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Conceptual justification of a new model of innovative modernization of the regional economy

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Abstract

The study aims at identifying the processes of new regionalization that manifested in the economic space within the regions, when the economy at the corporate business structures level has a network character via developing mathematical models of complex socio-economic systems. The main results of the article will contribute to the formation of tools for testing the most progressive innovations aimed at the formation of the spatial organization of the territory. In conclusion, in the process of government management of sustainable development of the region, government programs have proven to be an effective tool for a program-targeted approach.

Keywords: Region, Economy, Specificity, Economic Potential.

Justificación conceptual de un nuevo modelo de modernización innovadora de la economía regional

Resumen

El objetivo del estudio es identificar los procesos de nueva regionalización que se manifiestan en el espacio económico dentro de las regiones, cuando la economía a nivel de las estructuras empresariales corporativas tiene un carácter de red a través del desarrollo de modelos matemáticos de sistemas socioeconómicos complejos. Los principales resultados del artículo contribuirán a la formación de herramientas para probar las innovaciones más progresivas dirigidas a la formación de la organización espacial del territorio. En conclusión, en el proceso de

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gestión gubernamental del desarrollo sostenible de la región, los programas gubernamentales han demostrado ser una herramienta eficaz para un enfoque orientado a los programas.

Palabras clave: región, economía, especificidad, potencial económico.

1. INTRODUCTION

Modernization and innovation development are interrelated sides of the same process, as a result of which the country optimizes the accumulated experience to increase the sustainability and efficiency of the regional economies. An important part of the systemic modernization of the regional economy is institutional mechanisms, which implies the formation of market economy institutions that are new for the regions and adequate to the modern conditions of globalization. Solving new problems requires scientifically based approaches to the formation of regional policies aimed at shaping a model of an innovative regional economy and improving the well-being of the population through innovative modernization based on the rational use of economic, intellectual and social potentials. Insufficient practical elaboration of tools for a sustainable development strategy requires scientifically created conditions that will contribute to the sustainable development of regions.

2. LITERATURE REVIEW

Researchers have also made a significant contribution to developing the methods for solving the problems of sustainability and balance of the region widely discuss the development of the region in their

works. However, despite numerous works on managing the regional development and using the program-target method, more attention is paid to the economic component, while the managerial aspect remains not fully understood. Many issues of development and implementation of state programs during the state regional policy did not find a full justification. In particular, the category 'program management' in the context of the region's sustainable development, and the identification of a number of features inherent in this process require clarification and additional explanation. A more detailed analysis of the impact of government programs on sustainable development in the region, of improving the management of sustainable development in the region (in particular results-based management) is needed (Granberg, 2013).

Among the representatives of neoclassical theories, one can name Sala-i-Martin. Particular attention should be paid to the theory of cumulative regional growth, which is based on the concept of mutual and cumulative conditionality by Myrdal. He found that the concentration of economic entities occurs in the most favorable conditions for business areas. Hägerstrand and H. Richardson were also prominent representatives of cumulative regional development. They developed the theory of 'diffusion of innovations' as a spatial process of regional development. The views of the Scandinavian school are presented in the works of B. Lundvall and B. Jonsson. The theoretical basis of the institutional aspect of the new paradigm of regional development is first formed in the framework of the new paradigm of spatial development. The founder of this new direction of world regionalism, P. Krugman, divided the factors of competitive advantages to regions into groups:

First nature factors (natural resources, geographical location);

Second nature factors due to human activity (agglomeration effect, human capital, institutions).

Despite the huge number of publications on this topic, the development of mathematical models of the modernization of the regional economy is not sufficiently described, which led to the present study (Orlova & Polovnikov, 2015).

3. METHODOLOGY

The main feature of regional economy modernization is spreading innovative changes in economic activity, management and in the social sphere. The transition of Russia and its regions to spatial development means a course towards the creation of modern society, i.e. continuous modernization process. Yet in the context of globalization, when the importance of new factors of economic growth, primarily knowledge, increased, and differences in the conditions and quality of life of the population in the world as a whole and in individual countries intensified, modernization processes change their character. Involving new factors of economic growth requires overcoming social inequalities – in fact, spreading the principles of inclusive development. Therefore, assessing the prerequisites and conditions for the formation of a new strategy for the spatial development of Russia should be carried out within the framework of the modernization paradigm. In the new conditions of development of the world economy, the role of the state in the implementation of the main

factor of economic growth and systemic modernization — the development of innovative activity — increases. That is, the importance of state funding and state support for research and development, venture projects, the introduction of new technologies, and the development of the educational and intellectual potential of the country grows (Berezhnaya & Berezhnoy, 2016; Tayebiniya & Khorasgani, 2018).

In the context of globalization, the competitiveness of the regions is determined not only by the availability of appropriate technologies and firms but also by the ability of the regions to develop new technologies and create conditions for the arrival of the respective companies. Companies transferring their production and other divisions to new locations have more modern technologies than most of the enterprises in the host region and have a higher level of corporate management and technological culture. However, the economic strength of a state in the modern world is largely determined not only by natural wealth or the physical volume of generated GDP but by centers that regulate global financial and technological flows. The processes of new regionalization in the global economy are manifested in the changing roles of regions that are becoming increasingly independent players in global markets. There is a restructuring of the economic space within the region. These changes are caused primarily by the fact that the economy at the level of corporate structures in business takes on a network character. Acting in the global economy, corporations are re-structuring the economic space using the new exploration of territorial markets (Kulyanitsa & Soboleva, 2008).

A new type of economic growth based on the use of knowledge, information and innovations have become firmly established in the global

economy. This could not but affect the spatial structure of economically developed countries. In these countries, a gradual transition to new principles of spatial development has begun. The very understanding of development has changed: the unbridled growth of the industry, often achieved at the cost of causing significant damage to the environment, has ceased to be an absolute value. Priority was given to ideas about development as a combination of economic, social and environmental characteristics. It is not regions of a large-scale industry that have become more attractive for living, but those regions where a favorable quality of life is being formed. At present, the state policy of regional development shows the urgent need to update the program-target management method and its subsequent application in the development and implementation of targeted programs; a transition to strategic planning with regard to federal priorities and macro-regional goals is also needed. The state program as a complex instrument of the program-target approach used in the process of state regulation is a complex of projects (measures) and instruments. It requires the interaction of a large number of subjects at different levels in the process of developing, organizing and coordinating program participants' efforts, monitoring, evaluating intermediate results for feedback and adjusting the program, and, finally, evaluating the final results. That makes it possible to judge the effectiveness of the program and the achievement of set goals (Zhigalov et al., 2009).

It includes the subjects of management and measures to develop the properties of the object, including those based on the implementation of projects (including investment projects), as well as the program management process itself as a set of measures. Without an effective management system, the state program is rather formal, which does not

allow all the program subjects to achieve their interests and, accordingly, does not allow fully using the possibilities of the program-oriented approach in the state regional management. At the same time, the application of the tools of the program-oriented approach to managing the economy in practice is very limited. This is due to the objective reasons for the uneven distribution of resources throughout the country, to the factors of correlation between the issues of governance and self-governance that are subjective for a certain historical stage. The principle of subsidiarity, involving the transfer of a number of managerial powers to the level where they will be implemented with the greatest efficiency, involves a constant search for the relationship between sectoral and territorial management. To date, the development program of the territory (as an instrument of a program-target approach to managing the development of a region) is not actually managed, i.e. the program-target approach is not properly applied in planning the activities of state bodies. This raises many problems in the area: The efforts of sectoral departments are not coordinated in the process of developing state programs;

- Low-quality analysis of the current state of the region's development;
- Target indicators are poorly quantifiable;
- There is no targeted funding for the program;
- No assessments of the effectiveness of measures, and other problems that turn territorial development programs into low-

performing tools of the state regional policy for managing sustainable development (Porter, 1988).

The use of program-target approach in the management of sustainable development of the region (including in terms of the methodological support of the territory development and management program) does not fully correspond to the international experience in developing such programs, and needs to be improved. With the new approach to management, standards and regulations are being replaced by a flexible system for measuring the results of the implementation of state programs and the results of government activities; this system serves as an information basis for developing and selecting state programs for the development of territories and the formulation of goals. Thus, the new model of management, which allows taking into account the performance at the level of state bodies and at the level of specific programs, in particular, territorial development programs in the regional context, replaces the old model of state administration (which considers costs). Results management is characterized by greater flexibility, the involvement of all the participants in decision-making and is result-oriented, which ultimately leads to efficiency and the economy of public resources .

Results-based management tools include results-based budgeting tools, as well as strategic documents, territorial development programs, performance and impact assessment tools. The system of state planning should be based on long-term and medium-term goals and contain ways to achieve the goals. Since any system is a complex of homogeneous elements interconnected with each other and perceived as a single

mechanism, it should be noted that the system of state planning is represented by entities engaged in the planning process, by objects at which the management process is targeted, and by the principles, methods and elements of state planning as such. The system of state planning for regional development should be based on the paradigm of sustainable development, taking into account the ecological situation of a particular region and social and economic factors of development. At the same time, the environmental factor should be a priority. The environmental component in this process ensures the quality of life of the population (Dmitriev, 2013).

Since the development processes in the social, economic and environmental components are interrelated and interdependent, they should be considered from a single point of view. Moreover, they are the backbone of the state's activities, of regional development programs and strategic documents. Based on the analysis of financial and economic opportunities for the development of social infrastructure in the regions of Russia, it is necessary to improve intergovernmental relations in order to guarantee the population's access to social services in all the regions. The basis for improving intergovernmental relations should be as follows: the differentiation of financial standards for administrative-territorial units with the allocation of urban and rural areas, taking into account the climatic features, other factors and conditions. At the same time, taking into account international experience, state social standards should be revised at least once every 3 years, and the financial ones – annually. To implement the principle of spatial development, minimum social standards should be established not for infrastructure facilities of the social sphere

but only per capita or per recipient of services (Krugman & Obstfeld, 1997).

To improve the quality of vocational education, minimal state social standards are to be developed at three levels: primary, secondary, and higher. The main goal of the state is to ensure the social welfare of the population, which is impossible without economic development (ensuring the reproduction process), maintaining environmental standards, and making the transition to the principles of a 'green economy'. At the same time, the authors of the present study believe that in the process of managing the region's sustainable development, one of the most effective elements of the state planning system is territorial development programs that allow state authorities to take into account regional specifics and solve problems in the field of sustainable regional development. Program management focuses on the interdependencies of projects to develop an optimal approach to their management. Thus, the territory development program is a complex of interconnected resources, implementers, implementation dates and performance indicators of projects (events) aimed at solving systemic problems in the field of sustainable development of the regions of a particular country. The management of the state program of territorial development within the framework of the program-oriented approach to the sustainable development of the region includes several stages:

- A territorial development program and coordination of the efforts of various actors in the development process ;

- Program implementation, monitoring and evaluation of intermediate results for feedback and adjustment ;

- Evaluation of the results (Raizberg, 2002).

The development of regional programs in the process of analyzing, modeling, forming a vision and determining priorities, goals, target indicators, objectives, and ways to achieve them, and resource support for regional development programs. In the process of government management of sustainable development of the region, government programs have proven to be an effective tool for a program-targeted approach. At the same time, the development programs of territories, which are a set of interconnected resources, performers, implementation dates and performance indicators of measures aimed at solving systemic problems in the sustainable regions of the country, are the main levers of this approach. To ensure the effectiveness of the program-target approach to managing the region's sustainable development, state regional development programs should be managed first. The management of the regional sustainable development program includes several stages: A territorial development program and coordination of the efforts of various actors in the development process;

- Program implementation, monitoring and evaluation of intermediate results for feedback and adjustment ;

- Evaluation of the results.

- The sustainable development of the region means the purposeful process of public administration of the socio-ecological-economic system of the region; this process aims at ensuring a sustainable quality of life, economic well-being and an environmentally friendly environment (Raizberg, 2010). The analysis of the territorial development program management revealed the following shortcomings:

- Insufficient number of target and performance indicators of the tasks, many of which do not correspond to the established goals and planned activities from the point of view of the management methodology by results;

- Analysis of the socio-ecological and economic development of the region does not reflect many crucial problems, for example, demographic trends in administrative-territorial units, including the problem areas with high migration, historical pollution, inadequate assessment of economic diversification and others;

- Insufficient coverage and attention to environmental issues ;

- The absence of entities operating in the territory to help achieve the sustainable development of the region, indicating the relevant goals and objectives (target indicators) and activities of such organizations.

The main distinguishing feature of the regional economy modernization is innovative changes in economic activity and

management. The method of internal evaluation of the state program aims at the development of all the strategic areas, i.e. following the principles of performance management. Integral assessment combines phenomena (indicators) of different dimensions into one indicator. It synthesizes indicators that in other contexts have proven their adequacy. New phenomena in regional development are associated with the formation of a creative economy that changes the traditional ideas about the factors of business placement. Previously, access to sources of raw materials, transportation, local tax breaks was of predominant importance. For creative activity, other factors are of interest, namely, a favorable environment (ecosystem) (Scott, 2012). The application of methods of mathematical modeling to social processes is due to the increased requirements for the methodology of such modeling. Conventional theoretical methods cannot accurately investigate the complex socio-economic processes; in this regard, mathematical modeling is a component of scientific and technological progress. Creating and applying the methodology of mathematical modeling is impossible without analyzing non-linear models of systems. All economic and mathematical models are based on the following concepts:

- An economic system consists of subsystems of economic objects;
- Each economic entity is characterized by a set of objects (called local restrictions) admissible for this plane;
- An economic object is dependent on other objects, and this dependence is characterized by global constraints;

- A mathematical model should include a description of the goal, which can be expressed in the requirement of maximizing or minimizing some functionality that has some meaning (profit, gross output, cost, labor costs, etc.).

Any economic-mathematical model approximately describes the real system. Therefore, this task can be solved by management, which consists in achieving the goal of the entire economic system by organizing the exchange of information between individual objects and setting a specific goal in front of them. The authors of the present study offer the possibility of modeling industries in the region. When modeling industries across the region, the following key indicators are used: t – time (year); x_j – commodity output in the j industry; k_j – average annual value of fixed assets; L_j – average number of staff; M_j – cost of raw materials; E_j – electricity costs; I_j – capital investments; x_{ij} – production of the supplier's industry i for the industry j; D_j – depreciation; Z_j – salary fund; N – working population of the region; ρ_j – indicator of capital investments for rearmament; P_j and $\tilde{P}_j$ – balance sheet and calculated profit; l_j – payment for labor resources; $\gamma_j^{ý}$ and $\gamma_j^{ì}$ – standards determining the estimated profits sent outside the region; $Ð_j^{Ý}$ и $Ð_j^{M}$ – revenues from estimated profits to external and local budgets; $Ð_j^{Ï}$ – residual income; δ_j^1, δ_j^2 – deductions from the residual income in the material incentive funds and social development, respectively; FMP_j, FSR_j, FRP_j – deductions in material incentives, social

development and production development, respectively; d^k – depreciation charges for renovation; $\tilde{d}_j$ – depreciation deductions remaining at the disposal of enterprises of the *j* industry in the region; I^C – centralized capital investments; φ^I – deductions to the production development fund used as capital investment; R_j – external temporary influences, such as the natural environment. In accordance with the econometric principles of the main model of the *j* industry on a regional scale, the production function associates the output with its determining factors:

$$x_j(t) = f_j^1(t, x_j(t-1), k_j(t), L_j(t), M_j(t), E_j(t), \rho_j(t), FMP_j(t-1), R_j(t); \alpha^{x_j}) + \varepsilon_{x_j}. \quad (1)$$

Here, the indicators are: f_j^1 – actual function of its arguments, α^{x_j} – parameters vector, ε_{x_j} – random approximation error. The general specification (1) for an industry production function includes a deliberately redundant set of explanatory variables, since the time series of observations of economic indicators (usually not more than 15 years), on the basis of which the parameters α^{x_j} are identified, forces a natural limit on their number. Thus, for industries with high electrical intensity (for example, non-ferrous metallurgy and chemical industry), the significance of the variable E_j that should be included in (1) is high, while ignoring some other factors. Variable L_j is fundamental in describing the dynamics of output and is traditionally included in industry-specific production functions. However, sometimes it is not possible to

include L_j variable due to the negative corresponding coefficient. In this case, it makes sense to use combined variables, for example, $K_j L_j$, $M_j L_j$, etc. Such techniques make it possible to achieve the correct inclusion of L_j factor in the arguments of the function f_j^1 (8).

Semantic load carried by R_j variable in models of different industries is different. Thus, the model of the electric power industry of the regions with large power generation at hydroelectric power plants in its total volume should include the inflow of the corresponding reservoirs as R_j in function (1.26) The variables FMP_j, FSR_j reflect the positive feedback of labor incentives and the results of the industry's production activities. t or $X_j(t-1)$ in the function (1) is due to the need to take into account the inertia in the dynamics of the indicator X_j. The construction of sectoral production functions for the national economic complex of the administrative region, acceptable in its qualitative characteristics for a sufficiently accurate description of the processes under study, is difficult due to instability in the dynamics of the simulated factors. Classical types of such functions are sometimes not flexible enough to reflect the patterns of behavior of indicators X_j. Therefore, other types of dependencies are used in modeling. The average annual value of basic production assets in each year t is determined by the formula for years $t,\ t-1,\ldots,\ t-\tau$

$$K_j(t) = f_j^2\left(K_j(t-1), I_j(t), I_j(t-1),\ldots, I_j(t-\tau_j); \alpha^{K_j}\right) + \varepsilon_{K_j}. \quad (2)$$

The magnitude of lag τ_j depends on the timing of the construction of industrial facilities in the industry. In practice, due to the limited time series, as a rule, $\tau_j \le 4$ is accepted.

Usually, function f_j^2 (2) is linear.

$$K_j(t) = \alpha_0^{K_j} + \alpha_1^{K_j} K_j(t-1) + \sum_{i=0}^{\tau_j} \alpha_{2+i}^{K_j} I_j(t-i) + \varepsilon_{K_j}.$$

On the parameters $\alpha_s^{K_j}, s = \overline{0,2+\tau_j}$, it is customary to impose additional restrictions, for example,

$$\alpha_s^{K_j} \ge 0, s = \overline{0,2+\tau_j}; \alpha_2^{K_j} \le \alpha_3^{K_j} \le \alpha_{2+\tau_j}^{K_j},$$

which have an obvious meaningful interpretation, but can lead to a deterioration in the quality of the equation. Therefore, the following restrictions are more justified,

$$\alpha_1^{K_j} \ge 0; \sum_{i=0}^{\tau_j} \alpha_{2+i}^{K_j} \ge 0,$$

since they express the requirement to preserve a certain part of the basic production assets during the transition from year $t-1$ to year t of

non-negativity of the total effect $\sum_{i=0}^{\tau_j} \alpha_{2+i}^{K_j} I_j(t-i)$ of capital investments over $(\tau_j + 1)$ years.

When building dependencies for the number of employees, one should take into account temporary trends, the level of labor incentives and last-year productivity, as well as the number of working-age population in the region:

$$L_j(t) = f_j^3\left(t, L_j(t-1), Z_j(t-1), FMP_j(t-1), FSR_j(t-1), \frac{X_j(t-1)}{L_j(t-1)}, N(t); \alpha^{L_j}\right) + \varepsilon_{L_j}. \quad (3)$$

At the same time, for industries with few enterprises with small or medium-sized industrial production personnel the influence of the variable N on L_j is insignificant.

The dynamics of the indicator $M_j(t)$ is determined by the values of the lagged variables $M_j(t-1)$ and $X_j(t-1)$, reflecting its certain inertia, and the variables $X_{ji}, i = \overline{1,a}$ that allow to take into account the indirect influence of inter-industry relations

$$M_j(t) = f_j^4\left(M_j(t-1), X_j(t-1), X_{j1}(t), \ldots, X_{ja}(t); \alpha^{M_j}\right) + \varepsilon_{M_j}. \quad (4)$$

In some cases, variables $X_{ji}, i = \overline{1,a}$ can be included directly in the production function.

The equation for describing the dynamics of the indicator E_j is similar (5):

$$E_j(t) = f_j^5\left(E_j(t-1), X_j(t-1), X^{Ý}(t); \alpha^{Å_j}\right) + \varepsilon_{Å_j}. \quad (5)$$

The value of the variable $\tilde{O}^{Ý}$ at each time point (year) is calculated in the region's power industry model.

The amount of the wage fund Z_j each year depends on its volume last year, the corresponding standard of deductions $\hat{Z}_j(t)$, the incentive fund, the number of industrial personnel and many other factors, but the lack of information presupposes the following at the time being:

$$Z_j(t) = f_j^6\left(Z_j(t-1), \hat{Z}_j(t), FMP_j(t-1), L_j(t); \alpha^{Z_j}\right) + \varepsilon_{Z_j}. \quad (6)$$

The equation for depreciation $D_j(t)$ is introduced as follows:

$$D_j(t) = f_j^7\left(D_j(t-1), K_j(t); \alpha^{D_j}\right) + \varepsilon_{D_j}. \quad (7)$$

The description of the dynamics of balance sheet profit P_j, which is defined as the difference between the volume of marketable products and the cost, is a significant problem in modeling the development of the industry. The simplest way to solve it is to use a regression equation

$$P_j(t) = f_j^8\left(P_j(t-1), X_j(t); \alpha^{P_j}\right) + \varepsilon_{P_j}, \quad (8)$$

which, although it does not fully reflect the formation patterns of the indicator P_j and the factors affecting it (profit from sales, total cost, non-operating income and losses, price changes, etc.), however, is acceptable for small periods of forecasts subject to the absence of sharp price fluctuations. It should be noted that the replacement of equation (8) with a more detailed specification does not necessarily lead to a refinement of the calculated P_j values due to the possible accumulation of approximation errors for the corresponding regression equations. Another alternative to the equation above is the expert task of the coefficient $p_j(t)$ of the 'transfer' of output in monetary terms to the balance sheet profit of the industry:

$$P_j(t) = p_j(t) X_j(t).$$

Estimated profit P_j is generated from the balance sheet by deducting from the last labor payment and some other exemptions.

$$\tilde{P}_j(t) = P_j(t) - l_j(t) L_j(t) - \Delta P_j(t). \quad (9)$$

At the same time, the exogenous variable $\Delta P_j(t)$ includes payment for land, natural and other resources, fines, etc. The amounts of deductions from the estimated profit to higher and local budgets, as well as the residual income, are determined by natural ratios

$$P_j^{Э}(t) = \gamma_j^{Э}(t) \tilde{P}_j(t); \quad (10)$$

$$P_j^M(t) = \gamma_j^M(t)\tilde{P}_j(t); \quad (11)$$

$$P_j^{\Pi}(t) = \tilde{P}_j(t) - P_j^{\Im}(t) - P_j^M(t). \quad (12)$$

Similarly, deductions to material incentives and social development funds are described

$$FMP_j(t) = \delta_j^1(t)P_j^{\Pi}(t); \quad (13)$$

$$FSR_j(t) = \delta_j^2(t)P_j^{\Pi}(t). \quad (14)$$

The amount of depreciation deductions remaining at the disposal of enterprises in the industry $\tilde{D}_j$ is determined on the basis of the normative coefficient $\tilde{d}_j(t)$:

$$\tilde{D}_j(t) = \tilde{d}_j(t)D_j(t). \quad (15)$$

The proceeds to the production development fund consist of a part of the residual income and the share d_j^h of depreciation charges aimed at renovation:

$$FRP_j(t) = P_j^{\Pi}(t) - FMP_j(t) - FSR_j(t) + d_j^k\tilde{D}_j(t). \quad (16)$$

The ratio describing the formation of capital investments completes the sectoral model

$$I(t) = I_j^C(t) + \varphi^I(t) FRP_j(t) . \quad (17)$$

Thus, the mathematical model of the industry (1) - (17), considered on a regional scale, is a system of difference and algebraic equations, which allows a consistent calculation of the values of each endogenous variable for any year of the forecast period. The system includes calculation and regression equations, the parameters of which are identified based on a wide range of applied statistical analysis methods (Dombrovskaya, 2014). Developing and implementing a model of the socio-ecological and economic development of the regions will allow (at a rapid pace of economic development) significantly reducing the funding by eliminating costly projects, introducing highly efficient innovative technologies and saving resources. Thus, a balanced approach to the development of territories and a change in the vector of the economy towards export-oriented non-oil and high-tech energy-resource-saving production will significantly increase the level of investment attractiveness of Russian regions. There is a need for a new model and new methods of economic development that would contribute to the post-crisis economic growth, taking into account environmental concerns, the rational use of natural resources and the necessary conditions for sustainable development. To predict the sustainable development of the region, a system of regression equations is to be used where each equation reflects the three areas: economic, social and environmental. One type of econometric systems are systems of interdependent equations – same dependent variables enter either the left-hand part or the right-hand part of the system::

$$(b_{n1}y_1 + b_{n2}y_2 + \cdots + b_{nn-1}y_{n-1}) \quad (18)$$

In the process of estimating the parameters of simultaneous equations, endogenous and exogenous variables were used. The proposed model for predicting sustainable development includes the following functions:

$$\begin{cases} GDP = f(Inv) - \text{экономическая модель} \\ Pop = \varphi(UP, ANS, MG, PG, NUS, HB, CPO) - \text{социальная модель} \\ Emis = \psi(GDP, Pop, Manuf, Avto) - \text{экологическая модель} \end{cases} \quad (19)$$

Where: *GDP* – gross domestic product;

Inv – fixed investments;

Pop – total population;

UP – the unemployed;

ANS – the average monthly nominal wage;

MG – migration increase;

PG – natural population growth;

NUS – students in higher education institutions;

HB – hospital beds;

CPO –permanent pre-school organizations;

Manuf – enterprises with emissions of harmful substances into the atmosphere;

Avto – vehicles.

To predict economic sustainability, let us construct a dynamic model with a distributed lag by the Almon method.

To build a model, statistical data on the volume of GRP and the volume of investments in fixed capital can be used.

General view of the model with a distributed lag for l=3:

$$GDP_t = \alpha + \beta_0 Inv_t + \beta_1 Inv_{t-1} + \beta_2 Inv_{t-2} + \beta_3 Inv_{t-3} + \varepsilon_t . \quad (20)$$

The lag structure is described by a 2nd degree polynomial:

$$\beta_j = a_0 + a_1 j + a_2 j^2 \quad (21)$$

To calculate the parameters of this model, it is necessary to convert the original data into the new variables z_0, z_1, z_2 using the following formulas

$$z_0 = Inv_t + Inv_{t-1} + Inv_{t-2} + Inv_{t-3}; \quad (22)$$

$$z_1 = Inv_{t-1} + 2Inv_{t-2} + 3Inv_{t-3}; \quad (23)$$

$$z_2 = Inv_{t-1} + 4Inv_{t-2} + 9Inv_{t-3}. \quad (24)$$

Thus, using economic and mathematical models for predicting target indicators of regional development in the context of a sustainable

development paradigm will help improve the quality of regional development planning, design regional development programs and implement them. To expand the financial and economic opportunities for the development of social infrastructure in the regions of Russia, the authors of the present research recommend :

-Developing criteria for the effective use of allocated funds, depending on the level of social well-being;

- Expanding the social partnership between state, public, labor collectives, and entrepreneurs through the mechanism of public-private partnership (Izard, 1966).

4. CONCLUSIONS

The analysis of the organizational and institutional mechanisms of the development of Russia reveals the necessity to improve the existing strategic planning and program documents in order to provide a clear, definite functional relationship between their goals and methods. Realization of spatial development requires increasing the sustainability of current legislation, and the quality of the developed program documents requires decentralizing functions in the field of innovative development of Russian regions with maximum consideration for their features and for transferring the necessary powers and financial and economic resources to local authorities. It is necessary to create a modern management circuit

for socio-economic systems of the regions, consisting of three levels of the state institutions and management mechanism:

- The highest institutional level ensuring the creation of framework conditions and determining the legal framework for the regulation of economic activity ;

- Administrative level, which provides for the executive functions aimed at implementing the spatial policy of the country in the relevant regions, industries, sectors of the economy and other areas ;

- The third level, which provides direct interaction with interested individuals and legal entities.

The study of many different methodological approaches used to analyze the potential and trends of the socio-economic development of the territory, as well as methods for assessing the economic profile of the territory, led to the conclusion that none of them is universal, since they include a large set of indicators. In addition, many techniques are not complex and cannot fully reflect the true situation in the regions. The main disadvantage of most of the methods used for assessing the economic profile of a territory is the complexity of their application due to the lack of an adequate statistical base or a reasonable set of characteristics of the regional economic system. The most acceptable methodological approach for analyzing the spatial development of the economy is a system of criteria and indicators based on the index method (using relative indicators reflecting the ratio of the analyzed indicator over a period of time) or on the spatial comparison – the ratio of the analyzed indicator across different

regions. Using the proposed methodological approaches, one can choose an individual approach to assessing the potential for new spatial development policy. The most acceptable tool for measuring the spatial inequality of the socio-economic development of regions is the coefficients of spatial differentiation for a number of indicators: Grp, GRP per capita ,

- The number of people employed in the economy ,
- The volume of industrial production ,
- Population ,
- Retail volume ,
- Availability of fixed assets at book value (minus depreciation) ,
- The volume of cargo transportation by all types of transport .

Based on the analysis of the main trends and the degree of differentiation of the economic development of individual regions of the country, the conclusions were made:

-About the uneven regional economic development in Russia;

-The degree of differentiation of the economic development of regions may be different depending on which aspects of economic development are evaluated and by which indicators;

- The absence of positive changes in the structure of the regional economy;

-The emergence of new problem territories and settlements;

-Increase in structural distortions in the direction of sale;

-New gradation of regions.

The program-targeted approach to managing the region's sustainable development is the selection of priority objectives for the economic, social, and environmental development of a certain region, and the development and management of government programs for their optimal achievement. In the process of government management of sustainable development of the region, government programs have proven to be an effective tool for a program-targeted approach. At the same time, the development programs of territories, which are a set of interconnected resources, performers, implementation dates and performance indicators of measures aimed at solving systemic problems in the sustainable regions of the country, are the main levers of this approach. To ensure the effectiveness of the program-target approach to managing the region's sustainable development, state regional development programs need to be managed. The management of the regional sustainable development program includes several stages :

- Designing a territorial development program and coordinating the efforts of various actors in the development process ;

- Program implementation, monitoring and evaluation of intermediate results for feedback and adjustment ;

- Evaluation of the results.

Several regions can be attributed to established or emerging growth zones (centers) :

- The largest agglomerations of cities with the most stable growth based on the agglomeration effect, ensuring population and investment inflows ;

- Large multifunctional cities - centers of regions; their growth is provided by the concentration of industrial production but is weakly supported by the migration flow and does not receive significant investments yet ;

- Leading commodity, oil, gas and metallurgy regions, the growth of which depends on the conjuncture of prices for raw materials, but significant budget resources allow maintaining human capital and infrastructure, and attract migration flows. The development of these regions largely depends on the strategies of large companies.

Only by manifesting themselves in areas with natural advantages, the impulses of industrial growth and innovation can spread to the surrounding areas. This process, which in the world practice is called ‘diffusion of development’, should be directed through regional policy incentives. The analysis of program documents reveals that the institutional component of the spatial development of the national economy is not currently a factor positively influencing the solution of related tasks. The basic documents regulating the processes of the territorial and spatial development of the country are not sufficiently interconnected with each other both in structure and in content. To eliminate these deficiencies, it is advisable to use the methodological and organizational support, based on which program and planning documents are developed. Based on its results, changes and additions to the relevant

regulatory legal acts are to be made. The economic-mathematical model for forecasting target indicators of the regional development program will allow expanding the program-target approach to managing the region in terms of designing regional development programs and predicting the values of target indicators.

The results can be used in the state management of sustainable regional development, in the modernization of the public policy and administrative reforms, which allows increasing their effectiveness. The developed methods will allow increasing the efficiency of state management of the region's sustainable development. The methods of mathematical modeling are widely and successfully applied to both technical and economic systems, yet economic systems are heterogeneous and non-linear. Any society is characterized by nonlinear inverse and direct links. Social objects are constantly becoming more complex due to new knowledge, which, having become part of the object itself, changes its characteristics and properties. Thus, the mathematical model of managing the socio-economic situation in the region is relevant from the point of view of practical application. The study was carried out with the financial support of the Russian Foundation for Basic Research in the framework of the research project No. 18-010-00359 Theoretical and practical problems of the industrial policy of developing public-private partnerships and municipal-private partnerships in the innovation environment.

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