Territorial Differentiation in Modeling of Life Quality Impact on the Demographic Dynamics in Regions

A A Anepkina[1], E V Krasova[2], A L Mazelis[3]

[1]Postgraduate, Department of Mathematics and Modeling, Vladivostok State University of Economic and Service, Gogolya str., 41, Vladivostok, 690014, Russia
[2]Assistant Professor, Department of Economics and Management, Vladivostok State University of Economic and Service, Gogolya str., 41, Vladivostok, 690014, Russia
[3]Leader, Department of Mathematics and Modeling, Vladivostok State University of Economic and Service, Gogolya str., 41, Vladivostok, 690014, Russia

E-mail: lyalya134@bk.ru; elena_krasova@rambler.ru; lev.mazelis@vvsu.ru

Abstract. This study was carried out in the framework of an actual scientific direction - the development of a methodology for assessing the impact of quality of life on demographic dynamics due to territorial (spatial) differentiation. The purpose of the article is to determine the degree and nature of territorial differentiation in the process of modeling the impact of quality of life in Russian regions on the dynamics of demographic processes taking place in them. To achieve the goal, the authors applied cluster analysis. Based on the generated database of statistical data on 72 constituent entities of the Russian Federation for 2017, including 26 indicators of quality of life and 7 demographic indicators, a clustering of Russian regions was carried out according to the level of quality of life and demographic development. Data processing was carried out in the SPSS Statistic environment. In total, five clusters are allocated. The results of clustering allow us to assess the difference in infrastructural support and demographic development of the Russian regions, and also show the uneven development of various areas of social infrastructure within each cluster. It should be noted that even seemingly prosperous regions have their drawbacks and need to improve the quality of life to solve demographic problems. The results of this study serve as a starting point for a new stage in assessing the impact of quality of life on demographic dynamics, since they allow both improving the quality of subsequent econometric modeling and obtaining a number of independent valuable conclusions.

1. Introduction

1.1. *Statement of a scientific problem and its relevance*
The issues of influencing the demographic dynamics of various socio-economic components of social development are of great practical importance for national and regional management, using specific quantitative data and criteria for making managerial decisions in each territory. Optimization of demographic development in the regions with a significant differentiation of conditions and factors of their development is a process that is difficult to manage due to its complexity, scale and responsibility. However, the social, humanistic nature of demographic processes allows us to formulate a hypothesis about the significant impact of the quality of life on it - a generalized parameter

that, on the one hand, reflects the face and inner fulfillment of people's existence, on the other hand, transforms the national economy and politics into the well-being of everyone region, each person. The fundamental scientific task, which this study contributes to, is the improvement of approaches to the study of the dependence of demographic processes on the quality of life in the regions due to territorial (spatial) differentiation.

Currently, depending on the specifics and purpose of the study, there are many approaches to assessing the socio-economic differentiation of regions. The simplest approach is based on the choice of one indicator - a criterion for assessing the level of differentiation. However, if a whole group of indicators is used (for example, in a comprehensive analysis of the quality of life), then it is not possible to make a simple classification. Cluster analysis is the most popular method for searching for groups of similar objects in a data sample in the absence of clearly defined criteria. There is no universally accepted definition of the concept of a cluster, but it is obvious that a cluster can be characterized by a number of features, the most important of which are density, dispersion, size, shape, and separability [1]. Clustering as a statistical procedure often accompanies econometric modeling, which makes it possible to establish and quantify the relationship between parameters under the conditions of a large number of statistical indicators and their mutual influence on each other.

In this study, clustering is used as one of the stages of assessing the impact of quality of life on demographic dynamics in Russian regions. The purpose of this article is to determine the level and nature of territorial differentiation in the process of modeling the impact of quality of life in Russian regions on the dynamics of demographic processes taking place in them.

Analysis of the scientific development of the problem of assessing demographic dynamics shows the lack of unified approaches to its solution and, accordingly, various research results. In the world objectively there is a multidirectional course of demographic processes under the influence of the quality of life in different countries. So, from the second half of the twentieth century in developed countries there has been a phenomenon of sustainable natural decline in conditions of improving the quality of life. At the same time, the Soviet experience and the experience of Russia in the 1990s. demonstrate a direct relationship between population growth and living conditions, i.e. reverse picture. Modern Russia with its unique geographical and economic position is capable of enriching world science and practice with its own experience in research and the formation of demographic processes.

1.2. *The degree of development of a scientific problem*
Methodological issues of studying the general interconnections of demographic dynamics and various components of socio-economic development related to quality of life began to be actively considered in the second half of the twentieth century. The issues of quality of life, poverty, social inequality and territorial differentiation became especially important thanks to J. Stiglitz and A. Sen, who broke the stereotypes about the dominance of economic growth in explaining various trends in the formation of welfare of the population [2].

A significant contribution to the study of the indicated problem at the national and regional levels was made by Soviet and Russian scientists D.I. Valentei A.G. Vishnevsky, I.V. Zhuravleva, N.M. Rimashevskaya, L.L. Rybakovsky and others. Given the vastness and diversity of studies of socio-economic and demographic differentiation, the relationship of demographic processes and quality of life, the following main directions can be distinguished.

1. *General (fundamental) analysis of the components of demographic dynamics*. Demographers usually distinguish demographic factors, in particular, the influence of fertility cycles, the intensity of interregional migration, educational migration, etc. [3]. Economists and sociologists reveal the underlying mechanism of the influence of socio-economic processes on demographic processes by searching for empirical relationships between the relevant parameters [4; five].

2. *Assessment of the relationship between the differentiation of the quality of life and the characteristics of demographic dynamics*. It analyzes the degree and nature of the reaction of demographic development to changes in living standards and well-being in general. Studies show that the quality of life has a significant (and in some cases a key) effect on life expectancy, birth rate,

migration flow, and some other important demographic indicators of the regions [6–13]. Nevertheless, the list of indicators used in the clustering process and the time periods for their consideration vary significantly.

3. *Assessment of the impact of certain aspects of the quality of life on demographic development, both in general and on its individual parameters*. The main attention is paid to health factors, housing provision, quality of service, income level [14–21]. The variety of applied data, methods and author's concepts does not allow to effectively adapt the results to the needs of regional management.

Undoubtedly, the conducted studies enrich the modern methodological base. However, the lack of data and results characterizing the impact on the demographic dynamics of the infrastructure of the quality of life in certain territories should be noted. The level of infrastructure development and its accessibility is the material basis for the well-being of the population, which can affect both the change in the population and the quality of life itself. To date, there are no clear answers to questions about the impact of educational, sports, environmental, criminal and other components of the quality of life on demographic processes, as well as no large-scale studies on regional differentiation of the quality of life infrastructure. Further research in this direction will contribute to the optimization of regional governance through the adoption of more accurate and informed decisions related to the most important areas of human life.

2. The definition of territorial differentiation in the framework of assessing the impact of quality of life on demographic processes in Russian regions

2.1. *Data and Methods*
In general, the authors proceed from the concept traditional for world practice, within the framework of which the quality of life is understood as a generalized category that includes a set of indicators characterizing the standard of living in its various social aspects. In content, Russian methods are quite close to the system of indicators of the level of quality of life used by Russian and international organizations [22; 23].

A feature of the author's concept is the use of indicators of the development of social infrastructure as a level of material equipment and the fullness of people's lives. This corresponds to a narrower and more direct understanding of the quality of life without taking into account standard economic indicators (income, benefits, level of income differentiation, etc.), which in some cases only indirectly characterize the population's access to material wealth and social opportunities.

Thus, the authors selected 26 infrastructural indicators of quality of life, grouped according to 10 criteria: the degree of motorization of territories, Internet connection, health status, road safety, general education coverage, basic health care coverage, useful food consumption, housing provision, sports coverage infrastructure and general level of environmental pollution.

Further, 7 demographic indicators were selected, among which the population, natural and migration growth rates, life expectancy, population load ratio, infant mortality rate and the ratio of marriage and divorce. This list is fundamental for the analysis of demographic processes, both from the point of view of the methodology of Russian statistics [24] and from the perspective of the UN [25], and was tested in our previous studies [26].

The information base of the study is the data of the Federal Statistics Service of the Russian Federation "Regions of Russia" for 72 constituent entities of the Russian Federation for 2017 [24]. Data processing was carried out in the environment SPSS Statistic.

2.2. *Data processing results*
Given the existing differentiation of the Russian regions in terms of quality of life, in the process of data processing, a multidimensional ranking method was applied, aimed at a comprehensive assessment of the quality of life in the country. This method does not seek to combine the assessment of the quality of life in one aggregate indicator, but is focused on taking into account the varying degrees of development of various types of social infrastructure. Table 1 presents a fragment of

multidimensional ranking of regions by groups of indicators of quality of life.
Table 1. Multidimensional ranking result (fragment).

Регион	Уровень автомобилизации	Подключение к Интернет	Состояние здоровья	Безопасность на дорогах	Охват общим образованием	Охват базовым здравоохранением	Уровень потребления полезных продуктов	Обеспеченность жильем	Охват спортивной инфраструктурой	Уровень загрязненности окружающей среды	Демография	Среднее значение по региону по показателям (ранг)
Ивановская область	37,0	22,5	4,0	53,0	10,0	26,0	14,4	25,3	26,5	29,0	23,7	24,8
Республика Алтай	15,0	5,5	72,0	31,0	71,0	7,0	34,0	12,5	5,0	3,0	38,1	25,6
Томская область	17,0	31,0	10,0	3,0	34,0	67,0	26,4	31,3	24,5	19,0	44,3	26,3
Хабаровский край	8,5	38,0	47,0	55,0	32,0	42,0	29,2	45,4	36,5	7,0	34,9	34,1
Новосибирская область	39,0	68,5	25,0	6,0	43,0	58,0	38,4	44,0	54,0	31,0	46,4	40,7
Приморский край	45,5	29,5	55,0	56,0	31,0	64,0	32,4	31,3	46,8	32,0	41,3	42,3
Нижегородская область	48,5	64,0	38,0	65,0	11,0	48,0	43,8	53,8	66,3	54,0	43,4	49,2

Further data processing was carried out using cluster analysis. Based on the analysis of the dendrogram of hierarchical clustering, built on the values of 26 indicators of quality of life and 7 demographic indicators for 2017, where the Euclidean distance is used as a measure of proximity, a decision was made to divide the regions into clusters. Five clusters consisting of 14, 3, 7, 19 and 29 regions were formed by the k-means method. The validity of this clustering was verified using the Davis-Boldin criterion. The composition of the clusters is shown in table 2.

Table 2. The cluster composition obtained in the research process.

№ кластера	Регионы
1	Республика Бурятия, Забайкальский край, Амурская область, Республика Саха (Якутия), Республика Тыва, Республика Калмыкия, Приморский край, Алтайский Край, Красноярский край, Омская область, Архангельская область, Иркутская область, Хабаровский край, Костромская область
2	Магаданская область, Сахалинская область, Камчатский край
3	Кабардино-Балкарская Республика, Республика Северная Осетия-Алания, Карачаево-Черкесская Республика, Республика Адыгея, Республика Алтай, Республика Дагестан, Республика Карелия
4	Самарская область, Республика Татарстан, Краснодарский край, Белгородская область, Новосибирская область, Свердловская область, Республика Хакасия, Вологодская область, Удмуртская Республика, Пермский край, Челябинская область, Тюменская область, Астраханская область, Кемеровская область, Брянская область, Ставропольский край, Республика Башкортостан, Оренбургская область, Ростовская область
5	Ульяновская область, Орловская область, Смоленская область, Саратовская область, Мурманская область, Кировская область, Курганская область, Тверская область, Томская область, Республика Коми, Республика Марий Эл, Чувашская республика, Волгоградская область, Тамбовская область, Пензенская область,

Ивановская область, Республика Мордовия, Калужская область, Рязанская
область, Воронежская область, Калининградская область, Липецкая область,
Псковская область, Новгородская область, Курская область, Тульская область,
Ярославская область, Владимирская область, Нижегородская область

2.3. *Analysis of data processing results*

The results of clustering (dendrogram analysis) clearly show in which subsystems the studied clusters
lead. In particular, the third cluster lags significantly behind the others in almost all respects, with the
exception of health and education. The second cluster, which includes only three entities, leads in such
parameters as Internet connection, road safety, general education coverage and housing provision, but
it has the worst indicator in ecology and demography. The fourth and fifth clusters have average
values for all regional indicators, but the fourth cluster has high values of coverage of sports
infrastructure, environmental friendliness and demography. It should be noted that the development of
the automotive system in the first cluster is quite low, and Internet connectivity, road safety and basic
healthcare coverage in the third cluster are extremely low. Figure 1 shows the fluctuations of clusters
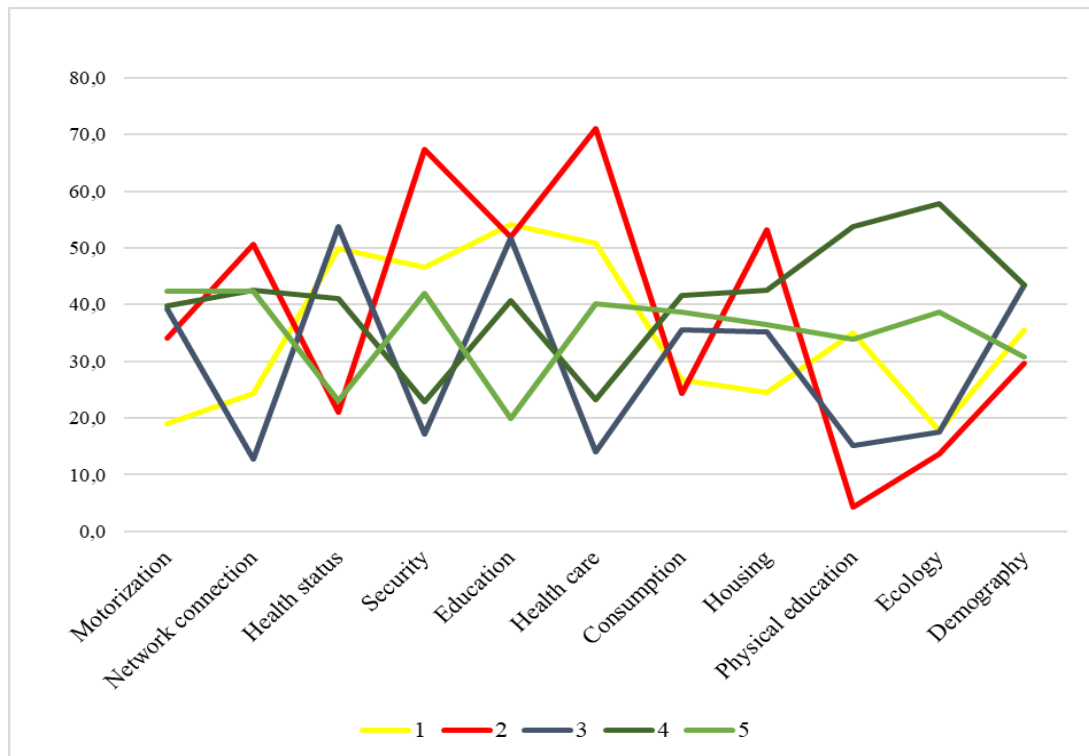in groups of studied indicators.

Figure 1. Fluctuations of clusters by groups of indicators of quality of life and demography.

The sharpest fluctuations between the levels of indicators are demonstrated by the 2nd and 3rd
clusters. This indicates the unsystematic social development of the regions included in these clusters,
the orientation of their social infrastructure either to satisfy the interests of a particular group of the
population, or to the low level of development of certain major infrastructure areas. The dominance of
any one group of industries (in particular, the extractive industries of the Magadan, Sakhalin, and
Kamchatka regions), the relatively low social orientation of the economy, and the negative
demographic dynamics greatly contribute to this unsystematic development.

The fifth cluster, on the contrary, includes mainly the regions of the European part of Russia and
shows that the formation of social infrastructure is carried out multilaterally: attention is paid to all
basic areas of material support of life. With a high degree of probability this is due to the relative

stability of the development of social infrastructure, the average standard of living for the country and moderately favorable demographic dynamics in these regions.

3. Conclusions
The study allows us to draw the following conclusions.

1. Clustering regions by quality of life and demographic development is an important scientific task in the framework of assessing the impact of quality of life on demographic processes, which allows both improving the quality of subsequent econometric modeling and obtaining a number of independent valuable conclusions.

2. Based on the generated database of indicators of quality of life and demographic development for 2017, 72 regions of the Russian Federation clustered according to the level of quality of life and demographic dynamics. The results of clustering allow us to estimate the difference in infrastructural support and the demographic development of regions, and also show the uneven development of various areas of social infrastructure within each cluster. It should be noted that even seemingly prosperous regions have their own shortcomings and need to improve the quality of life.

4. References

[1]   Kim J O 2012 *Factor, Discriminant, and Cluster Analysis* (Moscow: Kniga po Trebovaniyu) p 216
[2]   Stiglitz J E 2012 *The Price Of Inequality: How Today's Divided Society Endangers Our Future* (New York: W.W. Norton & Company, Inc) p 306
[3]   Rybakovsky O L and Sudoplatova V S 2014 General analysis of the demographic dynamics components *Population* vol 4(66) pp 4−17
[4]   Wongboonsin K and Phiromswad P 2017 Searching for empirical linkages between demographic structure and economic growth *Economic Modelling* vol 60 pp 364−379
[5]   Monnet E and Wolf C 2017 Demographic cycles, migration and housing investment *Journal of Housing Economics* vol 38 pp 38−49
[6]   Shields G M and Shields M P 1988 Families, migration and adjusting to disequilibrium *Economics Letters* vol 26(4) pp 387−392
[7]   Azomahou T and Mishra T 2008 Age dynamics and economic growth: revisiting the nexus in a nonparametric setting *Economics Letters* vol 99(1) pp 67−71
[8]   Nikulina I E and Khomenko I V 2015 Interdependence of demographic and economic development of regions *Procedia - Social and Behavioral Sciences* vol 166 pp 142−146
[9]   Shkolnikov V M and Cornia G A 2000 Population crisis and rising mortality in transitional Russia *The Mortality Crisis in Transitional Economies*, ed G A Cornia and R Paniccià (Oxford: Oxford University Press) pp 253−279
[10]   Vasilyeva E V 2012 *Socio-demographic Development of the Ural Federal District: Diagnostics, Forecasting and Assessment of Management Effectiveness*, ed A A Kuklina (Yekaterinburg: Institute of Economics, Ural Branch of the Russian Academy of Sciences) p 124
[11]   Merkulova E Y and Morozova N S 2017 Socio-economic imbalances of population reproduction according to place of residence *Regional Economics: Theory and Practice* vol 8(443) pp 1580−1594
[12]   Molchanova E V 2019 Assessment of the impact of social and economic development on regional demographic processes *Bulletin of the Altai Academy of Economics and Law* vol 4−2 pp 252−258
[13]   Starodubov V I, Sukhanova L P and Sychenkov Y G 2011 Reproductive losses as medical social problem in demographic development of Russia *Social Aspects of Public Health* vol 6(22) pp 1
[14]   Godefroy R and Lewis J 2018 Does male education affect fertility? Evidence from Mali

Economics Letters vol 172 pp 118–122

[15]	Rogojanu A and Badea L 2012 Higher education from the perspective of demographical evolution: obstacles and solutions *Procedia - Social and Behavioral Sciences* vol 46 pp 4555–4559

[16]	Shkolnikov V M, Andreev E M, Jasilionis D, Leinsalu M, Antonova O I and McKee M 2006 The changing relation between education and life expectancy in Central and Eastern Europe in the 1990s *Journal of Epidemiology and Community Health* vol 60(10) pp 875–881

[17]	Gainutdinova E A, Mukhina I A and Osipov A K 2019 Prediction of natural movement of population as a function of state and municipal administration *Bulletin of the Udmurt University. Series Economics and Law* vol 29(2) pp 117–124

[18]	Krasova E V, Jin Y and Zhao L 2016 The unevenness in the socio-economic development of the regions of China as the result of sustainable growth of Chinese economy *The Science Vector of Togliatti State University. Series: Economics and Management* vol 2(25) pp 42–49

[19]	Oborin M S 2018 The influence of sanatorium-resort services on the socio-demographic situation in the region *The Bulletin of NSIEI* vol 3 (82) pp 120–130

[20]	Potudanskaya V F and Alifer E O 2010 Standard of living and quality of life as the factors of demographic reproduction *Omsk Scientific Herald* vol 6(92) pp 48–51

[21]	Samorodskaya I V, Barbarash O L, Kondrikova N V and Boytsov S A 2017 Relationship between socioeconomic factors and mortality rates in the population *Preventative Medicine* vol 20(1) pp 10–14

[22]	*The Economist Quality of Life Index* (Available at http://reut-institute.org/en/Publication.aspx?PublicationId=1397)

[23]	*Research of Life Quality in Russian Cities 2014* (Moscow: Financial University of Russian Federation Government) p 175

[24]	Federal State Statistics Service of the Russian Federation (Available at http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/publications/catalog/doc_1138623506156)

[25]	*World Population Prospects: The 2017 Revision, Key Findings and Advance Tables* 2017 (New York: United Nations, Department of Economic and Social Affairs) (Available at https://esa.un.org/unpd/wpp/Publications/Files/WPP2017_KeyFindings.pdf)

[26]	Mazelis L S, Emtseva E D, Krasova E V and Krasko A A 2018 Evaluation of the human capital impact on social and economic development: econometric modeling on the example of Russian regions *Trends and Management* vol 4 pp 97–110

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