Advances in Economics, Business and Management Research, volume 164
Proceedings of International Scientific and Practical Conference "Russia 2020 - a new reality: economy and society" (ISPCR 2020)

The Use of Composite Quality of Life Indices for the Assessment of the Territorial Differentiation of Regions of the Russian Federation

Zhgun T.V.
Yaroslav-the-Wise Novgorod State University,
Veliky Novgorod, Russia,
Tatyana.Zhgun@novsu.ru

***Abstract*—Improving the quality of life of the population is a goal of Russia's social policy. An effective tool of social policy can be a well-grounded assessment of territorial differentiation. The dynamics of the divergence in the quality of life between regions most accurately characterizes the change in regional differentiation. Observing the behavior of single indicators of territorial differentiation over long intervals does not allow for unambiguous conclusions regarding changes in the differentiation of the observed objects. A more informative assessment of the territorial inequality of regions can be obtained using composite indices that integrate many individual indicators. The task of determining objective quantitative indicators of territorial differentiation requires the use of formal methods for constructing a composite index that do not use subjective assessments and rely on state statistics data. Using the author's methodology, the composite indices of the quality of life for Russia's constituent entities for 2010-2017 were calculated based on the method of principal components for a series of observations. The behavior of the characteristics of the calculated composite index allows us to conclude that territorial inequality in the quality of life between Russia's regions during the observed period decreases (the coefficient of variation decreases) with an increase in the average values of the indicator in the country as a whole. However, the gap in the quality of life of the population in Russia's constituent entities and Federal Districts remains significant and requires competent management decisions to overcome.**

Keywords—regional development, differentiation of regions, composite index, principal component analysis, quality of life of the population

I. INTRODUCTION

nequality of development is a feature that characterizes any large territorial system. (Inequality of development characteristic feature of any large territorial system.) The functioning of such systems cannot occur synchronously, since the parameters of large systems are characterized by great variability. Consequently, the difference in the level of socio-economic development of large regions is a natural phenomenon. However, too of a large gap in the characteristics of a population's quality of life between different regions is a cause of increased social tension and additional economic problems. In particular, a significant gap in the quality of life of the territories leads to increased migration of qualified personnel to regions with a higher quality of life. Unilateral migration processes escalate economic regional asymmetry and a further the gap in quality of life between regions.

Significant disproportions in socio-economic development and quality of life among Russia's regions leads to the collapse of a common economic space, to the strengthening of disintegration trends and are one of the main problems to solve in ensuring economic security in modern Russia. Such imbalances in development and quality, are named "a threat to the economic security of the country" by the "Economic Security Strategy of the Russian Federation until 2030".

Despite a significant number of studies devoted to territorial inequality [1-4], there is no consensus among researchers regarding the methodology and tools for diagnosing the territorial differentiation of regions.

Meanwhile, an objective methodology for assessing the territorial inequality of Russia's regions can be an effective tool for the timely diagnosis of acute economic and social problems. Further, such a methodology provides a tool for determining the directions of state support aimed at reducing regional inequality in socio-economic development and quality of life. In this regard, regional differentiation requires quantitative measurement, to which this work is devoted.

II. PROBLEM STATEMENT

Usually, separate indicators are used to determine the level of inequality of territorial systems. Researchers most often use the coefficient of variation, the Gini coefficient, Theil index, Atkinson index, the cost of living, the cost of a fixed set of consumer goods and services in the region to quantify the territorial differentiation of the population's quality of life. For a quantitative assessment of socio-economic inequality in the regions, demographic and monetary indicators are also used:

fertility and mortality rates, gross regional product per capita, average wages per employee, etc. All indicators can be used to characterize regional inequality, however, over a long period the dynamics of a single indicator often looks rather bizarre and does not allow making unambiguous conclusions.

An illustration of this behavior of individual indicators is shown in Fig. 1. Fig. 1 shows the behavior of two indicators of territorial inequality: the gap in GRP per capita and the gap in average per capita incomes of Russian regions relative to 2005. The indicator gap is defined as the ratio of the maximum indicator value to the minimum value. The data of state statistics were used - the statistical collection "Regions of Russia" for 2019. The gap in average per capita incomes, judging by the graph, is steadily decreasing. However, the indicator "Gap of GRP per capita" behaves completely differently: first it shows growth, then a decline, then fluctuations. The dynamics of this indicator does not have an unambiguous interpretation and the combined assessment of these two indicators is impossible. The graph does not allow for an unambiguous conclusion on the decrease or increase in territorial inequality.

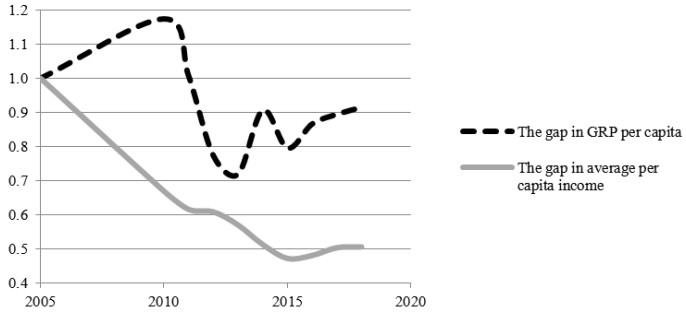

Fig. 1. Behavior of two indicators of territorial inequality: the gap in GRP per capita and the gap in average per capita income of Russian regions relative to 2005

III. RESEARCH METHODS

A more meaningful assessment of the territorial inequality of the regions of the Russian Federation can be obtained using complex indices that integrate many individual indicators. Let us consider the construction of a comprehensive assessment of the quality of a system of m objects, where each object is characterized by n features. For the i-th object at time t, the value of the composite index is determined by the formula.

$$CI^t_i = \sum_{j=1}^{n} w^t_j \cdot a^t_{ij} \qquad (1)$$

where t = 1,…, T – is the observation interval, – is the value of the j-th index of the i-th object at the moment t, – is the vector of weights of indicators for the moment t. Numerical characteristics of objects are viewed on the same scale. This is usually the interval [0, 1]. Conversion of variables into a single scale takes into account the nature of the dependence of the variable with the system quality indicator according to the principle "the more, the better". It is required to find the weights of indicators for each point in time to construct a composite system quality index.

Weights can be obtained subjectively from a priori information (expert assessments, sociological surveys) as assessments of the importance (significance) of variables, or determined using objective (formal) methods from the available data. Most commonly to determine the weighting factors methods of multivariate analysis are used, in particular, the method of principal components [5-7].

The set task of determining objective quantitative indicators of territorial differentiation requires the use of formal methods for constructing a composite index that do not use subjective assessments and rely on a reliable, verifiable and reproducible information base. State statistics data are usually used as an information base. Errors in the data used can be one of the reasons for the insufficient quality of composite indices. The use of formal methods for determining the weight coefficients in the case of errors (distortions) will lead to a change in the calculated coefficients and an erroneous calculation of the composite indicator according to formula (1). The presence of a large number of errors in statistical data is noted by the authors [8-10]. Nevertheless, it is the state statistics authorities that provide data that best estimates the real parameters of socio-economic systems [10].

The best tool for obtaining an empirical summary of a dataset is principal component analysis (PCA) [11]. However, in practice, PCA is rarely used to determine the weights of composite indices. This is partly because the technique is difficult to explain to non-experts, and partly because the PCA weights (1) vary significantly over time. This circumstance contradicts intuitive ideas about the properties of the analyzed system. Another major point of criticism with the use of multivariate analysis methods to obtain the weights of composite indices is the lack of socio-economic interpretation of the resulting weights [12-14] and the instability of computed composite indices [15,16]. The author of this study proposed a modification of the PCA, which determines the weight coefficients (1) as characteristics of the structure of the evaluated system based on a number of observations [17,18]. The interpretation of weight coefficients as characteristics of the structure of a system solves one of the main problems in the construction of composite indices, when the expert assessment of the importance of a variable differs significantly from the calculated weights [15,16].

IV. FINDINGS

Improving and equalizing the quality of life of the population of Russia's constituent entities is the goal of the state's socio-economic policy. The dynamics of the indicators of regional differentiation can be characterized by the behavior of the estimates of the quality of life of regions. To determine the indicator gap, it is necessary to calculate objective composite indices of the quality of life for Russia's constituent entities for series of observations using a single method.

Composite indicators of the quality of life of Russia's constituent entities for 2010-2017 were calculated using the author's methodology based on the method of principal components [17,19]. To calculate the composite indicators of quality of life, 37 indicators proposed in the study [20] were used. This set of indicators has been repeatedly used by various authors to determine the composite indices of the quality of life in Russia's regions. The values of the variables are taken from the Rosstat reference books "Regions of

Russia". The computed composite indices are scaled down for ease of comparison. Namely: for the first year, the minimum computed value of the composite index is 1, and the maximum is 100.

Analyzing the obtained results, it can be stated that in the country as a whole and in each of its constituent entities, a steady growth of the calculated indicator is observed. Table I shows the average values of the indices of the quality of life of the population in general for the Russian Federation and federal districts. The indicator demonstrates steady growth for all federal districts; however, the values of the integral indicator of the quality of life in federal districts differ significantly. In 2010, the ratio of the maximum value of the indicator to the minimum was 2.6, in 2017 – 1.8.

The values of the integral indicator of the quality of life also differ within each federal district. This difference is well illustrated by the coefficient of variation c_{var} . Table II shows the values of the coefficients of variation of the calculated indices of the quality of life in Russia's constituent entities as a whole in Russia and federal districts. This indicator shows a decrease for all constituent entities of the Russian Federation as a whole - the coefficient of variation decreases from 0.39 in 2010 to 0.25 in 2017. The decrease was about 36%. The coefficient of variation demonstrates a decrease in all federal districts, which indicates a decrease in territorial differentiation within each of the federal districts. The greatest differentiation in the quality of life of the population of the federal districts in 2017 is observed in Siberia (c_{var} = 0.24) and the Far East (c_{var} = 0.26), where the economy of raw materials prevails. However, it is these federal districts that demonstrated the maximum rates of decrease in territorial inequality within the district: in the Siberian FD and the Far Eastern FD, this decrease was 48.9% and 39.5%, respectively. The smallest differentiation of the entities of the federal district in terms of quality of life was observed in 2017 in the North Caucasian FD (coefficient of variation c_{var} = 0.08), the decrease was 20.0% over the observation period. The leader in equalizing the quality of life within the federal district is the Volga Federal District, where the coefficient of variation for the period under review has almost halved.

Fig. 2 shows the change in three characteristics of the calculated quality of life index for Russia's constituent indices as a whole in the country relative to 2010. The average value of the quality of life index in the period under review is growing, while the standard deviation of the index and the coefficient of variation, which characterize territorial inequality in the quality of life in the country as a whole, are decreasing.

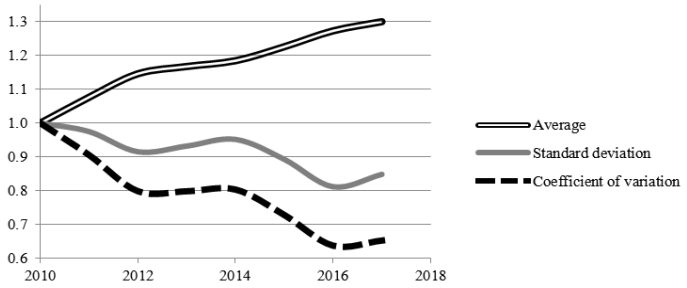

Fig. 2. Changes in the characteristics of the quality of life of the population of the Russian Federation as a whole across the country relative to 2010

TABLE I. AVERAGE VALUES OF THE INDICES OF THE QUALITY OF LIFE OF THE POPULATION OF THE CONSTITUENT ENTITIES OF THE RUSSIAN FEDERATION

Region	2010	2011	2012	2013	2014	2015	2016	2017
Russian Federation	44.5	48.5	51.8	53.2	54.3	57.0	59.6	61.0
Central Federal District	49.1	52.8	56.3	57.3	58.1	60.2	62.5	63.8
Northwestern Federal District	43.8	48.8	54.0	55.1	56.7	57.8	60.3	60.4
Southern Federal District	53.0	56.4	58.5	60.1	61.0	63.4	67.0	69.0
North Caucasian Federal District	70.2	71.1	73.0	74.5	76.1	78.8	81.2	84.1
Volga Federal District	42.5	46.7	50.4	51.5	52.0	55.6	59.3	60.2
Ural Federal District	51.6	54.6	57.6	58.2	59.1	61.1	63.2	64.9
Siberian Federal District	30.4	35.2	37.4	39.4	39.2	43.1	46.2	48.0
Far Eastern Federal District	27.0	31.6	35.5	37.8	40.8	42.8	45.8	47.0

TABLE II. VALUES OF THE COEFFICIENTS OF VARIATION OF THE INDICES OF POPULATION LIFE QUALITY OF THE SUBJECTS OF THE RUSSIAN FEDERATION

Region	2010	2011	2012	2013	2014	2015	2016	2017
Central Federal District	0.39	0.34	0.31	0.29	0.29	0.27	0.25	0.25
Northwestern Federal District	0.35	0.32	0.28	0.28	0.28	0.26	0.22	0.23
Southern Federal District	0.39	0.33	0.28	0.28	0.25	0.24	0.23	0.23
North Caucasian Federal District	0.16	0.14	0.15	0.13	0.12	0.12	0.11	0.10
Volga Federal District	0.10	0.08	0.07	0.06	0.05	0.05	0.07	0.08
Ural Federal District	0.25	0.20	0.19	0.17	0.18	0.15	0.13	0.13
Siberian Federal District	0.27	0.25	0.25	0.24	0.26	0.25	0.25	0.25
Far Eastern Federal District	0.47	0.36	0.38	0.31	0.34	0.29	0.27	0.24
Central Federal District	0.43	0.32	0.29	0.30	0.28	0.29	0.29	0.26

These indicators may demonstrate a different nature for individual federal districts. Fig. 3 shows the change in these

parameters relative to 2010 for two federal districts: the Ural Federal District and the North Caucasian Federal District. For the Ural FD, the nature of the variability of quality of life indicators within the district largely coincides with the national one. In this case, we can talk about a decrease in regional differentiation in the quality of life within the district throughout the observation period. For the North Caucasian Federal District, the variability of the quality of life indicators is non-monotonic and the regional differentiation in the quality of life of the population within the district increases after 2014.

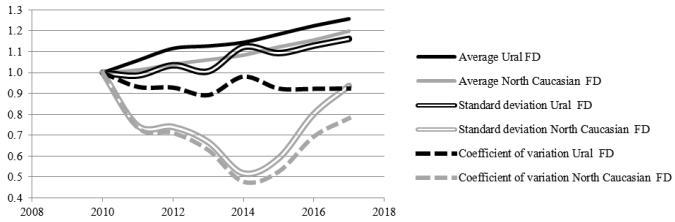

Fig. 3. Changes in three characteristics of the quality of life of the population of the Russian Federation for the Ural and North Caucasian Federal Districts relative to 2010

V. Conclusion

For an effective social policy, it is important to know the quantitative characteristics of the dynamics of social development. A well-founded assessment of the territorial differentiation of the Russia's regions can be an effective tool for social policy. Improving the quality of life of the population is the goal of the state's socio-economic policy. Therefore, it is the change in the gap in the quality of life for the regions that most accurately characterizes the dynamics of indicators of regional differentiation. Observation of the behavior of single indicators of territorial differentiation over a long interval does not allow for unambiguous conclusions regarding changes in the differentiation of the observed objects. A more informative assessment of the territorial inequality of the regions of the Russian Federation is provided by composite indices, which integrate many separate indicators into a single value. The task of determining objective quantitative indicators of territorial differentiation requires the use of formal methods for constructing a composite index that do not use subjective assessments and rely on state statistics data.

The technique in the proposed study is the author's modification of the principal component method for a series of observations. With the help of the author's method using state statistics data, complex indicators of the quality of life of the population of the constituent entities of the Russian Federation were calculated for 2010-2017. The behavior of the characteristics of the calculated composite index allows us to conclude that territorial inequality in the quality of life for the observed period decreases (the coefficient of variation decreases) with an increase in the average values of the indicator in the country as a whole and in each of the federal districts. However, the difference in indicators characterizing the quality of life between the subjects and federal districts remains significant, which requires competent management decisions to overcome.

References

[1] P. Aalto, and T. Forsberg, "The structuration of Russia's geo-economy under economic sanctions", Asia Europe Journal, 2016, vol. 14(2), pp. 221-237.

[2] R.C.M. Beyer, and M.A. Stemmer, "Polarization or convergence? An analysis of regional unemployment disparities in Europe over time", Economic Modelling, 2016, vol. 55, pp. 373-381.

[3] R. Boschma, "Towards an Evolutionary Perspective on Regional Resilience", Regional Studies, 2015, vol. 49(5), pp. 733-751.

[4] R. Martin, and P. Sunley, "On the notion of regional economic resilience: conceptualization and explanation", Journal of Economic Geography, 2015, vol. 15(1), pp. 1-42.

[5] M. Freudenberg, "Composite indicators of country performance: a critical assessment", OECD science, technology and industry working papers, OECD Publishing, 2003, vol. 16, pp. 1-34.

[6] A. Sharpe, Literature Review of Frameworks for Macro-indicators, Ottawa: Centre for the Study of Living Standards, 2004.

[7] A. Saltelli, "Composite indicators between analysis and advocacy", Social Indicators Research, 2007, vol. 81(1), pp. 65-77.

[8] V. Krishnan, "Development of a Multidimensional Living Conditions Index (LCI)", Social Indicators Research, 2015, vol. 120(2), pp. 455-481.

[9] R. Jacobs, P. Smith, and M. Goddard, Measuring Performance: An Examination of Composite Performance Indicators, UK, York: Centre for Health Economics, University of York, 2004.

[10] M. Nardo, M. Saisana, A. Saltelli, and S. Tarantola, Tools for composite indicators building, Ispra: Joint Research Centre, 2005.

[11] B.G. Tabachnick, and L.S. Fidell, Using multivariate statistics, Boston: Pearson Education, 2007.

[12] S.K. Mishra, A Comparative Study of Various Inclusive Indices and the Index Constructed by the Principal Components Analysis", 2007. Retrieved from http://mpra.ub.uni-muenchen.de/3377

[13] N. Somarriba, and B. Pena, "Synthetic Indicators of Quality of Life in Europe", Social Indicators Research, 2009, vol. 94(1), pp. 115-133.

[14] Y. Fukuda, K. Nakamura, and T. Takano, "Higher mortality in areas of lower socioeconomic position measured by a single index of deprivation in Japan", Public Health,2007, vol. 121, pp. 163-173.

[15] W. Becker, P. Paruolo, M. Saisana, and A. Saltelli, Weights and Importance in Composite Indicators: Mind the Gap, in: Ghanem, R., Higdon, D. and Owhadi, H. (Ed.), New York City: Quantification Springer International Publishing, 2017.

[16] W. Becker, M. Saisana, P. Paruolo, and I. Vandecasteele, "Weights and Importance in Composite Indicators: Closing the Gap", Ecological Indicators, 2017, vol. 80, pp. 12-22. DOI: 10.1016/j.ecolind.2017.03.056

[17] T.V. Zhgun, "Building an integral measure of the quality of life of constituent entities of the Russian Federation using the principal component analysis", Economic and Social Changes: Facts, Trends, Forecast, 2017, vol. 10(2), pp. 214-235.

[18] T.V. Zhgun, "Complex index of a system's quality for a set of observations", Journal of Physics: Conference Series, 2019, vol. 1352(1). DOI: 10.1088/1742-6596/1352/1/012064

[19] T.V. Zhgun, "Composite Indices Of Life Quality For Monitoring Of Sustainable Development Goals", The European Proceedings of Social & Behavioural Sciences (EpSBS), 2019, vol. 127, pp. 1038-1048. DOI: https://doi.org/10.15405/epsbs.2019.12.05.127

[20] M.A. Isakin, "Modification of a Method to k-Means with Unknown Number of Classes", Applied Econometrics, 2006, vol. 4, pp. 62-70.