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BEHAVIORAL MODELS OF DECISION-MAKING BY BUSINESS AND INDUSTRY STAKEHOLDERS

Abstract. The purpose of the study is to substantiate the methodological toolkit for decision-making by business and industry stakeholders, which is based on the development of a dynamic multilateral model of a strategic contract, taking into account the alternatives of agent behavior. In order to achieve the purpose of the study were used following methods: system analysis, logical generalisation, statistical and comparative analysis, principles of contract theory of the firm, the concept of dynamic abilities, methods of the theory of active systems etc. According to findings it is actualized the expediency of the transformational development of transdisciplinarity between behavioral sciences and quantitative methods of management in the context of the development of the contract theory of a firm, namely, regarding the development of a methodological basis for decision-making by business and industry stakeholders. The effectiveness of the use of a dynamic multilateral model of a strategic contract is substantiated, which takes into account the behavioral models of the main stakeholders (investor-owner-employees) based on individual utility functions, which as a result connects three tasks that are consistently solved during each period. For the targeted use of the behavioral effects that arise between the parties to the contract in the process of its implementation, the proposed model of agency relations is based on the relationship between themselves and the overall results of the strategy. It is presented the options for planning the effectiveness of contracts for the interaction of agents based on the use of organizational and economic management tools, which are determined by them independently or under targeted influence in order to create additional behavioral prerequisites. The proposed dynamic multilateral model synthesizes the prerequisites, conditions for the effectiveness of decision-making by business and industry stakeholders in conditions of risk and uncertainty. It allows to consider several behavioral effects that arise between the parties to the contract, based on the individual usefulness of the contribution to the implementation of the business strategy. The practical significance of the obtained results manifests itself in the fact that

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the use of the developed decision-making models by business and industry stakeholders for the purpose of strategic resource planning based on the optimization of the use of organizational and economic resources will contribute to the concentration on the relevant behavioral aspects of agents and restrictions, taking into account the exchange between the internal and external environments.

Keywords: behavioral model, decision-making, agent, stakeholder, strategic planning, contract efficiency, business, industry.

JEL Classification A12, C52, D1

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ПОВЕДІНКОВІ МОДЕЛІ УХВАЛЕННЯ РІШЕНЬ СТЕЙКХОЛДЕРАМИ БІЗНЕСУ І ПРОМИСЛОВОСТІ

Анотація. Метою наукової статті є обґрунтування методологічного інструментарію ухвалення рішень зацікавленими сторонами бізнесу і промисловості, який заснований на розробленні динамічної багатосторонньої моделі стратегічного контракту з урахуванням альтернативних варіантів поведінки агентів. Для досягнення мети дослідження були використані такі методи: системний аналіз, логічне узагальнення, статистичний і порівняльний аналіз, принципи контрактної теорії фірми, концепція динамічних здібностей, методи теорії активних систем і т. д. У результаті дослідження актуалізовано доцільність трансформаційного розвитку трансдисциплінарності між поведінковими науками і кількісними методами управління в контексті розвитку контрактної теорії фірми, а саме щодо розроблення методичної бази ухвалення рішень стейкхолдерами бізнесу і промисловості. Обґрунтовано результативність використання динамічної багатосторонньої моделі стратегічного контракту, яка враховує поведінкові моделі основних стейкхолдерів (інвестор — власник — працівники) на основі індивідуальних функцій корисності, що в результаті пов'язує між собою три завдання, які послідовно вирішуються протягом кожного періоду. Для цільового використання поведінкових ефектів, що виникають між учасниками договору в процесі його реалізації, запропонована модель агентських відносин базується на взаємозв'язку між собою і загальними результатами стратегії. Представлені варіанти

планування ефективності контрактів взаємодії агентів бізнесу і промисловості на основі застосування організаційно-економічних інструментів управління, які визначаються ними самостійно або під цілеспрямованим впливом з метою створення додаткових поведінкових передумов. Запропонована динамічна багатостороння модель синтезує передумови й умови для ефективності ухвалення рішень зацікавленими сторонами бізнесу і промисловості в умовах ризику і невизначеності. Вона дозволяє враховувати кілька поведінкових ефектів, що виникають між сторонами контракту, виходячи з індивідуальної корисності вкладу в реалізацію бізнес-стратегії. Практична значимість отриманих результатів полягає в тому, що використання розроблених моделей ухвалення рішень стейкхолдерами бізнесу і промисловості з метою стратегічного планування ресурсів на підставі оптимізації використання організаційно-економічних ресурсів сприятиме концентрації на релевантних поведінкових аспектах агентів і обмеженнях з урахуванням обміну між внутрішньою і зовнішньою середовищами.

Ключові слова: поведінкова модель, ухвалення рішення, агент, стейкхолдер, стратегічне планування, ефективність контракту, бізнес, промисловість.

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Introduction. Within the framework of economic science, strategic planning of resources of business and industry entities is most often associated with the section and function of management, because the main contribution to its research was made by the management sciences. In this regard, it seems appropriate to consider the resource planning strategy of business entities from a different point of view: in terms of a long-term exchange of resources between its stakeholders, that is, as a large contract. This approach is attractive for its functionality since strategic resource planning is more closely related to other types of activities of business and industry entities associated with exchanges between the external and internal environments of the latter. At the same time, it should be emphasized that most of the models within the framework of the contract theory deal with agency problems, modeling the mechanism for resolving conflicts between two or more parties to the contract.

Analysis of research and problem statement. Transformational changes in the modern economy are characterized by the weighty impact of behavioral interactions on business development, combined with the dominance of economic relations of a special kind — contractual relations. The relevance of the study of this issue is revealed by the fact that the behavioral models of decision-making, that are based on the contractual approach, determine the level of efficiency of business structures. The effectiveness of contractual relations based on the usefulness of the contribution of agents becomes one of the main factors of the integral effectiveness of socio-economic systems.

The theoretical and methodological foundations of the effectiveness of contractual relations in behavioral models were originally laid by A. Marshall who considered such a factor in the effectiveness of contractual relations as the entrepreneurial ability of a businessman [1]. Separating the functions of owner and manager, A. Marshall focused on the distribution of risks and control rights within the framework of contractual relations between shareholders and managers. Further, individual elements of the problem of the effectiveness of contractual relations were investigated within the framework of the neo-institutional theory of contracts, which was developed in the 1970s.

M. Jensen and W. Meckling placed the emphasis on such factors of the effectiveness of contractual relations as information asymmetry and behavioral opportunism [2]. They considered a special form of contractual relations — agency relations. The problem of asymmetry of information and behavioral opportunism arises within the framework of agency relations, which involve the participation of a principal and an agent.

B. R. Holmström and P. Milgrom examined such an aspect of the effectiveness of contractual relationships as their duration. They determined the degree of influence of the duration of contractual relations on the level of opportunism of the subjects of these relations [3].

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S. Izmalkov investigated the issue of the effectiveness of contractual relations, assessing the ratio of «marginal costs» and «marginal gain of contracting» [4]. All the above-mentioned economists studied the concept of a contract, its forms, the economic content of the effectiveness of contractual relations, but did not determine the behavior models of business stakeholders in the framework of the implementation of strategic contracts.

Y. Song and J. Hu considered in their study the decision-making process with different stakeholders based on linguistic preferences that can be probabilistically calculated, which will have a positive result on the effectiveness of investment decisions [5].

An important condition for this model is its transformation under the new conditions of an industry stakeholders or a project, which is the basis for the effectiveness of its application. The dynamic basis of the model is the rationale for the relevance of considering a dynamic multivariate model of a strategic contract of business and industry stakeholders.

M. M. C. Fritz, R. Rauter, R. J. Baumgartner and N. Dentchev argue the particular importance and necessity of identifying the interests of stakeholders as a tool for responsible decision making [6].

X. Ni explores the relationship between stakeholder orientation and revenue management, where it results in a negative relationship between these two categories, and stakeholder orientation reduces opportunistic manipulation of income, that is, despite the scientist's negative relationship between these categories, stakeholder orientation has a positive effect [7].

M. Bouzon., K. Govindan, and C. M. T. Rodriguez considered the gray decision-making approach, M. V. C. Fagundes, E. O. Teles, S. A. B. Vieira de Melo, F. G. M. Freires develop three types of models that influence decision-making: a qualitative multicriteria model, a stochastic and optimization model [8, 9].

R. Rajesh proposes an integrative decision-making model in supply chain management [10].

Chenghao Sun is considering creating a data mining model for big market data that dynamically analyzes it and proposes investment solutions [11].

Y. He, J. S. Dyer, J. C. Butler, J. Jia developed an additive model of decision-making under risk and uncertainty (additive model), which includes the magnitude of risk and uncertainty and the trade-off between them [12].

J. Luoma suggested that the decision-making process can be improved through the use of quantitative and qualitative modeling [13].

The purpose of the article. The purpose of the study is to substantiate the methodological toolkit for decision-making by business and industry stakeholders, which is based on the development of a dynamic multilateral model of a strategic contract, taking into account the alternatives of agent behavior, the implementation of which will ensure a balanced business and industrial entrepreneurship development based on optimizing the use of organizational and economic resources.

Methodology of the study. The study used methods of system analysis and logical generalizations, statistical and comparative analysis, principles of contract theory of the firm, the concept of dynamic abilities, methods of the theory of active systems, the theory of hierarchical games, financial mathematics, the theory of optimal control of continuous and discrete systems.

Research results. The proposed dynamic multilateral model of a strategic contract allows us to optimize the utility function of business and industry stakeholders and develop models of their behavior. This model combines the principles of utility theory, optimal control theory, and simulation.

On the basis of the theory of strategic prospects and rational choice under conditions of risk and uncertainty, a model of agency relations is proposed that allows us to consider several behavioral effects that arise between the parties to a contract in the process of its implementation.

In this study, the strategy is considered as a multiple long-term contract, each participant of which pursues his own interests, which makes them prone to opportunism, and they work according to the principle of bounded rationality. If we represent this contract in terms of the agent theory of the guarantor (principal) — executor (agent), then the following scheme will be obtained (*Fig.*).

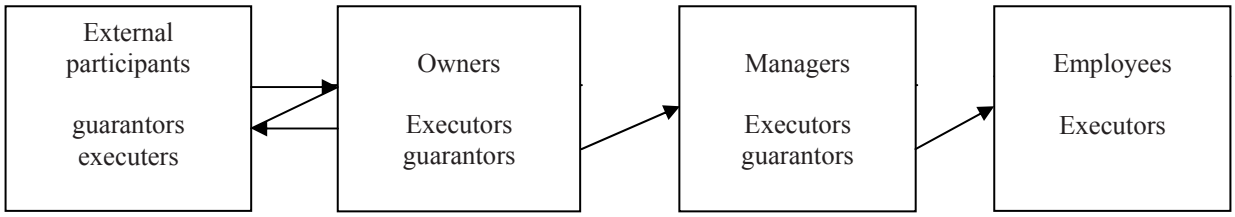

Fig. **The contractual approach to modeling the resource planning strategy of business and industry entities**

Source: authors result.

The term «principal» refers to the owner of certain resources that they offers to the agent. In this case, the agent either receives remuneration for the work (for example, an employee) or pays for the use of resources himself (franchising, credit).

In the *Fig.* the scheme is proposed, where external participants can relate to the owners of the production system as guarantors (for example, investors lending to the organization) or as performers (suppliers, contractors). In addition, relations with external participants can be in the form of a partnership, that is, within an agent-agent pair. An example of this is the relationship between the business structure and the state in the country's economy.

Within the business structure itself, a linear chain is formed, from owners — principals to employees — agents. Within each group of resource owners, these relations cannot be defined unambiguously, since there is a hierarchy and, depending on particular cases, they can be interpreted both in terms of partnership and as a principal — an agent.

The main link of the principal-agent scheme has been well studied in the scientific literature as a static two-sided model (that manifestates in different ways of decision-making by different groups of people) [3; 4; 14—19].

The static two-sided model is based on the assumption that each of the two parties is guided in their activities by an individual utility function, hence the likelihood of opportunistic behavior on the part of the agent in the form of subjective risk arises. The principal evaluates the agent's actions according to a certain criterion (for example, product release) and makes his remuneration dependent on this criterion. The challenge is to select the agent's reward in such a way as to maximize the utility of both parties.

Subsequently, the static two-sided model became the basis for creating multilateral models, in which many principals and agents participate. An important consequence of the study of such models was the conclusion that the effectiveness of the contract, achieved in the two-sided model, is violated when switching to multiple contract due to the occurrence of cross external effects between principals and agents.

In addition to static one-period models, there are dynamic models that consider contractual relationships over several periods. These models are most suitable for describing long-term relationships between participants that arise within the organization, since they take into account the previous experience of the relationship between them. Long-term relationships provide additional guarantees and incentives for agents, which should be reflected in the optimal solution of the model.

In this regard, it seems appropriate to use a dynamic multilateral model of a strategic contract, which is described by the scheme of its participants: investor — owner — employees.

Each participant in this scheme has its own optimization problem based on individual utility functions, thus, the model consists of three interconnected problems that are sequentially solved during each period. It is assumed that the parties to the contract are risk-neutral and have utility functions corresponding to this assumption. So, let us examine the content of the model.

We are considering the activities of a business structure that plans to implement a certain strategy within T — periods. At each stage (period) of the strategy $t\left(t=1, ..., T\right)$, the position of the business structure is characterized by a set of indicators $\left(G_1^t, G_2^t, \ldots, G_p^t\right)$.

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Examples of such indicators are market share for each product, employment, product quality, and other parameters that are targeted in the strategic development of a business structure. Then the matrix $G = \left(G_1, G_2, \ldots, G_p\right)$ will characterize the strategy of the business structure for the entire period — *T*.

We will assume that any target parameter of the strategy ultimately has a monetary dimension and makes a profit. Then the function $G^t = G^t\left(G_1^t, G_2^t, \ldots, G_p^t\right)$ will show the return on the strategy implementation at each of its stages.

The implementation of the strategy involves the attraction of borrowed funds from third-party investors (banks) on terms of loan repayment and interest, and the loan is issued in parts at the beginning of each period based on the return of interest. The bank as the owner of monetary resources is the surety, the owner as the recipient of these resources is the executor. We also assume that the owners of the business structure combine the functions of managers, therefore they directly manage the employees and are their guarantors.

The model is valid for *T* — periods, so will first consider the relationship between the parties for a period *t*, that is, a static multilateral model.

Let us assume that the behavior of the participants in the current period does not depend on the history of their previous relationships, that is, the decisions made today depend only on the current variables (in the future we will abandon this assumption when describing the dynamic model).

In this case, we believe that some of the variables are influenced by the state of the external environment, which we will designate S^t.

At the beginning of the period — *t* the owner owns the resources in the amount $\hat{q}^t$, and the bank transfers the loan to the owner in the amount $\overline{q}^t$. Then the total amount of resources at the disposal of the owner will be equal $q^t = \hat{q}^t + \overline{q^t}$.

Thus, at the beginning of the period, the owner distributes the amount of resources between the employees so that $\sum_{j=J} q_j^t = q^t$, where is *j* — the employee's index $\left(j \in J\right)$.

We will assume that the distribution method is set by the technology and qualifications of workers.

First, we will consider the investor behavior.

In the beginning of the period — *t* the investor decides on the amount of the loan $\overline{q^t}$ issued for the period. At the end of the period *t*, the investor expects to receive interest on the loan in the amount r^t and return the entire debt after the strategy is implemented.

$$\text{Let } \forall t \neq T,\ r^t = r^t\left(\overline{q^t}, s^t\right), \text{ and for } t = T,\ r^t = r^T\left(\overline{q}^t, s^T\right) + \overline{q}.$$

This designation will be useful in the future when considering a dynamic model.

The investor's income in the *t*-th period will be:

$$Z^t = r^t\left(\overline{q^t}, s^t\right) - d^t\left(s^t\right), \tag{1}$$

where $d^t\left(s^t\right)$ — is the transaction costs of the investor under the contract with the owner of the production system, which depend on the conditions of the external environment.

The specificity of the investor's task is that they optimize the size of the loan without having full information about all his transaction costs under the contract, since some of them are related to post-contract opportunism. Therefore, the bank adopts a somewhat pessimistic premise about the behavior of its agent.

Since we are considering a static one-period model, it is assumed that the past does not affect the current variables in any way, so the investor assigns interest based on the loan size and focusing on macro indicators of the capital market.

Let the investor's utility function W^t be designed so that it directly depends on the income on the loan Z^t, let it also be differentiable by Z and the condition $\frac{\partial W}{\partial Z} \geq 0$: $W^t = W\left(Z^t\right) = W\left(\overline{q}^t, s^t\right)$ is satisfied.

The employee maximizes the expected utility.

Then, the problem 1, optimization of utility for the investor is represented as follows:

$$EW\left(\overline{q^t}, s^t\right) \rightarrow \max_{\overline{q}}, \tag{2}$$

$$\overline{q^t} \leq \overline{Q}^t, \tag{3}$$

$$\overline{q}^t \geq 0, \tag{4}$$

$$s^t \geq 0, \tag{5}$$

where $\overline{Q^t}$ is the restriction on the investor's resources, specified outside the model.

As a result of solving this problem, we obtain the value of the borrowed capital $\overline{q}^t{}^*(s^t)$, that is optimal from the point of view of the investor. It will depend on a parameter determined by the external environment. In terms of the game approach, this solution will be equilibrium according to J. Nash [20], but not efficient, since the bank does not know the future behavior of the owner of the business structure and it optimizes its behavior with a fixed strategy of the owner.

Approaching the optimal solution allows considering these relations in the framework of a dynamic model, since then, when making a decision, the bank can rely on the history of relations with the business structure and relatively accurately predict the behavior of the agent.

The investor transfers the amount of capital obtained as a result of solving the problem to the owner, who, as we have already said, distributes the total amount of resources of the business structure among the employees. Therefore, it is logical now to consider the behavior of the employee.

Concluding a contract with a business structure, an employee can perform his functions with different quality.

We denote the set of actions of an employee $A_j = \left\{a_j\right\}$, A — is a compact.

By describing the agent's behavior in this way, we get the opportunity to include in the model the probability of opportunistic behavior, since a_j can denote any actions of the employee.

The result of the strategy $G\left(a^t, q^t{}^*, s^t\right)$ will depend on the actions of all employees $a^t = \left\{a_j^t\right\}$, on the total amount of resources $q^t{}^*$, as well as on changes of the external environment.

The owner does not know the agent's personal contribution to the overall result and puts his reward in dependence on G, therefore the reward function has the form: $I_j^t = I_j^t\left(G\left(a^t, q^t{}^*, s^t\right)\right) = I_j^t\left(a^t, q^t{}^*, s^t\right)$, it is arranged so that $\sum_j I_j^t\left(a^t, q^t{}^*, s^t\right) < G^t\left(a^t, q^t{}^*, s^t\right)$.

In the course of performing the functions, the employee incurs transaction costs for the implementation of the contract $c_j^t\left(a_j^t, s^t\right)$. They will depend, firstly, on the actions of the employee and, secondly, on external parameters of the environment (for example, USD rate). This can be, for example, daily travel expenses of time and money, expenses for meals, gifts for colleagues, etc. Some of these costs can be redistributed to the owner if the business structure pays them to the employee as social benefits.

Then the employee's income after the implementation of the action will be:

$$y_j^t = I_j^t\left(a^t, q^t{}^*, s^t\right) - c_j^t\left(a_j^t, s^t\right). \tag{6}$$

The employee's utility function is designed in such a way that it positively depends on income, that is $U = U\left(y_j\right) = U\left(a, q^*, s\right)$, it is differentiable by y_j and $\frac{\partial U}{\partial y} \geq 0$. In the period

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— t the employee chooses such an action a_j^t that maximizes the expected utility $EW\left(a^t, q^t*, s^t\right)$. All employees make their choices simultaneously and are unaware of the actions of others.

Then, problem 2, optimization for the j-th employee will look like this:

$$EW\left(a^t, q^t*, s^t\right) \to \max_{a_j \in A_j}, \tag{7}$$

$$I_j^t\left(a^t, q^t*, s^t\right) \le G^t\left(a^t, q^t*, s^t\right), \quad \forall j \in J, \tag{8}$$

$$a^t \ge 0, \quad \forall j \in J, \tag{9}$$

$$S^t \ge 0. \tag{10}$$

Here (8) is the employee's income constraint.

The solution of this problem will be an action $a_j^t* = a_j^t*\left(q^t*, s^t\right)$ that converts to the problem of the owner as a parameter. In contrast to the optimal solution that optimizes the function in all variables, this solution is characterized as «the second best» [3], since it is achieved by maximizing by a_j^t with fixed other variables a_i^t, $i \ne j$, that is, the employee does not know how his colleagues will behave and maximize his utility that is based only on its own set of actions. At the same time, we assume that coalitions between employees are excluded.

Now we will consider the behavior of the owner.

Similarly, we specify the set of actions of the owner in relation to investors $B = \{b\}$, B — compact. These are actions for the return of borrowed funds, which the owner, due to opportunism, may not return to the proprietary.

Its income Y^t directly depends on the performance of all employees and is equal to the result of the strategy minus the costs of wages, transaction costs under contracts, and interest on the loan:

$$Y^t = \sum_{j=J}\left[G^t\left(a^t*, q^t*, s^t\right) - I_j^t\left(a^t*, q^t*, s^t\right) - C_j^t\left(a_j^t*, s^t\right)\right] - r^t\left(b^t, \overline{q^t*}, s^t\right) - D^t\left(b^t, s^t\right), \tag{11}$$

where $C_j^t\left(a_j^t*, s^t\right)$ — transaction costs of the owner under the contract with the j-th employee. These costs will depend not only on the external environment — S, but also on the actions of workers — $a*$. For example, not doing work properly can significantly increase the owner's cost of controlling an employee that is part of C_j^t;

$D^t\left(b^t, s^t\right)$ — transaction costs of the owner under the contract with the investor. They depend on the actions of the owner and on the state of the world;

$r^t\left(b^t, \overline{q^t*}, s^t\right)$ — repayment of funds on a loan, the amount of which depends on the actions of the owner, the amount of funds allocated to him, and on external conditions.

The owner's utility function — V is structured in the same way as that of an employee and an investor, and positively depends on the owner's income, it is differentiable by — Y, and it is fulfilled $\frac{\partial V}{\partial Y} \ge 0$:

$$V^t = V\left(Y^t\right) = V\left(a^t*, b^t, q^t*, s^t\right). \tag{12}$$

Optimization problem 3 for the owner is to choose an action that maximizes the expected utility:

$$EV\left(a^t*, b^t, q^t*, s^t\right) \to \max_{b \in B}, \tag{13}$$

$$Y^t\left(a^t*, b^t, q^t*, s^t\right) \le G^t\left(a^t*, q^t*, s^t\right) - \sum_j\left[I_j^t\left(a^t*, q^t*, s^t\right) - C_j^t\left(a_j^t*, s^t\right)\right] - D^t\left(b^t, s^t\right), \tag{14}$$

$$b^t \ge 0, \tag{15}$$

$$s^t \ge 0. \tag{16}$$

The solution to this problem will be an optimal action $b^t* = b^t*\left(a^t*, q^t*, s^t\right)$.

Since many workers and one owner are involved in the model, in this connection we denote a contract between the owner and the *j*-th employee $K_j\,(j \in J)$, $K_j = \left(q_j, I_j(G)\right)$.

Thus, the proposed model simulates the decision-making process by stakeholders during one period. At the same time, the optimum of the first problem is a parameter for the second problem, and the optimum of the second is a parameter for the third, that is, the chain of variables used for optimization looks like this:

$$\bar{q}^t \rightarrow a_j^t \rightarrow b^t\,. \tag{17}$$

Each of these three problems is solved by mathematical programming methods. The first-order condition reduces such a problem to a system of equations and inequalities, and the optimal values of the variables are found by the Kuhn — Tucker theorem.

Now we will examine a dynamic multilateral model.

Moving on to dynamics, we abandon the assumption that the decisions of the participants are independent in time. The choice of action in the current period will be based on knowledge of the previous history of the relationship. For the relationship between the employee and the owner, this connection is more than obvious, as well as for the relationship between the owner and the bank.

Let it be described for a moment — *t*:

- employee's history — as a vector $h_w^t \equiv \left(a^0, G^0, I^0, \ldots, a^{t-1}, G^{t-1}, I^{t-1}\right)$;
- owner's history — as a vector $h_a^t \equiv \left(b^0, G^0, I^0, \ldots, b^{t-1}, G^{t-1}, I^{t-1}\right)$;
- investor's story — as a vector $h_b^t \equiv \left(r^0, \bar{q}^0 \ldots r^{t-1}, \bar{q}^{t-1}\right)$.

In this case, the individual utility functions of the employee, owner, and investor will depend on the parameters h_w^t, h_a^t, u h_b^t, respectively.

Then the problem for each participant in the contract is modified as follows:

Problem 1D: for the investor $\left(\forall t = \overline{1,T}\right)$,

$$EW\left(h_b^t, h_a^t, \bar{q}^t, s^t\right) \rightarrow \max_{\bar{q}}\,, \tag{18}$$

$$\overline{q^t} \le \overline{Q}^t\,, \tag{19}$$

$$\bar{q}^t \ge 0\,, \tag{20}$$

$$s^t \ge 0. \tag{21}$$

The investor's income — *Z* will now depend not only on the size of the loan or external influences, but it will also be determined by the history of the investor himself (since the size and rates of past loan tranches affect the future).

Besides, the income will depend on the history of the borrower (his ability to repay the loan is indirectly expressed in the results of the strategy — *G*, and his propensity for opportunism can be traced through the values — *b*).

From the set of variables that define the owner's history, perhaps only employee remuneration $I_j(j \in J)$ will not affect the investor's income.

Problem 2D: for an employee $\left(\forall t = \overline{1,T},\ \forall j \in J\right)$,

$$EU_j\left(a^t, h_{w_j}^t, q^t*, s^t\right) \rightarrow \max_{a_j \in A_j}\,, \tag{22}$$

$$q^t* = \hat{q}^t\left(h_a^t\right) + \bar{q}^t*, \tag{23}$$

$$I_j^t\left(a^t, h_{w_j}^t, q^t*\left(h_a^t\right), s^t\right) \le G^t\left(a^t, h_{w_j}^t, q^t*\left(h_a^t\right), s^t\right), \tag{24}$$

$$a_j^t \ge 0\,, \tag{25}$$

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$$s^t \geq 0. \quad (26)$$

Likewise, the employee is guided in his actions by previous experience in the company h_w. Equality (24) in this problem shows that the amount of personal resources of the owner depends on his history h_a^t. We introduce this dependence in order to foresee a situation in which the equity capital of a business structure decreases due to the repayment of the loan, not due to profit, but due to the sale of its funds. This is possible if the profit is not positive.

Problem 3D: for the owner $\left(\forall t = \overline{1,T}\right)$,

$$EV\left(a^t*, h_w^t, b^t, q^t*, s^t\right) \to \max_{b \in B}, \quad (27)$$

$$Y^t\left(a^t*, h_w^t, b^t, q^t*, s^t\right) \leq G^t\left(a^t*, h_w^t, q^t*, s^t\right) - \sum_j \left[I_j^t\left(a^t*, h_{wj}^t, q^t*, s^t\right) - C_j^t\left(a_j^t*, s^t\right)\right] - D^t\left(b^t, s^t\right), \quad (28)$$

$$b^t \geq 0, \quad (29)$$

$$s^t \geq 0. \quad (30)$$

The owner's problem ends the iteration of the period — *t*, and after receiving the solution, the model returns to the investor's problem in the next period. At the same time, past decisions passed as history into a new period.

The solution to the resulting model is a matrix $\Omega = \left\{\overline{q}^t*, a^t*, b^t*\right\}, \quad t = \overline{1,T}$ that consists of conditionally optimal strategies of each participant during the entire time of the strategy implementation — *T*.

A necessary and sufficient condition for the existence of a solution is the fulfillment of the above conditions of the Kuhn — Tucker theorem [13]. This solution will be conditionally optimal for the same reasons as the solution to a static problem. The decision matrix will correspond to the strategy results matrix $G = \left\{G_1^t, G_2^t, \ldots, G_p^t\right\}, \quad t = \overline{1,T}$.

Thus, it will be possible to judge the success of the strategy by the dynamics of indicators.

Since the proposed model is a simulation, the trajectories of the model variables can be obtained by simulating the input variables for the given parameters, but such a problem is beyond the scope of this model. Now we will try to analytically assess the possible outcomes that may arise under the described conditions. To do this, we fix the parameters of the external environment — *S*, and then the results of the model will depend only on the actions of the agents.

We suppose that when one of the participants leaves the contract, the strategy cannot be implemented (this assumption does not apply to each employee individually, because we believe that the labor market is quite competitive).

We will divide the whole set of actions of the employee and the owner into positive (in relation to the fulfillment of obligations) and negative (opportunistic).

If the reward function is designed so that all employees work for the good of the organization, then the results of the strategy will be positive, and therefore, it is highly likely that the owner will also choose a positive action. Then, in the next period, the contractual relationship will be continued. The reverse logic also works: if all employees sabotage, then this will certainly affect profits and then the owner will have a problem with the loan repayment. But in this case, the decision will be ambiguous, since the owner can repay it in whole or in part from his own capital. If the owner refuses his obligations to the bank, the latter terminates relations with him and both parties increase the costs of protecting property rights in court.

Note that in case of positive outcomes, over time, the value of many variables should decrease, including the value of transaction costs of the bank and the owner due to lower negotiation costs and the value of the loan rate due to the growth of trust between the bank and the borrower. But such a tendency is possible only in the absence of external fluctuations, the parameter — *S* introduces an element of stochastics into the model.

A long-term relationship approach to agency issues has many benefits. First, when building a contract for future periods, this gives the principal the opportunity to make the future

remuneration of the employee dependent on the current result of the strategy implementation, which is an additional incentive tool.

Second, the principal's review of the agent's past behavior allows one to assume the likelihood of his corresponding behavior in the future and to adjust the incentive system.

Finally, the dependence of the agent's remuneration on previous results allows the agent to be insured against those fluctuations in output that are not related to his actions.

The disadvantage of the dynamic model is that the optimal contract is too complex, which takes into account all the results of the previous relationship. Real-life experience demonstrates that real contracts are much simpler to arrange. It was shown in [4] that under certain assumptions regarding the preferences of the principal and the agent, as well as the type of utility functions, the optimal contract becomes simple and the agent's remuneration depends only on current results.

The proposed model of agency relations allows us to consider several behavioral effects that arise between the parties of the contract in the process of its implementation. One of the interesting effects of the resulting model arises from the fact that employment contracts are linked to each other by overall strategy outcomes. After all, the remuneration of an individual agent depends on the results of the strategy, which means that they are influenced by the actions of others. As a result, we get an external effect on the employee.

By definition, the contract K_j between the principal and the agent — j gives an external effect on the agent, if there is such an agent k, $k \neq j$, so U_k^* depends on K_j [11]. If the owner could evaluate the performance of each employee depending only on his individual contribution to the strategy, then the external effect on the agent would be equal to zero. The existence of such an effect leads to a violation of the efficiency of the optimal vector of contracts.

One example of a negative externality is the well-known «free-riding problem». An employee who knows that his work is being judged by the joint result of the efforts of their colleagues is tempted not to try too hard in the performance of his functions. In this regard, two natural questions arise:

1. How can the procedure for distributing individual contributions of employees to the overall result solve the problem of «free riders» and how will this affect the effectiveness of the contract?

2. How great is the damage from the «free-riding problem» if the order of distribution of individual contributions is determined exogenously?

To answer the first question, we will use the results of the work of B. R. Holmström [3] who studied the relationship between participants in the framework of the partnership model.

We will designate the contribution of each employee to the overall result — $S_j(G)$, where G — is the value of the result of the activity (for example, product output)

B. Holmström proved that for risk-neutral agents, the solution to the problem of maximizing individual utility will be effective only if it is such t that the following inequality holds:

$$\sum_j S_j(G_t) < G_t\,, \tag{31}$$

that is, at least in one period, the total contribution of workers is strictly less than the final product. And this means that there is still another person whose activities affect the result of the strategy, that is, it can be assumed that the rest of the contribution to the overall result falls on the principal.

Since both the principal and the agents are present in our model, the result of the strategy depends on their joint activity, that is, the agents satisfy inequality (31).

Then, in our problem, there is a rule for distributing the contributions of employees to the overall result, which allows us to achieve an effective solution.

If we assume that agents are risk-averse, then there is no such rule at all.

The question arises, what should be the rule for the distribution of contributions to the overall result, which would make it possible to achieve an effective optimum?

The first work that drew attention to the specifics of the distribution of workers' contributions to the total product was the article by S. Williams and R. Radner [21]. Scientists have

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shown that even with risk-neutral agents for the effectiveness of the solution of the model, it is necessary that there be some asymmetry in the contributions of individual employees.

The results of other studies, such as the work of P. Legros and H. Matsushima [22], also prove that the symmetric distribution of workers' contributions is incompatible with an effective solution to the problem.

Now we will turn to the second question: how great is the inefficiency caused by the «free-rider»?

Here it is possible to refer to the result obtained for the partnership model, the authors of which are D. Fudenberg and D. Levine [23]. According to their research, the Nash equilibrium [20] will be asymptotically efficient if the discount factor of their utility tends to zero. In other words, the more patient the worker is, and the more he values future usefulness, the less they have a tendency to opportunism in the form of free-rider behavior.

Thus, we have considered several cases in which conditionally optimal solutions can become effective. All these results are based on the assumption of the existence of a set of actions of the agent {A}, in the broad sense defined by him.

However, there are works showing that the guarantor can expand many of the agent's actions in such a way as to ensure the effectiveness of the contract [4; 9; 10; 18; 20; 24—27].

As a result, the model is a game with complete information and comes to an effective solution. If we abandon the assumption that agents are aware of the actions of others, the model does not achieve efficiency, but the principal can offer agents another, more complex game, in order to guarantee the only correct solution.

There are models that explore the relationship between multiple agents and multiple principals. Within the business structure, such relationships arise between investors and owners, since loans are often attracted from several sources. Then, in addition to the external effects on agents that we have indicated, external effects on the principals arise, which also violates the efficiency of the optimal contract.

Conclusion. In conclusion, it should be noted that the model we propose allows us to formally illustrate the prerequisites and conditions for effective decision-making by stakeholders in the framework of the strategic resource planning model for the purpose of business development. Moreover, it is a special case of exchange relations from many others that arise within the framework of a strategic contract.

Since decision-making by each of the participants is carried out under conditions of incomplete information about each other, the result obtained in the general case will not be effective from the point of view of its optimality. However, there are special cases that make it possible to achieve or at least come close to efficiency. All of them are based on additional assumptions regarding the behavior of agents.

Thus, the proposed contractual approach to modeling the resource planning strategy of business and industry, which is attractive for its functionality, since it is more closely related to other types of activities of business and industry structures associated with exchanges between the external and internal environments of the latter. This approach allows us to initially take into account the conditions for the effectiveness of strategic planning of resources as of industry, as well as business structures by rationalizing the organizational and economic component of management, considering the alternatives of the behavioral relations of agents.

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