

**COOPERATION AND INTEGRATION PROCESSES AND MODELS IN CONTEXT OF
DEVELOPMENT OF BRANCHES OF ECONOMY AND TERRITORIES**

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Abstract. The conditions of enterprise functioning in the agrarian sector have been analyzed. It has been proved that cooperation and integration are a basis for the development of the agro-industrial complex. The necessity of developing the models of forming and managing integration processes of enterprises of the agrarian sphere has been substantiated. The use of a multiagent approach to the study of agricultural servicing cooperatives has been proposed. The developed models of social and economic systems can serve as a tool for their optimization. Such indicators as stability of the system, competitive reliability have been used. Approaches to determining the optimal potential of the system, strategies for its management have been substantiated. Based on these approaches, a model of the optimal policy for updating equipment has been determined.

Keywords: cooperation, integration, agro-industrial complex, multi-agent structure, social and economic systems

JEL Classification: F15, P13, Q13

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1. Introduction

Appraising the situation at the stage of prospects of Ukraine for joining the association with the European Union, it has to be admitted that Ukraine's economy does not fully correspond to the EU's existing economic and technological structure, regional, branch division and the level of personnel corps. After all, the use of the potential can stimulate not only complex technological export production, but also development of industries, in particular, formation of the agro-industrial complex. Obviously, this sector, as a leader of the economy, can become one of the system-makers, stimulate development of economic and social processes in the respective territories (Chygryn et al., 2018; Czyzewski & Majchrzak, 2017; Czyzewski et al., 2018; Ivanov et al., 2016a; 2016b; 2016c; Ivanov et al., 2017; Kharazishvili et al., 2016; Lyeonov et al., 2018; Pająk et al., 2016; Yakubovskiy et al., 2017).

Identification of priority sectors affords an opportunity to implement development of other supporting industries, which in turn constitutes the basis for development of territories and reaching nationwide goals.

The main argument for such a model is self-organization of the economic system, since in complex systems, such a phenomenon may be in open non-linear systems which also include social and economic systems (SES). However, in this case, it is necessary to regulate emergence of stable elements constituting the structure of complex control systems. In the SES, the phenomenon of self-organization is also associated with processes of the world globalization with simultaneous integration ensuring an increase in exchange of technological innovations. At the expense of this, there is formulation of a basis for rapid dissemination of uniform international standards of manufacturing methods, necessary institutional factors in the political, economic and social spheres allowing to reduce differences in development of states and their territories.

In view of the stated above, it is important to study cooperation and integration as a basis for the development of the agro-industrial complex, consider servicing agricultural cooperatives as a multi-agent structure and model social and economic systems as an instrument for their optimization.

2. Literature review

It is evident that the policy of economic development should be built on the processes of self-organization of the domestic market which is possible as long as there are active processes of cooperation and integration of economic objects. At the same time, the state should not only be an observer, but actively participate in monitoring, regulation and management of these processes. It has been established that unstable business environment having a high level of dynamism affects conditions and generates risks for managing economic objects associated with the need for timely response to these changes when managing them. Therefore, the key is an ability to predict and implement necessary

changes that will ensure effective activities in the strategic perspective of both an economic object and the national economy as a whole.

Such tools can include analysis of business environment of any economic object, monitoring conditions and parameters of such changes while developing social and economic systems of territories. In this case, it is necessary to regulate the process of occurrence of stable elements in the structure of complex management systems, which will be related to the needs of consumers and changes in their behavior. This, in turn, gives grounds to consider issues related to management of cooperation and integration processes of developing economic entities, branches of the economy and territories (Dinar & Wolf, 1997; Dźwigoł & Dźwigoł-Barosz, 2018; Kvilinskyi et al., 2017; Kwilinski, 2018; Lakhno et al., 2018; Lyulyov & Pajak et al., 2016; Shvindina, 2017; Sheldon, 2017; Vasylieva et al., 2018; Vernay et al., 2018; Wink et al., 2017).

To achieve this, the modern paradigm of the domestic economy functioning was based on designing regional programs aimed at regulating development of economic sectors, concentration of material, technical, financial and other resources, scientific, technical and industrial potential of the country. Herewith, the coordinating of the activities of local self-government bodies, central and local executive authorities, as well as enterprises, institutions, organizations and citizens is envisaged to solve the most important problems (Grishova et al., 2013).

Although there are programs of legislative and regulatory state support of economic development, the process of self-organization of the domestic market of territories and the nation in general remains imperfect and is characterized by a number of shortcomings. In particular, they are related to distribution of funds allocated for financial support and insufficient funding of direct support measures for the agrarian sector (as a possible system-creating sector of the national economy). The main disadvantage lies in the fact that the provided support is disproportionate and situational, thus excuses are found for ambiguity of formulating objectives and results of the programs as well as lack of responsibility for their implementation. This is also due to unresolved issues of the regulatory and legal framework and termination of a number of state target programs, as a result of which certain areas of the state support for agriculture have ceased their existence (Grishova et al., 2013).

In such conditions, when the problem of providing financial resources is unsolved, the search for new forms of support for agro-industrial development becomes especially urgent. They should be aimed at forming financial stability of agricultural production. This, in turn, will create prerequisites for expanding production volume of competitive agricultural products and food security in the country. Emphasizing the role of the agro-industry for development of rural areas is necessary when there is a model of the economic development based on the priorities of development of certain industries and territories through development of the agro-industrial complex as the main industry. After all, this complex of industries provides development of other branches of the economy commissioned to manufacture products for

the agro-industrial complex (machinery, fertilizers, etc.). The said provides their development and, respectively, achievement of the main nationwide goals.

The situation is challenging because till the present time, there has not been set up an appropriate system of organizational and economic measures and models which would be able to ensure effective functioning of the agricultural industry. Discussions about methodology of cooperation and integration strategies have been in progress, which prevents to harmonize organizational and economic components of the agrarian reform. It results in incompleteness of the scientific and theoretical substantiation of completion of the agrarian reform in the country. The issues of establishing institutions at the industry level that would be capable of solving problems of social and economic development of rural territories have not been resolved.

The study is based on the hypothesis of possibility to overcome the crisis phenomena in the social and economic development of territories due to processes of cooperation and integration in the agrarian sector of the economy. This is possible provided that models of development of not only the economy but also corresponding territories are constantly being improved. The achievement of this goal has determined the need for solving problems on the basis of disclosure of methodological approaches to activities of rural servicing cooperatives. It is important to harmonize the complex of organizational and economic measures for development of agro-industrial production on the basis of integration processes and cooperation. The above mentioned motivates to elaborate methodological principles for assessing agro-economic potential and individual components as one of the grounds for development of rural areas (Czyzewski & Majchrzak, 2017; Czyzewski et al., 2018).

In support of this, it is necessary to provide the following statistics: domestic peasant households produce 97-99% of potatoes, 80% of vegetables, fruits and berries, about 80% of milk and up to 50% of meat. It should be borne in mind that these products are practically made by hand by means of a shovel and have no civilized channels of sales. It should be noted that fairly tight trends in the marketing of food products are developing worldwide. Obviously, Ukraine will not be able to avoid them. This means that small agricultural producers who are out of associations, do not have their own capacities of processing agricultural raw materials, storage and pre-sale preparation of agricultural commodities will not be able to ensure independently their competitiveness and sales at attractive prices. Therefore, there is no other way for domestic small-scale farmers than their association (Ivanov et al., 2017).

It should also be borne in mind that agricultural holdings constitute a serious problem for development of unintegrated and unassociated agricultural commodity producers. In fact, they have already monopolized food markets dictating conditions on the markets for agricultural raw materials. This is due to the fact that they have no counterweight - there is no cooperation, no association of producers. At the same time, agricultural holdings are not

motivated to develop social and economic processes in the territories where they operate, therefore they do not invest money in this.

It applies not only to agricultural servicing cooperatives, but also to consumer and credit cooperatives. It has resulted in one of the highest poverty rates on the continent, especially in rural areas, accompanied by unemployment, extinction of the Ukrainian rural territories and decline of territorial communities (Ivanov et al., 2017).

Cooperation in the rural territories has always contributed to the development of the infrastructure of the agrarian market and social sphere, and it is a complex social and economic problem for management. Problems of creating effective conditions, models and methods for the development of agricultural servicing cooperatives as an integral part of the agro-industrial complex of the state are caused by the following: lack of trained personnel, information and educational resources to form organization of the cooperatives themselves, lack of a legal form of regular financial support for cooperation development, indefiniteness of nonprofit character of agricultural servicing cooperatives, misunderstanding and disinclination of agricultural entities and rural communities to cooperate, underestimating the essence and benefits of the cooperative model of agrarian entrepreneurship (Vernay et al., 2018; Wink, 2017).

3. Methodology

To develop the models for formation and management of integration processes, which can be attributed to innovative ones, goals of the subject (a cooperative) must be divided into several directions, which are both external and internal.

The external type of tasks of the analyzed management object (a cooperative) should include the following: those connected with information security and decrease in uncertainty level, formation of working capital and renewal of fixed assets, support of the national regional producer, adoption of amendments to the Tax Code, identification of the world trends and, on this basis, improvement of management of the agrarian sector of Ukraine's economy, in particular, improvement of the state support for development of rural territories and the agrarian sector in general, etc.

In other words, creation of a system for effective study, analysis and use of information resources is one of the conditions for successful operation of an economic entity (a cooperative) under conditions of uncertainty in the competitive environment; it is a prerequisite for adoption and assessment of decisions on determination of a strategy for the development of servicing cooperation (Ivanov et al., 2017). This provides with an opportunity to establish a general methodological framework for the program of development of the Ukrainian rural territories on the principles of combining organizational and economic factors of development of the agro-industrial sphere. The reason for such optimism is the IMF's assessment of the fact that one dollar invested in the agriculture in Ukraine yields a return of ten times higher than in Europe.

The internal problem of the cooperation development is recognizing the need for taking into account the potential and peculiarities of forming cooperation and integration processes, forming an effective integrated structure of horizontal or vertical orientation, its influence on the activities and the development of the enterprises belonging to rural servicing cooperatives. In the context of globalization influences, such processes have a positive impact not only on the state, but also on any territory and object. Vertical integration is defined as extending activities and/or controlling an economic object (a cooperative) along the technological-distribution-sales chain: a) at the preliminary stage – till there is primary production; b) at the next stage - before commodities are sold to the end user. Its purpose is to replace market transactions with other forms of contacts (internal operations and processes, long-term contracts, etc.).

A vertically integrated structure model in the simplest form is a two-tier hierarchical structure consisting of Ω functionally dependent subsystems and P_m business processes where the results of the previous parts of the hierarchy are an input. In this case, all subsystems have the right to make decisions on organization of relevant business processes within the limits defined by the management system. Under this condition, the hierarchical location of the subsystems (a multi-strand structure) is determined by the fact that some of the processes are under the influence or managed (partially/completely) by the management system.

The following advantages of the vertical integration have been identified (Ivanov et al., 2017): decreasing the final product price due to elimination of a traditional distribution network, increasing competitiveness of enterprises, reducing transaction costs, synergy effect of joint activities, reducing prime cost of the final product, forming vertically integrated structures. This presents an important stimulus when forming agricultural servicing cooperatives, improving relations between agricultural commodity producers, enhancing peasants' well-being.

The main features of management of agricultural cooperatives are defined by the Laws of Ukraine "On Cooperation" and "On Agricultural Cooperation". Their main content is as follows: a cooperative is managed on the basis of self-government, publicity, participation of its members in solving issues of the cooperative. Governing bodies of a servicing cooperative are a general meeting and a board.

When modeling, it is necessary to take into account a possibility of participation of each association member in management. In this case, a structure of an agricultural servicing cooperative as a multi-agent system can be shown as follows (*Fig. 1*).

In this case (*Fig. 1*), an integrated structure is represented by a graph consisting of $n+1$ vertices. Each of them defines a type of an agent involved in the cooperation. The vertices B01 and B02 are, respectively, managing bodies (functions of which are executed by a general meeting and a board of a cooperative). It should be noted that the members of an

agricultural servicing cooperative have the right to vote and participate in economic activities of the cooperative. Therefore, between each agent B_i and other agents constituting a cooperative, there is interaction created when the members of a cooperative are rendered services provided by its charter.

Since a general meeting of the cooperative members is the supreme governing body of the cooperative, the following can be written (1):

$$\forall B_i : B_i \cup B_{01} \neq \emptyset. \quad (1)$$

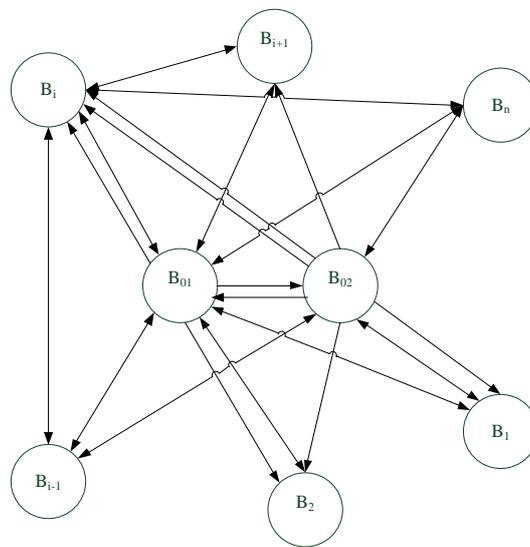


Figure 1. A servicing cooperative as a multi-agent system

Source: formed by the authors.

In this case, each agent B_i has the freedom to make managerial decisions within a defined joint strategy and has a controlling influence on the strategy formation.

It should be taken into consideration that a board headed by a chairman is the executive body of a cooperative, and there are restrictions on the number of board members depending on the number of the cooperative members. Then, you can specify the following (2):

$$\exists B_i : B_i \cup B_{02} \neq \emptyset. \quad (2)$$

Let us consider features of membership in a servicing cooperative. According to the legislation in force, cooperatives are non-profit organizations created to meet economic, social and other needs of cooperative members. We introduce the function $f(x)$ as a function of satisfying an agent's needs. According to studies, an agent's need will be considered a

desire to move from one current state to another or a desire to maintain the current state expressed in an agent's application to meet his needs. So, (3):

$$B^* = B \cup A_i \{f(A_i) < f(B^*) \mid \forall A_i \in A, i = 1, \dots, n\} \quad (3)$$

where $f(A_i)$ is a function of satisfaction of an agent's needs at the expense of his own resources;

$f(B^*)$ is a function of satisfaction of an agent's needs due to membership in a cooperative;

A is an external agent.

4. Results

Since an integrated system is a social and economic system (SES) and simultaneously is a subject and object of economic relations, it is necessary to understand the nature of reproductive and transformational processes that lead to the formation of a new structure of relations in the market-led economy. In such case, destabilizing and favorable factors for functioning of entity mechanisms should be taken into account. A list of the factors is rather general and does not reflect fullness of the economic environment. Therefore, a more detailed decomposition of various factors of such an environment of the SES as a subject of management (Butyrkin, 2003) is required.

To justify methodological foundations in the management mechanisms, it is necessary to consider the nature of interaction of a business entity with the external environment, components of which also have their own specifics. When modeling organizational structures, it is expedient to use a system quality indicator. It should be understood as totality of objectively existing characteristics (indicators) relating to the ability of the system to perform its function. In this case, quality indicators can include stability of the system, i.e. its ability to perform its functions within the specified parameters under the influence of external and internal stimuli (first of all, structural changes). The result of its functioning is directly related to the achievement of the system goals.

This indicator is directly related to the functioning or movement of the system to change the final state of the business-system in a given strategic period (development) (4):

$$R_{BS} = Z_{BS}(t_v) - Z_{BS}(t_0) = \Delta Z_{BS} . \quad (4)$$

The result of functioning of the business system is an absolute indicator demonstrating how much the state of the system at the moment differs from the state of the system in the past. A volume of commodities manufactured for a certain period, gross expenditures, net profit, etc. may be the indicators of the result of system activities.

Naturally, to analyze alternatives of influence on the system activities, it is necessary to develop an effective method for the analysis of production and economic activities. Efficiency should be the main static characteristic of such a method. This allows us to assess the quality of the functioning of the system/entity and, on its basis, to make managerial decisions.

The system analysis methods (hierarchy model) have been used for modeling the relations between the SES and external subjects (tax administration, government authorities, financial and banking system). Herewith, their dependence on economic, political, social, legal conditions has been taken into account. The external subjects' objectives were the criteria used in modeling. Therefore, models for adaptation of national economic development in the context of a model of the global development are needed. Given the peculiarities of Ukraine's economic development, an analysis of impact of the environment on the results of activities of the SES can be provided by assessing the potential of the SES.

Herewith, it should be borne in mind that mathematical models may prove to be complicated and their solving may prove to be excessively lengthy. Therefore, in order to obtain a result, it is necessary to use so-called heuristic methods based on intuitive and empirical rules that allow a researcher to improve already-existing solving.

Competitive reliability of any system depends on its ability to form, use and evaluate the available potential of all its elements in conditions where external and internal disturbances arise (which must be attributed to the nature of devastating effects).

It is possible to establish competitive reliability of the SES by means of determining the difference of potential states before and after the effect of disturbing influences on the system or by determining the difference in assessment of the potential use efficiency (5):

$$\Delta z = \sum_{j=1}^k \sum_{i=1}^m f_{0r0}^{k0}(x_i) - \sum_{j=1}^k \sum_{i=1}^m f_{0in}^{kn}(x_i) \quad (5)$$

where k is a set of potential states of the components of the SES;

m is potential components of the SES;

$f_{0r0}^{k0}(x_i)$, $f_{0in}^{kn}(x_i)$ are, respectively, the optimal potential of a separate component of the SES at the beginning and at the end of the forecast period;

$x \in X$ (X is a set of admissible potential components of the SES).

The need to determine the optimal potential is relevant to ensuring the model's efficiency in assessing the potential of each component of the SES. This is the potential of components of the SES, i.e. x , that (6):

$$f_0^k(x^*) \geq f_0^k(x) \text{ for all } x \in X. \quad (6)$$

Consequently, since the assessment of the potential use efficiency is an estimate that matches each potential x with a real number, i.e. it is a function of the variable x . In this case, a criterion of efficiency is a basis for determining the assessment. If values of y^0 factors that are not controlled are known, we have the criterion of efficiency $z = f(x, y^0) = f(x)$, which is a function of only x and can obviously serve as an efficiency assessment.

The model provides efficiency assessment in several ways, depending on the availability and the type of the distribution law of a quantity of random or uncertain impact factors. It is known that if an indefinite (or random) factor is a quantity with a known distribution law, mathematical expectation of a criterion of efficiency is used as an efficiency assessment (7):

$$z = f_0(x) = \sum_{i=1}^k \mu_i \cdot f(x, y_i) \quad (7)$$

where y_i is a random factor that takes k values with μ_i probability.

Having determined the assessment of the SES potential, we have an opportunity to establish its stability. Its stability is to be determined through reliability. Functioning of all system elements depends on its reliability. In relation to the potential of the SES components, this means a loss/decrease in not only certain times in specific time periods, but also a loss/decrease in its overall potential. In the context of competitive reliability of the SES, in case of their quantitative and qualitative accumulation, such violations lead to a failure of using the potentials of its components. It also means a decrease in the overall potentials.

Let us use the definition of reliability suggested:

$$\eta = 1 - \sum_{i=1}^m p_i \quad (8)$$

which depends on the total weight of violations of all elements (components) of the system ($i = 1, 2, \dots, m$):

$$p_i = \sum \delta_{ij} \alpha_{ij} \quad (9)$$

where α_{ij} is a number of violations of a j type in i element of the SES potential which leads to a decrease in the potential of these elements;

δ_{ij} is a numerical value of a significant factor (assessment) of j violation in i th element of the SES.

This allows to determine reliability of the system. We measure its efficiency in this way:

$$z = f_0(x) = \sum_{i=1}^k \mu_i \cdot f(x, y_i) \quad (1 - \sum \delta_{ij} \alpha_{ij}). \quad (10)$$

When examining the SES, destructive internal influences should be taken into account. Let us note that this estimate is applied to the process (potential use) which is repeated many times. In rare cases, it does not mean anything.

If for a random y factor, only the area of its possible values (variations interval) is known, in this case, it is possible to use so-called guaranteed efficiency assessment (11):

$$z_2^* = f_2(x^*) = \max_{x \in X} \min_{y \in Y} f(x, y). \quad (11)$$

This is also evident in many of the tasks of modeling potential use risk. When a system is viewed as a “black box”, an internal structure of which is unknown, it is necessary to observe only inputs and outputs of the system (Butyrkin, 2003).

Let us use the methodological approaches suggested in (Ivanov et al., 2017) to determine the parameters and state of potential of such an integrated structure as the SES. We assume that the physical system S is in the state $S_0 \in \overline{S_0}$, where $\overline{S_0}$ is a set of initial states and is controlled by influence of the parameters of the potential.

It should be noted that under the influence of some U potential management, the system grades from the initial state S_0 (the state in which the potential of the enterprise is characterized by the existing indicators of personnel, production capacities, financial possibilities, etc.) into a state $S_k \in \overline{S_k}$ where $\overline{S_k}$ is a set of final states (these are the indicators of the potential which are necessary to solve the tasks).

In this case, quality of each defined option to manage U potential is characterized by the corresponding value of the $W(U)$ function. The task is to find such U^* from a set of possible management options where the $W(U)$ function takes the extreme (minimum or maximum) value of $W(U^*)$. In this case, S is called a dynamic system and tasks that are put in this model are called dynamic programming tasks.

The state of the dynamic system S on a k th step ($k=1, n$) can be determined by a set of numbers (12):

$$X^{(k)} = (x_1^{(k)}, x_2^{(k)}, \dots, x_n^{(k)}), \quad (12)$$

obtained as a result of implementation of u_k potential management which ensures grading the system S from the state $X^{(k-1)}$ into the state of $X^{(k)}$.

Herewith, we assume that the state $X^{(k)}$, into which the system S graded, depends on the particular state $X^{(k-1)}$ and chosen u_k management and does not depend in what way the system S graded into the state $X^{(k-1)}$. This condition is called the condition of lack of aftereffect.

Therefore, if a certain gain $W_k(x^{(k-1)}, u_k)$ which depends on the state $x^{(k-1)}$ and chosen, u_k management is provided as a result of implementation of a k th step, the total state of the potential for n steps will be determined by the formula (13):

$$F = \sum_{k=1}^n W_k(x^{(k-1)}, u_k) \quad (13)$$

This condition is called the condition of additivity of the objective function.

Whatever the state of the system before the next step is, you should choose a management option in this step so that the gain at this step plus the optimal gain at all subsequent steps is maximal.

From this principle, it follows that the overall optimal potential management strategy U^* that equals $U^* = (u_1^*, u_2^*, \dots, u_n^*)$ is determined if the optimal management strategy is at the n th step (W_n^*). Then, it is done on the last two steps (u_{n-1}^*, u_n^*), next - on the last three steps ($u_{n-2}^*, u_{n-1}^*, u_n^*$) and so on till the first step.

Let us suppose that it is necessary to determine the optimum replacement policy for some equipment for n years. At the beginning of each year, a decision is made either to keep the equipment for its further exploitation, or to replace it with the new one. We denote the operating surplus of t -year equipment during a year and expenses for its maintenance for the same period by $r(t)$ and $u(t)$. Let $s(t)$ be the residual value of the sold equipment that operated for t years. Price of new equipment remains unchanged and is equal to p .

We introduce the function $f_n(t)$, which is an amount of total income for the last n years of the planning period, provided that at the beginning of this period there is equipment of t age. Let us take into account that the optimal replacement policy is chosen.

Replacing an existing car of t age with a new one makes sense when the revenue from a new car is bigger than the old one. If $f_1(t)$ – is the profit at the last stage, the ratios (14) and (15) express criteria for choosing a solution:

$$f_1(t) = \max \begin{cases} r(t) - u(t), \text{keep} \\ S(t) - p + r(0) - u(0), \text{replace} \end{cases} \quad (14)$$

$$f_{n+1}(t) = \max \begin{cases} r(t) - u(t) + f_n(t+1), \text{keep} \\ S(t) - p + r(0) - u(0) + f_n^{(1)}, \text{replace} \end{cases} \quad (15)$$

The formulas (14) and (15) establish a connection between the expressions t_n and t_{n+1} and are recurring relations that allow to solve the problem with the dynamic programming method.

5. Conclusions

The mentioned approaches to modeling and their further analysis in the process of organization of a cooperative and integrated structures on the basis of enterprises of rural servicing cooperation provide an opportunity to substantiate the strategies of their development and increase efficiency of their functioning taking into account trends, features, directions of improving management of economic subjects of the agrarian sector of the Ukrainian economy, to suggest ways of improving and creating a database to make effective management decisions. Herewith, the main goal of forming a modern level of an economic object is also provided. Having methodological tools for effective activities in the domestic market, it will be able to provide the external market with competitive commodities. This, in turn, creates necessary opportunities for growth of the potential of the economy of territories. In this case, there is no narrowing of market relations but formation of economic objects with modern management technologies. Mechanisms and models of interconnected viable processes, cooperation and integration models for development of the economy of industries and territories are in accordance with the tasks of constructing a model of transition to the development path through finding optimal management methods for integration structures of the economy.

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