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MACHINE-BUILDING ENTERPRISES FINANCIAL RISKS MINIMIZATION MODELS BUILDING

Abstract. The article is based on a financial condition indicators system, which assesses the financial risk of the enterprise, and their grouping according to the nature of the impact on the enterprise financial position. The following financial risks groups have been identified: the inappropriate capital structure, inefficient financial activity, liquidity decline, ineffective operating activities, the imbalances in cash flows and ineffective investment activities risks. Each group of indicators is selected by the "center of gravity" one representative method to construct a model for assessing the financial risk in the enterprise level. It is determined that representative indicators in identifying the financial risk in an enterprise level are: coefficient of autonomy, coefficient of turnover of capital, absolute liquidity ratio, return on sales, net cash flow ratio, total return on investment.

At the next stage of constructing a model for enterprise financial risks minimizing using expert method, representative indicators are measured according to their informativity for assessing financial risk at the enterprise. Taking into account the indicators significance, a machine-building enterprises assessment financial risk model was constructed on the basis of the enterprise financial risk level indicators-representatives additive convolution with their significance weight coefficients correction.

The functional dependencies between the indicators are determined given the direct and inverse nature of the link between the indicators that characterize the machine-building enterprises financial risk, using correlation-regression analysis. An optimization model for machine-building enterprises financial risks minimizing was built on the principle of limiting financial risks. Optimizing the model means getting the maximum integral index value of the financial risk neutralization level. To this end, the Kuhn-Tucker theorem is used. As a result of model optimization it was revealed that from the point of view the financial risks at machine-building enterprises level minimizing, the optimum values of financial indicators are: for the coefficient of autonomy — 0,41; for the capital turnover coefficient — 31,0; for the coefficient of absolute liquidity — 0,45; for a profitability ratio of sales — 0,29; for the coefficient of sufficiency of net cash flow — 0,60; for the coefficient of total return on investment — 0,28. The established norms of financial indicators provide financial risk minimization at machine-building enterprises.

Keywords: financial risks, financial risks minimization, neutralization, limitation, financial stability, solvency.

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ПОБУДОВА МОДЕЛІ МІНІМІЗАЦІЇ ФІНАНСОВИХ РИЗИКІВ МАШИНОБУДІВНИХ ПІДПРИЄМСТВ

Анотація. Побудовано систему показників фінансового стану, за якими оцінюється фінансовий ризик підприємства, та здійснено їхнє групування за характером впливу на фінансовий стан підприємства. Виділено такі групи фінансових ризиків: ризик нерациональної структури капіталу, ризик неефективної фінансової діяльності, ризик зниження ліквідності, ризик неефективної операційної діяльності, ризик незбалансованості грошових потоків і ризик неефективної інвестиційної діяльності. Для побудови моделі оцінки рівня фінансового ризику на підприємстві з кожної групи показників обрано по одному репрезентативному методом «центру ваг». Визначено, що репрезентативними показниками при ідентифікації рівня фінансового ризику на підприємстві є: коефіцієнт автономії, коефіцієнт оборотності капіталу, коефіцієнт абсолютної ліквідності, коефіцієнт рентабельності продажів, коефіцієнт достатності чистого грошового потоку, сукупна рентабельність інвестицій.

На наступному етапі побудови моделі мінімізації фінансових ризиків підприємства з використанням експертного методу проранговано репрезентативні показники за їхнього інформативністю для оцінки фінансового ризику на підприємстві. З урахуванням значимості показників побудовано модель оцінки фінансових ризиків машинобудівних підприємств на основі адитивної згортки показників-репрезентантів рівня фінансового ризику підприємства з коригуванням на вагові коефіцієнти їхньої значимості.

Ураховуючи прямий і обернений характер зв'язку між показниками, що характеризують рівень фінансового ризику машинобудівних підприємств, з використанням кореляційно-регресійного аналізу, визначено функціональні залежності між показниками. Побудовано оптимізаційну модель мінімізації фінансових ризиків машинобудівних підприємств, в основу якої закладено принцип лімітування фінансових ризиків. Оптимізація моделі означає отримання максимального значення інтегрального показника рівня нейтралізації фінансового ризику. Для цього використано теорему Куна — Таккера. У результаті оптимізації моделі виявлено, що з позиції мінімізації рівня фінансових ризиків на машинобудівних підприємствах оптимальними значеннями фінансових показників є: для коефіцієнта автономії — 0,41; для коефіцієнта оборотності капіталу — 31,0; для коефіцієнта абсолютної ліквідності — 0,45; для коефіцієнта рентабельності продажів — 0,29; для коефіцієнта достатності чистого грошового потоку — 0,60; для коефіцієнта сукупної рентабельності інвестицій — 0,28. Установлені нормативи фінансових показників забезпечують мінімізацію фінансового ризику на машинобудівних підприємствах.

Ключові слова: фінансові ризики, мінімізація фінансових ризиків, нейтралізація, лімітування, фінансова стійкість, платоспроможність.

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ПОСТРОЕНИЕ МОДЕЛИ МИНИМИЗАЦИИ ФИНАНСОВЫХ РИСКОВ МАШИНОСТРОИТЕЛЬНЫХ ПРЕДПРИЯТИЙ

Аннотация. Построены модель оценки уровня финансовых рисков на машиностроительных предприятиях, а также модель минимизации финансовых рисков машиностроительных предприятий. Определены оптимальные значения финансовых нормативов: коэффициента автономии, оборачиваемости капитала, абсолютной ликвидности, рентабельности продаж, достаточности чистого денежного потока, совокупной рентабельности инвестиций, соблюдение которых снизит уровень финансовых рисков на предприятиях, обеспечит эффективность их деятельности, финансовую устойчивость, ликвидность и платежеспособность.

Ключевые слова: финансовые риски, минимизация финансовых рисков, нейтралізація, лімітування, фінансова стійкість, платоспроможність.

Формул: 3; рис.: 2; табл.: 2; библи.: 13.

Introduction. The current state of the machine-building industry in Ukraine is characterized by a loss-making activity, a decrease in export potential, the volatility of the volumes of manufacturing and sales, and the volume of investment. The biggest crisis for the industry was 2014 when, due to the unstable macroeconomic and political situation in the country, the destruction of partnerships with counteragents, the volume of sales of mechanical engineering products decreased by 10.5% compared to 2013, the volume of capital investment — by 15, 1%. During 2015-2017, despite the increase in sales volumes, the industry remains unprofitable. According to the results of 3 quarters of 2017, the enterprises of machine-building industry received a surplus of UAH 5039.7 million. Against this background, exports are decreasing every year starting from 2014: the average annual rate of decrease is 18.4% [1]. The statistical data given testifies to the unstable financial state of the enterprises of machine-building industry and high level of financial risk, which determined the relevance of the study.

Analysis of research and problem statement. Significant contributions to the development of approaches to minimizing the financial risks of the enterprise were made by such scholars as: Pysmenna T. [2], Polyakova O. [3], Al-Kassar T. [4], Fang F. [5], Monti N. [6], Wang X. [7]. Despite a significant number of developments in this direction, the problem of defining internal

financial standards remains unresolved, observance of which will ensure the stable functioning of domestic enterprises.

Therefore, the purpose of the study is to improve the methodological tools for assessing financial risks of enterprises in the machine-building industry and determining the optimal values of financial indicators that will ensure the financial sustainability of the enterprise and maximize the efficiency of the activity, thereby minimizing the level of financial risks. Methods for solving the purpose of the study: generalization, systematization, expert method, "center of gravity" method, correlation-regression analysis, linear programming method.

Research results. In the system of methods of minimizing financial risks of the enterprise the main role belongs to internal mechanisms. Internal mechanisms for neutralization of financial risks are a system of methods for reducing their negative effects, which are selected and implemented within the enterprise itself. The algorithm of constructing a model for minimizing financial risks of an enterprise is presented in Fig. 1

	<i>Stages</i>	<i>Methods, techniques</i>
	I. Formation of a system of indicators of financial risk assessment of an enterprise by groups of financial risks	Generalization, systematization
	II. Determination of representative indicators by groups of financial risks	"Center of gravity" method
	III. Ranking of indicators by their significance (informative value) for assessing financial risk	Expert method
	IV. Construction of a model for assessing financial risks of an enterprise	Expert method, adaptive convolution
	V. Modeling of connections between indicators of financial risk assessment of an enterprise	Correlation-regression analysis
	VI. Construction of a model and definition of optimum values of financial indicators, which minimizes the level of financial risks of an enterprise	Linear programming method

Fig. 1. An algorithm of constructing a model for minimizing financial risks of an enterprise

In order to successfully select the direction of developing the internal mechanisms for neutralization of financial risks, it is necessary to develop a model for calculating the overall level of financial risks. The developed integral indicator of the level of financial risks should combine the assessment of different types of risks into one indicator, thus summarizing the level of financial risk neutralization in the enterprise.

For the construction of the model, financial indicators were used, which assess the financial risk of the enterprise, and are grouped according to the main types of financial risks: the risk of irrational capital structure, the risk of inefficient financial activity, the risk of reducing liquidity, the risk of ineffective operating activities, the risk of imbalance of cash flows and the risk of ineffective investment activity [3-4, 6-9]. All of the above-mentioned risks can be divided into three groups of risk: the risk of financial sustainability, the risk of insolvency and the risk of ineffective investment activity (Fig. 2).

Construction of a model for assessing financial risks of an enterprise based on the totality of these indicators will result in high labor intensity and multicollinearity between the indicators, which will reduce the reliability of the modeling results. Consequently, for constructing a model from each group of assessment of financial risk one representative was selected, using the "center of gravity" method.

Thus, the representative of the "risk of irrational structure of capital" group is the coefficient of autonomy. It is the one, that characterizes the financial independence of the enterprise, has the smallest amount of Euclidean distances to other objects of the group. A representative of inefficient financial activity risk group is the working capital turnover ratio. It reflects working capital turnover of the company and characterizes the effectiveness of the financial activity of the enterprise [3-4, 6-7].

<i>Types of financial risks of an enterprise</i>		<i>Estimation indicators</i>
<i>Risk of lowering financial stability</i>	Risk of irrational capital structure	Coefficient of autonomy Coefficient of dependence Coefficient of maneuverability of own funds Coefficient of financial dependence
	Risk of ineffective financial activity	Return on equity ratio Working capital turnover ratio Return on equity ratio Working capital turnover ratio
<i>Insolvency risk</i>	Liquidity risk	Quick liquidity ratio Current liquidity ratio Absolute liquid ratio Sufficiency of working capital Coefficient of maneuverability of equity capital
	Risk of ineffective operational activity	Non-current assets ratio Working capital ratio Non-current asset turnover ratio Current asset turnover ratio Return on Sales Gross profit ratio of the main activity Operating profit ratio
	Risk of cash flow imbalances	Cash flow liquidity ratio Cash flow efficiency ratio Net cash flow adequacy ratio
	<i>Risk of ineffective investment activity</i>	Total return on investment Return on investment less accounts payable Portfolio weight of investment income in the annual inflow of cash

Fig. 2. The system of indicators for assessing the financial risks of the enterprise

The representative responsible for the liquidity risk is the absolute liquidity ratio. It shows how much of the short-term debt can be covered by the most liquid assets: cash and cash equivalents, current financial investments. The risk group of inefficient operating activities is a return on sales ratio that describes the effectiveness of an operating activity [6-9]. In the groups of "cash flow imbalances" and "risk of ineffective investment activity", the representatives are the ratio of cash flow adequacy and total return on investment, accordingly.

At the next stage of constructing a model for minimizing financial risks of an enterprise using expert method, representative indicators were ranked according to the importance (informativity) for assessing financial risk. The main advantages of the chosen method of expert evaluations are the ease of organization of the survey, comprehension, consideration and use of the acquired knowledge and experience of each expert [10]. The experts were the workers of the planned economic, financial departments of the machine-building enterprises of Kharkiv: SE "Plant" Electrotyazhmash", SRPE "Kommunar Association", PJSC "Turboatom", PJSC "Kharkiv Machine-Building Plant "Light of the Miner", PJSC "Kharkiv Bearing Plant", PJSC "Plant "PivdenKabel", SE "Kharkiv Machine-Building Plant "FED", PJSC "Khartron", PJSC "Elektromashina", PJSC "Avtramat". Grades were put from 1 to 6 (1 — the most important indicator, 6 — the least important). The matrix of the ranks of indicators for assessing the financial risks of machine-building enterprises is shown in Table. 1.

The consistency of expert opinions on the importance of indicators for assessing financial risks of machine-building enterprises is confirmed by the coefficient of Kendal's concordance, the value of which is 0.8, which is above the permissible level of 0.7 [10]. Consistency of expert opinions and inclusion in the expert group of leading employees of machine-building enterprises makes it possible to assert the reliability of the results of expert evaluation and the importance of selected indicators for assessing financial risks of machine-building enterprises.

Table 1

The significance of the ranks of importance of indicators for assessing the financial risks of machine-building enterprises

Experts	Indicators					
	Coefficient of autonomy	Working capital turnover	Absolute liquidity ratio	Return on sales	Net cash flow adequacy ratio	Total return on investment
Expert 1	1,5	3	1,5	4	5	6
Expert 2	1	4	2	3	5	6
Expert 3	2	5	1	3	6	4
Expert 4	1	4	3	2	5	6
Expert 5	2	4	1	3	5	6
Expert 6	1	3	2	4	6	5
Expert 7	1	5	2	3	4	6
Expert 8	2	3	1	4	5	6
Expert 9	1	2	3	5	4	6
Expert 10	1	4,5	3	2	4,5	6

Based on expert estimates, the weight coefficients were calculated — coefficients of significance of indicators for assessing financial risks (Table 2) according to Fisher's rule (1) [10].

$$\alpha_i = \frac{2(n-i+1)}{n(n+1)} \quad (1)$$

where n — the number of factors;
 i — expert evaluation.

Table 2

Calculation of weight coefficients of financial risk assessment indicators according to Fisher's rule

Experts	Indicators					
	Coefficient of autonomy	Working capital turnover	Absolute liquidity ratio	Return on sales	Net cash flow adequacy ratio	Total return on investment
Expert 1	0,26	0,19	0,26	0,14	0,10	0,05
Expert 2	0,29	0,14	0,24	0,19	0,10	0,05
Expert 3	0,24	0,10	0,29	0,19	0,05	0,14
Expert 4	0,29	0,14	0,19	0,24	0,10	0,05
Expert 5	0,24	0,14	0,29	0,19	0,10	0,05
Expert 6	0,29	0,19	0,24	0,14	0,05	0,10
Expert 7	0,29	0,10	0,24	0,19	0,14	0,05
Expert 8	0,24	0,19	0,29	0,14	0,10	0,05
Expert 9	0,29	0,24	0,19	0,10	0,14	0,05
Expert 10	0,29	0,12	0,19	0,24	0,12	0,05
Resulting weight coefficient	0,27	0,15	0,24	0,18	0,10	0,06

The resulting weight coefficients is calculated as the average arithmetic estimate determined by each expert.

Consequently, taking into account the significance of the indicators and their weight coefficients, a model for assessing the financial risks of machine-building enterprises has been constructed. Since all the indicators for assessing the level of financial risk: the coefficient of autonomy, working capital turnover, absolute liquidity, return on sales, sufficiency of net cash flow, total return on investment are stimulators for the financial position of enterprises and their growth will reduce the level of financial risk, the model of integral estimation of level of financial risks neutralization of machine-building enterprises:

$$I = 0.27x_1 + 0.15x_2 + 0.24x_3 + 0.18x_4 + 0.1x_5 + 0.06x_6 \quad (2)$$

where I — integral indicator of the level of financial risks neutralization at the enterprise;

x_1 — coefficient of autonomy;

- x_2 — working capital turnover;
- x_3 — absolute liquidity ratio;
- x_4 — return on sales;
- x_5 — net cash flow adequacy ratio;
- x_6 — total return on investment.

In addition to assessing the level of financial risk, an important aspect of financial management is its neutralization.

The most common practice in risk management by the method of financial risk neutralization is limitation [2-3, 5-6]. Using it, the company takes risks and does not have significant costs.

Limiting operates through the introduction of internal financial standards at the enterprise. To this end, it is necessary to find the optimal values of the financial indicators, which will be the basis for calculating the relevant limits. Optimizing the model means getting the maximum value of the integral index of the level of financial risk neutralization. To this end, the Kuhn-Tucker theorem [11] is used. When it comes to optimization problems with constraints in the form of equations, when constructing optimality criteria, we can use Lagrange multipliers. Kuhn and Tucker summarized this approach in the case of the general problem of linear programming with constraints, both in the form of equality, and in the form of inequalities [12].

Since the indicators for assessing the level of financial risks in the constructed model can have a direct (working capital turnover ratio — absolute liquidity ratio, absolute liquidity ratio — return on sales ratio, return on sales ratio- net cash flow adequacy ratio) and inverse (coefficient autonomy — the working capital turnover ratio, net cash flow adequacy ratio- the total return on investment) nature of the connection, it is necessary to determine functional relationship between the indicators. For this purpose, the method of correlation-regression analysis was used. The statistical significance of the results of the modeling of the relationships between the indicators of financial risk assessment of the enterprise is confirmed by the correlation coefficient ($R \rightarrow 1$), the determination ($R^2 > 0,75$), the Fisher criterion ($F_{\text{розрах.}} > F_{\text{табл.}}$), Student ($|t_{\text{розрах.}}| > t_{\text{табл.}}$) and the level of error ($p < 0,05$) [13].

As a result of determining the functions of dependencies between the indicators, the following system of equations describing the model of financial risk minimization in machine-building enterprises was obtained:

$$\left\{ \begin{array}{l} I = 0,27x_1 + 0,15x_2 + 0,24x_3 + 0,18x_4 + 0,1x_5 + 0,06x_6 \rightarrow \max; \\ x_1 = -0,0008x_2 - 0,0620; \\ x_2 = 34,1482x_3 + 0,4937; \\ x_3 = 3,6365x_4 + 2,3443; \\ x_4 = 0,0218x_5 + 0,0454; \\ x_5 = -0,2737x_6 - 0,1277 \end{array} \right. \quad (3)$$

As a result of solving the system of equations, it was discovered that from the point of view of minimizing the level of financial risks at machine-building enterprises, the optimum values of financial indicators are: for the coefficient of autonomy — 0,41; for the working capital turnover ratio — 31,0; for the coefficient of absolute liquidity — 0,45; for return on sales ratio — 0,29; for the coefficient of net cash flow adequacy — 0,60; for the coefficient of total return on investment — 0,28.

The received norms have been tested on the financial records of SE "Plant" Electrotiyazhmash", SRPE "Komunar", PJSC "Turboatom", for which the integral indicators of the level of financial risks neutralization, taking into account the proposed norms, increased compared to the actual values for 2016 at 7,9%, 10,1% and 2,7% accordingly. We can conclude that the optimum values of the indicators can be used as a basis for the development of internal financial standards in machine-building enterprises.

Conclusions. As a result of the study, a model for minimizing the level of financial risks of machine-building enterprises was carried out, which determined the optimum values of financial

indicators, the use of which for the establishment of internal norms will improve the financial state and minimize the level of financial risk of enterprises. Prospects for further research in this area are development of scenarios for minimizing financial risks of domestic enterprises.

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