advantageous ties among the regions of Russia.

In this work we, firstly, have explained the significance of cross-regional interaction for innovative economic development; secondly, we have defined the problems being the obstacles for the development of the mentioned interaction; thirdly, we have formulated the concept of country's competitiveness growth at the expense of cross-regional clusters; fourthly, we have developed and put forward the analysis procedure for cross-regional clusters' effectiveness. Thanks to cross-regional cooperation and interaction the competitive advantages of one subject will create incentives for economic activity growth on the territory of other subjects. And this process will promote the transition of Russian Federation's economy to the innovative mode of development.

Acknowledgement

The work has been financed by the grant of the President of the Russian Federation (project #MK-5608.2016.6 "The formation of a cluster model of interregional cooperation with the goal of innovative development of national economy").

References:

- Akerman, E.N. (2011). *Public economic policy in conditions of modern economy*. Abstract of doctoral thesis. Tomsk.
- Akhmetova, M.I. (2014). Assessment of territorial innovative system development level within socioeconomic environment. *Actual Problems of Economics*, 12 (162), 260-270.
- Akhmetova, M.I. (2016). Key determinants of socioeconomic territorial development: the innovative aspect. *Actual Problems of Economics*, 12 (186), 188-198.
- Atkinson, R. & Andes, S. (2008). *The 2008 State New Economy Index. Benchmarking Economic Transformation in the States*. The Information Technology and Innovation Foundation.
- Audretsch, David B. & Thurik, R. (1999). *Innovation, Industry Evolution and Employment*. Cambridge: Cambridge University Press.
- Basov, N.V. & Minina, V.N. (2014). Innovative landscape: from metaphor to scientific category. *Innovation*, 7 (189), 20-26.
- Bogdanov, A.A. (2003). *Tectology. Universal Organizational Science*. Moscow: Economics.
- Etzioni, A. (1965). *Political unification: a comparative study of leaders and forces*. New York: Rinehart.
- Etzkowitz, H. & Leydesdorff, L. (2000). The Dynamics of Innovation: from National Systems and “Mode 2” to a Triple Helix of University-Industry-Government Relations. *Research Policy*, 29, 2-3.
- Faskhutdinov, A.R. (2014). Foreign experience of innovative clusters development in localized system of entrepreneurship in Russia. *Problems of Economics and Law*, 3, 93-98.
- Feser, E. J. (1998). Old and new theories of industry clusters. London. *Clusters and Regional Specialisation: Geography, Technology, and Networks*, 8.
- Fon Tyunen, I. (1826). *Isolated state in his relation to agriculture and national economy. Study of grain cost, soil richness and overhead resources influence on farming*. Moscow: Duma.
- Fritsch, M. (2003). Does R&D-cooperation behavior differ between regions? *Industry and Innovation*, 10(1), 25–39.
- Gennaioli, N. (2013). Grow in regions. *National bureau of economic research*, 44.
- Gokhberg, L.M. & Shadrin, A.E. (2013). *Pilot innovative territorial clusters in the Russian Federation*. Moscow: National Research University “Higher School of Economics”.
- Granberg, A.G. (2004). Regional Economy and Regional Science in Russia: ten years later. *Region: economics and social science*, 1, 57-82.
- Groenendijk, N. (2010). EU and OECD Benchmarking and Peer Review Compared. In: Finn Laursen (ed.), *The EU and Federalism: Politics and Policies Compared*, Ashgate.
- Grotz, R. & Braun, B. (1997). Territorial or Trans-territorial Networking: Spatial Aspects of Technology-oriented Cooperation within the German Mechanical Engineering Industry. *Regional Studies*, 31(6), 545- 557.
- Huggins, R. (2008). Regional Competitive Intelligence: Benchmarking and Policy-making. *Regional Studies*, 44(5).

CROSS-REGIONAL INTERACTIONS AS A SOURCE FOR

- Kostyukevich, D.V. (2009). *Evaluation and organization of cluster interactions of entrepreneurial structures*: Dis. Cand. Econ. Sciences. St. Petersburg.
- Krugman, P. (1993). First nature, second nature, and metropolitan location. *Journal of Regional Science*, 33(2), 129–144.
- Kucherenko, O.V. (2013). Clusters in Regional Economy: Institutional Environment and Tendencies of Development in Omsk Region. *Modern Problems of Science and Education*, 3.
- Leydesdorff, L. (2008). Configurational information as potentially negative entropy: the Triple Helix Model. *Entropy*, 12.
- Marshall, A. (1920). *Principles of Economics: An Introductory Volume*. London: Macmillan.
- McCann, P. & Ortega-Argilés, R. (2011). Smart Specialisation, Regional Growth and Applications to EU Cohesion Policy. *Economic Geography Working Paper 2011*, Faculty of Spatial Sciences, University of Groningen.
- Mironov, E.I. (2010). Necessity of accounting the factor of networkization in the organization of special economic zones. *Problems of modern economy*, 1-2.
- Moreno, R., Paci, R. & Usai, S. (2005). Geographical and sectorial clusters of innovation in Europe. *The Annals of Regional Science*, 39, 715-739.
- Naumov, V.A. (2006). Economic efficiency of cluster formation in the oil and gas region. *Oil and gas business*, 2.
- Ovcharenko, N.E. (2001). *Models of modern integration processes*. Moscow.
- Plikhun, O.G. & Kiselev, A.M. (2009). Questions of cross-regional and cross-border cooperation of Omsk region. *Bulletin of Omsk University. Series "Economics"*, 3, 56-59.
- Porter, M. (2000). *Competition*. Moscow: Williams Publishing House.
- Porter, M. (2007). *Competitiveness at the Crossroads: Choosing the Future Direction of the Russian Economy*. Choosing the Future Direction of the Russian Economy.
- Pyke, F. & Sengenberger, W. (1992). *Industrial districts and local economic regeneration*. Geneva: ILO.
- Reid, A. & Miedzinski, M. (2014). *A smart specialisation platform for advanced manufacturing. Scoping paper*. Prepared at the request of the European Commission, Directorate General for Regional and Urban Policy.
- Shastitko, A.E. (2009). *Clusters as a form of spatial organization of economic activity: the theory of matter and empirical observations*. Kaliningrad: Publication. I. Kant State University of Russia.
- Song, W. (2007). *Regionalization, inter-regional cooperation and global governance*. Springer-Verlag.
- Soshnikova, L.A. (1999). *Multivariate statistical analysis in economics*. Moscow: UNITY-DANA.
- Torre, A. & Rallet, A. (2005). Proximity and Localization. *Regional Studies*, 39(1), 47–59.
- Weber, A. (1929). *Theory of the Location of Industries*. Translated by C. J. Friedrich. Chicago: University of Chicago Press.
- Woodward Douglas, P. (2012). Industry Location, Economic Development Incentives, and Clusters. *The Review of Regional Studies*, 42, 5–23.

- Yolokhova, I.V., Kozonogova, E.V. & Dubrovskaya, Y.V. (2016). Russian regions typology based on the cluster structures formation. *Bulletin of PNRPU. Social and Economic Sciences*, 4, 160-171.
- Zadorova, T.V. (2009). Evaluation of the efficiency of industrial clusters as a necessary condition for the implementation of regional cluster policy (on the example of the Chuvash Republic). *Bulletin of the Chuvash University*, 3.

<i>Paper submitted</i>	<i>14 July 2020</i>
<i>Paper accepted for publishing</i>	<i>21 October 2020</i>
<i>Paper published online</i>	<i>30 November 2020</i>