MODELING AS AN EFFECTIVE MANAGEMENT TOOL FOR THE INTE-GRATED REGIONAL DEVELOPMENT

LA MODELIZACIÓN COMO HERRAMIENTA DE GESTIÓN EFICAZ PARA EL DESARROLLO RE-GIONAL INTEGRADO

Konstantin Eduardovich Tyupakov[1]*; Sergey Alexandrovich Verkhorubov[2]; Lyudmila Alexeevna Beloglazova[3]; Zamira Magometovna Pogorova[4]; Zaurbek Savarbekovich Hautiev[5].

1. Kuban State Agrarian University named after I.T. Trubilin, Russia. tupakov@yandex.ru
2. Saint-Petersburg University of the Ministry of Internal Affairs of the Russian Federation, Russia. 89816813333mvd@mail.ru
3. Voronezh State Technical University, Russia. maskarad-36@yandex.ru
4. Ingush State University, Russia. z.pogorova2016@yandex.ru
5. Kuban State Agrarian University named after I.T. Trubilin, Russia. magas-2020@yandex.ru

*corresponding author: Konstantin Eduardovich Tyupakov.email: tupakov@yandex.ru

ABSTRACT

Ensuring sustainable territorial development is one of the key tasks for developing regional industries and increasing the level of food security of the regions and the country in general. The solution to the problem of developing and implementing a competitive mechanism for territorial development should be based on the principles and methods of modern strategic territorialsectoral planning with a focus on the maximum use of the resources of the existing local potential. This study analyzes modeling as an effective management tool for integrated regional development. To that end, approaches based on constructing multivariate regression models are utilized. Based on the results, the main problem of management systems for the integrated territorial development is associated with an incorrect assessment of their starting capabilities, which results in the low performance of the implementation mechanism. A reliable methodological basis here can be an approach to managing territorial development using a system of linked indicators that consider more than just the parameters of social development. The list of priority areas (blocks), which should serve as a fundamental basis for developing concepts for the integrated development of regions, must include natural and climatic, technical and technological, infrastructural, and marketing characteristics.

Keywords: regional development; regional competitive potential; modeling; integrated development.

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RESUMEN

Asegurar un desarrollo territorial sostenible es una de las tareas clave para el desarrollo de las industrias regionales y el aumento del nivel de seguridad alimentaria de las regiones y del país en general. La solución al problema de desarrollar e implementar un mecanismo competitivo para el desarrollo territorial debe basarse en los principios y métodos de la moderna planificación estratégica territorialsectorial con un enfoque en el aprovechamiento máximo de los recursos del potencial local existente. Este estudio analiza la modelización como una herramienta de gestión eficaz para el desarrollo regional integrado. Para ello, se utilizan enfoques basados en la construcción de modelos de regresión multivariados. Con base en los resultados, el principal problema de los sistemas de gestión para el desarrollo territorial integrado está asociado a una incorrecta evaluación de sus capacidades de partida, lo que se traduce en el bajo desempeño del mecanismo de implementación. Una base metodológica confiable aquí puede ser un enfoque para gestionar el desarrollo territorial utilizando un sistema de indicadores vinculados que consideren más que solo los parámetros del desarrollo social. La lista de áreas prioritarias (bloques), que debe servir como base fundamental para desarrollar conceptos para el desarrollo integral de las regiones, debe incluir características naturales y climáticas, técnicas y tecnológicas, infraestructurales y comerciales.

Palabras clave: desarrollo regional; potencial competitivo regional; modelización; desarrollo integrado.

INTRODUCTION

Using the techniques of economic and mathematical modeling based on systemic and integrated approaches would be advisable to assess the possibilities of territorial development (Alipbeki et al., 2020). The proposed method for determining the parameters of the mechanism for managing the potential of territorial formations provides for a description of the conceptual mechanism for the implementation of the system; principles of its construction; structural elements and functionality. The implementation of the optimization problem with a fixed amount of resources makes it possible to find the best combination of industries and spheres and to assess the potential of the territory according to some criterion, i.e. build a simulation model (Dunets et al., 2019; Asheim, 2019). A simulation model intended for variant calculations may lack an explicitly expressed objective function, which implies a thorough analysis of the solutions obtained for each variant of combinations of functional characteristics of the system and the choice of the most optimal one (Costanza & Voinov, 2000; Dubishchev et al., 2019).

Modern territories are open systems whose internal stability greatly depends on the conditions of the external environment. Therefore, the model for the development of the competitive potential of territories can be classified as universal as it has such features as adaptive capabilities, the integrity of the study, comparability of indicators, the continuity of the analytical process, and multivariance.

METHODS

Improvement of the mechanism and tools for managing the integrated development of the territories of the region is aimed at the formation and selection of alternative options when creating a general

scheme for the development of its national economic complex. This problem, in our opinion, is key, as it determines the main vector of development and the mechanisms for its implementation. To solve this problem, we will use approaches based on the construction of multivariate regression models.

Economic phenomena, as a rule, are determined by a large number of simultaneously and cumulatively acting factors (Meshalkin & Khodchenko, 2017; Voronkova et al., 2019). In this regard, the dependence of the variable "Y" on several explanatory variables "X1, X2, ..., Xn" should be investigated. Multivariate (multivariate or multiple) regression allows building and testing the relationship between one resulting variable and several independent influencing factors.

Multifactor (multivariate or multiple) regression (multiple regression model) is a relationship equation with several independent explanatory variables. In general, it can be as follows:

$$Y = \beta_0 + \beta_1 \cdot X1 + \beta_2 \cdot X2 + \ldots + \beta n \cdot Xn \quad (1)$$

where X1, X2,… Xn are independent explanatory variables; β_0 is a random variable, an additional residual term that reflects the influence of random errors, measurement features and actions that affect the resulting variable, other explanatory variables that were not included in the equation. It is also called resentment or remnant. This random component can be considered a random forecast error Y for a given value X.

Building models involves the following steps:

1. specification of the phenomena, processes, the dependence between which is subject to assessment. Formulation of hypotheses about the dependence of economic phenomena;

2. determination of the number of desired factors, classification of the variables into resulting and explanatory. In theory, the regression model allows taking into account any number of factors; in practice, this is not necessary;

3. data collection. The minimum sample size is determined;

4. formulation of a hypothesis about the form of link (linear or nonlinear, simple or multiple), i.e. model specification is carried out;

5. determination of the numerical values ..of the regression parameters and indicators characterizing the accuracy of the regression analysis;

6. selection of the main factors. The factors included in the model must meet the following conditions: they must be quantifiable; factors should not contain trends; factors do not have to be in precise functional relationship;

7. checking for autocorrelation;

8. verification of the significance of the determination indicator and assessment of the quality of the selection of the theoretical regression equation. The regression error, the standard error of the regression and the mean error of the approximation are estimated. If the model is inadequate, the

development of the model should start again from the fourth stage;

9. comparison of the results with the hypotheses proposed at the first stage of the study, and assessment of their plausibility. Economic interpretation of the model.

RESULTS

Let us formulate hypotheses about the dependence of economic phenomena. Thus, three main indicators were chosen as dependent variables Y: the general rank of the technical and technological potential (Y1), the general rank of the investment potential of the rural areas of the region (Y2), and the general rank of the marketing potential of the entities in rural areas (Y3). As independent variables Xn, eleven indicators of the integrated regional development were selected, which characterize the key levels of competitive potential (Meshalkin & Khodchenko, 2017; Liang et al., 2018; Sheffield et al., 2018).

As a result of processing the initial data, the matrices of the initial data were formed. Here is an example (Tables 13):

Table 1. Initial data matrix (general rank of technical and technological potential (Y1))

		Y	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11
1	Boksitogorsky	10.0	17	16	14.1	22	14	13	16	14	16	15	15
2	Volosovsky	16.0	3	13	1.1	77	12	15	15	8	13	13	12
3	Volkhovsky	13.0	10	7	11	27	10	9	12	13	4	11	6
4	Vsevolozhskii	3.0	5	1	20.6	49	1	3	2	6	9	2	1
5	Vyborgsky	5.0	8	3	39.1	35	2	5	3	3	2	5	4
6	Tosnensky	9.0	13	5	4.3	27	7	8	7	4	10	8	5

Table 2. Initial data matrix (the general rank of the investment potential of the territories of the region

		Y	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11
1	Boksitogorsky	13	17	16	14.1	22	14	10	16	14	16	15	15
2	Volosovsky	15	3	13	1.1	77	12	16	15	8	13	13	12
3	Volkhovsky	9	10	7	11	27	10	13	12	13	4	11	6
4	Vsevolozhskii	3	5	1	20.6	49	1	3	2	6	9	2	1
5	Vyborgsky	5	8	3	39.1	35	2	5	3	3	2	5	4
6	Tosnensky	8	13	5	4.3	27	7	9	7	4	10	8	5

Table 3. Initial data matrix (the general rank of the marketing potential of economic entities in the territories of entities (Y3))

		Y	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11
1	Boksitogorsky	15.0	17	16	14.1	22	14	10	13	16	14	16	15
2	Volosovsky	12.0	3	13	1.1	77	12	16	15	15	8	13	13
3	Volkhovsky	6.0	10	7	11	27	10	13	9	12	13	4	11
4	Vsevolozhskii	1.0	5	1	20.6	49	1	3	3	2	6	9	2
5	Vyborgsky	4.0	8	3	39.1	35	2	5	5	3	3	2	5
6	Tosnensky	5.0	13	5	4.3	27	7	9	8	7	4	10	8

We rely on the assumption of multiple linear link used in the model. Let us consider an example of constructing correlation matrices and assessing the statistical significance of the correlation between them (Table 4).

Table 4. Correlation matrix Y1

	Y	*X1*	*X2*	*X3*	*X4*	*X5*	*X6*	*X7*	*X8*	*X9*	*X10*	*X11*
Y	1											
X1	0.259804	1										
X2	0.651961	0.230392	1									
X3	0.53595	0.15382	0.30954	1								
X4	0.041147	0.31527	0.16459	0.27844	1							
X5	0.688725	0.384804	0.887255	0.47138	0.11475	1						
X6	0.877451	0.134804	0.70098	0.64078	0.084613	0.654412	1					
X7	0.664216	0.463235	0.772059	0.51461	0.16691	0.889706	0.60049	1				
X8	0.35049	0.068627	0.487745	0.11213	0.67574	0.392157	0.382353	0.428922	1			
X9	0.340686	0.477941	0.296569	0.60962	0.111851	0.473039	0.291667	0.617647	0.090686	1		
X10	0.737745	0.333333	0.767157	0.6877	0.132714	0.860294	0.806373	0.791667	0.264706	0.482843	1	
X11	0.583333	0.333333	0.835784	0.34935	0.32976	0.85049	0.637255	0.838235	0.568627	0.465686	0.656863	1

It follows from the correlation matrices that the selected resulting features are influenced by all regressants; nevertheless, the degree of their influence is different. We can also note the presence of a correlation between exogenous variables, which may indicate the presence of a multicollinearity phenomenon in the model. Based on the presence of a linear relationship between endogenous and exogenous variables, it is possible to estimate the parameters of regression models using the least squares method. Let us calculate regression vectors ..of endogenous variables and random deviations. Let us build multivariate regression models:

$$Y = \beta_0 + \beta_1 \cdot X1 + \beta 2 \cdot X2 + \beta_3 \cdot X3 + \beta 4 \cdot X4 + \beta_5 \cdot X5 + \beta 6 \cdot X6 + \beta_7 \cdot X7 + \beta_8 \cdot X8 + \beta_9 \cdot X9 + \beta_{10} \cdot X10 + \beta_{11} \cdot X11 \quad (2)$$

Here is an example of the results of multiple regression in numerical form:

Table 5. Results of multiple regression Y1

	Coefficients	*Standard error*	*ttest*	*P*	*Lower 95%*	*Top 95%*
Y intersection	3.385559537	5.159301883	0.65620497	0.540684813	16.64796724	9.876848168
Variable X1	0.036845362	0.216045225	0.170544673	0.871268177	0.518516568	0.592207293
Variable X2	0.304888227	0.38194287	0.798256103	0.460937232	1.28670363	0.676927176
Variable X3	0.098132544	0.101559857	0.96625327	0.378295493	0.16293538	0.359200469
Variable X4	0.003087915	0.069455318	0.04445902	0.966259455	0.175452664	0.181628495

Variable X5	0.978688466	0.523196668	1.870593845	0.120321687	0.366231384	2.323608316
Variable X6	1.367084403	0.332627068	4.109961374	0.009264211	0.512039303	2.222129502
Variable X7	0.435226822	0.363385886	1.197698752	0.284709782	0.498886336	1.36933998
Variable X8	0.058758602	0.263172704	0.223270122	0.832160351	0.617748371	0.735265574
Variable X9	0.149514846	0.254726031	0.586963354	0.582729592	0.505279262	0.804308953
Variable X10	0.731062009	0.458848383	1.593253971	0.171983281	1.910569328	0.448445311
Variable X11	0.767723185	0.39186422	1.95915612	0.107403885	1.775042232	0.239595861

Table 6. Dispersion analysis Y1

	df	*SS*	*MS*	*F*	*Ftest*
Regression	11	373.4173097	33.94702815	4.908095328	0.045889591
Surplus	5	34.58269031	6.916538063		
Total	16	408			

Table 7. Regression statistics Y1

Multiple R	0.956680983
R square	0.915238504
Normalized Rsquared	0.728763213
Standard error	2.62993119
Observations	17

As follows from the data obtained by the least square method (Tables 57), the obtained multivariate regression model of the technical and technological potential Y1 will be as follows:

$$Y1 = 3.39 + 0.04 \cdot X1 - 0.31 \cdot X2 + 0.1 \cdot X3 + 0.003 \cdot X4 + 0.98 \cdot X5 + \\ + 1.37 \cdot X6 + 0.44 \cdot X7 + 0.06 \cdot X8 + 0.15 \cdot X9 - 0.73 \cdot X10 - 0.77 \cdot X11 \quad (3)$$

This equation expresses the dependence of the technical and technological potential Y1 on the factor signs X1 X11. Equation coefficients show the quantitative impact of each factor on the effective indicator, while others remain unchanged.

The obtained equation allows determining the quantitative response of the resulting feature to a change in each of the factor features. The resulting model also makes it possible to rank factor signs according to the degree of their influence on the change in technical and technological potential. Thus, a ranked list of five key factors according to the degree of influence reduction is as follows:

1. X6 – the level of investment potential (1.36)
2. X5 – the level of labor potential (0.97)
3. X11 – the level of marketing potential (0.76)
4. X10 – the level of potential of consumer markets (0.73)
5. X7 – the level of organizational and managerial potential (0.43)

A multivariate regression model of the investment potential of rural areas of the region (Y2):

$$Y2 = 2.2 + 0.01 \cdot X1 + 0.25 \cdot X2 - 0.09 \cdot X3 + 0.01 \cdot X4 - 0.71 \cdot X5 + \\ + 0.56 \cdot X6 - 0.28 \cdot X7 + 0.01 \cdot X8 - 0.16 \cdot X9 + 0.55 \cdot X10 + 0.57 \cdot X11 \quad (4)$$

Let us build a ranked list of five key factors for the investment potential of rural areas of the region (impact on the level of investment potential in decreasing order):
1. X5 – the level of labor potential (0.71)
2. X11 – the level of marketing potential (0.57)
3. X6 – the level of technical and technological potential (0.56)
4. X10 – the level of potential of consumer markets (0.55)
5. X7 – the level of organizational and managerial potential (0.28)

A multivariate regression model of the marketing potential of business entities (Y3):

$$Y3 = – 1.49 – 0.04 \cdot X1 – 0.09 \cdot X2 – 0.08 \cdot X3 – 0.03 \cdot X4 + 0.88 \cdot X5 – \\ – 0.57 \cdot X6 + 1.01 \cdot X7 + 0.4 \cdot X8 + 0.02 \cdot X9 + 0.22 \cdot X10 – 0.67 \cdot X11 \quad (5)$$

Let us build a ranked list of five key factors for the marketing potential of business entities (impact on the level of marketing potential in decreasing order):

1. X7 – the level of investment potential (1.01)
2. X5 – the level of labor potential (0.88)
3. X10 – the level of potential of consumer markets (0.67)
4. X6 – the level of technical and technological potential (0.57)
5. X8 – the level of organizational and managerial potential (0.4)

As a result of the calculations, three basic directions were identified to increase the competitive potential of a particular territory, depending on the level of its development. These directions (all other things being equal) are as follows:

technical and technological;
investment;
marketing.

The obtained regression models distinguish factor signs according to the degree of their influence on the resulting indicator; on this basis, the ranked series of frustration (development) points were compiled, whose changes are a pressure point for the resulting trait. The ranked series made it possible to form a matrix of preferred directions of development, as well as spheres and sectors affecting the dynamics of the territories. This technique can be used for a rational choice of options for the development of regions on the basis of assessing the alternative possibilities of territories with the same set of influencing factors but their different meaning for each of them (Keeler et al., 2019) (Table 8).

Table 8. Matrix of preferred spheres of influence on the development of the competitive potential of rural areas

Areas of development	A ranked range of preferred spheres of influence				
	1	2	3	4	5
Technical and technological potential	Investment	Labor	Marketing	Market	Organization and management
Investment potential	Labor	Marketing	Technical and technological	Market	Organization and management
Marketing potential	Investment	Labor	Market	Technical and technological	Organization and management

The developed statistical models make it possible to use specific basic strategies for the indicated areas for the sustainable territorial development, considering the peculiarities of their current state (Kralisch et al., 2011). For example, if the development of the territory should go through increasing the marketing potential, then the proposed model clearly identifies areas such as the investment base, labor resources, market infrastructure, territorial organizational and managerial factors. The priorities identified on the basis of the model will contribute to the more dynamic development of a specific territory (Danson & 2012).

The proposed technique of territorial assessment and classification according to the level of development of competitive potential makes it possible to more specifically determine the set of strategies and tactics that allow maintaining the planned dynamics. The use of the proposed strategies in conjunction with the developed statistical models and a matrix of preferred sectors for a given territory makes it possible to trace or simulate the quantitative parameters of development (Larchenko et al., 2019).

The following seems to be the most productive for territories with a declining competitive potential: strategies with a focus on cooperative collaboration; territorial (systemic) integration; local and horizontal diversification; reducing costs. At the same time, the most effective tactics within these territories will be: reorganization of enterprises; business diversification; activation of internal reserves; reduction of unprofitable assortment; allround cost reduction (Table 9).

Table 9. Implementation of the development strategies for the competitive potential of territories in the corresponding areas of the Leningrad region

Territory classification by potential level	Districts	Basic strategies	Tactics of competition
1	2	3	4
declining potential	Boksitogorsky	Cooperative strategy Territorial (system) integration strategy Local and horizontal diversification strategy Cost reduction strategy	reorganization of enterprises; business diversification; activation of internal reserves; reduction of unprofitable products; adjustment of pricing policy; allround cost reduction; going out of business.
low potential	Volkhovsky Volosovsky	Regional market development strategy Coordinationoriented strategy Innovation strategy Cost reduction strategy Local and horizontal diversification strategy	differentiation of services and their reduction in price; maintaining market share and investment volumes for profit; accumulation of resources from the wound down business areas to move them to promising sectors
1	2	3	4
developing potential	Tosnensky	Segregationoriented strategy Territorial (system) integration strategy Regional market development strategy Product and service development strategy	fight for niches with weak competition; further adaptation to the selected target market; focus on the leader and imitation of his actions; acquisition of small competitors; creating a favorable image.

relatively high potential	Vyborgsky Vsevolozhsky	Leadership strategy Market share maximization strategy Innovation strategy Cost reduction strategy	active attack on the market, attracting innovations to increase pressure on competitors; maintaining market share; maintaining the achieved level of profitability; establishment of entry market barriers; active struggle with competitors; attracting consumers of suppliers, discrediting competitors,

The most preferable strategies for the lowpotential territories will be the development of the territorial market; focus on coordination; introduction of innovations; and local and horizontal diversification. The set of the most effective tactics defined is as follows: differentiation of services and their reduction in price; maintaining market share and investment volumes for profit; accumulation of resources from the curtailed business areas to move them to promising sectors.

CONCLUSION

Territories of the region, characterized by indicators of developing competitive potential, can successfully master strategies: with a focus on isolation, territorial (system) integration; development of the range of goods and services. The most adapted tactical methods of competitive struggle in this zone can be: struggle for niches with weak competition; further adaptation to the selected target market; orientation towards the leader and imitation of his actions; absorption of small competitors, etc.

The most effective strategies for territories with a relatively high potential, will be leadership; maximization of the market share; introduction of innovations, etc. Competitive tactics supporting strategic directions are characterized by the following set of actions: active attack on the market; attraction of innovations to increase pressure on competitors; maintaining the achieved level of profitability; establishment of market entry barriers; active struggle with competitors, their discrediting.

Unlike the traditional approach aimed at developing the social sphere and infrastructure of municipal formations, the proposed method is more productive and justified for ensuring the integrated development of territories (Dubishchev et al., 2019; Grillitsch & Sotarauta, 2020).

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