Comparative research on socio-economic development of Russian megacities

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Annotation. The research is devoted to the problem of differentiation of Russian megacities on the basis of comparative studies of socio-economic development. The authors study the most important indicators for the differentiation of megacities to provide the population with housing, well-being and employment, longevity, the human development index. To select the indicators for the assessment, it’s necessary to analyze the results of Russian and foreign scientists’ research, the materials of the ratings of global cities and indicators of quality of life in megacities. The research method used in the article is the economic and mathematical method that calculates multidimensional average socio-economic indicators of the megacities, characterizing the quality and level of urbanization. Based on the socio-spatial approach and the results of the combined analysis of the human potential index in the Russian megacities and the multidimensional average socio-economic indicators characterizing the level of socio-economic development and the quality of life, the authors determine clusters of Russian megacities, which allow assessing the level of their socio-economic development and comparing megacities.

1. Introduction

Comparative analysis of megacities development is one of the most interesting and promising socio-economic research. The study of new phenomena and trends in the system of global cities gives a more detailed assessment of the phenomenon of “archipelago of Russian cities”, establishes the most important links between them, identifies those emerging trends that determine the presence of the potential of the megacities, the ability to assess it from the standpoint of competitiveness and the possibility of inclusion in the global globalization network.

According to P. Taylor [1-2], N. Ah. Sluka [3-4] et al., megacities are the driving force of social and economic development of society. The study of megacities development allows clarifying position of megacities in the general system, justifying the strategy and tactics of socio-spatial development. Publications on global cities, which appeared in recent years, focus mainly on the processes of transnationalization, smart cities, digitalization [5-8]. Quite a large number of works in the field of methods of identification of global cities is aimed at identifying the rating of the city in a previously defined structure, or at ranking megacities on a certain basis [3,9-11]. Theoretical studies of Saskia Sassen [12], D. Clark [13], David E. Andersson, etc. [14] allowed creating a scientific basis for the assessment of megacities on the development of various components of the city's economy, assessing the potential and rating of global cities.
However, Russian megacities, for the most part not included in the rating system of such influential world ratings as, for example, GaWC, Monocle, Mercer [9-11], nevertheless, have some potential that determines their place in the overall system of world economic and national relations.

Being the points of growth, Russian megacities represent the concentration of social communities, which are permanently influenced by the peculiarities of the city location, its social, historical and cultural environment. The importance of social and spatial components allowed drawing a conclusion about the need for comparative studies from the standpoint of the socio-spatial approach. Within the framework of the proposed approach, the Author study the socio-economic development of the megacities in order to clarify the strengths and weaknesses of their development and to establish groups of megacities comparable in quality of life.

2. Problem definition

Globalization processes, the growth of cities and megacities entail the creation of new conflict nodes that arise both in the inner space of the megacities and in the external environment. The external conflict of megacities results in a competitive struggle due to the problems of population ageing in developed countries and the problems of youth growth in developing countries, excessive dependence of the population of megacities on the level of motorization, economic and social problems. The internal conflict is connected, among other things, with the problems of urban space planning, building processes, the increase in the number of representatives of different ethnic cultures and religions [4]. These issues have been highlighted in sufficient depth in UN – HABITAT’s “Planning for sustainable cities: global report on human settlements 2009” [15].

Conflicts on the territories of these expanding urban formations leads to conflict of megacities. The rivalry between them inevitably leads to the need to identify certain groups-clusters, within which comparisons should be made and on which it is possible to assess the level of development and attractiveness of the megacities. The authors [16, 17] noted the importance of investments in human capital as one of the strategic priorities of socio-economic development of regions and cities. Based on the studies [18,19], special attention has been given to the socio-economic factors and the factor of human capital development to assess the attractiveness of the metropolis. In turn, the development of human capital is possible only if a number of conditions are met: the provision of human needs for housing at a basic level for each specific period of time; the achievement of a certain level of well-being; the provision of the social need for health services; employment, etc. The calculation also included the human development index (HDI), which represents the average indicator of population development in a particular country or region, and is an indicator of human potential [20].

According to the results of analysis [17-19], the following indicators have been selected as the main ones for assessing the level of socio-economic development:

- the total area of dwelling per inhabitant (at the end of the year; square meters) – X1;
- average per capita income per month (RUB) – X2;
- subsistence minimum (RUB) – X3;
- population with monetary income above or equal to the subsistence minimum (% of the total population) – X4;
- employment rate (%) – X5;
- life expectancy (years) – X6;
- infant mortality rate (the number of children who died before the age of 1 year, per 1000 live births) – X7.

Clustering of megacities is based on the method to array human development index × multidimensional average socio-economic indicators presence matrix, characterizing the achieved level of socio-economic development. The task of the study is to group Russian megacities according to the level of socio-economic development on the basis of indicators characterizing the life quality in megacities.
3. Materials and methods
The base for the study is the works of leading Russian and foreign scientists that researched the global cities [1-6, 8, 12-14]. The author used the information and statistical base of Rosstat that provides socio-economic indicators of Russian regions [20-21]; data on the human potential index by the Analytical center under the Government of the Russian Federation [20], plans and programs for the city development published by the authorities of Russian megacities in free access [22-23].

The author used the economic and mathematical method to array human development index × multidimensional average socio-economic indicators presence matrix, characterizing the level of socio-economic development and life quality in megacities.

4. Research results and discussion
According to foreign scientists [1-2], world cities do not compete with each other, they are inherent in network connectivity. However, as noted in [3], also there is the hierarchy of cities. Such duality reflects the essence of global cities. On the one hand – the connection as an information and economic interaction, the reaction to the geographical “rupture” of space and the need to fill the “voids” due to the large-scale outflow of population from towns and rural areas to the growing point of attraction. On the other – the need to rank or build a hierarchy of megacity, as a result of the formation of different levels of economic and human potential of cities.

Russian megacities also perform a dual function: on the one hand, being a potential source of prosperity, a point of growth and a center of attraction, on the other hand – centers of conflict and risk zones. The works of Animitsa E. G. and Vlasova N. G. [24], Vendina O. [17], Zubarevich N.V. and S. G. Safronova [16] have researched the nature of such differences. However, at present the studies of the clustering of megacities in terms of development, assessing the potential of the megacities on the indicators of current level of socio-economic development, identifying its position in the current network of global cities, the possibility of achieving the planned level of development, reducing inequality are important. The main methodological problem of the clustering methods used is the differences in the results obtained, associated with the inevitability of subjective evaluation in the definition of indicators.

The results of research in the field of identifying the inequality of megacities largely depend on the initial information and methods of its processing [16,17,25]. The proposed method is based on the method of clustering, the megacities has been divided into groups according to the index of human development and multidimensional average socio-economic indicators characterizing the level of socio-economic development and quality of life in megacities (table 1).

| No | City          | HDI   |
|----|---------------|-------|
| 1  | Moscow        | 0.949 |
| 2  | St. Petersburg| 0.922 |
| 3  | Kazan         | 0.896 |
| 4  | Krasnoyarsk   | 0.878 |
| 5  | Yekaterinburg | 0.871 |
| 6  | Voronezh      | 0.868 |
| 7  | Omsk          | 0.868 |
| 8  | Samara        | 0.867 |
| 9  | Novosibirsk   | 0.867 |
| 10 | Perm          | 0.860 |
| 11 | Chelyabinsk   | 0.859 |
| 12 | Volgograd     | 0.854 |
| 13 | Nizhny Novgorod| 0.852 |
| 14 | Ufa           | 0.852 |
| 15 | Rostov-on-Don | 0.851 |

*Compiled by [20].
Table 2. Calculation of the multidimensional average socio-economic indicators.

| City          | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ | $X_7$ | % to average | Multidimensional average value, % |
|---------------|-------|-------|-------|-------|-------|-------|-------|-------------|----------------------------------|
| Moscow        | 19.1  | 59203 | 15092 | 91.1  | 75.1  | 77.08 | 5.7   | 78          | 192                              |
| St. Petersburg| 24.3  | 41165 | 10526 | 92     | 73.5  | 74.9  | 4     | 99          | 134                              |
| Volgograd     | 23.7  | 20739 | 8794  | 84.7  | 62.5  | 72.49 | 5.8   | 96          | 67                               |
| Kazan         | 25.7  | 32609 | 8108  | 86     | 68.7  | 73.64 | 5.4   | 104         | 106                              |
| Chelyabinsk   | 25.4  | 23466 | 8984  | 85.9  | 65.9  | 70.5  | 5.8   | 103         | 76                               |
| Yekaterinburg | 25.2  | 35159 | 9973  | 89.9  | 64.6  | 70.02 | 5.8   | 102         | 114                              |
| Ufa           | 24.8  | 28125 | 8323  | 87.5  | 63    | 71    | 6     | 101         | 91                               |
| Rostov-on-Don | 24.1  | 27104 | 9414  | 92.5  | 63.8  | 72.2  | 6.6   | 98          | 88                               |
| Omsk          | 24.1  | 25245 | 8442  | 85.6  | 65.4  | 70.78 | 6.2   | 98          | 82                               |
| Krasnoyarsk   | 24.3  | 28030 | 10821 | 81.6  | 64.3  | 70.01 | 5.9   | 99          | 91                               |
| Voronezh      | 28.8  | 29569 | 8121  | 90.4  | 63    | 72.08 | 4.8   | 117         | 96                               |
| Nizhny        | 26.3  | 30598 | 8639  | 90.4  | 68.4  | 70.75 | 6.5   | 107         | 99                               |
| Novgorod      | 24.3  | 25401 | 10225 | 83    | 64.6  | 71.2  | 6.2   | 99          | 83                               |
| Novosibirsk   | 24.3  | 28400 | 9594  | 85.1  | 63    | 69.74 | 5.8   | 94          | 92                               |
| Perm          | 23.2  | 26795 | 9664  | 86.2  | 68.7  | 71.08 | 5.1   | 104         | 87                               |
| Samara        | 25.6  | 26795 | 9664  | 86.2  | 68.7  | 71.08 | 5.1   | 104         | 99                               |
| **average**   | 24.6  | 30773.9| 9648  | 87.5  | 66.3  | 71.8  | 5.7   | 100         | 100                              |

$^a$ Compiled by [21-23].

Then, groups of cities with equal intervals for HDI and multidimensional average have been identified.

The interval step is determined by the formula:

$$h = \frac{(x_{\text{max}} - x_{\text{min}})}{n},$$

where $x_{\text{max}}$, $x_{\text{min}}$ – maximum and minimum value, $n$ – number of groups.

Number of groups is determined by the Sturgess’ formula:

$$n = 1 + 3.322 \lg N,$$

where $N$ – total number of items.

Based on the formulas (1-2), total number of HDI values (table 1) is divided into 5 groups with an interval of 0.020.

$$n = 1 + 3.322 \lg 15 = 5, \quad h = \frac{0.949 - 0.851}{5} = 0.020.$$

Total number of multidimensional average values (table 2) divided into 5 groups with an interval equal 6.

$$n = 1 + 3.322 \lg 15 = 5, \quad h = \frac{121 - 93}{5} = 6.$$

Based on the results of the combined analysis, a matrix of city clusters on HDI and multidimensional average indicators of socio-economic development has been arrayed (table 3).
Table 3. Differentiation of Russian megacities in socio-economic development

| HDI          | Multidimensional average indicators |
|--------------|-------------------------------------|
| 0,932-0,951  | Moscow                              |
| 0,912-0,931  | St. Petersburg                      |
| 0,892-0,911  | Kazan                               |
| 0,872-0,891  | Krasnoyarsk                         |
|              | Volgograd, Chelyabinsk, Ufa, Omsk, Voronezh, Novosibirsk, Perm, Samara |
| 0,851-0,871  | Yekaterinburg, Nizhny Novgorod, Rostov-on-Don |

According to the results of the study, a gap in socio-economic development between the Russian megacities-leaders and megacities significantly lagging behind them has been revealed (table 3).

According to the results, Cluster 1 includes Moscow; Cluster 2 – St. Petersburg; Cluster 3 – Kazan; Cluster 4 – Krasnoyarsk; Cluster 5 – Yekaterinburg, Nizhny Novgorod, Rostov-on-Don; Cluster 6 – Volgograd, Chelyabinsk, Ufa, Omsk, Voronezh, Novosibirsk, Perm, Samara.

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