SCTCMG 2019

International Scientific Conference «Social and Cultural Transformations in the Context of Modern Globalism»

METHODICAL APPROACHES TO THE ANALYSIS OF DEVELOPMENT LEVEL OF URBAN AGGLOMERATION

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Abstract

Urban agglomerations are a special form of combining the production and human resources of different municipalities of a certain territory based on the effects of concentration and specialization. Agglomerations arise on the basis of integration processes that form the spatial-economic features in the organization and placement of elements of the agglomeration space. The level of agglomeration development can be traced based on the analysis of demographic and social economic quantitative indicators, reflecting the potential and interaction degree of municipalities within its composition. Allotment and quantitative identification of the parameters of social economic interaction of cities included in the agglomeration, allows methodically evaluate the level of agglomeration development. The social economic interconnection of cities is one of the most important results of the development of urban agglomerations. It provides a special mechanism for the interaction of municipalities and involves the identification of contact processes between them, aimed at achieving territorial and economic unity, spatial community based on a compact spatial grouping of cities with different specializations. There is a number of techniques that allow identifying and assessing the degree of such territorial and economic connectedness of its elements. The application of these methods is carried out with respect to Rostov agglomeration as the largest in the south of Russia. The authors assessed its level of development; analyzed the spatial concentration of the population and economy in cities and districts that are part of it. The monocentric type of Rostov agglomeration was proved and its quantitative and qualitative features were determined.

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Keywords: Agglomeration, development, social, economic interconnectedness, Rostov.

1. Introduction

In the agglomeration space, cities form a specific system of interaction between them at economic and social levels, and the agglomeration itself acts as a special form of their concentration based on the rational and efficient use of common, integrated production and human resources of different municipalities within its composition. An indicator of the urban agglomeration development, in addition to its population size, area occupied by the territory and the number of united municipalities, is the social economic connectedness of settlements. It indicates the level of interaction between the settlements, and is assessed the stronger, the more diversified the agglomeration economy is and significantly differentiated functions of the settlements in its composition are. Labor division within the agglomeration, along with concentration and specialization processes, are fundamental determinants in the formation of diverse and stable territorial and economic relations of settlements in time and space, and, above all, cities as centers of localization of the population and economy. Identifying the intensity of these relationships manifestation allows us to estimate the level of agglomerative development as a whole, for which a number of various methods and synthetic quantitative indicators are used.

2. Problem Statement

Urban agglomerations, as centers of innovative economic growth and social development of the territory, are the main form of settlement in the Russian Federation and other countries of the world (Lappo, Polian, & Selivanova, 2007; Fang, 2015). Despite a number of critical statements by the representatives of scientific community, today it is impossible to deny the important role of agglomeration in the social economic development of society (Lipets, 2003; Wang, 2002).

The agglomeration form of population and economy concentration largely corresponds to the conditions of our country with its territorial scope, multinationality, diversity of natural and other resources, and its contrast of social economic conditions of the development (Lappo et al., 2007). With a focused approach, agglomerations can act as a means of solving a number of acute problems of the regions, becoming peculiar points of priority development, fulfilling the role of "fastening" the territory based on a combination of economic, domestic, transport, cultural, educational and social ties (Kutovoi, 2013; Fang, 2011). At the same time, there is a need to map agglomerations among themselves, typology based on the determination of their development level as a special form of settlement and a complex territorial-economic complex.

The evaluation problem of the development level of urban agglomerations is associated with differences in the approaches to allocate the agglomeration, delimitation of its borders; with the absence of generalized system of quantitative and qualitative analysis indicator of the intensity degree of agglomerative interconnections included in agglomeration composition (Carr & Chen, 2002). Such an evaluation has not only theoretical and methodological, but also practical value associated with the characteristic features of the interaction of cities within the agglomeration, the agglomeration influence on the development of regional economic space, as well as the development of proposals for further development of urban agglomerations and effective models for managing them.

3. Research Questions

The study of the evaluation problem of the level of urban agglomeration development is based on the following tasks in this article.

1. Consideration of agglomeration as a special system of cities interaction.

2. Characteristics of the main methods of analyzing cities interaction within the agglomeration and identifying the most appropriate of them, based on the available information base of the research and analysis goals.

3. Testing of methods for analyzing the level of agglomerative development on the example of Rostov agglomeration as the largest in the South of Russia.

4. Purpose of the Study

The aim of the study is to assess and characterize the level of urban agglomeration development based on the analysis of the interaction degree of cities within its composition, as well as the impact of the agglomeration on the development of regional economic space; forming conclusions and proposals for further development of Rostov urban agglomeration.

5. Research Methods

The study was conducted using system-structural and comparative analysis, modeling, expert-analytical assessment, as well as the method of scientific abstraction, logical approach, method of classifications and statistical analysis.

To determine the level of agglomeration development, there are five main methods of identifying and evaluating the degree of territorial and economic connectedness of municipalities within the agglomeration:

1. The Theil Index Spatial Concentration Method.

2. Research method of regional contact-gravitational environment of the territory (RCGE).

3 The integrated assessment method of the indicators variation of municipalities based on the Gini coefficient.

4. Method of delimiting agglomeration based on transport interconnections between cities.

5. Method for studying the cities interaction as business entities.

Each of these methods has its advantages and disadvantages, especially in the context of their actual application and testing of results in practice. Therefore, the use of these methods in the complex allows us to obtain results as close to reality as possible, thus to most adequately assess the connectedness of cities in the agglomeration composition (Table 1).

Table 01. Methods of analysis of urban agglomeration interaction

Methods for analyzing agglomerative interaction of cities	Advantages	Disadvantages
The Theil Index Spatial Concentration Method	Allows identifying inequalities in urban development. Visibility of results	The application complexity. Not applicable for the analysis of monocentric agglomerations.
Research method of regional contact-gravitational environment of the territory (RCGE)	Able to ensure the selection of main elements of interaction between cities; allows identifying growth points. Technique novelty; versatility	Difficult to calculate the cities interaction in polycentric agglomerations
The integrated assessment method of the indicators variation of municipalities based on the Gini coefficient	Reflects uneven distribution of the studied trait among several cities of agglomeration	Limited functional of application; the results are not detailed for each of the studied subjects
Method of delimiting agglomeration based on transport interconnections between cities	Visibility, reliability of the results, repeated positive experience of application in domestic and foreign practice	Need for a large amount of cartographic data and basic information about motor complex volume of the agglomeration core
Method for studying the cities interaction as business entities	Novelty. Applicable for calculating the economic potential of small and medium cities	Not applicable for studying the relationship of cities in large and largest agglomerations. Significant complexity of the application

Note: Compiled by the author according to the data (Baranov, 2011; Volchkova, 2013; Kolomak, 2015; Kutovoi, 2013).

In our opinion, the research method of RCGE and the method of delimiting agglomeration based on transport interconnections between cities are the most appropriate and acceptable from the considered set of methods in the study of agglomerations and based on the available information base.

The research method of RCGE is one of the forms for agglomeration analysis from the standpoint of the spatial forms theory of cities contact. The expediency of its use as a basis for the study of the mechanism of cities interaction is due to the need for such a conceptual construct that combines main structural components, allowing the understanding of the prerequisites of intercity interaction (Ivanova & Belikova, 2015). This is dictated by the fact that available scientific theories do not fully explain modern causes, peculiarities and consequences of cities interaction within the agglomeration (Hassan, Wajid, & Ahmed, 2012). An important advantage of using RCGE method is its versatility, owing to which the researcher is able to obtain specific information about interterritorial contacts of various directions, genesis and intensity degree inside the agglomeration, without being distracted by unnecessary details.

Since agglomeration is a specific form of spatial organization of the population and economy, which concentrates enterprises of the economic complex, recreational zones, production and social infrastructure, one of the important criteria for its research is the transport accessibility of objects. It can be assessed by the method of delimiting agglomeration on the basis of transport links between cities. The essence of the method is to isolate the so-called rings around the agglomeration core. This method performs a significant gnoseological and methodological role, since natural, social economic, political and other factors being in

the aggregate form a unique image of agglomerations in a single territory. Regarding the development of labor mobility and the speed of goods and passengers delivery, the role of this method is more increasing in regional studies. The application of this method is reflected in the works of many domestic authors, primarily because of the ease of use and visibility (Animitsa, Bochko, & Peshnina, 2010; Sheina & Shishkunova, 2017). It should be noted that this approach, with all its fidelity, has a rather significant drawback, namely, it cannot be used as the main one in assessing urban agglomeration in the context of reflection of the cities interaction degree.

The considered methodological approaches to the analysis of the level of territorial-economic interaction of the settlements can provide a fairly complete picture of the agglomeration development level, since they reflect its endogenous features and dynamic changes in the structure. These methods and approaches are most applicable in relation to monocentric agglomerations, having in their administrative-territorial structure one clearly dominant center forming the core of agglomeration. Undoubtedly, Bolshoi Rostov can be attributed to this type as the largest urban agglomeration of southern Russia (Druzhinin, 2013; Fedorovskaia & Shishkunova, 2016).

Rostov agglomeration (Bolshoi Rostov) is the leading center of attraction for economic resources of the entire South of Russia. Its territory covers 5.8 thousand km^2, where about 1.8 million people live; 1.6 million is urban population. The reference area within the zone of influence of the agglomeration core, represented by the regional center, unites 10 municipalities, including the cities of Taganrog, Azov, Novocherkassk, Bataisk, Aksai. Municipal areas in the composition of the urban agglomeration form a kind of crescent around Rostov-on-Don, stretching to the west and south of it along the coast of the Sea of Azov. There are 391 rural settlements within their borders.

The cities that are part of the agglomeration differ from each other not only by quantitative parameters (population, transport distance, investment activity, budgetary support), but also by qualitative indicators according to their functional purpose (Ivanova, 2017). The development indicators of five cities of the agglomeration reference area clearly illustrate this (Table 2).

Table 02. Indicators of spatial concentration of the cities of Rostov agglomeration model regionally contact-gravitational environment of the territory

Cities	Bataisk	Azov	Novocherkassk	Taganrog	Aksai
Distance from agglomeration core, km	15	38	41	77	16
Urban population, thous. people	122	82	170	251	44
Number of enterprises, un.	2175	1756	4070	7090	2811
Territory area, km^2	77,68	67,5	128,0	95	65,7
Length of roads with hard surface, km	282,3	159,8	945,0	615,7	81,4
Density of roads with hard surface, km per km^2	3,6	2,3	7,4	6,5	1,2
Correction factor	1,5	1,25	1	1	1,25
RCGE value	11119,9	1304,6	1338	246,3	4107,2

Note: Compiled and calculated according to Comparative figures (RosStat, 2016)

Calculation of the connectedness degree of the cities entering Rostov urban agglomeration, based on RCGE model (table 2), allows us to state a significant range of indicators characterizing their interaction with the agglomeration core. The cities of Bataisk and Aksai, which have traditional, historically

established and actively developing economic ties with Rostov-on-Don, being its satellite cities, demonstrate the greatest connection. At the same time, there is a direct correlation between the income level of the population in these cities and the gross regional product produced by the agglomeration core (Mirgorodskaya & Sukhinin, 2018). However, RCGE model application allows us to select Bataisk as the main center of attraction. This city is a priority area for the development, in particular the construction of the "sleeping" areas and industrial co-workings of the agglomeration core. The connectedness of other cities with the agglomeration core is substantially weak, due to their location at greater distance from Rostov-on-Don and lower transport accessibility for residents.

In order to correct the obtained results, it is necessary to investigate the transport infrastructure of the agglomeration as a communicative basis of interaction between municipalities. To do this, we use the method of delimiting agglomeration on the basis of transport interconnections between cities.

Transportation hubs of the agglomeration (primarily Rostov-on-Don and Bataisk in land relation, Taganrog due to the importance of its transit functions, including sea communication) serve as focuses through which the agglomeration core gets resources and distributes the capital of the reference area, including labor resources as the most important part of it. The leading position in transport interaction with Rostov agglomeration core is occupied by Bataisk, which is associated with the importance of transport arteries located in the city, and the formation of large traffic flows (especially in railway traffic). In general, the transport interaction of the cities of Rostov agglomeration is stable and fully meets the needs of the population in these cities. However, there is an asymmetry between the transport accessibility of cities and rural settlements of municipal districts being comprised in the agglomeration composition.

6. Findings

Summarizing the system of indicators reflecting the links between the cities of Rostov agglomeration, we present their final score (Table 3).

Table 03. Ballroom assessment of the indicators of territorial and economic connection of the cities of Rostov urban agglomeration

Cities	Bataisk	Aksai	Novocherkassk	Azov	Taganrog
Ranks of cities in terms of interaction with the center	5	4	3	2	1
Ranks of cities on the dynamics of development	5	3	2	1	4
Ranks of cities by social economic level of development	1	2	3	5	4
Ranks of cities on transport interaction between them	5	1	2	3	4
Total number of points	16	10	9	11	13
Final place in ranking of cities in the agglomeration	I	IV	V	III	II

Note: Compiled and calculated according to Comparative figures (RosStat, 2016).

According to the obtained results, it is possible to present a typology of cities that are part of the agglomeration, on the basis of their economic and spatial connectedness with the center - Rostov-on-Don.

1. The city of Bataisk should be considered the most promising in the development of Rostov agglomeration. It houses one of the largest logistics centers in Russia, formed on the basis of a railway hub and proximity to M 4 federal highway. The enterprises of the city have a pronounced export specialization. At the same time, the average per capita monetary incomes of the population are at a high level, which indicates the close relationship of the city with the agglomeration core where Bataisk labor resources are concentrated.

2. The second economically significant in agglomeration development is Aksai, another satellite city of Rostov-on-Don. Primarily it is positioned as a small industrial center and a kind of "sleeping" area of the agglomeration.

3. The city of Novocherkassk has the smallest connection with Rostov agglomeration core. The city demonstrates dependence on the city-forming enterprises in its development (Novocherkassk SDPP and the electric locomotive plant), the demand for products is inelastic. In this regard, it is necessary to diversify the branches of the city economy, since at present its potential is limited for the development of agglomeration links.

7. Conclusion

Urban agglomerations differ in the interaction degree between the core and the supporting territory. The use of a complex of methods and quantitative indicators allows evaluating the degree of the agglomeration development on the basis of identifying the degree of inter-municipal interaction (Dociu & Dunarintu, 2012).

 The mechanism of interaction between cities of agglomeration is expressed in the organizational and institutional spatial-economic relations between them. They are caused by the social natural economic factors of localization and functioning of cities. The most capacious mechanism of interaction between cities in the agglomeration can be traced in the framework of a study of the regional communication and gravity environment (RCGE), which takes into account organizational and institutional spatial and economic ties between settlements, due to a variety of factors and conditions for their development. The interaction of cities in this case serves as the basis for the formation of a single social economic space of the agglomeration.

Rostov agglomeration development, as the largest in the south of Russia, can be considered high in level. Consideration of the degree of territorial and economic relations is necessary when solving theoretical and practical problems related to the peculiarities of cities interaction within the agglomeration, the agglomeration influence on the development of regional economic space, as well as the development and implementation of proposals for further development of urban agglomerations. Further development of Rostov agglomeration according to an intensive scenario, aimed mainly at modernizing its social economic infrastructure, will allow achieving a rational balance of municipalities based on their functional specializations and interactions.

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