Modeling of Influence of Resourcing Factors on Gross Regional Product

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Abstract: The transformation processes occurring in the country, causing the uneven development of individual regions, are characterized by increased competition at the regional level. The consequence of the acquisition of economic independence by the regions of the Russian Federation is a reappraisal of its current position and basic functions, the implementation of which is aimed at asserting themselves and strengthening their reliable position in the market and socio-economic spaces of the country by increasing competitive advantages. The formation of competitive advantages of the regions based on the resource potential in the conditions of market relations is the main condition for increasing the efficiency of regional socio-economic systems, predetermining both the sustainable development of the region by ensuring a high level of economic performance and the life quality of the population, and further prospects for the development of environmental and institutional components.

The purpose of the study is to assess the degree of influence of key components of the region's resource potential on the gross regional product per capita as the main recognized indicator of regional development and regional competitiveness based on building an econometric model with the subsequent development of a projection of changes in the indicator of a specific region under the influence of quality and quantity resource potential.

Keywords : regional development, gross regional product, resource potential, modeling, projection scenario.

I. INTRODUCTION

The problem of projection of socio-economic development and raising the level of competitiveness of Russian regions is important and is widely discussed in the works of modern researchers (Gerasimov, Tretyakova, 2017, Kuznetsova, Kocheva, Matev, 2015, Tretyakova, Vlasova and etc., 2018). The basis for determining an effective regional development strategy should be a multidimensional assessment of the socio-economic situation in the regions (Valentey, Bakhtizin, Bukhvald, Kolchugina, 2014, Savaley, 2017) in complex with the assessment of the resource potential, as well as the construction of scenario predictions, allowing to vary the managerial impact (Kuklin, Korobkov, 2018).

Projection scenario is recognized as one of the effective tools used to predict the possible development trends of the phenomena under study. The basis for the preparation of projection scenarios is the construction of projection models that reflect the possible directions of changes in the phenomena under the influence of the most important factors and the arsenal of tools of the control system. The prediction of changes in the level of gross regional product per capita as the main recognized indicator of regional development and regional competitiveness under the influence of the qualitative level and quantitative composition of the resource potential of the regions serves as a basis for developing socio-economic programs for regional development at various levels and a key guideline for their implementation.

II. MATERIALS AND METHODS

Currently, one of the most used methods for predicting the qualitative change in gross regional product per capita under the impact of resource potential remains the method of multifactorial correlation and regression modeling, the use of which allows to identify the main factors influencing the resultant attribute, assess the strength of their influence and make a model used to make factor predictions.

Conducting multivariate modeling includes the following phases: the choice of factor indices that affect the performance indicator; the formation of a homogeneous set; the choice of the form of the equation to reflect the patterns of formation of the effective indicator, depending on the influence of factor indices; check of connection factors for the presence of multicollinarity; determining the closeness of the correlation between the factor indices and the effective indicator with the subsequent evaluation of the statistical reliability of the indicators of communication and the adequacy of the model.

The analytical base of the research was made up of official statistical data in the context of subjects of all federal districts of the Russian Federation, data processing and analysis was carried out using the statistical analysis software package Statistica 7.0.

III. RESULTS AND DISCUSSION

Before directly starting to build a multi-factor econometric model of the influence of factors on the resource availability of the region on the gross regional product per capita, the dynamics of the development of this indicator for 2010-2017. in terms of federal districts will be characterized (Table 1).

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Table 1. Dynamics of the gross regional product per capita by federal districts of the Russian Federation in 2010-2017

	2010	2011	2012	2013	2014	2015	2016	2017.	2017 to 2010, %	The ratio of the level of the district to the average Russian level (for 2010-2017) times
Russian Federation	263829	317515	348642	377006	405148	449098	472050	510253	193.4	1.00
Central Federal District	350204	417288	451517	494483	536608	580707	616493	666427	190.3	1.31
North West Federal District	289611	350764	383339	403613	430131	520253	556775	588507	203.2	1.12
South Federal District	168773	200307	229215	256445	255076	283856	304870	326245	193.3	0.64
North-Caucasian Federal District	94915.3	112648	127042	146117	163950	176400	182558	190285	200.5	0.38
Privolzhsky (Volga) Federal District	190720	236240	263976	284810	308995	339075	348227	372654	195.4	0.75
Ural Federal District	423495	521192	583244	619541	662531	737316	767531	864540	204.1	1.65
Siberian Federal District	214402	249420	269171	287294	317785	353119	367222	401809	187.4	0.78
Far East Federal District	334910	403573	431768	454144	516740	577684	599195	628172	187.6	1.26

Source: compiled and calculated by authors based on data of Rosstat (In Russian)

The size of the gross regional product per capita in Russia in 2017 was 510,253 rub. and exceeded the 2010 level by 93.4%. Presented data indicates a significant differentiation of the indicator by federal districts, which is a consequence of an even higher differentiation of the indicator by sub-federal units, and a relatively small difference in the rate of growth of the indicator for the period under review.

Then the econometric modeling should be studied. The gross regional product per capita as the main recognized indicator of regional development and regional competitiveness was chosen as an effective indicator.

As factor indices, indicators reflecting the resource potential of the region are used. The choice of factor indices is due to their logical connection with the effective indicator and the availability of official statistical data in the regions of the Russian Federation. In determining the factors, various authorial approaches were considered (Heon-Goo Kim, 2008, Howard-Grenville, 2016, Tretyakova, Tselyutina and etc., 2015, Vlasova, Glotov, 2018).

At the initial stage, the following factors are identified as factor indices: life expectancy at birth; natural growth rate per 1000 population; migration growth rate per 10,000 people; the ratio of the average per capita cash income of the population with the subsistence minimum; the proportion of the population with cash incomes below the subsistence minimum; employment rate; average monthly nominal accrued wages of employees of organizations; density of autoroads with hard surface; the degree of depreciation of fixed assets at the end of the year; volume of investments in fixed capital per capita; the share of investments in fixed assets to GRP; the share of domestic research and development costs in GRP; level of innovation activity of organizations; the proportion of unprofitable organizations.

During the verification of the pattern of distribution and homogeneity of the aggregate using descriptive statistics, the following factor indices were excluded from the aggregate: the rate of natural increase per 1000 population; migration growth rate per 10,000 people; density of public roads with hard surface; the share of investments in fixed assets to GRP; the share of internal research and development costs in the GRP, as well as a number of objects of observation: Amur Oblast, Arkhangelsk Oblast, Moscow, Jewish Autonomous Oblast, Magadan Oblast, Komi Republic, Sakha Republic (Yakutia), Tatarstan Republic, Sakhalin Oblast, Tyumen region, Chukotka Autonomous Region, Chuvash Republic, Chechen Republic.

The total complex of the sampled exponents is represented by 8 factor indices 69 region-wise.

Statistical evaluation of the indicators selected for the construction of the model is presented in Table 2.

Table 2. Statistical evaluation of indicators selected for building the model

Index	Index designation	Lower bound	Upper bound	Average value	Standard deviation	Variation coefficient, %
Life expectancy at birth, years	x_1	64.5	80.8	71.4	2.17	3.0
Proportion of the population with money incomes lower than subsistence wage population, %	x_2	7.8	40.3	15.6	5.11	32.9
Employment rate, %	x_3	50.5	73.2	63.4	4.11	6.5
Average monthly nominal wage of workers assessed by organization, rub.	x_4	20603	61457	28863	7372.06	25.5
Consumption of fixed capital at the end of the year, %	x_5	35.2	71.2	48.6	7.74	15.9
Amount of investment to the fixed capital per capita batch, rub.	x_6	24721	194982	72478	24086.79	33.2
Innovation level of organizations, %	x_7	1.9	19.2	7.7	2.57	33.1
Proportion of loss-making organizations, %	x_8	19.0	45.6	32.9	5.91	17.9
Value of gross regional product, rub.	у	109519	696618	329028	106054.10	32.2

The absence of collinearity between the factor indices was confirmed by the analysis of the matrix of paired correlation coefficients.

In the course of building a multifactor correlation-regression model, the following equation was obtained:

$$\hat{Y}_x = -239388 - 1920x_1 - 1229x_2 + 6577x_3 + 8x_4 + 832x_5 + 2x_6 - 290x_7 + 2566x_8$$

The initial model, which reflects the influence on the size of the gross regional product per capita of 8 selected factors, is statistically reliable. The actual value of Fisher's F-criterion, equal to 72.75, exceeds the critical value - 8.60 for the significance level of 0.05 with the number of degrees of freedom 8 and 60. The value of the multiple correlation coefficient is 0.95, and indicates a strong correlation between the resultant and factor indices. The value of the coefficient of determination was 0.91, considering the adjustment for the number of degrees of freedom - 0.89 and is evidence that 89% of the gross regional product per capita can be explained by the cumulative effect of the selected factor indices. But at the same time, the calculated ß-coefficients indicate the fact that the individual factors included in the model, for which [ß] 0.1 have a weak connection with the resultant mark.

In order to determine the best regression equation reflecting the correlation between the level of gross regional product per capita and factor characteristics, the method of step by step elimination of variables unreliable by Student's t-test was used. Conducting a multi-step regression analysis allowed us to successively exclude from the equation the factor indices with the lowest values of the t-criterion. Thus, the regression coefficients of the factor indices become significant in the third step after the exclusion of factors x_7, x_1, x_2, x_5 (Table 3).

Table 3. The final results of a step-by-step correlation and regression analysis of the interrelation between the yields of sugar beet and factors (with the exception of predictors from the regression model)

Correlational statistics						
Regression summary for dependent variable Y: R=0.95; R²= 0.90; corrected R²=0.89; F(4.64)= 146.88; p<0.000000						
Factors	Beta (ß)	Constant error ß	Regression coefficient (b)	Constant error b	t (64)	Probability level (p)
a			-429087	81112.81	-5.29001	0.000002
x_3	0.280064	0.047959	8194	1403.22	5.83964	0.000000
x_4	0.453255	0.049994	8	0.84	9.06619	0.000000
x_6	0.383211	0.051012	2	0.22	7.51211	0.000000
x_8	-0.145085	0.039782	-2983	817.90	-3.64702	0.000534

As a result, after eliminating unreliable factors, the multiple regression equation has taken the following form:

$$\hat{Y}_x = -429087 + 8194x_3 + 8x_4 + 2x_6 - 2893x_8$$

The final equation is statistically reliable, the value of Fisher's F-test was 146.88, which is well above the critical value of 4.64 for a significance level of 0.05. The value of the coefficient of multiple correlation is 0.95 and is evidence of the strong link between the resultant and factor indices. The resulting equation explains 89% of the variation in the level of gross regional product per capita, since the coefficient of determination is 0.90 and corrected for the number of degrees of freedom is 0.89.

The construction of a multifactor model made it possible to distinguish four factors that sufficiently fully describe the total variation of the gross regional product per capita. At the same time, the level of gross regional product per capita is directly dependent on factors: the level of employment of the population, the average monthly nominal accrued wages of employees of organizations and the volume of investments in fixed capital per capita and in the opposite direction the factor of unprofitable organizations.

The values of the beta coefficients indicate that the average monthly nominal accrued wages of employees of organizations (ß = 0.453255) and the level of investment in fixed capital per capita (0.383211) have the greatest impact on the level of gross regional product per capita.

Based on a comparison of the actual and calculated by the model value of the gross regional product per capita separately for each subject, it was established that only 11 of

the 69 regions included in the aggregate to build the model use the available resources to ensure the possible level of the gross regional product per capita. The Belgorod region also became part of these 11 regions.

The obtained multifactor model was used to predict the gross regional product per capita in the Belgorod Region, which is part of the Central Federal District of the Russian Federation, for the near future. At the same time, in the course of the study, three scenario options for changing the main factors reflecting the resource potential of the region were identified: the inertial scenario, the neutral scenario and the recommended scenario.

The projections of the gross regional product per capita calculated in accordance with the selected scenarios are given in table 4.

Table 4. Prediction of growth factors of the gross regional product per capita in accordance with the selected scenarios

Index	Index designation	Average actual level during 2015-2017	Inertial scenario	Neutral scenario	Recommended scenario
Employment rate, %	x_3	66.8	67.0	68.4	69.5
Average monthly nominal wage of workers assessed by organization, rub.	x_4	27204	32750	35000	40000
Amount of investment to the fixed capital per capita batch, rub.	x_6	92483	94700	100500	131500
Proportion of loss-making organizations, %	x_8	27.4	27	23	20
Value of gross regional product, rub.	y	474972	493200	545844	665536
Run-rate changes in comparison with the actual average level during 2015-2017, %		100	104	115	140

The inertial scenario reflects a pessimistic variant, which presupposes a change in the values of the main indicators-factors, at a rate lower than the prevailing in recent years. With the implementation of the inertial scenario, the probability of which is low in the modern conditions of regional development, the growth rate of the gross regional product per capita can be only about 4% compared to the average actual level for 2015-2017. The recommended scenario assumes the implementation of regional development programs and potentially the size of the gross regional product per capita may increase to 665,536 rubles, which is 40% higher than the actual average level.

IV. CONCLUSION

The results of the study indicate a significant differentiation of the components of the resource potential of the regions of the Russian Federation, which determines the high differentiation of the level of gross regional product per capita. The construction of a multifactor model made it possible to distinguish four factors that sufficiently describe the total variation of the gross regional product per capita. At the same time, the level of gross regional product per capita is directly dependent on factors: the level of employment of the population, the average monthly nominal accrued wages of employees of organizations and the volume of investments in fixed capital per capita and in the opposite direction the factor

of unprofitable organizations. The obtained multifactor model allows simulating possible scenarios of changes in the gross regional product per capita, depending on factors identified in the course of building the model, which can be used in decision making at various levels of government and setting priorities for the socio-economic development of regions.

REFERENCES

1. Gerasimov, A.V., Tretyakova, L.A., 2017. Nauchno-obrazovatel'nyj klaster kak mehanizm regional'nogo razvitija [Scientific-educational cluster as a mechanism for regional development]. Ekonomika i predprinimatel'stvo [Economics and entrepreneurship],1 (78): 1026 – 1030 (In Russian).
2. Heon-Goo Kim, 2008. The Effect of IT Innovation on Industrial Output Elasticities. Hitotsubashi Journal of Economics, 49 (1): 11-22.
3. Howard-Grenville J., 2016. Understanding and tackling societal grand challenges through management research. Academy of Management Journal, 59 (6): 1880–1895.
4. Kuklin, A. A., Korobkov, I. V., 2018. Vybor effektivnoj traektorii social'no-ekonomicheskogo razvitija regiona [Selection of an Effective Trajectory of Regional Socio-Economic Development]. Ekonomika Regiona [Economy of Region], 14(4): 1145-1155 (In Russian).

5. Kuznetsova, N.V., Kocheva, E.V., Matev ,N.A., 2015. Balance of Economic Development of APR Countries. Journal of Advanced Research in Law and Economics, 3 (13): 584–605.
6. Savaley, V.V., 2017. Valovoj regional'nyj produkt kak indikator effektivnosti i urovnya razvitiya territorial'noj ekonomiki [Gross regional product as an indicator of territorial economy efficiency and development level]. Territoriya novyh vozmozhnostej [The Territory of New Opportunities], 9(2): 31–43 (In Russian).
7. Tretyakova, L.A., Tselyutina, T.V. and etc., 2015. Function Representation of the Civil Society Institutions Within the Transforming Sustainability of the Regional Development. International Business Management, 9 (5): 963-965.
8. Tretyakova, L. A., Vlasova, T. A. and etc., 2018. Formation of the knowledge-intensive clusters as factor of innovative development of russian regions. J. Fundam. Appl. Sci.,10 (4S): 1570-1579.
9. Valentey, S. D., Bakhtizin, A. R., Bukhvald, Ye. M., Kolchugina, A. V., 2014. Trendy razvitiya rossiiskikh regionov [Development trends of the Russian regions]. Ekonomika regiona [Economy of Region], 3: 9–21 (In Russian).
10. Vlasova, T. A., Glotov, D.S., 2018. Prostranstvennaya differenciaciya regionov Central'nogo federal'nogo okruga RF po urovnyu ih konkurentnyh preimushchestv [Spatial differentiation of the regions of the Central Federal District of the Russian Federation by the level of their competitive advantages]. Audit i finansovyj analiz [Audit and financial analysis], 3: 162-166 (In Russian).