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The Parametric Method of the Evaluation in Interregional Differentiation and its Application in the South of Russia

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Abstract: The aim of the author is to give grounds to methodological approach to integral evaluation of interregional differentiation of economies of a certain territory as exemplified by North Caucasian Federal District, a macro region in the south of Russia. Proposed by the author method of analysis of spatial development and identification of the degree of interregional inequality is based on the tools from vector algebra. Using this method the author evaluates the size of interregional differentiation in the south of Russia, analyzes socio-economic development of the regions in the south of Russia; the author arrives at conclusion about increasing divergence by the indicators which characterize development of South-Russian regions and by all-Russia average indicators. The trend towards further interregional divergence in the South of Russia will go on. The key reasons of interregional differentiation are differences in adaptation characteristics of the regions, competitive advantages, agglomeration potential.

Key words: Interregional differentiation · The level of development of the region · Integral evaluation · Effects of localization and urbanization.

INTRODUCTION

Scientific literature demonstrates a broad range of methods used for a. of interregional differentiation: 1)Taylor inequality index [1]; 2) Darbin spatial model [2]; 3) weighted coefficients of variation [3] etc. Interesting approaches to evaluation of the degree of interregional differentiation based on economic methods were presented in the works of Mehran F. [4], Esteban J. и Ray D. [5], Sen A. [6], Коломак. [7]. These methods allow to evaluate the spread in values of separate indicators which characterize regional development. Availability of different-directional trends in dynamics of separate indicators do not allow to identify distinct trend to convergence or divergence in regional development. This can be overcome by the method of integral evaluation of interregional differentiation.

MATERIALS AND METHODS

The essence of my method is as follows. Region R_i, where $i = \overline{1-L}$ can be considered as vector $\overline{R}$ ($x_{i1,} x_{i2,} ..., x_{in}$) of n-dimensional vector space. Uniformity of objects in such space is based on metrics - ordinary Euclid distance between points $R_k(x_{k1,} x_{k2,} ..., x_{kn})$ and R_m ($x_{m1,} x_{m2,} ..., x_{mn}$) and can be calculated by formula:

$$E(R_k, R_\infty) = \sqrt{(x_k - x_\infty)^2 + (x_k - x_\infty)^3 + ...(x_k - x_\infty)^4} \quad (1)$$

It is understood that if the metrics (function) is E (R_k, R_m), then near objects (in terms of this function) can be considered as uniform, they belong to the same class. The metrics can be used as some integral indicator of the nearness of these objects. It is obvious that we can build a scale of values E (R_k, R_m) and compare them with some threshold values identified in every specific case in its own manner. For metrics E (R_k, R_m) the condition of symmetry: E (R_k, R_m) = E (R_m, R_k) and the condition of maximum similarity of object (region) to itself: E (R_k, R_k) = 0 are true.

Thus, economic significance of the formula (1) is opportunity to evaluate the level of differentiation of the regions: the less value of E (R_m, R_k), is the less interregional differentiation is and vice versa. The results

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of analysis by formula (1) can be demonstrated in the form of graphs both for separate time moments and in dynamics.

In Euclid space every pair of vectors $\overline{R_k}$ and $\overline{R_i}$ corresponds to a real number which is called scalar production of these vectors; it is found by the formula:

$$\overline{R_i} \cdot \overline{R_k} = x_{i1} \cdot x_{i1} + x_{i2} \cdot x_{i2} + \ldots + x_{in} \cdot x_{in}$$

Through scalar production of vectors a length (module) $|\overline{R_i}|$ of the vector $\overline{R_i}$ can be found by formula:

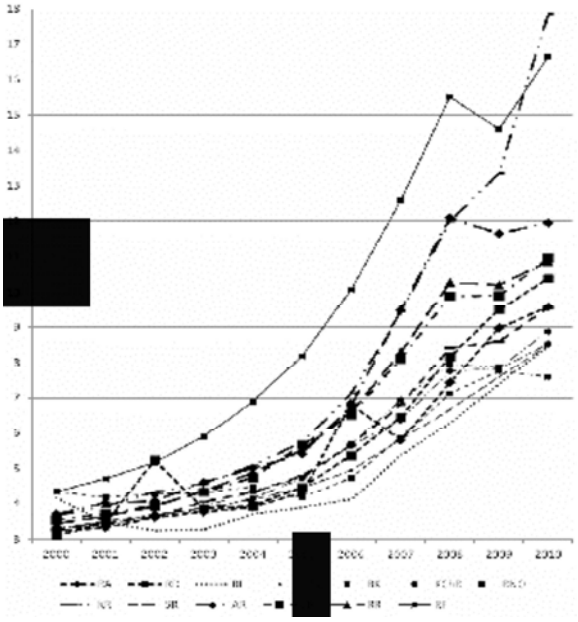
$$|\overline{R_i}| = \sqrt{x_{i1}^2 + x_{i2}^2 + \ldots + x_{in}^2} \quad (2)$$

Value $|\overline{R_i}|$ can be found for every object in every moment of time. Economic interpretation of the formula (2) which can be re-written in the form $|\overline{R_i}| = E(R_k, R_\infty)$, where R_0 = (0, 0, …, 0), by which the degree of nearness of socio-economic indicators of R_i region to zero values is evaluated, is in the fact that module of the vector is integral characteristic of development of socio-economic system of the region at present moment by values (x_1, x_2, …, x_n). High value of module is specific feature of developed regions. We shall try to investigate the dynamics and the rate of vector module change in time and its comparison with corresponding modules for other objects.

Our assumptions about the essence of the formulas (1-2) are true in real objects only if proposed formalization of the region as a vector can be described by a certain final set of parameters with sufficient for practical purposes similarity. Sometimes the reason for inadequacy of the real system and mathematic model is wrong set of parameters.

Indicators x_1, x_2, …, x_n must be chosen or constructed in such a way that with growth of their values they should correlate with quality scale "worse-better", here to higher value of the indicator x_i, i = 1, 2, …, n the higher level of regional development by this indicator will correspond. In this case higher value of vector module will correspond to higher level of regional development as a whole.

Analysis of dynamics of socio-economic system suggests that investigation of changes of 4 sub-systems must be done: economic, ecological, social and innovation. Sustainable development can be achieved only if positive changes within one system do not worsen the state of other systems - when Pareto optimum is achieved. Every of these subsystems can be presented as a set of parameters (Table 1).



Legend: RA - Republic of Adygea; RD - Republic of Dagestan; RI - Republic of Ingushetia; KBR - Kabardino-Balkaria Republic; RK - Republic of Kalmykia; KChR - Karachay-Cherkess Republic; RNO - Republic of North Ossetia - Alania; KR - Krasnodar Region; SR - Stavropol Region; AR - Astrakhan Region; VR - Volgograd Region; RR - Rostov Region; the Russian Federation - Russian Federation

Fig. 1: The Level of development of the southern Russian regions of the Russian Federation

These system of indicators can be broadened and supplemented with due consideration to the following criteria [8]: 1) indicators must be in quantitative form and be maximum representative and relatively independent; 2) list of indicators must include the most significant parameters which satisfy the requirement to objectivity and correlation and be based on available system of statistics and be rather cheap in terms of collection of information in calculations; 3) the opportunity to evaluate in dynamics and in time.

Main part.

Method of integral evaluation of interregional differentiation was used for calculation of integral parameters of the level of development of regions in the south of Russia, see Table 2.

Graph representation of the results allows to visualize the level of differentiation in development of the southern Russian regions and compare it with all-Russia average value (Figure 1).

Table 1: Indicators of socio-economic development of regional subsystems

Subsystem	Indicators	Purpose
Economic	GRP per 1 person Budgetary completeness Price index Unemployment level Investments into fix assets per 1 person External trade turnover per one person	Characterize the change of key parameters of economic system of the region
Ecological	Wasted materials input into atmosphere Volume of circulated and repeatedly used water to volume of fresh water ratio Investments into fixed assets intended for protection of environment and rational use of natural resources* Current expenditure for the protection of environment*	Describe the level of anthropogenic impact on the territory and reproduction of environment and natural resources quality
Social	Income per 1 person Gini coefficient Number of population with income below the minimum costs of living Area of living apartment per 1 person at average Life duration Natural population growth coefficient	Assess the changes in well-being of the region's population and demographic characteristics of regional system
Innovative	Share of R&D in GRP Share of innovative products in total volume of delivered products Fixed assets depreciation rate Labour productivity Return on assets	Characterize the rate of innovation time and reflect the ability of the region to generate innovations, degree of progressivity of economic culture

* this indicator was not taken into account for period from 2000 to 2010 because of absence of official statistical data.

Table 2: Integral indicator of development level of the regions in the South of Russia (vector length)

Region	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Republic of Adygea	3,23	3,34	3,61	3,77	3,91	4,30	6,84	5,8	7,43	8,97	9,57
Republic of Dagestan	3,11	3,46	5,25	3,86	3,93	4,47	5,37	6,47	8,17	9,49	10,39
Republic of Ingushetia	4,16	3,47	3,24	3,28	3,71	3,89	4,12	5,37	6,3	7,39	8,46
Kabardino-Balkaria Republic	3,29	3,52	3,68	3,87	4,10	4,46	4,95	5,81	6,68	7,59	8,49
Republic of Kalmykia	4,33	4,18	4,27	4,31	4,50	4,18	4,74	5,88	7,13	7,76	7,59
Karachay-Cherkess Republic	3,24	3,40	3,71	3,80	4,16	4,74	5,65	6,38	7,75	7,83	8,52
Republic of North Ossetia – Alania	3,31	3,48	3,65	3,90	4,35	4,76	5,68	6,94	7,96	7,87	8,88
Krasnodar Region	3,66	3,92	4,33	4,58	5,09	5,74	7,13	9,43	11,99	13,35	17,85
Stavropol Region	3,28	3,46	3,63	4,05	4,34	4,80	5,66	6,81	8,42	8,61	9,55
Astrakhan Region	3,71	4,01	4,08	4,62	5,02	5,42	6,77	9,48	12,09	11,64	11,94
Volgograd Region	3,55	3,71	3,95	4,34	4,75	5,66	6,52	8,11	9,89	9,9	10,94
Rostov Region	3,44	3,64	3,92	4,37	4,89	5,53	6,58	8,3	10,27	10,2	10,86
Russian Federation	4,36	4,73	5,17	5,91	6,90	8,19	10,07	12,58	15,52	14,6	16,65

Source: [9]

The most comprehensive information on the regions' development level, including their comparison with each other, can be provided by Euclid distance between regions which is calculated by formula (1). By the value of Euclid distance we can judge about the level of differentiation of the south of Russia for all period of observation and have an idea about spatial-temporal dynamics of regional development level. By this distance we can judge about degree of nearness of the South Russia regions to the Russian Federation by combination of basic indicators (Table 3).

By the level of development the nearest to the Russian Federation is Volgograd Region (2000, 2005), Rostov Region (2001, 2004), Astrakhan Region (2010) and Krasnodar Territory (2002, 2003, 2006-2009), the farthest – the Republic of Adygea (2006-2007), Dagestan (2002 ã.), Ingushetia (2000-2001, 2003-2005, 2008-2009), Kalmykia (2010).

Table 3: Degree of differentiation between the southern Russian regions and the Russian Federation assessed by combination of basic indicators (Euclid distance between vectors).

Region	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Republic of Adygea	2,36	2,48	2,73	3,27	4,20	5,16	7,43	8,79	9,34	6,66	8,52
Republic of Dagestan	2,39	2,57	4,26	3,52	4,12	4,90	5,98	7,37	8,9	6,56	8,06
Republic of Ingushetia	3,04	2,94	3,36	4,01	4,53	5,42	7,07	8,56	11,13	9,14	10,22
Kabardino-Balkaria Republic	2,25	2,25	2,46	3,09	3,97	4,96	6,47	8,07	10,4	8,15	9,58
Republic of Kalmykia	2,58	2,12	2,36	2,93	3,79	5,05	6,34	7,85	9,66	8,02	10,35
Karachay-Cherkess Republic	2,22	2,25	2,44	3,08	3,82	4,50	5,51	7,26	9,22	7,83	9,87
Republic of North Ossetia – Alania	2,17	2,34	2,65	3,19	3,80	4,85	5,91	7,09	9,26	8,17	9,26
Krasnodar Region	1,46	1,76	*1,70*	*2,09*	2,67	3,31	*3,87*	*4,37*	*5,42*	*4,27*	7,22
Stavropol Region	1,93	2,14	2,33	2,62	3,36	4,26	5,33	6,96	8,9	7,13	8,37
Astrakhan Region	1,83	1,78	1,92	2,20	2,75	3,65	4,37	4,93	5,53	4,87	*6,37*
Volgograd Region	*1,44*	1,65	1,79	2,13	2,76	*3,07*	4,23	5,05	6,36	5,89	7,16
Rostov Region	1,64	*1,59*	1,74	2,12	*2,63*	3,35	4,11	4,78	5,87	4,95	6,38

Indications: 7,43 – maximum; *1,70* – minimum level of differentiation

Source: [9].

Table 4: Maximum values of Euclid distance between vectors which characterize the state of the southern Russian regions (degree of difference in the levels of development of the southern Russian regions by combination of basic indicators)

Year	Regions which are characterized by the greatest differentiation	Euclid distance
2000	Ingushetia – Adygea	2,91
2001	Ingushetia – Astrakhan Region	2,54
2002	Дагестан -Astrakhan Region	4,49
2003	Ingushetia – Astrakhan Region	2,9
2004	Ingushetia – Krasnodar Region	3,06
2005	Ingushetia – Astrakhan Region	3,23
2006	Adygea – Astrakhan Region	5,73
2007	Ingushetia – Astrakhan Region	5,43
2008	Ingushetia – Astrakhan Region	7,97
2009	Ingushetia – Krasnodar Region	8,56
2010	Ingushetia – Krasnodar Region	12,64

Source: [9]

At average the gap between the southern Russian regions and the Russian Federation is growing, the trend in differentiation between the southern Russian regions and the Russian Federation is clearly seen. Side by side with this trend we should mention the trend towards increase of interregional divergence of the South of Russia (Table 4):

Inference: So, historically formed interregional differentiation of the South of Russia increased in conditions of worsening crisis in economy during its transition to market and post-crisis growth. This is connected, first of all, with actuation of the mechanism of market competition, which divided the regions by their competitive advantages - in such conditions different regions manifested different ability to adaptation to market because of different economy structure.

Secondly, increase in differentiation of socio-economic development of the regions is connected with the factor of cumulative economic growth determined by the fact that advantages of some regions – so called growth centers - lead to their development, while a region which lags behind becomes more retarded. Development of the regions - growth centers - is to a great extent achieved thanks to attractiveness of city agglomerations for companies (they allow to save production costs - agglomeration effect in Weber terms - which stimulate technical progress and labour productivity growth. Agglomeration effect includes 2 types of effects: localization effect and urbanization effect.

Localization is achieved thanks to concentration of companies of specific industry at specific territory, which results in reduction of production costs. This effect is determined by two main reasons: scale effect in production of intermediary factors, formation of single labour market, transferring of knowledge.

Urbanization effect takes place if production costs of one company reduce with growth of population and total volume of production at the city territory. This is determined by the growth of size of the whole city economy.

Faster growth of a number of the southern Russian regions (Astrakhan, Volgograd, Rostov Regions, Krasnodar Territory) occurs thanks to urbanization effect. Comparison of integral indicator of the southern Russian regions' development level (Table 2) with the share of population living in cities (Table 5) testifies that there is direct link between these two indicators. The highest level of development is characteristic for regions with big share of city population or city districts with a number of inhabitants over 250 000.

Table 5: Share of population living in cities (city districts) of the South of Russia in groups, %

Region	Cities with millions of inhabitants	Biggest (500 000. – 1 000 000)	Very big (250 000. – 500 000)	Big (100 000 – 250 000)	Medium (50 000 – 100 000)	Small (up to 50 thousands.)	Total
Republic of Adygea	0	0	0	37,7	0	2,8	40,5
Republic of Dagestan	0	23,9	0	12,1	4,1	4,1	44,2
Republic of Ingushetia	0	0	0	0	22,9	16,3	39,2
Kabardino-Balkaria Republic	0	0	30,9	0	6,8	17,8	55,5
Republic of Kalmykia	0	0	0	37,9	0	8,1	46,0
Karachay-Cherkess Republic	0	0	0	26,9	0	29,5	56,4
Republic of North Ossetia – Alania	0	0	46,3	0	0	13,6	59,9
Krasnodar Region	0	16,1	14,0	4,0	13,3	6,2	53,6
Stavropol Region	0	0	1,6	20,4	10,2	10,8	43
Astrakhan Region	0	52,0	0	0	0	11,3	63,3
Volgograd Region	39,3	0	12,6	4,5	2,3	11,7	70,4
Rostov Region	25,7	0	6,0	18,8	7,1	19,1	76,7

Source: [10].

Proposed by us method allows to obtain integral estimate of the level of regional development and to identify the degree of interregional differentiation by combination of basic indicators. Empirical verification of the method performed on the material of the southern Russian regions proves the increase of interregional differentiation.

What must be done to overcome further socio-economic divergence in the south of Russia: to facilitate adaptation abilities of retarded regions through realization of mega-projects based on use of competitive advantages of a region: relief, climate, availability of surplus labour resources); to form new and develop already existing growth centers, which provide agglomeration effect.

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