

Selection of sources of financing for an emerging networked systems based on mathematical analysis

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Abstract. The use of approaches and methods of mathematical analysis to the selection and justification of sources of financing for an emerging networked systems is an important and urgent task. The approach presented in the paper is based on a system of equations that allow determining the optimal capital structure necessary to finance an innovative project. This system of equations, using methods of mathematical analysis, provides the best effect of financial leverage. The use of this methodology in the activities of commercial organizations is a modern practical tool necessary for the effective functioning of the control support system.

1 Introduction

The essence of innovation activity is not only in the development of innovations, but also in the introduction of innovative products to the market, the development of competition and scientific and technological progress. [1, 2]

The process of successful implementation of innovations includes three components: organizational, legal and financial.

The solution to the organizational problem involves the creation of a centralized infrastructure. The solution to the organizational problem involves the creation of a centralized infrastructure. [3, 4] The most important goals of creating legal support for the commercialization of innovations are the protection of ownership of scientific results, the participation of scientists in the development of innovations, the formation of effective mechanisms to promote patenting. Innovation financing mechanisms are implemented by searching for and attracting financing, building an effective system for using funds. [5, 6]

One of the main risks that an enterprise faces in the course of implementing innovative activities is the risk of insufficient financial support for the project being implemented. This may be due to the fact that there were no funds to finance the project or the chosen method of financing does not work.

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Of course, the risk of insufficient funding is less than the risk of failure of research, development and implementation of the project. However, it is also large, and novice innovators face a number of problems, among which the need for careful selection of the optimal method of financing stands out. [7, 8]

In addition to financing innovation activities at their own expense, currently there are various ways of external financing of innovative projects – equity, borrowing, budget financing. Enterprises engaged in innovative activities independently determine ways to raise funds [9, 10].

Innovative projects of enterprises, allow to realize the idea of their technological leaps due to the freedom of novelty and focus on local developments. Therefore, the chosen methods of financing such projects should initially be configured for a specific business, profit generation depends on the success of the introduction of innovations. [11, 12]

2 Relevance of the study

With the right choice of financing methods and successful completion of the stages of creation and implementation of innovations, absolutely all participants in this investment and innovation process will be able to realize their interests. Firstly, the innovator enterprise will be able to receive the implemented project and income from its use. In the future, this will affect both the development of production activities and the stability of the market position. Secondly, the author of the project, the manager and his team, of course, will receive payment under the contract, will increase their professional rating. Thirdly, an investor who has carried out external financing of the project will be able to return the invested capital. Fourth, consumers will learn about the created innovative product, which is more attractive and has competitive advantages in the market. [13] When they purchase such a product, a fee arises that reimburses the costs of the project and forms a profit received by active project participants. Fifth, the authorities receive taxes from all participants, from which public, social, environmental needs and requirements will be met in the future. All this will allow us to develop the economy of the state and improve its position on the world stage.

3 The methodology of the study

The methodological basis of the research is the principles of dialectical logic, the unity of logical and historical approaches to the study of economic phenomena. The research uses a systematic approach, as well as general scientific methods of cognition: abstraction, generalization, analysis.

In methodological terms, the work is based on general scientific methods of functional and structural analysis. The nature of the problem brought to the center of the study required the authors to ensure a systematic approach and continuity in the study of the range of issues related to it.

4 The results of the study and their discussion

In the course of the research and based on the previously acquired potential [14, 15], a methodology was developed that allows choosing the right way to finance an innovative project, taking into account all factors and conditions. This technique is shown in Figure 1. Where $OF_{enterpr}$ - the company's own funds allocated for the implementation of the investment project; $BF_{enterpr}$ - borrowed funds of the enterprise that can be attracted for the implementation of the investment project; Σ_{requir} - the required amount to finance the investment project. [16]

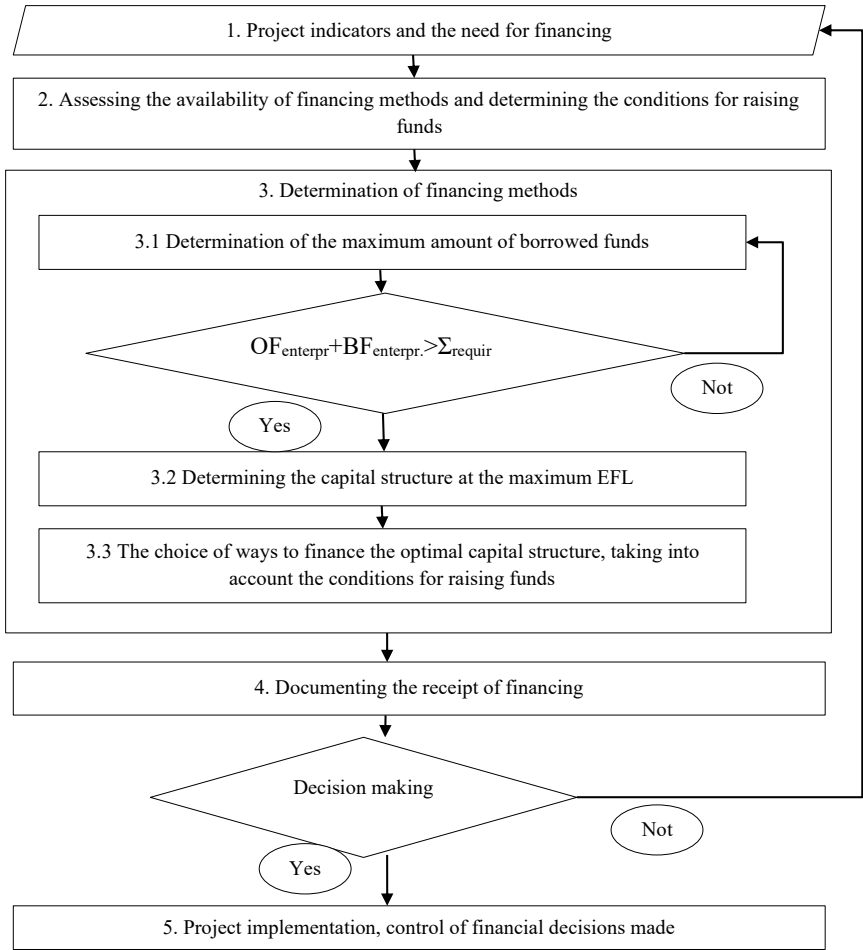


Fig. 1. Methodology for choosing ways to finance an innovative project.

This technique consists of five stages, and the significance of each stage is very great. Making an error on any of them can lead to an unsatisfactory implementation of the project or to a lack of implementation in general. [17, 18]

At the very beginning, the project indicators and funding needs are determined. It is necessary to calculate the future operating profit and the term that affect the most effective decisions on financing. The amount of necessary funds for the implementation of an innovative project is also determined.

The effectiveness of innovation management and the implementation of an innovation project always causes the need to calculate the needs for the funds that are needed to carry out this activity. At the same time, it is important not to make a mistake with the definition of the term of use and the estimated future operating profit. [19] Innovators need to carry out various analyses and evaluation work, carry out calculations to identify the required amount, operating profit and deadline. In the future, it is on the basis of such work that the issue of financing will be decided. [20]

The second stage of the methodology consists in assessing the availability of financing methods and determining the conditions for raising funds. At this stage, the process of compiling a list of proposed financing methods is being carried out and the conditions for

their attraction are being studied, that is, a description of possible financing methods is being compiled.

The most difficult thing for an enterprise is to influence the availability of financing methods. It depends on many factors. For example, in a short period of time, a company will be able to increase its assets to a size sufficient to secure a loan or collateral, raise its financial ratings, gain prestige and a good reputation in the market. For the convenience of definition, you should fill out Table 1, which allows you to visually compare their characteristics and see which financing methods should be worked out in the future, and which ones should be excluded altogether, since they will not be able to satisfy the interests of the enterprise.

Table 1. Characteristics of the availability of funding sources (example)

Conditions Methods	Amount of financing	Term of use	Cost of attraction	Co-financing	Material support
Reinvesting profits	+	+	-	-	-
Depreciation	-	+	+	+	+
Equity participation	+	+	-	-	-
Borrowing	+	+	-	-	-
Budget financing	-	-	-	-	-

When filling out the most necessary conditions are considered: the amount of financing, the period of use, the cost of attraction, the requirement for co-financing and material support. Assessing the availability of a financing method, it should be remembered that not all firms can easily use all possible financing methods, it is necessary to realistically assess the situation.

The third stage of the methodology is key, since the methods of financing an innovative project are being determined, and three tasks need to be solved during its passage.

First, it is necessary to determine the maximum amount of borrowed funds. [21, 22] If, according to the results of the calculation, the amount of the initial equity of the enterprise and the maximum borrowed capital is greater than the amount of the needs of the innovation project, then you can proceed to the following actions. If not, then it is worth reviewing the calculations done and, possibly, changing the values of the indicators.

Then the capital structure is determined, in which the effect of financial leverage will be maximized. The basis of such a definition is a system of equations developed through the differentiation of partial derivatives, while taking into account the parameters that affect the formation of the capital structure.

In order to determine at which borrowed capital the effect of financial leverage will be maximized, it is necessary to carry out a differential calculation on borrowed funds. For convenience, conditional values are taken: y – the effect of financial leverage, $(1 - Spn) - t$, own funds – c , operating profit – p , i – the average calculated interest rate, x – borrowed funds. The result is a function:

$$y = t * \left(\frac{p}{c+x} - i \right) * \frac{x}{c}; \tag{1}$$

Or

$$y = \left(\frac{tp}{c+x} - it \right) * \frac{x}{c}. \quad (2)$$

Next , the derivative is taken:

$$y' = -\frac{tp}{(c+x)^2} * \frac{x}{c} + \left(-\frac{tp}{(c+x)} - it \right) * \frac{1}{c}. \quad (3)$$

Simplifications are being implemented:

$$y = \frac{1}{c} * \left(-\frac{tpx}{(c+x)^2} + \frac{tp}{c+x} - it \right); \quad (4)$$

$$y' = \frac{t}{c} * \left(\frac{p}{c+x} - \frac{px}{(c+x)^2} - i \right); \quad (5)$$

$$y' = \frac{t}{c} * \left(\frac{p(c+x)-px}{(c+x)^2} - i \right); \quad (6)$$

$$y' = \frac{t}{c} * \left(\frac{pc}{(c+x)^2} - i \right); \quad (7)$$

$$y' = t * \left(\frac{p}{(c+x)^2} - \frac{i}{c} \right). \quad (8)$$

Then the initial designations are substituted and the effect of financial leverage is obtained:

$$EFL = (1 - Itr) * \left(\frac{OP}{(OF+BF)^2} - \frac{ACIR}{OF} \right). \quad (9)$$

Since the first multiplier is a constant numeric value, further actions are performed with the second multiplier:

$$\frac{OP}{(OF+BF)^2} - \frac{ACIR}{OF} = 0. \quad (10)$$

The conversion of such a multiplier will allow you to determine the total amount of capital:

$$OF + BF = \sqrt{OF \frac{OF*OP}{ACIR}}. \quad (11)$$

Borrowed funds are expressed from this expression:

$$BF = \sqrt{\frac{OF*OP}{ACIR}} - OF. \quad (12)$$

This criterion allows you to determine the amount of borrowed capital at which the effect of financial leverage will be maximized.

Next, a system of equations is compiled that will determine the capital structure necessary to finance an innovative project, ensuring the maximum effect of financial leverage.:

$$\begin{cases} BF = \sqrt{\frac{OF*OP}{ACIR}} - OF \\ OF + BF = K \end{cases} \quad (13)$$

Where K – Balance sheet currency.

The solution of such a system of equations should be carried out through the expression of borrowed funds from the second equation:

$$BF = K - OF. \quad (14)$$

Next, the resulting expression is substituted into the first equation:

$$K - OF = \sqrt{\frac{OF * OP}{ACIR}} - OF; \quad (15)$$

$$K - OF + OF = \sqrt{\frac{OF * OP}{ACIR}}; \quad (16)$$

$$K = \sqrt{\frac{OF * OP}{ACIR}}; \quad (17)$$

$$K^2 = \frac{OF * OP}{ACIR}; \quad (18)$$

$$K^2 * ACIR = OF * OP; \quad (19)$$

$$OF = \frac{K^2 * ACIR}{OP}. \quad (20)$$

The capital structure is uniquely determined by the need for capital, the amount of operating profit and the cost of capital. Changes in these parameters affect the formation of the capital structure.

Next, the selection of ways to finance the optimal capital structure is carried out, taking into account the conditions for attracting funds. The various available methods are compared using the brute force method, taking into account the characteristics and interests of the enterprise itself. It is necessary to choose such financing that will have the maximum return, while satisfying the interests of the enterprise. [24]

The fourth stage can be described as formal and organizational, since the documentation of obtaining funding is carried out. If for some reason this stage cannot be passed, then it is necessary to return to the work done and make a check. Stages from the second to the fourth can be completed several times if the resulting management solution does not meet the necessary parameters. [25]

The final stage is defined as the implementation of the project. There is a process of mobilization, investment of accumulated funds and targeted management of them. The use and return of the advanced financial resources is monitored. [26]

5 Conclusions

The proposed methodology for choosing ways to finance an innovative project can allow for the attraction of funds in accordance with the necessary needs. [27] At the same time, a consistent and high-quality passage of the stages will lead to an accurate and correct choice, while avoiding an erroneous decision. The provision of financial needs will allow the company to introduce a new product to the market and will contribute to strengthening its financial reputation in the future. [28]

The use of the developed methodology is a kind of tool designed for practical application. In the future, such use will significantly improve the efficiency of management decisions.

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