Modeling the cost of transferring funds taking into account the initial information

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Abstract. The construction of a model of the optimal amount of money transfer, taking into account the uncertainty of the initial information, depends on the strategy practiced by the enterprise. The type of the strategy of the enterprise, first of all, depends on the choice of the decision-making criterion in conditions of uncertainty. For a machine-building enterprise, a priority strategy is such that the amount of money transferred should be equal to the amount of the cash gap. In this paper, using economic and mathematical methods for the model of forming an optimal portfolio of alternatives, a mathematical model for determining the amount of optimal transfer of funds, based on the construction of the function of transaction and opportunity costs, is developed. We also propose a method for calculating the absolute liquidity ratio, which is recommended for use not only in operational financial planning, but also for analyzing the current financial condition of an enterprise.

1 Introduction

The rise and development of mechanical engineering, the restoration of solvency, and the increase in investment attractiveness in order to ensure the competitiveness of products in the difficult economic conditions of the present period are impossible without improving the management system of the financial and economic activities of the enterprise [1-3]. Market transformations that have changed the internal and external environment of the functioning of economic entities has required more attention to the issues of managing the financial activities of the enterprise, which are the most important component of the entire management system [4-6]. The basis for improving the management of the company's financial activities is effective financial planning, which is present at all levels of planning. Along with the strategic and current levels of planning, more and more attention is paid to operational financial planning, which largely determines the success of the development and operation of the enterprise. The results of numerous studies [7-9] the lack of a system for planning financial flows and, above all, operational financial planning, as a planned receipt and expenditure of revenue from the sale of products [10], in many cases are the main reasons for the insolvency of Russian enterprises, which ultimately leads to bankruptcy. Thus, improving the efficiency of financial flow management, solving the problem of insolvency of the enterprise are impossible without the implementation of the process of operational financial planning. The solution to this problem is connected with the need to improve the approaches and methods of operational financial planning [11, 12], considering the industry specifics of Russian enterprises.

2 Materials and Methods

The results of scientific research of Russian and foreign scientists were used as the initial materials. Information from available sources describes the activities of machine-building enterprises in the Russian Federation.

The methodological basis of the research consists of the following methods: economic analysis; system analysis; mathematical statistics; economic and mathematical methods and models; methods of decision-making in conditions of uncertainty and risk.

3 Results

The data set, which shows the relationship between the amount of funds raised and the amount of transaction costs, is the input information for building a model of the optimal amount of money transfer.

To determine the functional relationship between the amount of funds raised and the amount of transaction costs, a graph is constructed using the available source information. The resulting point values on the graph must be approximated using one of the methods of mathematical analysis. In this case, the following methods can be used [5, 6]: uniform approximation. It is theoretically feasible to require for the best

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approximation, to maximize the value of $|f(x) - \phi(x)|$ on that interval $a \le x \le b$, where you want to get an approximate image $f(x)$, which would be the smallest (compared to the other choice $\phi(x)$). However, there is no method for efficiently obtaining such uniform approximations, except in certain special cases.

The second is the approximate least squares method. The most commonly used approximation is $\phi(x)$, for which the smallest value is value (1):

$$M = \int_a^b \left[f(x) - \varphi(x) \right]^2 dx \quad (1)$$

By requiring the reversal to zero of the partial derivatives of M in terms of the parameters, defining the function $\phi(x)$, we obtain an equation that allows us to find the best (in the specified sense) value of these parameters [13, 14].

The third is zoom in on individual points. In many cases, and especially if the function $f(x)$ is given by a graph or table to estimate the degree of approximation, the differences are considered $f(x) - \phi(x)$ not for all points of the interval (a, b) on which you want to approximate the function $f(x)$, but only for individual, pre-selected points x1, x2, …, xn. The function $\phi(x)$ is considered as the best approximation to $f(x)$ (using the least squares method), if (2):

$$S = \sum_{i=0}^{n} \left[f(x_i) - \phi(x_i) \right]^2 \quad (2)$$

It has the smallest value in comparison with other functions, among which the desired approximation is selected. If $\phi(x)$ is completely determined by the parameters k, l, m, …, then the best (in the specified sense) values of these parameters will be found by solving the system of equations (3):

$$\frac{\partial S}{\partial k} = 0, \frac{\partial S}{\partial l} = 0, \frac{\partial S}{\partial m} = 0, \quad (3)$$

The fourth is the approximation by the method of averages. Using the method of averages, the linear relationship between the "aligned" variables X and Y is first determined (obtained by the alignment method): Y=aX + b. To do this, the conditional equations Yi=aXi + b for available value pairs Yi and Xi are divided into two equal (or almost equal) groups in an ascending order of the variable Yi or Xi. Adding up the equations of each group, we get two equations, from which a and b are determined. Expressing X and Y in terms of the initial variables, we get the desired relationship between x and y. If at the same time not all the parameters are defined, then you should apply the same method again, aligning the other values of X and Y.

Note. For an approximate image of a given function $f(x)$ we choose the approximating function $\phi(x)$ from functions of a certain type.

The function obtained in this way is shown in Figure 1.

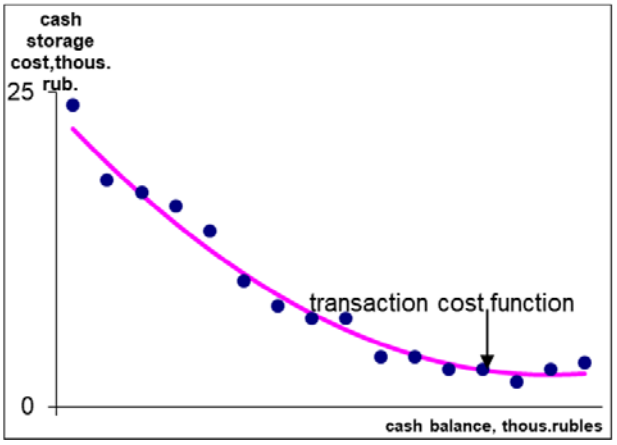

Fig. 1. Transaction cost function.

-To construct the opportunity cost function, it is necessary to obtain data on the relationship between the amount of money placed and the income received at the same time. In the dissertation research, the task of forming an optimal investment portfolio was not set, and therefore the initial data for constructing the function will be third-party.

A certain functional dependence is shown in Figure 2.

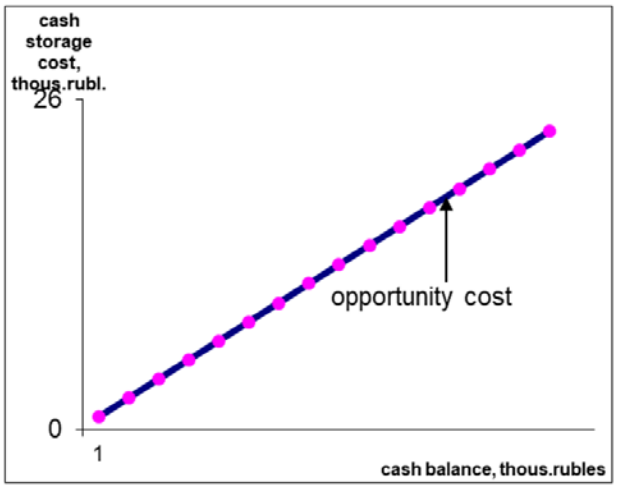

Fig. 2. Opportunity cost function.

-The optimal amount of money transfer can be determined by taking into account some competition between the desire for profit and security. With the increase in the liquidity reserve, the growing amount of opportunity costs is countered only by the costs of eliminating the shortage of means of payment – transaction costs. The optimal amount of money transfer is obtained when the sum of transaction and opportunity costs (a function of total costs) reaches its minimum. To find the minimum value of the function, you need to find the points where the first derivative is zero. Thus, the extremum points were determined. Then you can calculate the second derivative. If the found value is greater than zero, then the local minimum is located at this point. We can say that the point of correspondence to the amount of the optimal transfer of funds is not only the minimum value of the function, but also the point of intersection of the functions of alternative and transaction costs. As a result, it can be found by solving the system of equations (4):

$$\begin{cases} F=T(V) \\ F=A(V') \end{cases} \quad (4)$$

We obtained value of the optimal transfer of funds, determining the portfolio of alternatives by solving the dynamic programming problem [15]. The uncertain nature of the information about the receipt and expenditure of funds in the original payment calendar makes it necessary to take into account the uncertainty. For this purpose, a payment matrix is formed (Table 1).

Table 1. Payment matrix.

Alternative Portfolios	Total cash balance					
	Δ_1	Δ_2	Δ_3	Δ_4	…	Δ_m
1	Z_{11}	Z_{12}	Z_{13}	Z_{14}	…	Z_{1m}
2	Z_{21}	Z_{22}	Z_{23}	Z_{24}	…	Z_{2m}
…	…	…	…	…	…	…
n	Z_{n1}	Z_{n2}	Z_{n3}	Z_{n4}	…	Z_{nm}

Z_{nm} - value of total costs, according to the selected portfolio of alternatives for each total cash balance $\Delta_1<\Delta_2< \ldots <\Delta_n$.

To use the constructed payment matrix, it is necessary to make a choice of the decision criterion, based on the propensity of the decision-maker to risk.

It is proposed to choose a solution based on one of four criteria [7-10].

The Wald decision criterion, or maximin, is a criterion of conservatism and an attempt to maximize the level of reliability. It presents the external conditions and makes the assumption that Murphy's law is fully confirmed. Therefore, by this criterion, it is necessary to determine the worst possible outcome of each strategy, and then choose the strategy that provides the best of the worst outcomes.

The Hurwitz decision alpha criterion involves determining the decision index d for each strategy, which is the weighted average of its extreme returns. The weighting factors are the coefficients of optimism α, which is applicable to the maximum return M, and its complement 1 -α, which is applicable to the minimum return, m. The cost of each strategy is thus equal to (5):

$$di= \alpha M+ (1-\alpha)mi. \quad (5)$$

The strategy with the highest cost for di is selected as the optimal one. The coefficient of optimism is in the range from 0 to 1, which allows the decision-maker to express their subjective attitude to risk with a certain degree of optimism.

The Savage decision criterion, sometimes called the mini-max loss criterion, examines losses that represent losses resulting from making a wrong decision. Loss is measured as the absolute difference between the return for a given strategy and the return for the most effective strategy within the same state.

There is a Beis postulate, which states that if the probabilities of a phenomenon are unknown, then they should be taken equal. In the Laplace decision criterion, this postulate is used to calculate the estimated cost of any strategy; therefore, the Laplace criterion is also called the Base criterion. The chosen strategy is the strategy with the highest estimated cost, assuming equal probabilities [16].

Based on the selected criteria, the payment matrix determines the final portfolio of alternatives and the amount of money transferred. The most difficult task for the decision-maker is to choose a specific criterion that is most suitable for solving the proposed problem. The choice of criteria should be logical under the circumstances. In addition, the selection criteria should take into account the philosophy, temperament and outlook of the company's management**.** This requires that decision-makers have sufficient knowledge about the possible conditions of the external and internal environment of the enterprise and the resulting benefits.

4 Discussion

In the study, as such a criterion for assessing solvency in a given period of time and for drawing up a payment calendar, the standard of absolute liquidity was proposed, showing the degree of coverage of current liabilities. The calculation of the absolute liquidity ratio is presented below:

$$\Psi = \frac{(A+P)}{C} \quad (6)$$

where A is the cash inflow; P - rolling cash balance at the beginning of the period; C - cash outflow.

The recommended value Ψ has the following limits: $1 \le \Psi \le b$, where b is the upper value of the absolute liquidity ratio, which is set by the company itself based on established practice.

The resulting standard of absolute liquidity can be used in operational financial planning and in the analysis of current financial activities, but it must be recalculated if there is a change in the operating conditions of the enterprise [17, 18].

Testing of the proposed methodology for planning highly liquid assets of the enterprise was carried out on the basis of JSC "DZNVA". The specifics of the activity of this enterprise is the production of products and goods of electrical engineering: low-voltage equipment, consumer goods. The proposed methodology for planning highly liquid assets at the enterprise was used by JSC "DZNVA" when developing an operational financial plan for 1 month.

At the initial stage, the company carried out work to determine the data on the basis of which the original payment calendar was compiled. The necessary data was taken from the information bases of the financial, planning department and accounting department [19]. The constructed payment calendar (table. 2) has a four-level method of specifying information due to a significant interval of uncertainty in the amount of the cash balance. Such a high share of uncertainty is due to the practice of selling products on the basis of prepayment at JSC "DZNVA" and as a result, it is

impossible to determine the exact portfolio of orders for materials, components and services that need to be placed, received and brought to the enterprise. Taking into account the real possibilities in the implementation of alternatives allowed us to form an optimal portfolio of alternatives for the transfer of funds, which is presented in table 2.

Table 2. Structure of the optimal portfolio of alternatives for the transfer of funds

Alternatives Portfolio amount (thous. rubles)	Amount of the sale of receivables (thous. rubles)	Amount of restructuring of accounts payable (thous. rubles)	Amount of securities sold (thous. rubles)	Amount of the loan received (thous. rubles)
428	428	0	0	0
512	500	0	0	12
590	500	0	0	90
685	500	140	0	45

The relationship between transaction costs and the amount of money transferred was established using the optimal portfolio of alternatives model and looks like this (7):

$$T = -0.0547V^6 + 3.2201V^5 - 70.396V^4 + 671.47V^3 - 1852.6V^2 - 13481V + 114499 \quad (6)$$

where V is the required amount of money transfer.

The function of opportunity costs due to the current practice of accumulating funds in the Savings Bank of the Russian Federation was set in the form of a linear relationship, which has the following form (8):

$$A = kV' \quad (7)$$

where k is the deposit rate of the Savings Bank of the Russian Federation for one month;

V' - the amount of the deposited funds.

A graphical interpretation of the optimal money transfer model is shown in Figure 3.

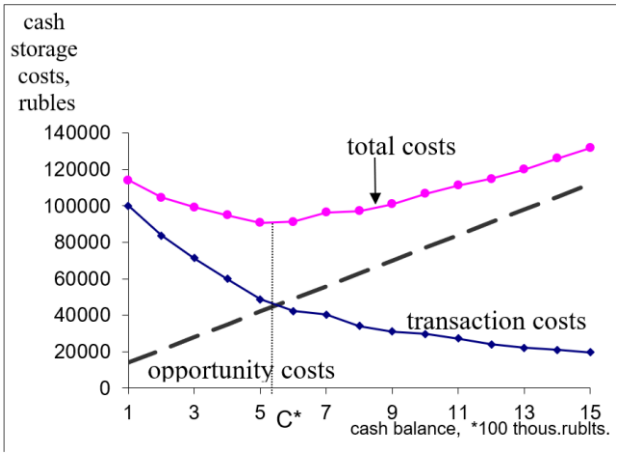

Fig. 3. Money transfer definition diagram : C*- the amount of the transfer of funds at the minimum cost.

The optimal transfer of funds, taking into account the uncertainty of the initial information on the inflow and outflow of funds in the original payment calendar, was 530,000 rubles. At the same time, the Savage criterion was used to make a decision in conditions of uncertainty. Based on the obtained optimal value of the transfer of funds, an optimal portfolio of alternatives was formed. And the final payment calendar was obtained, which allowed calculating the vector of standard coefficients of absolute liquidity Ψ (1,03; 1; 1,02; 1,01).

5 Conclusions

The algorithm for calculating the above methodology for planning highly liquid assets for enterprises and the vector of standard coefficients of absolute liquidity is proposed as the basis of the software product. This is necessary for further planning, accounting and control of the current financial and economic activities of the enterprise.

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