Method of Integrated Assessment of Regional System

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Doi:10.5901/mjss.2014.v5n18p149

Abstract

Article presents the author's method of comparative assessment of cities and municipalities level of socio-economic development. It is based on application of a special approach, which allows to combine substantial analysis, quantitative and mathematical-statistical methods using the system of estimative indicators. Method allows obtaining conclusions of the comparative evaluation of the quality of regional socio-economic systems on the basis of solution of mathematical classification problems and includes stages of mathematical-statistical analysis of indicators, partial estimates in the context of the indicators and their blocks, summary assessment and classification/grouping of objects based on this assessment.

Keywords: *regional system, socio-economic assessment, assessment of the level of development, classification of the state, econometric methods*

1. Introduction

The object of method for the assessment of a regional system elaboration is to conduct a comparative analysis of current socio-economic situation of cities and municipalities included in the region. This ultimately allows drawing the conclusions about the features of their development and increasing the effectiveness of regional government problems solution [11]. The main criterion of selection and assessment of indicators of the regional system (RS) state is the level of socio-economic development of its subjects. Significant differences in the character of main socio-economic processes in the cities and municipalities determine a split decision of assessment problems for given sets of subjects of RS. The methodical part is based on application of a special approach, quantitative and mathematical-statistical methods, a special system of estimative indicators.

Method includes the following steps:

- The initial selection and rationale for choosing of the statistical indicators system for the assessment of the regional system state.
- Statistical analysis of the indicators, selection of the most informative ones, formation of the system.
- Assessment of cities and municipalities state based on individual indicators and their functional blocks.
- Summary assessment of a regional system state region-wise based on the criterion of the level of socio-economic development.

2. Method. Phase I: The initial selection and rationale for choosing of the statistical indicators system for the assessment of the regional system state

The methodological basis for development of an integrated assessment of the state is a theoretical concept of the regional systems [6, 8]. City and municipality are complex subjects of analysis emerging from the interaction of heterogeneous components. There are three main subsystems in their structure: social, economic and natural.

The functional blocks (subsystems) of estimative indicators includes:

1) «Production», 2) «Finance», 3) «Social sphere», 4) «Infrastructure», 5) «Demography», 6) «Ecology».

The process of formation of a complex of parameters of each block is associated with the need to address both the substantive and technical problems. The substantial problems are principally related to the achievement of a sufficient level of representativeness of a complex of parameters in the state assessment. Technical problems are serious enough to limit and reduce the availability of efficient collection and effective information consolidation opportunities in the framework of the existing system of regional statistics.

Analysis and selection of indicators, not only informative, but also statistical were carried out, the goal of which was to identify the level of indicators informativeness and their degree of interconnectedness within the system being formed. The final system contains 37 indicators for the municipalities and 32 for cities of republican subordination.

3. Method. Phase II: Statistical analysis of the indicators, selection of the most informative ones

The goal of statistical analysis is to identify the level of informativeness of the indicators and the extent of their interdependence. It is performed by the methods of correlation, regression and factor analysis.

Statistical sampling is set by the values of all indicators for a single period of time sufficient to evaluate dependencies (e.g. for one year). For more significant results, analysis on multiple consecutive periods that allows bringing to light the stability of relationships should be performed.

Statistical analysis includes the following steps:

1. Checking sampling for the presence of the normal distribution of indicators.
2. Building a matrix of coefficients of multiple correlation, showing the degree of dependence between each of the indicators and all the others. Identification of subgroups comprising the most relevant indicators (correlation coefficient of more than 0.75-0.8). Conclusions about the possibility of reduction of indicators system and their replacement within separate blocks.
3. The regression analysis. Allows to determine functional dependence between estimative indicators. It is mainly conducted for indicators with a high degree of correlation. This stage is a subsidiary, it refines the results of the previous one.
4. Factor analysis. Aims to identify subsets of indicators, each of which has a certain contribution to an explained sum of squares**.** In accordance with this the analytical relevance of subsets, degree of informativeness of the indices is estimated. The result of the analysis is the conclusion about the possibility of reduction of indicators system.

Statistical analysis of the system of indicators for the Republic of Tatarstan has shown, in particular, the presence of high (more than 0.8) level of correlation between a small number of indicators sampling (2 -3 indicators).

The result of factor analysis conducted by method of principal components was identification of relatively small group of indicators (3 - 4) that made a small contribution in the information base. The following general conclusions were made:

1. The composition of the indices is rather balanced. The level of in-system correlation is generally low.
2. Main role in the system is played by two indicators – “Volume of gross regional product per capita” and “Volume of the unearned increment per one person employed in large and medium-sized enterprises”.

Finally, an adjustment, including reduction and change of composition in the system of pre-selected indicators was made.

4. Method. Phase III: Assessment of cities and municipalities state based on individual indicators and their functional blocks

Assessment is carried out both on separate indicators and by block as a whole. In accordance with the main objectives of the method development, as well as practical experience in solving assessment problems the following assumptions were brought to the focus:

1. The operational management of the subjects of the RS determines the necessity of from three to ten levels of assessment of their state quality (classes or groups of objects of RS). Selection of a number of levels depends on the specific analytical tasks, requirements for the degree of detail of the results and the number of groups of objects for each indicator, identified on the basis of economic analysis.
2. Number of assessments must be the same for all indicators of the system, as otherwise the results of the assessments comparison of different measures will not be comparable.
3. For each indicator groups/classes of objects, each of which has the quality of a state, assessments relevant to classification were made.
4. Groups of objects do not intersect.
5. Groups contain approximately equal number of objects.

Based on these assumptions, two tasks are being solved, the first one for the cities, and the second for the municipalities of the region. The solution process includes two stages.

4.1 Formation of Assessments of the Regional System Objects for Individual Indicators

For each indicator sampling values for the existing set of RS objects are specified. Suppose the range of values variation of an indicator is divided on n intervals (n = 3, 4, ...10) so, that the number of sample values belonging to the same

interval, would be about the same.

Each interval has a lower and upper bound and characterizes a certain set of values of the indicator [2]. It defines the evaluation group the objects which has values of the corresponding indicator belonging to the specified set. If the i-th interval is upper and lower limited by specified quantities H_i and L_i, then a value of the index w refers to the *i*-th interval if satisfying the following relations $L_i \leq w < H_i$. The result is n approximately similar sized groups.

To characterize features of a group of object values on the given indicator, the score characteristics that define the summary measure or specific "estimated weight" of the group are used. They can take on values in accordance with a predetermined scale, for example, three-, five - or ten-point. The main thing in the choice of scale - to achieve adequate quality of clustering.

In the method scale of values of the points was proposed, their number is equal to the number of allocated groups, i.e. n. All objects in a group is assigned to the score, which for the high-level assessment of the values of the indicator is the maximum value (for example, 3 or 10), and further reduced by one point from group to group until the last, which has the lowest level of evaluation and characterized by the value of points equal to 1. As a result, each object of RS receives a score, which further allows forming a summary assessment characteristics with regard to qualitative differences in the values of each indicator and removes issues of comparability.

Such approach allows effectively solving a number of problems associated with the presence of weakly and strongly differentiated values of quantitative indicators, or with the presence of a small number of runouts - sampling values with considerable (several tens and hundreds of times) differences from the main part of the indicators and so on. Solving the problem we proceed from the premise of presence of two types of indicators. For the first type, sign of high level of assessment is large quantitative values (for example, volume of the unearned increment, retail turnover and other), for the second - small values (for example, the unemployment rate, infant mortality, etc).

4.2 The Calculation of the Average Score Assessments by the Individual Blocks of Indicators

Calculations of average score assessments by blocks are determined due primarily to the different number of indicators in blocks, and, consequently, their different «weight» in terms of the results of the assessment problems. Use of average block score assessments enables to align the significance of all the blocks in the final assessment of the state of analyzed object. If the k-th block comprises of m^k indicators, for an arbitrary object specified scores of all indicators of the block are s_i^k ($i = 1, 2, \ldots m^k$). The average value of scoring assessment of the object for this block is defined as

$$\overline{S^k} = \frac{\sum_{i=1}^{m^k} s_i^k}{m^k}$$, где k = 1,2, … 6

Such average assessments are calculated for all blocks of indicators for each object of RS.

5. Method. Phase IV: Summary assessment of a regional system state region-wise based on the criterion of the level of socio-economic development

Average block scores indicators are the basis for the solution of tasks of the integrated assessment of cities and municipalities state by obtaining final summary aggregated assessments. Calculation of estimated values based on the consideration of the following provisions:

- Comparative analysis of the assessments should be made separately for cities and municipalities.
- All blocks should have the same weight that reflects their equal significant confidence in the assessment system. Any definition of weights of blocks increases the subjectivity solutions.

For each object of the investigation (city or municipality) the total value of the assessment of the state ***S*** as the sum of the average scores of the blocks of indicators is determined ($\overline{S^k}$)

$$S = \sum_{k=1}^{6} \overline{S^k}$$

To obtain conclusions of qualitative nature, i.e. to define which objects of the analysis are high, medium, and other levels of estimates mathematical methods of classification are used [3, 4, 5, and 11].

Setting the task of this stage issues from having a sample of n objects, each of which is characterized by the numerical value of the summary assessment score *S*. It is necessary to divide objects of the sampling into several classes/groups, each of which characterizes certain comparative level of estimates. If the task is to part into k groups, it forms k assessments of the state of analyzing objects, for example, if k = 3, objects can be split into groups with relatively high, medium and low comparative assessment of socio-economic development.

Based on the setting, for clusterization tasks it is expedient to use methods of classification when a predetermined number of classes. A number of algorithms for solution of such kind of tasks are developed. For a number of problems it is appropriate to use a common method of k-means, where k is the given number of groups [1, 10, 13]. The result of the solution [7, 9, 12] is selection of groups, which, taking into account the results of previous steps, usually have a slightly different size.

The final stage is a summary assessment of the group of RS objects. Each of them, as noted above, characterizes the specific quality of the system state of the city or region. Because groups do not overlap, and the grouping is performed on a single indicator S, each group corresponds to the interval of its values, which allows you to indirectly assess the state of the object.

Average values of the indicator of the summary assessment S for each of the groups are defined as S^{g}_{j} - average indicator S for the *j*-th object, a member of the group g (g = 1, 2, ... k; j = 1, 2, ... n^{g}, where n^{g} - a number of objects in a group g).

Then,

$$\overline{S^{g}} = \frac{\sum_{j=1}^{n^{g}} S^{g}_{j}}{n^{g}} \qquad (\mathbf{g}=1, 2, \ldots k)$$

characterizes average value for group g.

These values allow carrying out qualitative comparative assessment of the objects in the group. The higher is the value , the higher will be the assessment of the level of socio-economic development of RS objects, included in group.

A group with a maximum value of $\overline{S^{g}}$ obtains the greatest comparative assessment. All objects of the RS, in this group are characterized by the best comparative state of the economy, social sphere and environment. The group with the lowest $\overline{S^{g}}$ has the lowest assessment of the state.

6. Conclusions

It should be noted that the obtained assessments are relative and are valid only for the analyzed region. They cannot be compared with assessments for other regions derived from separate samplings. Results of the method application are the conclusions which have qualitative nature, allowing comparing the state of socio-economic systems of analyzed municipalities by the level of their development. Regular solving assessment problems of the region empowers analysis of its dynamics of state and, ultimately, contribute to efficient operational management of the regional system.

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