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Gurskaya Y.M., Elizarova M. I., Slavyanov A.S. Matrix tools for the formation of a corporation's investment portfolio in conditions of financial instability

Gurskaya Yulia Mikhailovna

Researcher at CEMI RAS, Moscow

Elizarova Marianna Ioanovna

Candidate of Economic Sciences, Senior Researcher at CEMI RAS, Moscow

Slavyanov Andrey Stanislavovich

Candidate of Economic Sciences, Associate Professor of the Department of the Bauman Moscow State Technical University, Moscow

***Abstract.** The paper analyzes the existing methods of evaluating the effectiveness of investment projects, which take into account mainly the financial result. In an unstable external environment, the influence of external factors can significantly affect the effectiveness of the project, which are usually not taken into account. An industrial corporation can assemble a portfolio of projects that will meet its goals with maximum results. At the same time, several scenarios should be taken into account, each of which corresponds to a certain result. Taking into account the probability of occurrence of each event, a portfolio of investment projects is formed. To solve this problem, it is proposed to use a matrix toolkit developed on the basis of the methodology of game theory. The paper proposes an approach based on the matrix method of forming a portfolio of projects that ensures uniform and sustainable development of the corporation.*

***Keywords:** investment project, economic efficiency, payment matrix, project portfolio, matrix*

Introduction

The existing methods of selecting investment projects are mainly focused on achieving a financial result, when the project that will give the maximum economic effect is selected. At the same time, the public, social, budgetary and other effects of the project are not always taken into account. Thus, the introduction of automatic lines, robots, processing centers and other advanced equipment allows to multiply the output of products, but their use leads to the release of labor, which will affect the unemployment rate, a decrease in purchasing power, and an increase in social tension is possible. Due to these negative effects, it is necessary to implement another project that would create jobs in the region. It can be argued that it is almost impossible to find such a project that would give positive effects in all areas, and therefore, the problem of selecting projects in such a portfolio that would ensure the uniform and sustainable development of the economic system becomes urgent.

Materials and Methods

When making a decision, the investor uses tools based on discounting cash flows, which allow you to correctly compare several projects, the volume of investments and the return of funds in which does not coincide in time. Based on the obtained value of the net present value of the project (NPV), the derivatives NPV are analyzed - the internal

rate of return of the project (IRR); the profitability index - (Profitability Index); the payback period of the project, etc. [1, 7, 11] These methods are widely used in industrialized countries with market economies, due to their ease of use for evaluating economic efficiency and selecting commercial projects, where the financial result is the determining indicator. Using these tools in countries with a developing economic system characterized by its instability and high risks, these methods led to unexpected conclusions. Calculations based on these methods showed that it is unprofitable to conduct research and development on the basis of domestic research organizations, it is much more efficient to get technological licenses or finished products abroad than to go through the entire innovation cycle independently [2, 12]. As a result, in the early 90s, the development of its own software was stopped in Russia and the country completely switched to foreign software, projects in the aviation, machine-tool industry, instrument-making and other knowledge-intensive economic activities were frozen. Local markets of high-tech products and services in a short time came under the influence of foreign corporations, and the economic sanctions that followed, due to the complication of the international situation, damaged the innovative development of the country [13].

The paper proposes, on the basis of mathematical modeling methods, to develop a mechanism for selecting projects in the portfolio that ensures the achievement of not only the commercial goals of the investor, but also the solution of social, environmental and other tasks of society.

Результат

The selection of projects that will determine the development of the corporation for the next decades should be carried out not only by evaluating the financial result, but also by social significance [9].

The economic state of the corporation at the current time can be described by a certain set of indicators, which may include indicators of economic, innovative and social development, as well as the level of security, sustainability, and others. It is proposed to analyze the development of the corporation in dynamics in Table 1, where we will enter the current and planned state of the system.

Tabl. 1

System State Matrix

System indicators	The current state of the system (A)	Planned state of the system (B)	Planned change (C) $Y^c = Y^b - Y^a$
Y_1	Y^{a_1}	Y^{b_1}	Y^{c_1}
Y_2	Y^{a_2}	Y^{b_2}	Y^{c_2}
....
Y_i	Y^{a_i}	Y^{b_i}	Y^{c_i}
....
Y_{m-1}	$Y^{a_{m-1}}$	$Y^{b_{m-1}}$	$Y^{c_{m-1}}$
Y_m	Y^{a_m}	Y^{b_m}	Y^{c_m}
F (resource)	-	-	F

Где Y_i - System indicators, F – Resource.

In the matrix form, the economic state of a corporation can be represented in the form of three column vectors:

$$C = B - A,$$

where a is the column vector of the current state of the system, B is a column vector of the planned state of the system and the column vector of the change (S).

It should be noted that the matrix method was used to estimate the economic efficiency of production and economic activities of market entities [8], however, focused on cost indicators such as income, value added commodity products etc., while indicators of social effect attention has not been paid.

The planned state of the system should be determined based on the goals of its strategic development at the current stage [4]. The change in the state of the system is achieved by the implementation of a certain set of projects and programs, which includes those activities that will have the most positive impact on the result in the conditions of budget constraints [6].

Each project has a diverse impact on the system status indicators and requires a certain amount of resources. Thus, the growth of total output (a positive factor) due to the use of foreign technologies can negatively affect the economic security of the system and its sovereignty or lead to environmental problems (a negative factor). An increase in labor productivity (a positive factor) can lead to an increase in the unemployment rate and a decrease in disposable personal income (a negative factor), etc. It may turn out that some indicators will be achieved by reducing others, and this may slow down the development of the system. The task will be to form such a composition of the project portfolio:

$$X = \sum_{j=1}^n X_j, \quad (1)$$

which could satisfy the condition:

$$C \leq X \quad (2)$$

under restrictions:

$$F \leq \sum_{j=1}^n F_j, \quad (3)$$

where F – the total budget for financing the development of the system, F_j – budget j - project, X – vector column of the project portfolio, X_j – vector column j -project of portfolio, n – number of project's. From all the projects submitted for consideration, it is possible to collect a certain set of portfolios that will meet the conditions (2) and (3).

$$X_k \in X$$

$$X = \{1, 2, 3, \dots, k, \dots, s-1, s\} \quad (4)$$

Each project is characterized by its own final results and the level of their achievement:

$$Y_i \in Y$$

$$Y = \{1, 2, 3, \dots, i, \dots, m-1, m\} \quad (5)$$

To achieve these goals, it is necessary to choose from a set of X such a portfolio of projects that would contribute to the maximum possible result on the one hand, and

on the other, would be resistant to the most unfavorable environmental conditions [3, 5]. The external environment (E) can be in various states-from threatening to favorable [10] and this will inevitably affect the indicators (Y_i) project of programm's:

$$E_q \in E$$

$$E = \{1, 2, 3, \dots, q, \dots, q-1, Q\} \quad (6)$$

After calculating the project indicators for all possible states of the external environment, we will enter the results obtained into the payment matrix of the game (Table 2).

Table 2

Project indicators in various states of the external environment

Project indicators	The state of the external environment					Mathematical expectation of the result indicator
	E ₁	...	E _q	...	E _Q	
	Probability of the state of the external environment					
	P ₁	...	P _q	...	P _Q	
Y _{1-j}	Y _{1-j} (E ₁)	...	Y _{1-j} (E _q)	...	Y _{1-j} (E _Q)	$Z_{1-j} = \sum_{q=1}^Q Y_{1j}(E_q) \times P_q$
...
Y _{i-j}	Y _{i-j} (E ₁)	...	Y _{i-j} (E _q)	...	Y _{i-j} (E _Q)	$Z_{i-j} = \sum_{q=1}^Q Y_{ij}(E_q) \times P_q$
...
Y _{m-j}	Y _{m-j} (E ₁)	...	Y _{m-j} (E _q)	...	Y _{m-j} (E _Q)	$Z_{m-j} = \sum_{q=1}^Q Y_{mj}(E_q) \times P_q$

Y_{i-j} – i –indicator j -project; Y_{i-j} (E_q) – indicator state of the external environment (E_q); Z_{i-j} – Mathematical expectation of the result indicator. We will represent the project portfolio in the form of a matrix Z, which will be the sum of the matrices of several projects Z_j.

In conditions of uncertainty, the portfolio is formed based on the condition:

$$C \leq Z, \quad (6)$$

where Z is the matrix of the project portfolio, calculated under conditions of uncertainty, under previously introduced budget constraints (3).

Conclusions and conclusion

This approach can be used to form a portfolio of projects that ensure the achievement of the goals of the corporation's development program and any other economic system, both in conditions of relative stability and in conditions of uncertainty. The proposed approaches to solving the problem of balanced and sustainable development of the economic system can be developed in models based on game theory.

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