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Modern Tools for Sustainable Development of Territories. Special Topic: Project Management in the Regions of Russia

SOCIO-ECONOMIC DEVELOPMENT AND REGIONAL DIFFERENTIATION BASIS

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Abstract

The article considers a methodology to indices formation for the main directions of the regional socio-economic development of the Russian Federation regions. The proposed methodology is statistically based and being formed in the space of the basic regional differentiation characteristics, and it is considered as a tool for project management. At this stage of research, the basic characteristics of differentiation include the components listed below: 1) scale of the economy, 2) specialization of the regional economy (which is characterized by 1-st and 2-nd PCA-components of the GRP structure) 3) technical efficiency, 4) trend of technical efficiency. The indicated components are formed using theoretically grounded models of regional development. The position of the region with reference to its differentiation characteristics determines its economic originality. The index of each direction, constructed in the basis, is the most correlated with the index formed for corresponding group of indicators characterizing this direction. In its application, eight indices for the main directions of regional development are identified: production of goods and services, material well-being, standard of living of the population, quality of the social sphere, internal security. The indices constructed on the basis of the proposed approach make it possible to quantify the relative change in the level of the socio-economic development of a region when the basic characteristics of differentiation change.

Keywords: Econometric modeling, hypothesis testing, indices, regional economy.

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1. Introduction

At the regional level, the advantages associated with the use of the principal components analysis in the formation and analysis of the main directions of socio-economic development are fully revealed in the book (Aivazian, 2012). The novelty of the presented approach to the construction of indices for various directions of the regional socio-economic development is determined by the fact that all indices are constructed in the space of regional differentiation characteristics, which are formed and evaluated using theoretically reasonable models of regional development (Ayvazian, Afanasiev, & Kudrov, 2019). The position of the region in the basis of the characteristics of differentiation identifies its economic originality. The indicators are constructed on the basis of the proposed approach make it possible to quantify the relative change in the regional level of the socio-economic development with respect to the changings in characteristics of differentiation. Changes in the positions of regions in the space of differentiation characteristics can be predicted as a consequence of the implementation of federal and regional investment projects. And it is important to evaluate, using indices constructed on a common basis, the impact of such projects on various areas of socio-economic development and life quality at the regional level. Over time, such tasks may become common place for the network of computer centers, which is a key element of the digital economy (Kozyrev, 2018). Therefore, the basis of the regional differentiation characteristics can become one of the tools of project management (Makarov, 2010).

2. Problem Statement

The basis of differentiation characteristics. We assume that the economic identity of the region is determined by its location in the basis of the differentiation characteristics. The basis of the regional differentiation characteristics $\mathbf{B}_t^{\cdot} = \left\{\boldsymbol{l}_{k,t}, \boldsymbol{s}_{k,t}^{\boldsymbol{1}}, \boldsymbol{s}_{k,t}^{\boldsymbol{2}}, \boldsymbol{te}_{k,t}, \boldsymbol{dte}_{k,t}\right)\}_{\boldsymbol{k}}$ for the time $\boldsymbol{t}$ includes 5 elements: $\boldsymbol{l}_{k,t}$ — the scale of the economy for $\boldsymbol{i}$-th region at the time $\boldsymbol{t}$; $\boldsymbol{te}_{k,t}$ — comparable estimator of the technical efficiency, see (Kumbhakar & Lovell, 2004), $\boldsymbol{s}_{k,t}^{\boldsymbol{1}}$ — industry specialization index; $\boldsymbol{s}_{k,t}^{\boldsymbol{2}}$ — industrialization index; $\boldsymbol{dte}_{k,t}$ — technical efficiency trend, $\boldsymbol{dte}_{k,t} = \boldsymbol{te}_{k,t} - \boldsymbol{te}_{k,t-1}$. This study uses "economically active population" provided by the Russian Statistical Agency, as a characteristic of the economy scale. The basis contains also the 1-st and 2-nd PCA-components as the characteristics of the GRP structure. For the regions of Russian Federation the 1-st PCA-component segregates the regions with the concentration of mining in the structure of GRP from the other regions and interpreted as the *index of industry specialization* (Regions of Russia. Socio-economic indicators-2016, 2019). The 2-nd PCA-component segregates the regions with the concentration of industry (both mining and manufacturing) in the structure of GRP from the other regions (both developed and developing regions) and could be characterized as the *index of industrialization* (Results of federal statistical observations on socio-demographic problems, 2017; Statistics: Health care in Russia, 2017; Labor force, employment and unemployment in Russia, 2016).

The vector basis $\mathbf{B}_t^{\cdot}$ creates an informational base for assessing the interconnection of various directions of regional socio-economic development. A feature and advantage of the proposed approach is the ability to assess the impact of the relative change in the characteristics of the differentiation of a region on the relative level of its socio-economic development.

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3. Research Questions

3.1. Indicators for the basic directions of regional socio-economic development. Basic directions

In the monograph (Aivazian, 2012), using the PCA-analysis it is described and evaluated the following socio-economic directions: "production of goods and services", "material well-being", "social sphere quality", "population quality". The direction "social security", for which the relevance of the study is increasing, is described in (Gavrilets, Klimenko, & Kudrov, 2016). Below in Table 01 it is presented the number of regional characteristics which are used for the formation of the indices for the basic directions of socio-economic development.

Table 01. Indicators to form indices (the description of the mentioned below regional characteristics in more details see (Ayvazian, Afanasiev, & Kudrov, 2019)

Index	Indices and indicators
IB^1	"production of goods and services, volumes" which consists of 5 regional characteristics
IB^2	"material well-being" which consists of 5 regional characteristics
IB^3	"production of goods and services, per capita" which consists of 5 regional characteristics
IB^4	"social sphere quality" which consists of 5 regional characteristics
IB^5	"social security" which consists of 5 regional characteristics
IB^6	"demography" which consists of 4 regional characteristics
IB^7	"health" which consists of 7 regional characteristics
IB^8	"material well-being (subjective)" which consists of 5 regional characteristics

The group of regional characteristics for each considered socio-economic directions is formed using the statistically-based techniques named direct dependency-links analysis, which differs from ordinary correlations approach and reflects the actual internal structure of their direct dependencies. In the Gaussian case for a collection of m random variables $(X_1, \dots, X_m)$, the absence of the direct dependency-links between X_i and X_j is determined by the equality to zero of the partial correlation coefficient $\rho^{ij} = \rho(X_i, X_j | X_{)i;j(})$, which does not include information $X_{)i;j(} = (X_k | k = 1, \dots, m, k \neq i, j)$. For partial correlation the following equality holds:

$$\rho^{ij} = cor\left(resid\left(X_i \middle| X_{)i;j(}\right), resid(X_j | X_{)i;j(}\right),$$

where $resid\left(X. \middle| X_{)i;j(}\right)$ – residuals for the regression of $X.$ on the variables $X_{)i;j(}$. For more details about application the concept of partial correlations see, for example, (Kenett, Huang, Vodenska, Havlin, & Stanley, 2015).

Accordingly, in order to form the above mentioned groups of regional characteristics relative to the correspondent socio-economic direction, there were analyzed the direct dependency-links graph. To establish direct connections, the following hypotheses were checked: $H_0^{ij}: \rho^{ij} = 0$ against $H_1^{ij}: \rho^{ij} \neq 0$ for all possible pairs (i, j) of indicators and significant partial correlations were revealed, see (Goeman & Solari, 2014; Aigner, Lovell, & Schmidt, 1977). The analysis shows that there are fewer direct links than it might seem when analyzing the matrix of pair correlations. The regional characteristics used in the formation of eight indices for each correspondent socio-economic direction, shown in Table 01, were selected from a set of 98 initially considered regional characteristics. The indices IB^i, $i = 1, \dots, 7$, are

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based on objective regional characteristics, one IB^8 - on the basis of data from sociological surveys, which express subjective assessments.

4. Purpose of the Study

The proposed approach to the formation of indices for different directions of the regional socio-economic development is arranged such that all indices are constructed in the space of basis regional differentiation characteristics. Interrelation patterns of differentiation characteristics and indicators, including direct links for indicators IB1 "production of goods and services, volumes" and IB2 "material well-being", are given by the authors in the articles (Ayvazian, Afanasyev, & Kudrov, 2018).

5. Research Methods

Formation of the index characterizing the direction of economic development Let $\boldsymbol{I^S(\gamma, \mathbf{y_t^k})} = \sum_i \boldsymbol{\gamma_{i,t} y_{i,t}^k}$ — linear combination of the regional characteristics which correspond to the direction $\boldsymbol{S}$ of the socio-economic development for the $\boldsymbol{k}$-th region, where $\mathbf{y_t^k} = (\boldsymbol{y_{1,t}^k}, \dots, \boldsymbol{y_{N,t}^k})$ — vector of $\boldsymbol{N}$ regional characteristics which correspond to the socio-economic direction $\boldsymbol{S}$ for the $\boldsymbol{i}$-th region at the moment $\boldsymbol{t}$, $\boldsymbol{\gamma} = (\boldsymbol{\gamma_1}, \dots, \boldsymbol{\gamma_N})$ – vector of linear combination coefficients for $\boldsymbol{I^S(\gamma, \mathbf{y_k^t})}$.

Let $\boldsymbol{IB^S(\delta, \mathbf{B}_{t-1}^k) = \delta_{1,t} l_{k,t-1} + \delta_{2,t} s_{k,t-1}^1 + \delta_{3,t} s_{k,t-1}^2 + \delta_{4,t} te_{k,t-1} + \delta_{5,t} dte_{k,t-1}}$ — linear combination of the vector basis components for the $\boldsymbol{i}$-th region, formed according to the year $\boldsymbol{(t-1)}$, where $\mathbf{B}_t^k = (\boldsymbol{l_{i,t}(k), s_{i,t}^1(k), s_{i,t}^2(k), te_{i,t}(k), dte_{i,t}(k)})$ and $\boldsymbol{\delta} \in \mathbf{R^5}$. The problem is to determine such values of vector parameters $\boldsymbol{\gamma, \delta}$, for which $\boldsymbol{I^S(\gamma, \mathbf{y_t^.})}$ and $\boldsymbol{IB^S(\delta, \mathbf{B}_t^.)}$ are most correlated, that is:

$$\boldsymbol{(\hat{\gamma}, \hat{\delta}) = \underset{\gamma \in \mathbf{R}^N, \delta \in \mathbf{R}^5}{\operatorname{argmax}} \operatorname{corr}(I^S(\gamma, \mathbf{y_t^.}), IB^S(\delta, \mathbf{B}_{t-1}^.))}.$$

This problem has analytical solution which is presented in the articles (Hotelling, 1936; Waugh, 1942).

As a result, the indices $\boldsymbol{I^S(\gamma, \mathbf{y_t^.})}$ and $\boldsymbol{IB^S(\delta, \mathbf{B}_{t-1}^.)}$ for the direction $\boldsymbol{S}$ are constructed. As a result, it is possible to construct two groups of regional development indices in this area. The first group — projections $\boldsymbol{I^S(\gamma, \mathbf{y_t^.})}$ of the set of vectors $\{\mathbf{y_t^k}\}$ of indicators characterizing given socio-economic direction for each region k. The second group of indices —projections on $\boldsymbol{IB^S(\delta, \mathbf{B}_{t-1}^.)}$ of the basis differentiation components for each region. With a sufficiently significant $\boldsymbol{\mathbf{corr}(I^S(\gamma, \mathbf{y_t^.}), IB^S(\delta, \mathbf{B}_{t-1}^.))}$, the regional indices $\boldsymbol{\mathbf{corr}(I^S(\gamma, \mathbf{y_t^.}), IB^S(\delta, \mathbf{B}_{t-1}^.))}$ can be used as integral characteristics of the regional development level in the macro- and meso-level models, as well as for constructing regional rankings for the direction $\boldsymbol{S}$.

6. Findings

Table 02 shows the coefficients for the components of the basis differentiation characteristics which are used for forming the indices of the basic directions, estimated for the data from the 2015 year and 2016 year. The coefficients under the scale of the economy, technical efficiency and the first two principal components of the GRP structure are stable in time for all indicators.

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Table 02. Characteristics of differentiation in the indices for the 2015 – 2016 years

Coefficients in the indices estimated using data for the 2015 year						Coefficients in the indices estimated using data for the 2016 year				
	l	**te**	**s1**	**s2**	**dte**	**l**	**Te**	**s1**	**s2**	**dte**
IB^1	0.968	0.051	-0.056	0.048	0.043	0.970	0.049	-0.052	0.054	0.000
IB^2	0.681	0.390	0.275	0.126	0.452	0.625	0.499	0.456	-0.050	0.262
IB^3	0.175	0.207	0.443	0.758	0.085	0.318	0.223	0.457	0.671	0.067
IB^4	0.933	0.301	0.041	-0.164	-0.024	0.928	0.299	-0.049	-0.163	0.052
IB^5	0.604	-0.168	-0.045	0.017	-0.082	0.656	-0.183	-0.038	0.020	-0.140
IB^6	0.092	0.183	0.714	-0.642	-0.134	0.061	0.203	0.847	-0.471	0.138
IB^7	-0.163	0.087	-0.285	-0.485	-0.145	-0.250	0.085	-0.420	-0.759	-0.385
IB^8	0.108	-0.122	-0.468	0.694	0.352	0.037	-0.194	-0.526	0.829	-0.187

In Table 03 it is presented the correlation matrix of the indices for basic directions, estimated using data from the 2016 year. A high positive correlation corresponds to the index IB^1 "production of goods and services, volumes" and IB^4 "quality of the social sphere". In these indices, the highly significant basis component is the scale of the economy. Index IB^6 "demography" is negatively correlated with IB^8 "material well-being (subjective)". The IB^7 index "health" is negatively correlated with all indicators characterizing the material conditions of life. The highest negative correlation with IB^7 is "production of goods and services, per capita". There is a high negative correlation between indices IB^5 "social security" and IB^6 "demography".

Table 03. Correlation matrix for the indices of basic directions estimated for the 2016 year

2016	**IB^1**	**IB^2**	**IB^3**	**IB^4**	**IB^5**	**IB^6**	**IB^7**	**IB^8**
IB^1	1							
IB^2	0.633	1						
IB^3	0.456	0.724	1					
IB^4	0.957	0.745	0.406	1				
IB^5	0.768	0.024	0.058	0.635	1			
IB^6	-0.165	0.514	0.163	0.002	-0.731	1		
IB^7	-0.338	-0.543	-0.89	-0.225	-0.049	-0.058	1	
IB^8	0.302	-0.23	0.308	0.092	0.681	-0.875	-0.363	1

In Table 04 it is presented the regions with the highest and lowest indices for each considered direction. Moscow leads in indices IB^1, IB^2, IB^3, IB^4, IB^5, which characterize the material basis of life. The Moscow region also occupies a leading position in these indices, with the exception of IB3 (production per capita). The indices IB^1, IB^2, IB^4 for St. Petersburg are also high and the main feature of these indices is high influence of the scale of the economy. The highest values of IB^7 index ("health") correspond to the Republic of Ingushetia, North Ossetia-Alania, Dagestan. In the second column of Table 04 the features of the indices are noted.

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Table 04. Indices features, regions-leaders and regions-outsiders according to data for the 2016 year

Indices	Indices features	Regions-leaders	Regions-outsiders
IB^1	"production of goods and services, volumes" is determined mainly by the scale of the economy, other differentiation characteristics do not have a significant impact	Moscow, Moscow region, St. Petersburg	Altai Republic, Republic of Kalmykia, Jewish Autonomous Region
IB^2	"material well-being" higher in the regions with large scale of the economy, developed mining industry, high technical efficiency and its positive trend	Moscow, Moscow region, St. Petersburg, The Republic of Sakha	Republic of Mordovia, Kurgan Region, Jewish Autonomous Region
IB^3	"production of goods and services, per capita" higher in the regions with developed mining and manufacturing industries, the scale of the economy has little impact, technical efficiency is insignificant	Sakhalin region, Krasnoyarsk region, The Republic of Sakha, Moscow	Jewish Autonomous Region, Chechen Republic, Altai Republic, Republic of Kalmykia
IB^4	"social sphere quality" is highly determined by the economy, technical efficiency is significant, the structure of GRP is insignificant	Moscow, Moscow region, St. Petersburg	Kurgan region, Jewish Autonomous Region, Komi Republic
IB^5	"social security" is higher in the regions with the large economy scale, other characteristics are insignificant	Moscow, Moscow region, Sverdlovsk region	Magadan Region, Sakhalin region, Chukotka Autonomous Region
IB^6	"demography" (growth) is higher in developing regions, developed agricultural and mining regions, the economy scale and technical efficiency are insignificant	Chukotka Autonomous District, Sakhalin region, The Republic of Sakha (Yakutia)	Tula region, Lipetsk region, Vologodskaya Oblast
IB^7	"health" is better in agricultural and developing regions, the economy scale and technical efficiency are insignificant	The Republic of Ingushetia, The Republic of North Ossetia - Alania, The Republic of Dagestan	The Republic of Sakha, Sakhalin region, Tyumen region
IB^8	"material well-being (subjective)" is higher in the regions with a uniformly developed industry and developed manufacturing industry, the economy scale and technical efficiency are insignificant	Vologodskaya Oblast, Lipetsk region, Tula region	Tyva Republic, The Republic of Kalmykia, Magadan Region

7. Conclusion

It has been formed a basis which includes five regional differentiation characteristics obtained based on theoretically grounded models of regional development. In this basis of the differentiation characteristics, eight indicators have been constructed, characterizing the five basic directions of socio-economic development of the Russian Federation regions: production of goods and services, material well-being, population quality, social sphere quality, internal security. The indices constructed in the basis are correlated as much as possible with the index formed using the group of indicators characterizing the correspondent socio-economic direction.

The indicators characterizing the material basis of life are constructed based on a group of indicators selected as a result of the graph of direct links analysis, constructed using the coefficients of partial correlations. Indicators of the directions "demography" and "health" are formed on the basis of regulatory materials.

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