

ASSESSMENT OF THE FINANCIAL SECURITY LEVEL OF MACHINE-BUILDING ENTERPRISES USING THE INTEGRAL-RATING METHOD

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In the article the necessity of financial diagnostics of machine-building enterprises as one of the tools of financial and economic security has been substantiated. The presence of a large number of output indicators complicates the process of analysing financial security, makes it cumbersome, reduces its informativeness and negatively affects the importance of weighting factors has been established. To solve this problem, it has been proposed to use a sequential convolution procedure, in which the output indicators were first grouped into four groups according to a certain characteristic. For each group a generalized indicator has been defined which contains a number of calculated initial indicators. With the help of financial diagnostics, indicators of activity of certain enterprises of mechanical engineering of Zaporizhzhia region have been calculated and, on their basis, the financial safety of the investigated enterprises has been determined. It has been established that the critical value of the integral indicator of financial security reached the enterprise of PJSC "Zaporizhtransformator." The integral indicator of financial security of this enterprise was far from the norm, but also became negative. The actual definition of such an economic category as the financial and economic security of the enterprise has been given.

ОЦІНКА РІВНЯ ФІНАНСОВОЇ БЕЗПЕКИ ПІДПРИЄМСТВ МАШИНОБУДУВАННЯ ЗА ДОПОМОГОЮ ІНТЕГРАЛЬНО-РЕЙТИНГОВОГО МЕТОДУ

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Обґрунтовано необхідність фінансової діагностики підприємств машинобудування як одного з інструментів забезпечення фінансово-економічної безпеки. Установлено, що наявність великої кількості вихідних показників ускладнює процедуру аналізу фінансової безпеки, робить його громіздким, знижує інформативність та негативно впливає на значущість вагових коефіцієнтів. Для вирішення цієї проблеми запропоновано використати процедуру послідовної згортки, у якій вихідні показники спочатку групуються на чотири групи за певною характеристикою. Для кожної групи визначено узагальнений показник, який містить низку розрахованих вихідних показників. За допомогою фінансової діагностики розраховано показники діяльності окремих підприємств машинобудування Запорізької області та на їх основі визначено стан фінансової безпеки досліджуваних підприємств. Установлено, що критичного значення інтегрального показника фінансової безпеки досягло підприємство ПАТ «Запоріжтрансформатор». Інтегральний показник фінансової безпеки цього підприємства не тільки не перебував у межах нормативу, але й набув від'ємного значення. Надано власне визначення такої економічної категорії, як фінансово-економічна безпека підприємства.

Statement of the problem

In the deepening of the financial crisis, enterprises are trying to implement an effective anti-crisis policy. The financial system as a source of accumulation of modern crisis phenomena, which are spreading further to all spheres of the economy, generally requires the formation of new instruments to ensure their financial and economic security. The constant increase in the riskiness of economic activity may entail a significant decrease in the level of financial stability and solvency of the enterprise, and in the future lead to bankruptcy, and

requires each business entity to create a perfect system of financial and economic security.

The modern business environment highlights the issues of ensuring financial and economic security. Proper assessment of it, as well as diagnostics of the financial condition of enterprises is a priority task of ensuring sustainable development and operation of the enterprise.

Analysis of recent studies and publications

In the economic theory and law theory, various concepts of security have been developed, in particular, in the management of economic systems. It should be noted

that the category of economic security is treated differently in the scientific literature [2-4]. Thus, in the opinion of T.H. Vasylytsiv, V.I. Voloshyn, O.R. Boikevych and V.V. Karkavchuk [4], "...under the economic security of the system, it is necessary to understand the set of properties of the state of its production subsystem, which provides the possibility of achieving the goal by the whole system." Y.A. Blank [3] believes that "...economic security is a system to protect the vital interests of the state. Objects of protection at the same time can act: the economy of the country as a whole, certain regions, spheres and sectors of the economy, legal entities and individuals." According to I.P. Moiseienko and O.M. Marchenko [2] "...economic security is a state of the economic system that allows it to develop dynamically, effectively and solve social problems, and in which the state has the ability to produce and enforce an independent economic policy."

Following the analysis of the given definitions, let's provide our own interpretation of this indicator. Thus, the financial and economic security of the enterprise is constant maintenance at the enterprise increase of a level of financial and economic indicators, effective management of the finance using the creation of necessary preconditions of protection of the enterprise from external and internal threats.

Analysis of approaches to diagnosing the level of financial security of the enterprise shows that this problem has not yet been sufficiently investigated. Thus, there are no sufficiently substantiated criteria for the level of financial security, the formation of which can be carried out after the development of a typology of possible states of the enterprise's security on the basis of the classification of financial security factors of the enterprise.

Objectives of the article

The purpose of the article is the assessment of the financial security level of machine-building enterprises in the Zaporizhzhia region using the integrated-rating method.

The main material of the research

The providing of the financial security involves the allocation, analysis and assessment of existing threats for each of the functional components and the development on their basis of a system of measures that prevent and counteract the emergence of crisis phenomena in the enterprise.

The main requirements for the model of financial security are:

- to reflect the general features of financial security;
- to be adequate and produce results that are close to real;
- to enable the use of the model for making managerial decisions;
- to provide the possibility of comparing several enterprises;

In addition, the model should be implemented in a certain, preferably available software product, and when changing the input data, it must correctly generate a response to the assigned tasks.

However, the presence of a large number of initial indicators complicates the procedure for analysing financial security, makes it cumbersome, reduces its informativeness and negatively affects the importance of weighting factors. To solve this problem, it is suggested to use the sequential convolution procedure, in which the initial indicators are first grouped into four groups according to a certain characteristic. For each group, a generalized indicator has been defined that contains a number of calculated baseline indicators.

Adequate mathematical models for the management of financial security require a comprehensive consideration of uncertainties associated with the features of the functioning of enterprises in modern market conditions:

- target conditions (availability of qualitatively defined decision-making goals, psychological aspects of human acceptance of the proposed solutions);
- simulated objects and subject areas (conflict nature, availability of expert information, describes the object, restrictions on resources)
- initial and current information about the occurring processes (contradictions, inaccuracies, fuzziness, ambiguity).

There are a significant number of methods in which various analytical formulas are used to calculate the valuation of individual properties and to comprehensively assess the level of financial security.

One of the most convenient ways to construct a generalized response is the Harrington desirability function. The construction of this function is based on the idea of converting the natural values of private responses into a dimensionless scale of desirability or advantages. The desirability scale refers to psychophysical scales, the purpose of which is the establishment of a correspondence between physical and psychological parameters. Various responses that characterize the functioning of the investigated object are understood by physical parameters [9].

The choice of indicators is due to the fact that all indicators in the complex should determine the financial security of the enterprise. Factors of the financial security of the company are ordered on the basis of an expert method (the employees of the economic department of the enterprises studied were sent questionnaires for the expert assessment to determine the main indicators of the financial security of enterprises, then, taking into account these questionnaires, the group of financial safety factors was formed). As a result, the following indicators of the financial security factors of the enterprise were selected: liquidity; financial sustainability; profitability; business activity.

The financial security of the enterprise (Y) can be estimated on the basis of values of generalized groups of indicators (factors) (Table 1):

$$Y=f_Y(X_1, X_2, X_3, X_4), \quad (1)$$

where X_i – the corresponding i -th group of exponents.

Table 1 – Groups of indicators (factors) of financial security of the enterprise

Groups of indicators		Indicators	
Indicators of financial sustainability	X ₁	Coefficient of stability of economic growth	X ₁₁
		Concentration factor of borrowed capital	X ₁₂
		Coefficient of financial stability	X ₁₃
		Coefficient of financial stability (financing)	X ₁₄
		The coefficient of financial independence (autonomy)	X ₁₅
		Coefficient of manoeuvrability of equity capital	X ₁₆
Indicators of solvency and liquidity	X ₂	Absolute liquidity ratio	X ₂₁
		Coefficient of quick liquidity	X ₂₂
		Total liquidity ratio	X ₂₃
Indicators of receivables	X ₃	Ratio of own capital turnover	X ₃₁
		Asset turnover ratio	X ₃₂
		Accounts receivable turnover ratio	X ₃₃
Indicators of profitability and solvency	X ₄	Profitability of capital (assets) by net profit	X ₄₁
		Profitability of equity capital	X ₄₂
		Profitability of production assets	X ₄₃
		Profitability of sales on net profit	X ₄₄

The integrated value of each of these groups of indicators can be calculated by the following factors:

$$X_i = f_i (X_{i1}, \dots, X_{ij}), i=1, N, j=1, M, \tag{2}$$

where N – the number of generalized groups (N = 4);

M – the number of indicators in a group.

The presented set of indicators is one of the possible variants and can be formed by the expert individually for each individual enterprise considering its specificity.

The enterprises of the Zaporizhzhia region will determine the values of performance indicators, which further we will use for building the model.

After the values of the parameters characterizing certain aspects of the financial state of the investigated enterprise have been obtained, they must be reduced to a dimensionless form. The normalized value of the i-th indicator is calculated by the formula:

$$\tilde{x}_i = \frac{x_i - x_i^{min}}{x_i^{max} - x_i^{min}}, i = 1, n. \tag{3}$$

In the future, let's determine the importance of groups and individual indicators, for which let's use the Fishburn rule [9], which reflects the fact that nothing is known about the significance level of indicators except their importance relative to each other.

Let's determine the significance of each indicator in accordance with the strategy of the enterprise or the main objectives of its activities, assigning the corresponding ratings to the indicators. Let's put in correspondence to

each exponent X_j the level of its significance r_i for analysis. To assess this level, it is necessary to arrange all the indicators in descending order of significance in such way that the rule is fulfilled:

$$r_1 \geq r_2 \geq \dots \geq r_n. \tag{4}$$

If the system of indicators is ranked in order of decreasing importance, then the importance of the i-th index will be determined in accordance with the Fishburn rule:

$$r_i = \frac{2(N - i + 1)}{(N + 1)N}, i=1, N \tag{5}$$

where r_i – the significance of the corresponding factor;

N – the total number of factors;

i – the place in the rank of a separate indicator.

Then the estimate (9) corresponds to the maximum entropy of the available information uncertainty about the object of research; it allows making better estimates in a bad information situation.

In accordance with this, let's obtain the following results (Table 2). In this case, let's assume that all the indicators in the groups are equivalent to each other, that is, the weight coefficients for them will be the same:

$$r_{ji} = 1/M, i=1, N, j = 1, M. \tag{6}$$

Calculations of the weight coefficients of groups and individual indicators are given in Table 2.

Table 2 – Weights for financial security indicators

Name of the group	Weight of the group	Indicators, x _i	Weight of the indicators, ω _i
Indicators of financial sustainability	0,4	Coefficient of stability of economic growth	0,08
		Concentration factor of borrowed capital	0,08
		Coefficient of financial stability	0,08
		Coefficient of financial stability (financing)	0,08
		The coefficient of financial independence (autonomy)	0,08
Indicators of solvency and liquidity	0,3	Coefficient of manoeuvrability of equity capital	0,1
		Absolute liquidity ratio	0,1

		Coefficient of quick liquidity	0,1
Indicators of receivables	0,2	Total liquidity ratio	0,07
		Ratio of own capital turnover	0,07
		Asset turnover ratio	0,07
Indicators of profitability and solvency	0,1	Accounts receivable turnover ratio	0,025
		Profitability of capital (assets) by net profit	0,025
		Profitability of equity capital	0,025
		Profitability of production assets	0,025

For the diagnosis of financial security, let's use the Harrington desirability function [7, 9], which is a quantitative, unambiguous, unique and universal indicator of the quality of the investigated object, and if let's add qualities such as adequacy, efficiency, and statistical sensitivity, it becomes clear that it can be used as an optimization criterion:

$$D = \sqrt[k]{d_1 \times d_2 \times \dots \times d_k}, \tag{8}$$

$$d_i = \exp(-\exp(-G_i)). \tag{9}$$

where k – the number of indicators used for assessment;
 d_i – a particular function defined in accordance with the Harrington scale;
 G_i – group generalizing exponents of the i -th group in the non-virtual form.

To construct the generalized Harrington desirability function, it is necessary to convert the response values into a dimensionless desirability scale. The construction of a desirability scale that establishes the relationship between the response value and the corresponding value of the particular desirability function is basically subjective, reflecting the investigator's attitude.

For the qualitative assessment of all levels of economic parameters, let's define the linguistic variable "Indicator level," the set of values of which will be represented by the following subsets:

1. Financial danger ("FD") – an enterprise is characterized as having very low financial stability, it is on the verge of bankruptcy.
2. Unsustainable financial security ("U") – situation in which there is a violation of solvency, but it remains possible to replicate the balance of payment instruments and payment obligations by attracting temporarily free sources of funds into the turnover of the enterprise.
3. Normal financial security ("N") – the enterprise is characterized by an average financial stability.
4. High financial security ("H") – the enterprise is characterized by high financial stability, has a high margin of competitiveness.
5. Absolute financial security ("A") – the financial condition of the enterprise is stable, so rapidly developing, characterized by a sufficiently high level of solvency in comparison with other enterprises.

The Harrington scale is conditionally divided into five sections that correspond to the above variables of financial security and characterizes the dimensionless value of the considered indicators. The point with the coordinates (0.00; 0.37) is the critical point of inflection of desirability – it divides the values of the indicators into satisfactory and unsatisfactory (Table 4).

Table 4 – Grades of investment attractiveness depending on the values of the desirability function

Function value	Characteristics of the financial security level
1,00-0,81	Absolute financial security ("A")
0,80-0,64	High financial security ("H")
0,63-0,38	Normal financial security ("N")
0,37-0,21	Unsustainable financial security ("U")
0,20-0,00	Financial danger ("FD")

In the practical implementation of the proposed methodology, it should be considered a simplification that the choice of financial coefficients is not always unambiguous.

Let's calculate the corresponding values of the desirability function (12) and determine the level of financial security in accordance with the scale of assessments of the machine building enterprises of the Zaporizhzhia region. The results are shown in Table 5.

Table 5 – Assessment of the financial security level

№	Enterprise	Період				
		2014	2015	2016	2017	2018
1	PJSC "Zaporizhzhia plant of heavy crane building"	0,075	0,175	0,278	0,129	0,097
		(«FD»)	(«FD»)	(«U»)	(«FD»)	(«FD»)
2	PJSC „Zaporizhtransformator”	0,211	0,222	0,327	0,330	0,272
		(«U»)	(«U»)	(«U»)	(«U»)	(«U»)
3	NPO «Energomash»	0,309	0,303	0,322	0,225	0,248
		(«U»)	(«U»)	(«U»)	(«U»)	(«U»)
4	PJSC «Berdyansk reapers»	0,316	0,341	0,221	0,265	0,298
		(«U»)	(«U»)	(«U»)	(«U»)	(«U»)

Consequently, the level of financial security of machine building enterprises in the Zaporizhzhia region during 2014-2018 is characterized by a low level.

Based on the obtained value of the generalized desirability function, it is possible to construct a regression equation, to obtain the predicted value of this indicator for the future period and to predict the level of financial security for the forthcoming period.

Conclusions

Thus, in the process of assessing the financial and economic security of the enterprises of mechanical engineering using the integral-rating method are:

- the table with financial security input data has been generated;

- the calculation table has been constructed with the ones defined in the modelling of financial security for each research object;

- the calculation of standardized values of financial security indicators;

- for the transition to the calculation of the group generalizing indicators by additive convolution, the calculation of the weight coefficients by the Fishburn rule has been carried out;

- the integral indicator has been calculated by using Harrington generalized desirability function, which allows the numerical quality of the object to match the verbal value of desirability.

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