

Economic and Statistical Modeling and Evaluation of Quality of Life of the Sakha Republic (Yakutia) Population

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Abstract. The article is concerned with statistical modeling and evaluation of quality of life of the population of the Sakha Republic (Yakutia). The territory of the region exhibits significant intra-regional disparity of natural and climatic conditions of living; it is located in absolutely uncomfortable and extremely uncomfortable zones of the country. Structural components of the quality of life are identified as follows: quality of living conditions (natural-climatic and environmental conditions), quality of population; living standards (welfare); quality of social sector. Living standards of the population are analyzed. Based on a set of multivariate statistical analysis methods, a model for evaluating the quality of life is developed and regions of the Sakha Republic (Yakutia) are classified in a multidimensional manner. Clusters that are homogeneous as per quality of life are identified

1. Introduction

Significantly differing living conditions in the Russian Federation dictate an uneven distribution of population with a greater concentration of human resources in the European part of the country, as well as in the Urals and in Western Siberia. The rest of the territories with less favorable climatic conditions and less developed infrastructure are characterized by a relatively low population density and high migration outflow. To secure the Russian Federation's position on the geopolitical map of the world, it is essential to attract labor resources to the eastern, northern and arctic regions, which requires adjustment of living standards and quality of life throughout the country. Therefore, a quantitative assessment and a differentiation of the quality of life in the regions is a pertinent scientific and practical problem

2. Methods

Quality of life of a population is controlled by a variety of factors: satisfaction of the population's needs in goods and services, development and accessibility of social infrastructure, employment and incomes of the population, security ensuring, and subjective well-being, which preconditions the need to use multidimensional statistical analysis methods.

The USA president John F Kennedy voiced 'the quality of living' term in his New Year's message to the Congress in 1963 [5]. Researchers have developed various methodological approaches to studying the quality of life, the core ones being normative approach [2,3], and qualimetric approach,

with most substantial results obtained by the CEMI RAS (Central Economic and Mathematical Institute, Russian Academy of Sciences) school under supervision of Professor S A Aivazyan [1]. Both approaches are combined in our research [6,7]. In the context of our research we consider 'quality of life' as an amplification of the 'living standards of population' economic concept; based on this, we build econometric models and integral coefficients, allowing to proceed to a quantitative analysis of qualitative variables.

As a result of previous studies, we have identified the main structural components of the quality of life:

- 1) quality of living conditions (natural-climatic and environmental conditions);
- 2) quality of population;
- 3) living standards (welfare);
- 4) quality of social sector [8].

The Sakha Republic (Yakutia) is the largest region of the Russian Federation (3,103.2 thousand km²) and is located in the northeast of the country. It has a large natural resource potential. The territory exhibits significant intra-regional disparity of natural and climatic conditions of living; it is located in absolutely uncomfortable and extremely uncomfortable zones of the country.

The territory is characterized by a significant intra-regional differentiation of climatic conditions of residence, located in the absolutely uncomfortable and extremely uncomfortable zones of the country.

The quality of population is investigated based on a system of demographic indicators, as well as on health and education standards. In terms of its toolbox and logic, it is close to the method of calculating the Human Development Index (HDI) (until 2013, the Human Potential Development Index (HPDI)). The HDI was developed based on conceptual approaches of Amartya Sen [4,9] and is calculated and published annually by experts of the United Nations Development Program for inter-country comparison of living standards [11].

Standard of living of a population depends on the degree to which people's needs for material goods and services are satisfied, on the level of income, and the condition of consumer market. Statistical modeling of consumption is aimed at generating standard consumption models according to methodology of standard consumer budgets, as well as at analyzing and forecasting consumer behavior. The latter two are particularly relevant for marketing domain and studying the demand for goods and services, as well as for product promotion. It is necessary to take into account the differences in the structure of consumption for different population groups, which have differing incomes and household compositions, or live in differing economic and geographical zones. Thus, staple foods consumption patterns for people living in the extremely uncomfortable conditions of the Extreme North and similar areas differ significantly from those for residents of southern and central regions of Russia due to objective physiological features; it is a protein-lipid-based pattern. Therefore, generation of standard family budgets must take into account rational and physiological standards of consumption in extreme conditions of the North.

Existing modeling methods are based on the following methods of economic and statistical analysis:

- multifactor correlation-regression modeling;
- correction of elasticity coefficients from key indicators;
- fitting of statistical series and their further extrapolation.

Consumption should be investigated based on sample surveys of family budgets undertaken by Rosstat (Russian Federal State Statistics Service), as well as on expert assessments and sociological sampling studies.

Standard of living is also influenced by parameters of employment and incomes of population. The employment situation differs significantly at the regional level. Tracking changes in the labor market requires accounting for high mobility of labor resources and linking employee wages to the place of work for statistical records.

Social sector and development of infrastructure at the regional level play a significant part in assessment of the quality of life, since they ensure equal access to public goods, such as health,

education, and culture, guaranteed by the country’s Constitution. It is the maturity of the social domain that allows to determine the degree of social well-being of the population of a given territory, and to indirectly assess how efficiently local authorities and state structures can ensure it.

The study used data obtained from the statistical reports of the Federal State Statistics Service Territorial Office in the Sakha Republic (Yakutia) [10], as well as data of sample surveys undertaken over a number of years. A database containing indicators of living standards and quality of life in various districts of the region has been generated in MS Excel. The data was statistically processed using Statistica software package. As a result, we have developed a model for calculating the Integral Quality of Life Indicator (IQLI) [8].

The model is built using deviation ratios for each district of the republic:

$$k_{ij} = p_{ij} / q_j ; i = 1, n; j = 1, m;$$

where k_{ij} – ratio of indicator deviation from average for republic;

p_{ij} – j-th indicator of i-th district;

q_j – j-th average republic-wide indicator in base year;

n – number of districts;

m – number of indicators, describing the quality of life in the republic.

The following formula is used to calculate Integral Quality of Life Indicator for a district:

$$Q_i = \frac{\sum (k_{ij} * \omega_j)}{\sum \omega_j},$$

where ω_j - weights, assigned to the j-th indicator through expert method ($0 < \omega_j < 1$).

3. Results

Figure 1 shows the behavior of real income and wages plotted from 1990 to 2016 in prices of 1990, clearly demonstrating an outpacing growth of wages at almost unchanging real per capita incomes.

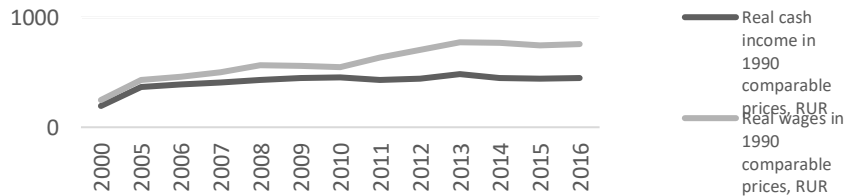


Figure 1. Real Income and Real Wages Behavior in 1990 prices (calculated based on Data Base of Federal State Statistics Service).

Table 1 shows behavior of the key indicators of living standards in the Sakha Republic (Yakutia) in 2000-2016. The calculated real values of cash income and wages show maximum growth in 2013, with gradual stagnation by 2017 in 1990 prices.

For the purpose of the study, over a number of years, we have been carrying out sample surveys of the population using a common methodology. Thus, we have carried out a comparative analysis of food consumption by residents of rural settlements, and estimated their revenues from incomes in kind, wild plants gathering, hunting, fishing, and personal subsidiary farming. Based on the respondents’ answers, a database was produced. The results indicate an insufficient level of income and consumption of the surveyed families (with 10% coverage of permanent population of a settlement).

Table 1. Behavior of Living Standards Indicators in the Sakha Republic (Yakutia)[10].

| Indicators | 2005 | 2010 | 2013 | 2014 | 2015 | 2016 |
|---|---------|---------|---------|---------|---------|---------|
| Average cash income per capita, RUR | 11391.4 | 22745.4 | 29111.2 | 29823.2 | 32518.8 | 34867.6 |
| Real cash income in 1990 comparable prices, RUR | 364.8 | 451.9 | 483.9 | 449.4 | 443.5 | 448.6 |
| Nominal wage per 1 employee, RUR | 13437.0 | 27512.4 | 46542.0 | 51111.0 | 54631.0 | 59000.0 |
| Real wages in 1990 comparable prices, RUR | 430.3 | 546.6 | 773.6 | 770.2 | 745.1 | 759.1 |
| Average assigned monthly pensions inclusive of compensation payments, RUR | 3557.0 | 10402.0 | 13779.0 | 15011.0 | 16640.0 | 22054.0 |
| Total residential area per 1 person, sq. m. | 19.5 | 20.3 | 20.6 | 21.1 | 21.5 | 21.7 |
| Subsistence minimum, RUR | 4705.0 | 9486.0 | 11342.0 | 12879.0 | 15140.0 | 16150.0 |
| Average per capita cash income, % to SM | 242.1 | 239.8 | 256.7 | 231.6 | 214.8 | 215.9 |
| Nominal wage per 1 employee, % to SM | 285.6 | 290.0 | 410.4 | 396.9 | 360.8 | 365.3 |
| Average assigned monthly pension, % to SM | 75.6 | 109.7 | 121.5 | 116.6 | 109.9 | 136.6 |
| Consumer price index for goods and services, % | 112.1 | 106.0 | 106.0 | 110.3 | 110.5 | 106.0 |

In small rural settlements, the majority of surveyed respondents were retired individuals and families with children. In Verkhnevilyuisky district, the share of retirement pensions in the income structure was 58.9%, in Gornyy – 63.8%, in Tattinsky – 52.5%, in Khangalassky – 59.8%, in the city of Yakutsk – 36.8%. On average, in the surveyed districts, retirement pensions accounted for 54.4% of all incomes, wages – 40.5%, allowances – 3.2%, scholarships – 0.8%. A part of the surveyed population receives insignificant income from selling agricultural products (up to 0.5% of all incomes). Incomes from financial system were registered only in three districts (up to 0.5%). Revenues from sales of wild harvests make 0.06%, other incomes – 0.34% (Figure 2).

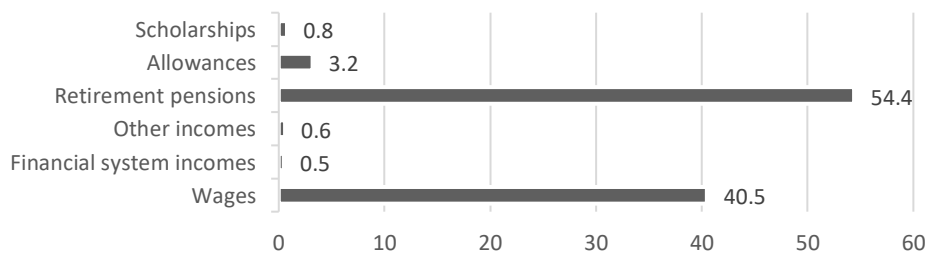


Figure 2. Cash Income Structure (from Sample Surveys Data).

Spending structure of the surveyed families (Figure 3) shows that 59% of the entire income is used for purchasing food, which indicates a low standard of living for the families surveyed. In the surveyed families, 18.1% of a family’s cash income is spent for purchasing non-food items, and 12% is spent on housing and communal services. Low share of expenditures on utility bills in the general structure of expenditures is explained by the fact that in rural areas population lives in private houses without necessary communal amenities; some members of the surveyed families were entitled to utility reliefs (provision of ice, water, firewood, etc.). The pattern is completely different in the city of Yakutsk: utility payments make up a large proportion of spending by non-working pensioners (up to 31.2%).

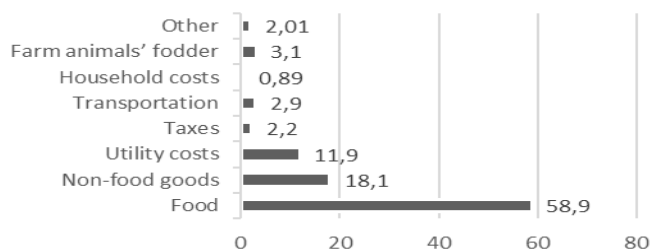


Figure 3. Spending Structure of Surveyed Families.

Calculated Integral Quality of Life Indicators are given in Table 2.

Table 2. The Sakha Republic (Yakutia) Integral Quality of Life Indicators Behavior.

| | 2005 | 2010 | 2013 | 2014 | 2015 | 2016 |
|------------------------------|------|------|------|------|------|------|
| Total in the republic | .81 | .27 | .33 | .28 | .21 | .17 |
| Abyisky | .43 | .6 | .64 | .61 | .56 | .53 |
| Aldansky | .84 | .44 | .50 | .45 | .38 | .33 |
| Allaikhovskiy | .3 | .42 | .46 | .43 | .38 | .36 |
| Amginsky | .89 | .12 | .20 | .13 | .04 | .98 |
| Anabarsky | .04 | .65 | .69 | .66 | .61 | .58 |
| Bulunsky | .27 | .52 | .56 | .53 | .48 | .45 |
| Verkhnevilyuiskiy | .1 | .19 | .25 | .20 | .13 | .09 |
| Verkhnekolymsky | .81 | .46 | .50 | .47 | .42 | .39 |
| Verkhoyansky | .96 | .14 | .19 | .15 | .09 | .04 |
| Vilyuiskiy | .16 | .96 | .01 | .97 | .91 | .87 |
| Gornyy | .1 | .03 | .08 | .04 | .98 | .94 |
| Zhiganskyy | .22 | .86 | .91 | .87 | .81 | .78 |
| Kobyaisky | .98 | .46 | .50 | .47 | .42 | .39 |

| | | | | | | |
|-----------------------------|-----|-----|-----|----|-----|-----|
| | 1 | 1 | 1 | 1. | 1 | 1 |
| Lensky | .32 | .65 | .69 | 66 | .61 | .58 |
| | 2 | 2 | 2 | 2. | 2 | 2 |
| Megino-Kangalassky | .3 | .17 | .22 | 18 | .11 | .07 |
| | 2 | 2 | 2 | 2. | 2 | 2 |
| Mirninsky | .04 | .34 | .40 | 35 | .28 | .23 |
| | 1 | 1 | 1 | 1. | 1 | 1 |
| Momsky | .21 | .69 | .73 | 70 | .65 | .61 |
| | 1 | 2 | 2 | 2. | 2 | 2 |
| Namsky | .92 | .15 | .20 | 16 | .10 | .05 |
| | 0 | 1 | 1 | 1. | 1 | 1 |
| Nizhnekolymsky | .93 | .47 | .51 | 48 | .43 | .40 |
| | 1 | 1 | 1 | 1. | 1 | 1 |
| Nyurbinsky | .5 | .76 | .80 | 77 | .72 | .68 |
| | 1 | 1 | 1 | 1. | 1 | 1 |
| Oymyakonsky | .17 | .29 | .32 | 30 | .26 | .23 |
| | 1 | 2 | 2 | 2. | 2 | 2 |
| Olyokminsky | .02 | .21 | .27 | 22 | .15 | .11 |
| | 1 | 2 | 2 | 2. | 1 | 1 |
| Olenyoksky | .04 | .04 | .09 | 05 | .99 | .95 |
| | 0 | 0 | 0 | 0. | 0 | 0 |
| Srednekolymsky | .98 | .5 | .51 | 50 | .49 | .48 |
| | 1 | 0 | 0 | 0. | 0 | 0 |
| Suntarsky | .16 | .42 | .43 | 42 | .41 | .40 |
| | 0 | 0 | 0 | 0. | 0 | 0 |
| Tattinsky | .96 | .65 | .67 | 65 | .63 | .62 |
| | 0 | 0 | 0 | 0. | 0 | 0 |
| Tomponsky | .67 | .37 | .38 | 37 | .36 | .35 |
| | 1 | 0 | 0 | 0. | 0 | 0 |
| Ust'-Aldansky | .11 | .75 | .77 | 75 | .73 | .72 |
| | 0 | 0 | 0 | 0. | 0 | 0 |
| Ust'-Maysky | .71 | .27 | .28 | 27 | .26 | .26 |
| | 0 | 0 | 0 | 0. | 0 | 0 |
| Ust'-Yansky | .84 | .35 | .36 | 35 | .34 | .33 |
| | 1 | 0 | 0 | 0. | 0 | 0 |
| Khangalassky | .06 | .68 | .70 | 68 | .66 | .65 |
| | 1 | 0 | 0 | 0. | 0 | 0 |
| Churapchinsky | .04 | .81 | .83 | 81 | .79 | .77 |
| | 0 | 0 | 0 | 0. | 0 | 0 |
| Eveno-Bytantaysky | .9 | .59 | .60 | 59 | .57 | .56 |
| | 1 | 1 | 1 | 1. | 1 | 1 |
| Neryungri and suburban area | .14 | .16 | .19 | 17 | .13 | .11 |
| | 1 | 2 | 2 | 2. | 2 | 2 |
| Yakutsk and suburban area | .81 | .71 | .78 | 72 | .64 | .59 |

To down-weight the attribute space we have used the principal component analysis; the first four principal components account for 82% of the total variability of the studied process. The most significant contribution is made by the first principal component, which describes the quality of the social sector. The component that describes the standard of living was taken as the second principal component. The component that describes the quality of population was taken as the third principal component. The fourth principal component has high coherence with the first block of indicators. Thus, it would be logical to call it a component related to the living conditions of the population.

Using the method of stepwise regression, we have obtained a regression equation that describes the quality of life of the region's population. This method provides for selection of informative features

and construction of a regression equation, which includes only significant variables. The equation is written as:

$$y = 0,887 + 6,611 * f_1 + 5,006 * f_2 + 4,123 * f_3,$$

$F_{cr.} = 21,33 > F_{tab} = 2,76$ at $\alpha = 0,05$.

Student's coefficients $t_1 = 4.21$; $t_2 = 4.01$; $t_3 = 2.12$ are significant at $\alpha = 0.05$. Relative approximation coefficient is 0.159, multiple determination coefficient $R = 0.837$.

4. Conclusions

Quantitative assessment allows us to trace changes in the standard and the quality of life of the population, as well as to map opportunities for further balancing of these in the territory of the Sakha Republic (Yakutia). This methodology can be applied to analyzing the quality of life of the population of the Russian Federation. Based on a set of methods of principal components and cluster analysis, we have identified groups of districts that are homogeneous as per the quality of life. The structure of the clusters, grouped based on the IQLI values, is shown in Figure 4.

The results of the cluster grouping demonstrate that the groups embrace districts that are amply close by their economic profile, natural and geographical situation.

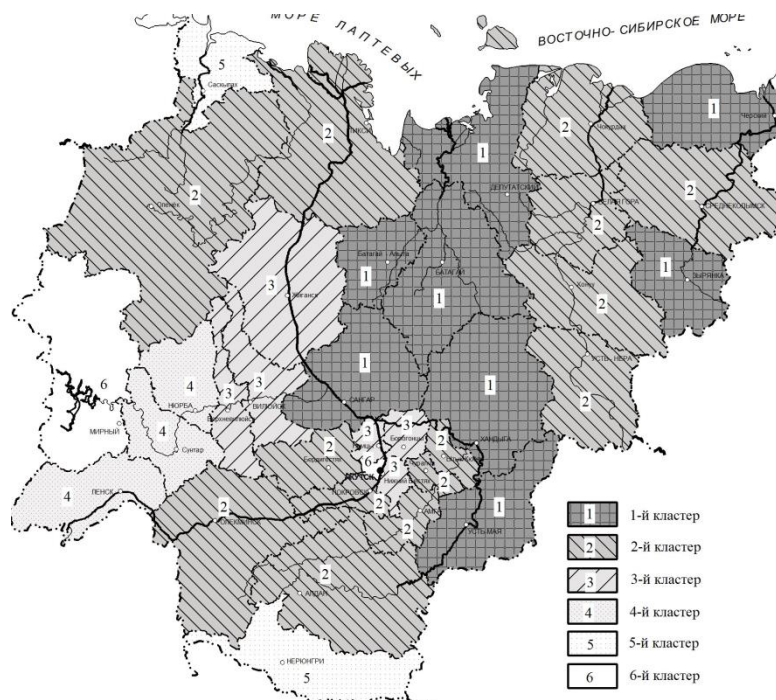


Figure 4. Clustering Based on IQLI.

The developed model of economic and statistical assessment and multidimensional classification of districts according to the quality of life of the population allows us to obtain a more true-to-life judgement about real social processes taking place in the region. Higher indicators of quality of life are observed in industrial districts, where the levels of wages and incomes are up to 4.5 times higher than the those for rural areas. They also have a more developed social, transport, and housing-and-utility infrastructure.

Further research requires enhancing the system of indicators with data on life satisfaction, including the quality of socialization and personal fulfilment.

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