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MODELING OF PROCESSES INVOLVING EXTERNAL FINANCIAL RESOURCES FOR SUSTAINABLE DEVELOPMENT OF THE INDUSTRIAL ENTERPRISE

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МОДЕЛИРОВАНИЕ ПРОЦЕССОВ ПРИВЛЕЧЕНИЯ ВНЕШНИХ ФИНАНСОВЫХ РЕСУРСОВ В ЦЕЛЯХ ОБЕСПЕЧЕНИЯ УСТОЙЧИВОГО РАЗВИТИЯ ПРОМЫШЛЕННОГО ПРЕДПРИЯТИЯ

An economic utility of using short- and long-term financial resources for fixed and circulating capital is determined based on an economic-mathematical model which involves an aggregative balance sheet scheme in order to ensure the sustainable development of industrial enterprises.

CIRCULATING CAPITAL. FIXED CAPITAL. BALANCE SHEET. MODEL. SHOT- AND LONG-TERM CREDITS. LOANS.

Определяется экономическая целесообразность привлечения краткосрочных и долгосрочных финансовых ресурсов под внеоборотные и оборотные активы на основе экономико-математической модели на базе укрупненной схемы баланса в целях обеспечения устойчивого развития промышленного предприятия.

ОБОРОТНЫЕ АКТИВЫ. ВНЕОБОРОТНЫЕ АКТИВЫ. БАЛАНС. МОДЕЛЬ. КРАТКОСРОЧНЫЕ И ДОЛГОСРОЧНЫЕ КРЕДИТЫ. ЗАЕМНЫЕ СРЕДСТВА.

In the modern social and economic conditions, an increasing effectiveness of industrial enterprises and their sustainable development are of particular importance. The main directions of the enterprise development are associated with manufacturing new product and reorganizing production. At the same time, this development is possible because of finance from several sources. If the enterprise does not have enough own funds for development, it should use loans. Thus, the basic sources of financial means for the enterprise development are:

– short-term credits or loans for circulating capital;

– short-term credits or loans for fixed and circulating capital;

– long-term credits or loans for fixed and circulating capital;

– using cash flows for fixed and circulating capital [8].

These sources of finance are used in order to increase revenue and profit by increasing the necessary fixed and circulating capital. This is accompanied by the growth of accounts payable and receivable, inventory and budget payments.

Let's determine the economic expediency of borrowing short- and long-term financial resources for fixed and circulating capital using an economic and mathematical model. For this, let's construct an integrated scheme of the enterprise's balance sheet, shown in Fig. 1, where FC – fixed capital; CC – circulating capital; CR – capital and reserves; LTP – long-term passives; STP – short-term passives; IC – inventory and costs; L – loans; AR – accounts receivable; AP – accounts payable; OP – other passives; a – minimal profit rate on short-term loan; a' – minimal profit rate on long-term loan; b – rate of the profit tax; x – required projected volume of the short-term loan; x' – required projected volume of the long-term loan; z – required figure of rising (decreasing) accounts receivable; y – required figure of rising (decreasing) inventory; v – required figure of rising (decreasing) accounts payable (excluding rising profit tax); w – required figure of rising (decreasing) fixed capital [11].

$FC + w$	CR including: $ax + a'x'$
CC including: $L + y$ $AR + z$	$LTP + x'$
	SHP including $L + x$ $AP + v + \frac{(ax + a'x')b}{1 - b}$
$A + y + z + w$	$P + (1 + a)x + (1 + a')x' + v + \frac{(ax + a'x')}{1 - b}b$

Fig. 1. Integrated scheme of the enterprise balance sheet with short- and long-term credits for fixed and circulating capital

Short- and long-term credits are used to increase revenue and profit, which leads to consequent changes:

– fixed capital on w;
– circulating capital on $y + z$;
– capital and reserves on the net profit $ax + a'x'$;
– long-term passives on x';
– short-term passives on $x + v + \frac{(ax + a'x')b}{1 - b}$.

According to this, let's form the following system of mathematical relations:

1. Projected balance sheet parameters

$$y + z + w = (1 + a)x + (1 + a')x' + v + \frac{(ax + a'x')b}{1 - b}. \quad (1)$$

2. Relation of projected revenue, costs and balance profit

$$(1 - b)(R - C - BP_0) \geq ax + a'x', \quad (2)$$

where R – projected revenue; C – projected costs; BP_0 – basic balance profit.

3. Relation of projected revenue with circulating («working») capital

$$\frac{R_0}{CC - STP} = \frac{R}{(CC + y + z) - \left(STP + x + v + \frac{(ax + a'x')}{1 - b}b\right)}.$$

Hence

$$y + z - x - v - \frac{(ax + a'x')}{1 - b}b = (CC - STP)P, \quad (3)$$

where $P = \frac{R}{R_0} - 1$.

4. Expediency of getting short- and long-term credits respectively in volumes x и x' can be shown in the following way:

$$(1 - b)\left(\frac{BP_0 + \frac{ax + a'x'}{1 - b}}{(A + y + z + w) - \left(AP + v + \frac{(ax + a'x')}{1 - b}b\right)} - \frac{\overline{BIR} \cdot STVC + BIR \cdot x + \overline{BIR'} \times LTVC + BIR' \cdot x}{STVC + x + LTVC + x'}\right) \times \frac{STVC + x + LTVC + x'}{CR + ax + a'x'} \geq 0,$$

where $\overline{BIR}$, BIR – bank interest rate on short-term credit in basic and current periods (parts of the unit); $STVC$ – current volume of short-term credit; $\overline{BIR'}$, BIR' – bank interest rate on long-term credit in basic and current periods (parts of the unit); $LTVC$ – current volume of long-term credit.

In this case, the second factor is the differential of the financial leverage [5]. Therefore, loans take advantage, if it is not negative, i. e.

$$\frac{BP_0 + \frac{ax + a'x'}{1 - b}}{(A + y + z + w) - \left(CR + v + \frac{(ax + a'x')}{1 - b}\right)b} - \frac{\overline{BIR} \cdot STVC + BIR \cdot x + \overline{BIR'} \cdot LTVC + BIR' \cdot x'}{SLVC + x + LTVC + x'} \geq 0. \quad (4)$$

Result interest rate on short- and long-term credits (СБП) is calculated by the formula

$$BIR = \frac{\overline{BIR} \cdot SLVC + BIR \cdot x + \overline{BIR}' \cdot LTVC + BIR' \cdot x'}{SLVC + x + LTVC + x'}. \quad (5)$$

Determining the result interest rate on short- and long-term credits appears difficult, especially in economic crisis [1, 10]. If determining the interest rate on this credits is difficult or impossible, and, consequently, the enterprise cannot calculate the approximate credit volumes, it should determine the result interest rate with the current data, i. e.

$$BIR = \frac{\overline{BIR} \cdot SLVC + \overline{BIR}' \cdot LTVC}{SLVC + LTVC}.$$

If determining the interest rate on short- and long-term credits for the projected time is not so difficult, and, consequently, the enterprise can calculate the approximate credit volumes, the (4) formula takes the following form:

$$BIR = \frac{BIR \cdot x + BIR' \cdot x'}{x + x'}. \quad (6)$$

Result interest rate on the described credits is calculated by (6) formula, in case the enterprise has no debts by the end of the current period.

Thus, the enterprise can determine the result interest rate on short- and long-term credits in several economic conditions. Thereby, the (5) formula takes the form:

$$\frac{BP_0 + \dfrac{ax + a'x'}{1-b}}{(A + y + z + w) - \left(CR + v + \dfrac{(ax + a'x')b}{1-b}\right)} - BIR \geq 0.$$

Hence

$$y + z + w - v - \frac{(ax + a'x')}{1-b} b \leq \leq \frac{ax + a'x'}{BIR(1-b)} + \frac{BP_0}{BIR} - (A - CR). \quad (7)$$

5. Restriction of the period of circulation of the accounts receivable has the form:

$$\frac{zT}{R - R_0} \leq t_z,$$

or

$$z \leq t_z \frac{R - R_0}{T}, \quad (8)$$

where t_z – allowable period of circulation of the accounts receivable; R_0 – current revenue; T – plan period [2, 4, 6, 7].

6. Restrictions of the current liquidity ratio and own funds have the form:

$$\frac{CC + y + z}{STP + x + v + \dfrac{(ax + a'x')}{1-b} b} \geq d; \quad (9)$$

$$\frac{CR + ax + a'x' - FC - w}{CC + y + z} \geq L, \quad (10)$$

where d, L – minimal figures of current liquidity ratio and the own funds respectively.

7. Restriction of the period of circulation of the fixed capital has the form:

$$w \leq t_w \frac{R - R_0}{T}, \quad (11)$$

or

$$\frac{wT}{R - R_0} \leq t_w,$$

where t_w – allowable period of circulation of the fixed capital [2, 4, 6, 7].

8. If the current profitability indicators are the minimums of projected profitability indicators, the appropriate restrictions on the indicators of the assets profitability, capital and reserves, costs and revenue have the form:

$$\frac{R - C}{A + y + z + w} \geq \frac{BP_0}{A}; \quad (12)$$

$$\frac{R - C}{CR + ax + a'x'} \geq \frac{BP_0}{CR}; \quad (13)$$

$$\frac{R - C}{C} \geq \frac{BP_0}{C_0}; \quad (14)$$

$$\frac{R-C}{R} \geq \frac{BP_0}{R_0}. \quad (15)$$

9. Restriction of the variable (C_{var}) and fixed (C_{const}) costs

$$\frac{R}{R_0} C_{var} + C_{const} \geq C. \quad (16)$$

Relations (1)–(3), (4)–(16) form the basis for the algorithm of determining volumes of short- and long-term credits (Fig. 2). For this let's do more detail iteration analysis of the elaborated system.

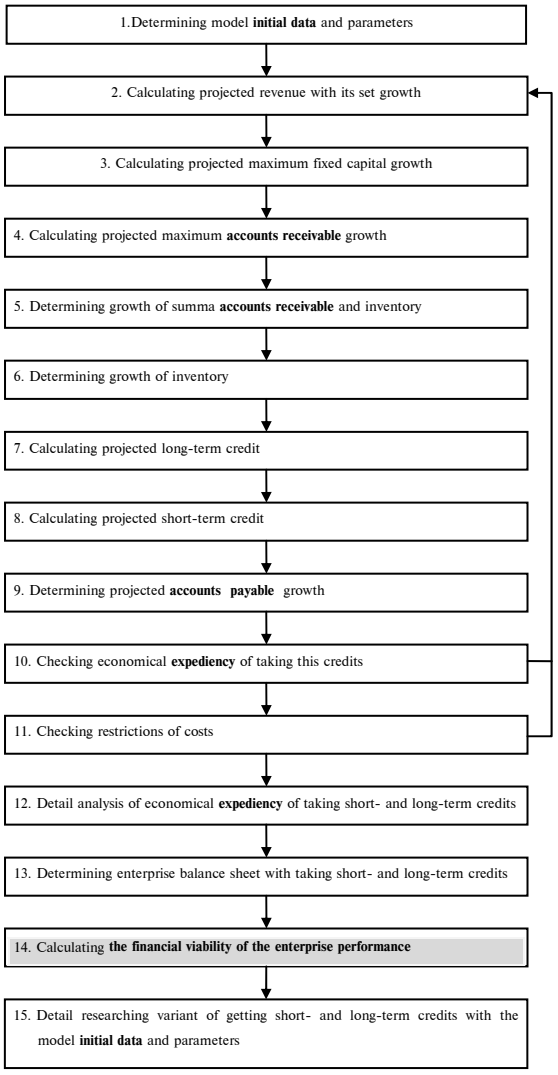

Fig. 2. Algorithm of determining financial viability of the enterprise with short- and long-term credits for fixed and circulating capital

1. Determining model initial data and parameters.

2. Calculating projected revenue

$$R = R_1 = (1+p)R_0,$$

where p – revenue growth, equal $\left(\frac{R}{R_0} - 1\right)$.

3. Using the (11) relation, we should calculate projected maximal growth of fixed capital, connected with the revenue growth (plan period is one quarter or 90 days):

$$w \leq \frac{t_w R_0 p}{T}, \quad (17)$$

where t_w – allowable period of circulation of the fixed capital, calculated on current data with the formula

$$t_w = \frac{FC \cdot T}{R_0}.$$

4. Using the (8) relation, the should calculate projected maximal growth of accounts receivable, connected with the revenue growth:

$$z \leq \frac{t_z R_0 p}{T}, \quad (18)$$

where t_z – allowable period of circulation of the accounts receivable, calculated on current data with the formula

$$t_z = \frac{AR \cdot T}{R_0}.$$

5. Determining growth of summa accounts receivable and inventory – $y + z$ with the (9) relation:

$$y + z = \frac{dSTP - (CC - STP)pd - CC}{1-d}. \quad (19)$$

6. Growth of inventory is determined by (17) formula:

$$y = \frac{dSTP - (CC - STP)pd - CC}{1-d} - z. \quad (20)$$

7. For calculating projected long-term credit – x', let's use (10) relation, if the enterprise own funds, calculated on current data – L_{ϕ}, are more than normative, i. e.

$$CR + ax + a'x' - FC - w \geq \geq L_{\phi}(CC + y + z). \quad (21)$$

In this relation, let's substitute the projected short-term credit – x, determined with (1) and (3) relations:

$$x = \frac{(CC - CR)p + w - (1 + a')x'}{a}. \qquad (22)$$

Substituting formula (20) in (21), we get:

$$x' = CR + (CC - STP)p - FC - \\ - L_{ф}(CC + y + z). \qquad (23)$$

w and $y + z$ are determined with (18) and (19).

8. Projected short-term credit – x is calculated by substituting (22) in (23).

9. Determining projected accounts payable growth v is done with (1) and (3) relations.

$$v = y + z + \left(\frac{1 + a'}{a} + \frac{b}{1 - b}\right)x' - \left(\frac{1}{a} + \frac{b}{1 - b}\right)w - \\ - (CC - STP)p\left(1 + \frac{1}{a} + \frac{b}{1 - b}\right). \qquad (24)$$

Substituting $y + z$, x' and w, determined in (19), (24) and (17), we should calculate v.

10. The check of the economic expediency of getting these credits is done with (4) by substituting w, $y + z$, x, x' and v, shown respectively in (17), (17), (21)–(24).

If the (7) relation is correct, go to 11, other wise you need to increase revenue to B_2 and repeat steps 2–9.

11. Checking restrictions of costs ((2), (12)–(16)):

$$C \le \begin{cases} (1 + p)R_0 - \dfrac{ax + a'x'}{1 - в} - BP_0; \\ (1 + p)R_0 - \dfrac{BP_0}{A}(y + z + w) - BP_0; \\ (1 + p)R_0 - \dfrac{BP_0}{CR}(ax + a'x') - BP_0; \\ \dfrac{(1 + p)R_0}{1 + \dfrac{BP_0}{C_0}}; \\ (1 + p)(R_0 - BP_0); \\ (1 + p)C_{var} + C_{const}. \end{cases}$$

If this conjunction is correct, the calculated costs reach the maximum, without worsening other financial parameters, otherwise need to increase revenue to B_2 and repeat steps 2–11.

12. Detail analysis of the economic expediency of getting short- and long-term credits.

If (4) is false, you need to calculate r_1 and r_2:

$$r_1 = y + z + w - v - \frac{(ax + a'x')}{1 - b}\left(b + \frac{1}{BIR}\right)$$

$$\text{and } r_2 = \frac{BP_0}{BIR} - (A - AP).$$

If $r_1 \ge 0$, $r_2 < 0$, getting short- and long-term credits in these amounts is not economically viable.

If revenue growth due to the credits is not economically viable, you need to increase revenue growth to P. The solution is finalised by the last revenue variant, appropriate for (1)–(3), (4)–(16), if the revenue growth in this variant is not more than maximal. Otherwise getting short- and long-term credits with such revenue growth is not economically viable.

13. Determining enterprise balance sheet with short- and long-term credits.

14. Calculating the financial viability of the enterprise performance.

15. Detail research of the variant with short- and long-term credits using the model initial data and parameters.

Determining a simultaneous use of short- and long-term financial resources in order to increas performance of industrial enterprises allows calculate most effective credit amounts for the best results with the integrated scheme of the enterprise's balance sheet. An increase of fixed and circulating capital in the most preferred destinations of enterprise development using these credits will lead to a long-term climb of revenue and profit, i. e. to an increase in competitiveness and financial stability [3, 9].

There are also two variants in the algorithm realization: first, for given values of a, a', b, $СБП$, $СБП'$ getting credits for fixed and circulating capital is not economically viable; second – credits are economically viable. In the second variant there can be several relevant decisions. An optimum variant is giving

$$\max_i NP_i\left[q_i(R_i)\right],$$

where $NP_i[q_i(R_i)]$ – net profit in i $(i = \overline{1, m})$ variant of the enterprise development with the short- and long-term credits, according to the possibility q_i of getting projected revenues R_i in plan period if $\sum_{i=1}^{m} q_i(R_i) = 1$.

Such is the integrated scheme of a company's involvement in the short-term and long-term loans for non-current and current assets, which is formed on the basis of economic and mathematical model for determining those financial resources for the sustainable development of the enterprise and, at the same time, characterized by the calculation of these types of loans. On the basis of this model, algorithm for calculating a required amount of money involved is formed, which allows to suggest a number of feasible solutions. In conclusion, it should be noted that the important task of strategic management of industrial firms is embodied in the life of the model. The proposed model can be used in various sectors of the national economy, taking into account the specifics of a particular company.

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