Artículo de investigación

Modelling Interregional Cooperation in the Real Sector of the Russian Economy

Моделирование межрегионального взаимодействия
в реальном секторе экономики России

Simulación de la cooperación interregional en el sector real de la economía de Rusia

Recibido: 25 de junio del 2019 Aceptado: 28 de julio del 2019

Written by:
Ol'ga P. Smirnova [1]
SPIN-ID elibrary.ru: 6704-3030
Alena O. Ponomareva [2]
SPIN-ID elibrary.ru: 8906-1275

Abstract

The article substantiates the relevance of spatial development for Russian regions. The authors emphasize the importance of industrial cooperation for socio-economic and industrial development. The paper describes an empirical study of interregional relations of 10 subjects of Russia within the Ural and Volga Federal Districts, previously called the “Big Ural”. The article reveals the potential for interregional interaction using the spatial econometrics method. The results obtained lead to the conclusion that the most durable and effective interregional industrial cooperation is achieved with a cluster system of cooperation. The study shows that the development of interregional cooperation in a real economy requires the development of a unified economic policy based on the regions' competitive advantages.

Keywords: Interregional cooperation, Industry, Spatial modelling, Economic policy.

Аннотация

В статье обоснована актуальность проблем пространственного развития субъектов России. Отмечена значимость производственной кооперации для социально-экономического и промышленного развития. Эмпирически исследованы межрегиональные связи 10 субъектов России, входящих в Уральский и Приволжский федеральные округа, ранее называемые “Большой Урал”. На основе метода пространственной эконометрики в статье выявлены возможности взаимодействия регионов. Полученные результаты позволяют сделать вывод, что наиболее долгосрочное и эффективное межрегиональное взаимодействие в области промышленности достигается при кластерной системе кооперации. В исследовании показано, что для развития межрегионального взаимодействие в реальном секторе экономики необходима разработка единой экономической политики, учитывающая сравнительные конкурентные преимущества регионов.

Ключевые слова: Межрегиональное взаимодействие, Промышленность, Пространственное моделирование, Экономическая политика.

[1] Cand.Sci. (Economics), Researcher, Institute of Economics of the Ural branch of Russian Academy of Sciences; Ural Federal University named after the First President of Russia B.N. Yeltsin. Ekaterinburg, Russian Federation. Email: olygsmirnova95@gmail.com
[2] Researcher, Institute of Economics of the Ural branch of Russian Academy of Sciences. Ekaterinburg, Russian Federation.

Resumen

En el artículo se justifica la actualidad de los problemas del desarrollo espacial de las subdivisiones de Rusia. Se indicada la importancia de la cooperación productiva para el desarrollo social y económico e industrial. Los vínculos interregionales de 10 subdivisiones de Rusia que forman parte de los distritos federales de Ural y Volga, anteriormente llamados "Gran Ural", se investigan empíricamente. En base del método de econometría espacial, el artículo identifica las capacidades de interacción de las regiones. Los resultados permiten concluir que la interacción interregional más eficaz y a largo plazo en el contexto de la industria se logra mediante el sistema de cooperación en conglomerados. El estudio muestra que para el desarrollo de la interacción interregional en el sector real de la economía es necesario desarrollar una política económica unificada que tenga en cuenta las ventajas competitivas comparativas de las regiones.

Palabras claves: Interacción interregional, Industria, Simulación espacial, Política económica.

Introduction

The complex federal structure and the size of Russian territory require particular attention to the issues of its spatial development. The high level of socio-economic differentiation stresses the problem of levelling interregional differences. Some regions are the "engines of growth", which force less competitive regions to cooperation and make them dependent in a certain sense.

To strengthen the interregional cooperation of the subjects of Russia, the Russian Government approved the "Strategy of Spatial Development of the Russian Federation until 2025" (2019). The draft strategies were developed for 12 macro-regions. The Ural-Siberian macro-region, which includes the subjects forming the Ural Federal District of Russia, is one of them. This macro-region was selected as the object of study for the predominance of manufacturing and mining industry in its economic structure. The authors suggest that its interregional cooperation may be found in cooperation links of its industrial enterprises based on value chains, and in the formation of its infrastructure.

This study is aimed at assessing the unevenness of the regions' socio-economic development, revealing links of industrial cooperation and determining the resource potential of the territories.

Literature review

Many world cities retain their unique industrial status. Such feature of an industrial metropolis economy imposes additional requirements on the development of spatial distribution of workplaces. Akberdina *et al*. (2017) substantiate the spatial distribution of workplaces considering the projected number of people employed and the number of the working-age population, distinguishing features of citizens' transport behaviour. Identifying, understanding and gaining access to such territorial resource require a diagnosis of the current situation. Socio-spatial inequality lies in the heart of regional development problems facing the double disease of poverty and environmental degradation (Eddelani *et al*., 2019).

The problems of possible interregional imbalances are actively discussed in scientific literature. Today, the substantial scientific and theoretical background has been formed in the study of territorial development asymmetry. Particular attention should be paid to the works by Markov (2012), Kuznetsov *et al.* (2015), Nikolaev and Makhotaeva (2015), Leksin and Shvetsov (2016), Moreno and Trehan (1997), Conley and Ligon (2002), and Le Gallo (2004). Their approach is based on spatial econometrics, which establishes the dependence of economic development on the growth rates of the surrounding territories. The concept of sustainable development of the regions has received sufficient arguments of consistency in the work by Pavolová *et al*. (2019). Zeibote *et al*. (2019) emphasise that the regional development is based on competitive advantages, which have been a subject of fundamental research by Michael Porter and which serve as a basis for the modern scientific methodology for assessing the competitiveness of regions and countries.

In an emerging post-industrial economy, sustainable industrial development of society is impossible without intellectual, scientific, technological and technical innovation (Romanova *et al*., 2017). Therefore, scientific and production cooperation is the most important form of interregional cooperation. Following the study of industrial enterprises held by the Interdepartmental Analytical Centre and the Higher School of Economics and Management (Russia), 25% of respondents noted the need for new advanced technologies, 22% – the need to interact with scientific and educational organizations in the field of training and requalification of engineering personnel (nearly 8% of enterprises noted the need for scientific personnel in production). Almost 20% of enterprises have a need for product testing and certification services (Kuzyk, 2016).

The creation of industrial and innovative territorial clusters is a special tool for enhancing research and production cooperation, which combines various types of interaction. Industrial clusters are the most advanced form of cooperation (Pilipenko, 2009). According to Porter, "a cluster is a geographically proximate group of interconnected companies and associated suppliers and service providers in a particular field, linked by commonalities and complementarities" (Porter, 2005). A cluster implies a territorial concentration of its participants, but at the same time, it might include enterprises of various administrative centres and regions (Markov, 2015). The creation and development of clusters in Russia are implemented under the strategy of spatial development. According to the Ministry of Industry and Trade and the Association of Clusters and Technology Parks of Russia, 28 regions of Russia are involved in clustering projects. In total, 38 industrial clusters were created in 2018, of which only 5 are interregional (Tools for Regional Development, 2018).

Based on the analysis of the above approaches of industrial cooperation, it can be concluded that the most durable and effective interregional industrial ties are achieved under a cluster system of cooperation. The development of interregional relations of territories based on industrial clusters requires a thorough assessment of its resource potential.

Materials and Methods

The article defines interregional cooperation as a special form of coordinated joint activities aimed at achieving common goals, such as sustainable socio-economic development. The methods of spatial econometrics are widely used to assess interregional cooperation. In particular, the interaction can be detected using the global and local Moran indices. These indices also help characterize the establishment of potential clusters.

The construction of a spatial matrix of weights is an important element in assessing and building links between territories. This study used the road distances between the key regional administrative centres.

The global Moran index is determined by the formula (Pavlov, & Koroleva, 2014):

$$I_G = \frac{N}{\sum_i \sum_j w_{ij}} \cdot \frac{\sum_i \sum_j w_{ij} \left(x_i - \mu\right)\left(x_j - \mu\right)}{\sum_i (x_i - \mu)^2}, \quad (1)$$

where N is the number of regions; w_{ij} is the element of the spatial weights matrix for the regions i and j; μ is the average indicator value; x is the indicator under consideration.

The significance of the Moran indices is determined using z-statistics, which is a traditional method for spatial econometrics.

$$E[I] = -\frac{1}{n-1}, \quad (2)$$

$$Z = \frac{\left(I - E[I]\right)}{s}, \quad (3)$$

where s is the Moran index dispersion.

The value Z indicates the number of standard deviations of the actual Moran index value from the expected value. The farther it is removed, the less likely the actual distribution is random (Introduction to Spatial Analysis, 2006).

When IG > E(I), there is a positive spatial autocorrelation, i.e. the values in the neighbouring territories are similar;

When IG < E(I), there is a negative autocorrelation, the values in the neighbouring territories are different;

When IG = E(I), the values of observations in the neighbouring territories are randomly distributed.

The next stage of spatial data analysis is the construction of the Moran dispersion diagram. The standardized z-values of the indicator under consideration are plotted along the horizontal axis and the values of the spatial factor Wz – along the vertical axis. The axes of the spatial

ISSN 2322- 6307

diagram divide the sampled areas into four quadrants.

The HH quadrant contains areas with positive autocorrelation, which have relatively high values, surrounded by similar territories with relatively high values.

The LL quadrant – positive autocorrelation; its territories show relatively low indicator values, and are surrounded by similar territories;

The HL quadrant – comprises areas with negative autocorrelation and relatively high values, surrounded by areas with relatively low indicators;

The HH quadrant – negative autocorrelations; its territories have relatively low values and are surrounded by similar territories.

The local Moran index (LISA – Local Index of Spatial Autocorrelation) is determined by the formula (Anselin, 1995; Chen, 2013):

$$I_{Li} = N\frac{(x_i-\mu)\sum_i w_{ij}\left(x_j-\mu\right)}{\sum_i (x_i-\mu)^2}. \qquad (4)$$

A positive value of the local index indicates positive autocorrelation, i.e. the given territory has a similar indicator value under consideration with the neighbouring territories. A negative value of the local index indicates negative autocorrelation, that is, the given territory is sig nificantly different from the neighbouring territories.

To analyse the relationship of territories in this study, the authors used a matrix of $LISA_{ij}$ components. This matrix was used to analyse the interrelations for each territory as an intermediate stage of the local index calculation. That is, this matrix allows characterizing the strength of mutual influence of the territories (Pavlov, & Koroleva, 2014).

Results and discussion

The spatial structure of the Russian economy is characterized by serious interregional socio-economic contrasts. The development of the Urals and Siberia is a significant factor in the industrial growth throughout Russia. Production cooperation becomes especially critical in terms of interregional cooperation (Kuznetsova, 2018). The authors evaluated the resource potential of the territory in terms of mining operations; production potential – in terms of the volume of products shipped to manufacturing facilities in the territory; the territory's human capacity – by the number of universities and scientific organizations in the region, and the last fourth block – technological infrastructure was assessed in terms of advanced production technologies used in the region.

Below are the results of the study for the territories' interregional relations, namely, the assessment of interaction between 10 regions comprising the Ural and Volga Federal Districts of Russia, previously called “the Big Ural”. The study used the official data of the Russian Statistics Service for 2017 (Appendix A).

The global Moran indices are shown in Table 1. The highest value of the global Moran index was revealed in production (0.192) and resource interaction (0.154); the least developed was interregional interaction in the field of personnel and technologies.

Table 1. Global and local Moran indices

Subjects of the Russian Federation	Resources	Production	Human resources	Technologies
Orenburg Region	0.0045	-0.0137	-0.0086	-0.0358
Perm Region	0.0100	0.0008	0.0052	-0.0057
Republic of Bashkortostan	0.0136	-0.0090	0.0013	-0.0408
Udmurtia	0.0107	-0.0140	-0.0041	0.0022
Kurgan Region	0.0192	-0.0942	-0.0311	-0.0131
Sverdlovsk Region	0.0218	0.0183	-0.0107	-0.0299
Tyumen Region	0.0114	-0.0199	-0.0116	-0.0019
Khanty-Mansi Autonomous Area	0.0367	-0.0028	0.0007	0.0024
Yamal-Nenets Autonomous Area	0.0022	-0.0015	-0.0058	0.0008
Chelyabinsk Region	0.0238	0.0177	0.0316	0.0112
Global Territory Index	0.1540	0.1920	0.1110	0.1440

ISSN 2322- 6307

Graphic maps of Moran dispersion of the above indicators are presented in Annex B. The relationships, as noted above, were revealed using the components of the local Moran index ($LISA_{ij}$), where a stable relationship corresponds to the LISA value above 0.007.

It can be concluded that the Khanty-Mansi Autonomous Area has become an extremum for resource interaction of the territories. At the same time, the Tyumen Region and the Republic of Bashkiria can become the growth drivers in terms of industrial cooperation.

The Sverdlovsk, Chelyabinsk and Perm Regions belong to the HH quadrant; therefore, these territories are satellite counterbalances to the growth locomotives. These territories show relatively high rates and are surrounded by similar territories; therefore, they cannot become the growth drivers.

The strong territories (LH quadrant) influence the following territories: the Kurgan and Orenburg Regions, the Udmurt Republic, the Khanty-Mansi Autonomous Area, and the Yamal-Nenets Autonomous Area. The Sverdlovsk Region is the leader and the driving force behind the growth of interregional cooperation in terms of human capacity. Its area of influence includes such territories as the Udmurt Republic, the Kurgan, Tyumen, and Orenburg Regions, as well as the Yamal-Nenets Autonomous Area.

The Republic of Bashkiria, Chelyabinsk Region, and Perm Region turned out to be the strong territories with no influence on the neighbouring areas. The Sverdlovsk Region and the Republic of Bashkortostan are leaders and extremes for the development of technical cooperation between the regions. Their influence zone includes the Perm Region, the Khanty-Mansi Autonomous Area, the Orenburg, Kurgan, and Tyumen Regions. The Chelyabinsk Region and the Udmurt Republic are not the extremums for enhancing the interregional technological infrastructure, as their high technological potential does not significantly differ from the neighbouring territories.

The map of resource potential shows that the connections are stretched along the entire territory; the greatest flow of resources passes from the Khanty-Mansi Autonomous Area and the Yamal-Nenets Autonomous Area through the territories of the Chelyabinsk, Sverdlovsk, Tyumen and Kurgan Regions. It is worth noticing that the Volga Federal District does not participate in resource cooperation relations. The closest production cooperation is implemented between the Chelyabinsk, Sverdlovsk and Orenburg Regions. It is important to note a negative autocorrelation in the Kurgan Region, which indicates a strong difference in this territory from the neighbouring territories in terms of manufacturing.

In terms of personnel training, the Sverdlovsk Region has a strong relationship with almost all regions under consideration. It may thus be concluded that the Sverdlovsk Region is of great importance in preparing industrial and scientific personnel, not only for its own needs but also for the needs of all the surrounding territories. The most complex interaction is obtained in the field of technical infrastructure. Thus, the Sverdlovsk Region, the Republic of Bashkortostan, the Orenburg Region, the Chelyabinsk, Kurgan, and Tyumen Regions have the greatest number of technology interactions. The nature of these interactions is very complex and extensive. Such territories as the Perm Region, the Khanty-Mansi Autonomous Area and the Yamal-Nenets Autonomous Area are poorly involved in technical cooperation.

Interregional clusters can be created both between strong and weak regions, considering their specialization and comparative advantages in the proposed types of interaction. The local and global Moran indices can be used to define interregional interaction. However, this is only a preliminary stage of spatial analysis. The proposed approach allows revealing the interregional relations but does not explain their reasons. This requires using qualitative methods of analysis, which would be the object of further studies.

Further prospects of interregional industrial cooperation will largely depend on the timely development of the macroregional economic policy and its reliance on supporting the most promising areas of economic development.

Conclusion

Using the calculated global and local Moran indices, the authors revealed the potential for interaction between territories in terms of their resource potential and geographical location. The study defined the “driving regions’ of interregional production cooperation considering their resource, production and personnel potential. Furthermore, the researchers mapped the most stable links of interregional cooperation on the proposed four aspects of interaction.

The study revealed that the Khanty-Mansi Autonomous Area is the "driving engine" in the field of resource interaction, while the Tyumen Region and the Republic of Bashkortostan are the leaders of industrial cooperation. The Sverdlovsk Region is a leader in terms of personnel training cooperation. The Republic of Bashkortostan and the Sverdlovsk Region seem promising in terms of further development of the interregional technological infrastructure. The study shows that the development of interregional cooperation in the real sector of economy requires a unified economic policy of macro-regions considering the comparative competitive advantages of its territories.

The review of forms of interregional industrial cooperation has shown that scientific and industrial cooperation is of particular importance in the current conditions. The study revealed that the most durable and effective interregional industrial cooperation is achieved with a cluster system of cooperation.

Acknowledgments

The article was prepared within the Research Plan for the Laboratory of Spatial Development Modelling of the Institute of Economics, the Ural Branch of the Russian Academy of Sciences, for 2019.

References

Akberdina, V.V, Tretyakova, O.V, & Vlasov, A.I. (2017). A Methodological Approach to Forecasting the Spatial Distribution of Workplaces in an Industrial Metropolis. *Problems and Perspectives in Management, 15*(4), 50-61. http://doi.org/10.21511/ppm.15(4).2017.05
Anselin, L. (1995). Local Indicators of Spatial Association – LISA. *Geographical Analysis, 27*(2), 93-115. https://doi.org/10.1111/j.1538-4632.1995.tb00338.x
Chen, Y. (2013). New Approaches for Calculating Moran's Index of Spatial Autocorrelation. *PLoS ONE, 8*(7), e68336. https://doi.org/10.1371/journal.pone.0068336
Conley, T.G., & Ligon, E. (2002). Economic Distance and Cross-country Spillovers. *Journal of Economic Growth, 7*(2), 157-187. https://doi.org/10.1023/A:1015676113101
Eddelani, O., El Idrissi, N.E., & Monni, S. (2019). Territorialized Forms of Production in Morocco: Provisional Assessment for an Own Model in Gestation. *Insights into Regional Development, 1*(1), 6-18. https://doi.org/10.9770/ird.2019.1.1(1)
Introduction to Spatial Analysis. Invited Lecture. Population Science and GIS Workshop. (2006). UC Santa.
Kuznetsov, S.V., Mezhevich, N.M., & Lachininskii, S.S. (2015). Spatial Prospects and Limitations of Modernization of the Russian Economy: The Example of the North-West Macro-Region. *Economy of the Region, 3*, 25-38. https://doi.org/10.17059/2015-3-3
Kuznetsova, E.P. (2018). Development of Production Cooperation in Russia. *Russia: Trends and Development Prospects, 13-1*, 990-996.
Kuzyk, M. (2016). *The Interaction between Universities, Scientific Organizations and Industrial Enterprises: Trends, Challenges, Government Incentives*. Retrieved June, 2019, from http://www.iacenter.ru/publication-files/240/192.pdf?1.1%20Mb
Le Gallo, J. (2004). Space-Time Analysis of GDP Disparities among European Regions: A Markov Chains Approach. *International Regional Science Review, 27*(2), 138-163. https://doi.org/10.1177/0160017603262402
Leksin, V.N., & Shvetsov, A.N. (2016). *State and Regions. Theory and Practice of State Regulation of Territorial Development*. Moscow: Librokom. (p. 370).
Markov, L. (2012). Spatial Development of the Russian Economy. *Board of Siberian Directors, 11*(86), 18-19.
Markov, L.S. (2015). *Theoretical and Methodological Foundations of the Cluster Approach*. Novosibirsk: IEEPP SB RAS. (p. 300).
Mishenin, Y., Koblianska, I., Medvid, V., & Maistrenko, Y. (2018). Sustainable Regional Development Policy Formation: Role of Industrial Ecology and Logistics. *Entrepreneurship and Sustainability Issues, 6*(1), 329-341. https://doi.org/10.9770/jesi.2018.6.1(20)
Moreno, R., & Trehan, B. (1997). Location and the Growth of Nations. *Journal of Economic Growth, 2*(4), 399-418. https://doi.org/10.1023/A:1009741426524
Nikolaev, M., & Makhotaeva, M. (2015). The Role of the Territorial Factor in Economic Dynamics. *Economist, 3*, 42-49.
Pavlov, Y.V., & Koroleva, E.N. (2014). Spatial Interactions: An Assessment Based on the Global and Local Moran Indices. *Spatial Economics, 3*, 95-110. https://doi.org/10.14530/se.2014.3.95-110
Pavolová, H., Bakalár, T., Emhemed, E.M., Hajduová, Z., & Pafčo, M. (2019). Model of Sustainable Regional Development with the Implementation of Brownfield Areas. *Entrepreneurship and Sustainability Issues, 6*(3),

1088-1100. https://doi.org/10.9770/jesi.2019.6.3(2)
Pilipenko, I.V. (2009). Regions Competitiveness and Cluster Policy in Russia. In E.G. Yasin (Ed.), *Modernization of Economy and Globalization. In 3 Books* (Book 3, pp. 285-293). Moscow: HSE Publishing House.
Porter, M. (2005). *Competition* (Trans. from English). Moscow: Williams. (p. 608).
Prause, G., Tuisk, T., & Olaniyi, E.O. (2019). Between Sustainability, Social Cohesion and Security. Regional Development in North-Eastern Estonia. *Entrepreneurship and Sustainability Issues*, *6*(3), 1235-1254. https://doi.org/10.9770/jesi.2019.6.3(13)
Romanova, O.A., Korovin, G.B., & Kuzmin, E.A. (2017). Analysis of the Development Prospects for the High-Tech Sector of the Economy in the Context of New Industrialization. *Espacios, 38*(59), 25.
Rosstat. (2018). *Regions of Russia. Socio-Economic Indicators. Statistical Book*. Moscow. (p. 751)
Strategy of Spatial Development of the Russian Federation until 2025. (2019, February 13). Approved by the Government Order of the Russian Federation No. 207-p.
Tools for Regional Development. Major Investment Projects in the Regions: Some Important Results and Indicators over the Six Years. (2018). Official Website of the Government of the Russian Federation. Retrieved June, 2019, from http://government.ru/info/32202/
Zeibote, Z., Volkova, T., & Todorov, K. (2019). The Impact of Globalization on Regional Development and Competitiveness: Cases of Selected Regions. *Insights into Regional Development*, *1*(1), 33-47. from https://doi.org/10.9770/ird.2019.1.1(3)

Annex A

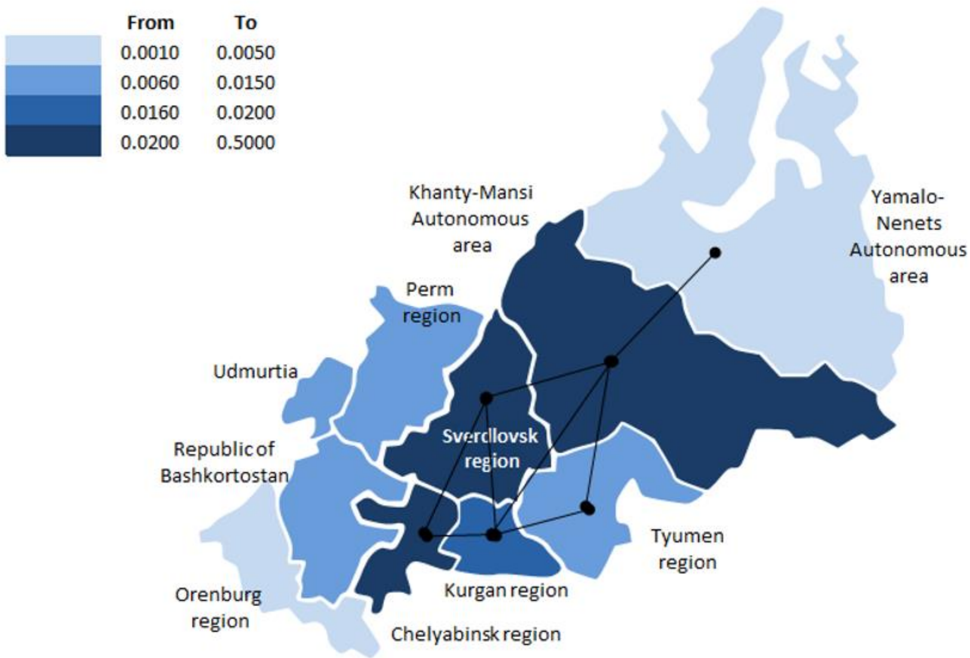
Table. Initial data for assessing interregional cooperation

Subjects of the Russian Federation	Resources	Production	Human resources	Technologies
	Mining, million rubles	Manufacturing, million rubles	Number of universities and scientific organizations, units	Used advanced production technologies, units
Orenburg Region	389,692	304,238	5	1,154
Perm Region	294,130	933,960	10	4,216
Republic of Bashkortostan	233,703	1,082,923	10	10,026
Udmurtia	191,064	321,066	7	5,651
Kurgan Region	3,315	96,670	3	1,684
Sverdlovsk Region	66,980	1,734,335	23	10,662
Tyumen region	173,825	1,568,613	5	2,273
Khanty-Mansi Autonomous Area	2,983,368	534,441	7	2,309
Yamal-Nenets Autonomous Area	19,117,22	346,799	0	4,354
Chelyabinsk Region	63,272	1,360,874	15	7,306

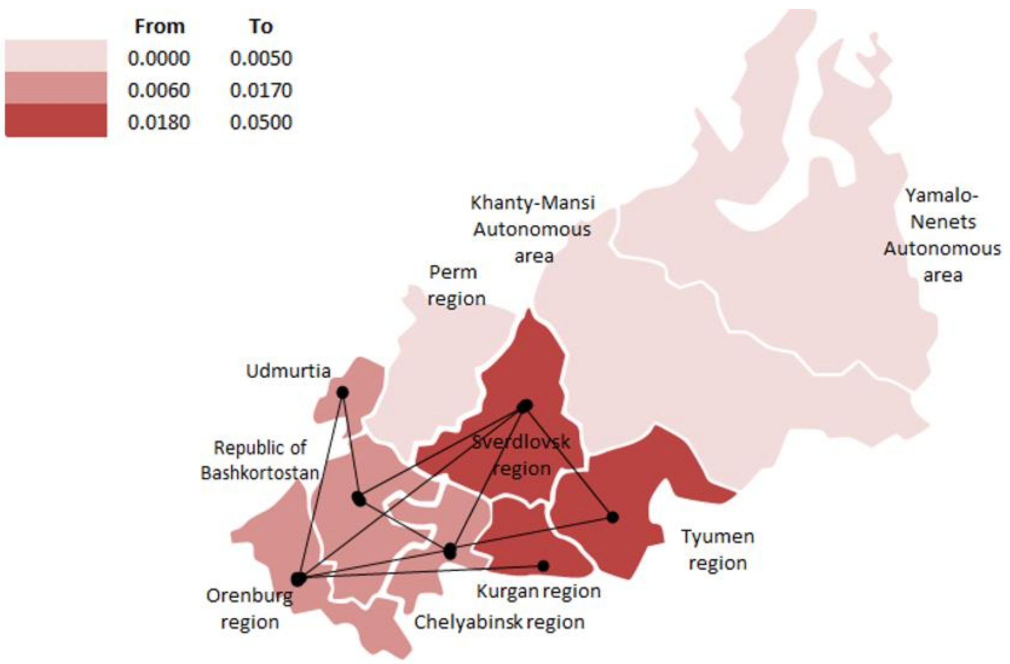
Source: (Rosstat, 2018).

Annex B

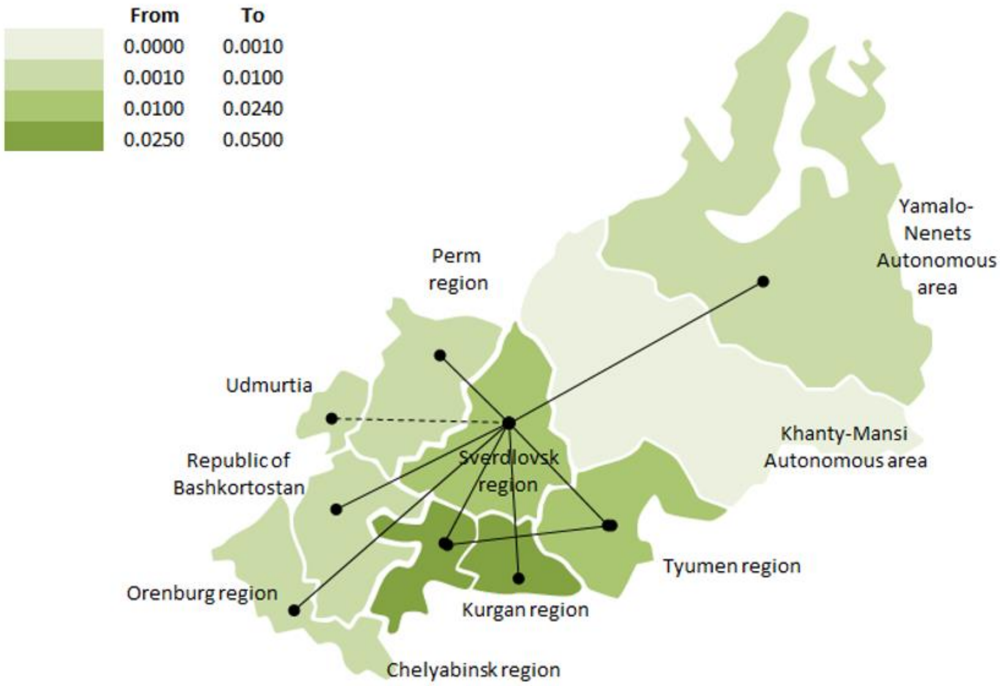
Moran dispersion maps by territory interaction potentials



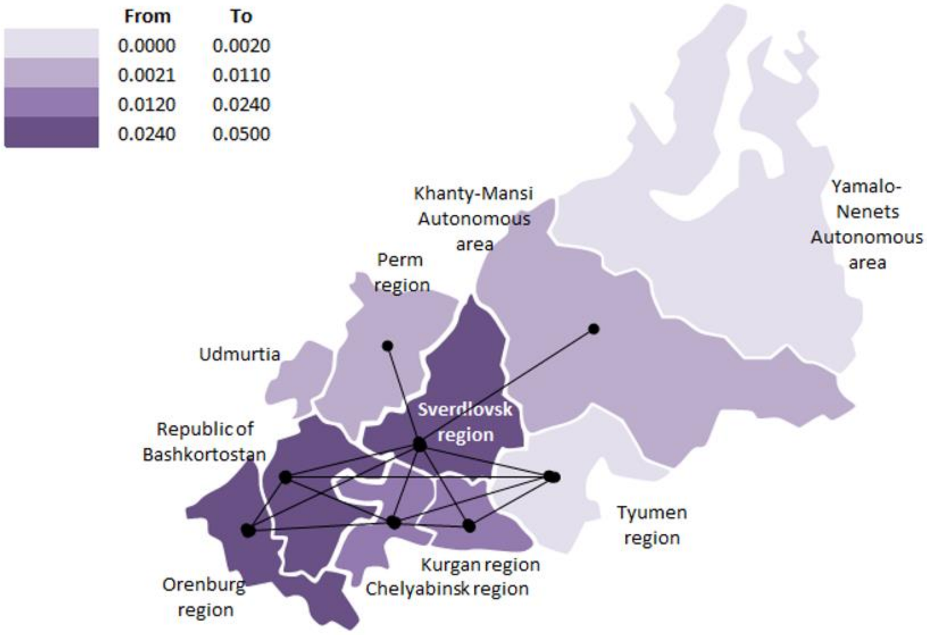
a) Resources



b) Production



c) Human resources



d) Technologies