"Assessment of the level of financial and economic security at machine-building enterprises: evidence from Ukraine"

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ASSESSMENT OF THE LEVEL OF FINANCIAL AND ECONOMIC SECURITY AT MACHINE-BUILDING ENTERPRISES: EVIDENCE FROM UKRAINE

Abstract

Determining the level of financial and economic security of an enterprise allows assessing the real possibilities to confront internal and external challenges and defining the potential for future development. To develop proposals on assessing this level, the study uses data on machine-building enterprises of Zaporizhzhia region (Ukraine) and applies integral method, regression analysis and normalization. The expert evaluation method was used to form the system of key parameters. The experts were economists, the accounting departments' and the economic security departments' members of the studied enterprises. The experts selected six indices that they consider to be the most representative of the financial and economic security of an enterprise. These parameters were used to calculate the integral indicator of the level of financial and economic security of enterprises. Harrington's approach was used to group enterprises according to their level of financial and economic security (very high, high, steady, satisfactory and unsatisfactory). The calculations have shown that the integral indicator of financial and economic security of the enterprises of Zaporizhzhia region ranged from 0.32 to 0.66 for the period 2014–2018. It was justified that along with the support of financial stability, solvency, business activity, profitability, investment attractiveness and innovativeness and absent sharp changes in the environment, the level of financial and economic security of machine builders will increase from 0.4 to 11.9%.

INTRODUCTION

Deepened international cooperation, both nationally and at the micro level, is accompanied by an increase in external and internal challenges and increased competition. The purpose of an enterprise is not only to survive in the face of uncertainty and risk, but also to achieve a high level of development and enter international markets with competitive products. Therefore, determining the level of the enterprise security is necessary to evaluate the prospects for its development.

The industry in general and the machine-building sector in particular have a strategic impact on the development of any state; this determines its priority in terms of investment attractiveness. The higher

the level of financial and economic security the enterprises of the industry have, the higher the indicator for the industry as a whole, which determines the stability and prospects for its future development. Therefore, the machine building industry will be more attractive to invest.

Assessing the level of financial and economic security is important for an enterprise, as it reveals its strengths and weaknesses and, based on forecasts, identifies the directions of ensuring adequate financial and economic security.

1. LITERATURE REVIEW

Over the last years, in Ukraine, the issue of the enterprise security is increasingly addressed by researchers. An important element of security is its financial and economic component. Therefore, business managers are interested in getting actual data on its level and means of support.

Teneva, Nikolova-Alexieva, and Yaneva (2018) have explored theoretical aspects of financial and economic security in Ukraine. They view economic security as the state, level and prospects for the industrial enterprise development. In view of this, financial and economic security is assessed by constructing a multifactor model and must consider the nature and impact of external factors, on the one hand, and, on the other, the operation of an enterprise in the financial, economic and industrial context under dynamic development of market relations. Only a comprehensive assessment, which includes several common functional components such as financial, technological, intellectual, human, political, legal, and environmental, allows diagnosing the level of financial and economic security of the enterprise. Nikitina and Gorovyi (2017) confirmed the need to consider many factors. They identified main functional components of financial and economic security of an enterprise and argued that the environmental factor significantly affects its financial and economic security.

Sosnovska and Zhytar (2019) have argued that in today's economic realities, achieving the necessary level of financial security of enterprises is a condition for ensuring their sustainable development and competitiveness in the internal and external market environment. The authors propose to systematize the indicators of assessment of the financial security level by its most typical functional components, among which one can distinguish

investment, credit, issuing, innovations and currency. The paper indicates that the level of financial and economic security contributes to creating high-quality financial potential, ensuring competitive advantages, harmonizing the interests of economic entities and creating an effective system of financial and economic security of an enterprise. Sustainable development of an enterprise in unstable economic environment is defined as a criterion for the efficiency of ensuring financial and economic security of an enterprise.

Vasilenko and Titova (2019) show the impact of macroeconomic policy on financial and economic security. They point out that the current conditions are driven by constant changes in macroeconomic policies that directly affect the financial and economic performance of economic entities. The economic security of an individual enterprise depends on a properly formulated accounting and taxation policies, as well as counterparty agreements. Iershova, Tkachenko, Garkusha, Miroshnyk, and Novak-Kalyayeva (2019) share this opinion. They proved that the main causes of economic dangers for enterprises are: unstable economic and political situation in the country forcing enterprises to carry out economic activities under risk and uncertainty. This requires the improvement of economic policy, which envisages a symbiosis of the rationality principles and appropriate risk in business activity of enterprises, support of their own financial interests in the market, the desire of enterprises to increase profits and competitive advantages, which directly affect the level of financial and economic security. When analyzing the concept of financial and economic security, scientists have defined it as protection or conservation of entrepreneurial activity to ensure the realization of their own financial interests, optimal use of financial resources, maintaining and growth of profitability and liquidity. Financial and economic security of enterprises is seen as two as-

pects: protection and state (condition), which includes three components such as financial interests, financial resources and financial condition.

Ganushchak (2017) provides approaches to assessing financial and economic security. The author gives a structural and logical scheme of the procedure for analyzing financial and economic security of an enterprise, characterizes the integral index of financial and economic security, assesses and compares industrial enterprises by the level of their financial and economic security.

Kosny and Piotrowska (2019) have proposed a methodology for assessing the level of financial and economic security based on an analysis of scenarios covering the real-world potential combinations of positive and negative future events, which allows them to assess their impact.

Karanina, Ryazanova, Timin, and Domracheva (2018) analyze the main factors and threats to the financial and economic security of economic entities within certain territories. The system of indicators of financial and economic security assessment of the entities was developed and proposals for diagnostics and risk monitoring were provided.

Hryhoruk, Khrushch, and Grygoruk (2019) analyzed the impact of various threats on the level of financial and economic security of economic entities, which is especially relevant in the context of changing external and internal environment. This requires constant monitoring of the level of financial and economic security to detect and neutralize possible crisis phenomena in a timely manner. The research presents a scientific and methodological approach to developing a composite indicator of financial and economic security and to determining its level.

When considering the problem of assessing the level of financial security, Kondratenko, Kovalenko, and Novikov (2019) use a construction company as an example. They have determined that the specific nature of construction companies and their diverse financial relationships require an appropriate system to protect certain financial interests against existing and potential internal and external threats. Their system of financial and economic security of an enterprise allows selecting

factors that influence its level, classifying them and calculating the integral index of financial security. According to these scientists, applying the proposed methodological approach to assessing the level of financial and economic security allows business managers to respond in a timely manner to the deterioration of the entity's financial state and to negative trends that may deepen in the course of the entity operation.

Yaremko, Shykova, and Syvolap (2019) focus on the need to find an effective method for assessing financial and economic security and to identify conceptual and strategic directions for improving the economic security of agricultural enterprises operating in the instable and uncertain environment. To ensure proper economic security of agricultural enterprises, it is proposed to use financial, personnel, legal, information, and organizational tools. The study found that the methodology for assessing the level of economic security consists of two approaches: qualitative and quantitative. The authors systematized indicators for assessing the level of financial and economic security of an agricultural enterprise and substantiated the overall enterprise strategies, which can be used by both agricultural enterprises and enterprises of other industries, according to the level of financial and economic security.

Karpenko and Voronzhak (2017) deal with development of the budget management system at industrial enterprises in terms of the level of financial and economic security. The authors substantiated the need to make sound management decisions of innovative development of enterprises, administrative control over the functioning of the organization within the system of financial and economic security

The concept of economic security has, however, become more widespread, and financial security is seen as its component. Besides, the term of economic security is usually used at the level of state, interstate relations, the world, as well as individuals and families. This can be explained by the origin of the concept, which was first used during the Great Depression in the United States. At that time, the primary task was to protect and secure the assets of individual citizens, which in general affected the socio-economic stability of

the entire economic system. This approach has then taken root as Anglo-Saxon in the world economic thought. And today, the Aspen Institute Financial Security Program (2019) operates in the United States, whose mission is to illuminate and solve the most critical financial challenges facing American households and to make financial security for all a top national priority. In contrast, Asian economic thought has highlighted the macroeconomic approach.

Tamošiūnienė and Corneliu (2015, July 2-3) (Lithuania and Moldova) clearly identified and characterized these two approaches. They noted that the macro-economic approach had a complex geometry, especially since this period coincides with the time of the two world wars. In particular, it includes Russian school that tried to quantify economic security using critical values, the perspective of national economic vulnerability and capacity for resistance (counteracting the crises and shock absorption).

Representatives of the modern Polish school also follow the macroeconomic approach. Thus, Ignatov (2019) identifies economic security as a condition or state of affairs of a country's socio-economic environment, which is characterized by stable welfare generation supporting the growing living standards. Economic security describes the ability of countries to efficiently implement policies and strategies to reach the desired goals without being constrained by any external or internal threat.

However, Tamošiūnienė and Corneliu (2015, July 2-3) believe that there is a strong need to analyze the concept of economic security broadly taking into consideration both micro- and macroeconomic approaches. Ianioglo and Polajeva (2016) consider economic security from the perspective of enterprise economics. They determine economic security of an enterprise as a state characterized by the ability of the economic entity to ensure taking advantage of resources and opportunities to prevent threats and increase competitive advantages that will allow ensuring stable functioning and development to achieve business goals (2016).

In addition, they analyzed the interpretation of the concept of enterprise economic security and iden-

tified the following basic approaches: the state of protection from threats; the state of efficient use of resources; the ability for a stable functioning and development; the presence of competitive advantage; the ability to achieve business goals (Ianioglo & Polajeva, 2016).

The complex concept of financial and economic security of an enterprise is used by Ukrainian, Russian, Byelorussian, Moldovan, Kazakh and other scientists from post-Soviet countries. This can be due to considerable business sector vulnerability in these countries to the financial and economic crises that have intensified since the collapse of the USSR.

Stolbov and Shapoval (2013) define financial and economic security of an enterprise as protection of its resources and intellectual capacity from the existing and potential threats of the external and internal environment, which is characterized by high financial performance and the prospect for economic development in the future.

Moiseienko and Marchenko (2011) consider financial and economic security as a condition that ensures protection of its financial and economic interests from internal and external threats and creates necessary financial and economic preconditions for sustainable development in the current and long-term periods.

Arefieva and Kuzenko (2009) believe that financial and economic security can be defined as the most effective use of corporate resources of an enterprise, expressed in the best values of financial indicators of profitability and cost-effectiveness of business, management quality, the use of fixed and current assets, the structure of its capital, the rate of payment on the enterprise's securities, as well as the exchange rate of its securities as a synthetic indicator of the current financial and economic condition of an enterprise and prospects for its technological and financial development.

Kyrychenko and Kudria (2009) define financial security of an enterprise as activities on risk management and protection of the enterprise interests against external and internal threats to ensure its stable development and growth of its capital in the current and strategic perspectives.

Kudrytska (2012) believe that the financial and economic security of an enterprise should be considered as a balanced state of its elements and subsystems as a separate economic system; the elements can be expressed as quantitative or qualitative indicators and characterized by resistance to negative internal and external influences and by the ability to ensure its effective functioning, sustainable development, and economic growth.

Mulyk (2013) defines the financial security of an enterprise as protection of its financial interests at all levels of financial relations from the influence of external and internal threats, which ensures its self-preservation and development in the current and strategic perspectives.

Kriuchko (2013) defines financial security as an entity's ability to effectively and steadily carry out its economic activities, including financial activities, by using a set of interrelated diagnostic, instrumental and control financial measures that should optimize the use of financial resources, ensure their proper level and mitigate internal and external effects.

An analysis of the above definitions suggests that many authors combine different approaches. Besides, there is no particular distinction between financial security and financial and economic security. However, the approaches of Ianioglo and Polajeva can be extended by treating financial and economic security as a risk management activity and protecting the interests of the enterprise. This study also considers it necessary to combine all key interpretations as one definition; this will allow presenting the concept in the most comprehensive way and revealing its essence.

Therefore, this study considers the financial and economic security as the ability of an entity to effectively manage its resources and the benefits available to minimize risks, protect against external and internal threats, and uphold personal interests, which will ensure the stable operation, development and implementation of strategic guidelines.

Over the last decade, financial and economic security has become a widespread issue. For example, Vergun, Nefedova, and Tarasenko (2015) suggested the stages of managing the financial and economic security of an enterprise.

Onishchenko and Siurkalo (2018), Vasilyev and Maita (2013), Kovalenko and Lehka (2015) propose mechanisms for managing financial and economic security of enterprises.

Cherniak (2015), Bondarenko and Levytskyy (2015), Korniienko (2013) and others analyze the methods to evaluate financial and economic security of an enterprise.

Determining the performance efficiency and the value of the enterprises, investigated by Young and O'Byrne (2000) and Lewis (2006), remains a problem area. Analysis of articles by Roe (2012), Thompson (2009), Haralambides (2002) and others for the years 2002–2018 indicates that many authors explored the methods for assessing the level of enterprise competitiveness.

In developed countries, many scientific and professional journals also pay special attention to the following issues: protecting businesses from all kinds of threats; use of truthful, reliable and timely information; identifying strengths and weaknesses to ensure their viability (Giannopoulos, Filippini, & Schimmer, 2012; Vercellis, 2009). Calof (2015, 2016), Prescott (1990), du Toit (2015) and others are the leaders in the number of publications assessing both the level of competitiveness and the value of enterprises.

Despite the multifaceted nature of the issues already addressed, it is worth noting that there is no single, systematic approach to assessing the financial and economic security of enterprises, which would allow economic entities not only to adjust the indicators of financial and economic security and to determine the factors influencing their reduction, but also to become competitive in the market and increase the possibility of innovative investment development in the future. It is advisable to improve the methodology for assessing the level of financial and economic security of enterprises.

2. AIMS

The purpose of the paper is to assess the level of financial and economic security of enterprises, as well as its further forecasting, which will help to identify key areas of management policy.

3. METHODS

To assess the level of financial and economic security, enterprises of the machine-building industry were selected, which is promising in terms of attractiveness for internal and external investors and ensuring the competitiveness of the economy, and is also sensitive to changes in the external environment.

The financial and economic security of the enterprise (Y) is estimated based on the values of generalized groups of indicators (factors) (Table 1).

Table 1. Generalized indicators (factors) of financial and economic security

Source: Authors.

Group	Indicators, x_i
Group integral indicators of financial sustainability (I_{FS})	Economic growth sustainability ratio
	Loan capital concentration ratio
	Financial sustainability (funding) ratio
	Financial autonomy ratio
	Equity maneuverability ratio
Group integral indicators of liquidity and solvency (I_S)	Absolute liquidity ratio
	Current ratio
	Quick liquidity ratio
	Overall liquidity ratio
Group integral indicators of business sentiment (I_{BS})	Equity turnover
	Asset turnover ratio
	Receivables turnover ratio
Group integral profitability indicators (I_P)	Return on assets ratio
	Return on equity ratio
	Return on production assets
	Return on sales
	Net operating margin
	Net Profit Margin
	Economic growth sustainability ratio
Group integral indicators of investment attractiveness (I_{IA})	Investment ratio
	Return on Investment
	Investment coverage ratio
Group integral indicators of innovative development (I_{ID})	Innovation rate
	Innovation-intensive ratio
	R&D performance ratio

The indicators are grouped based on expert assessments by means of questionnaires, the result of which is the determining key indicators of financial and economic security. The values of the relevant indicators are derived from the analysis of the enterprises' statistical reporting. The expert evaluation method was used to form the key metrics system. 16 economists, 24 accounting department members and 12 economic security department employees act as experts. They all worked at Zaporizhzhia Mechanical Plant, Zaporozhye Heavy Crane-Building Plant, Berdianski Zhnyvarky, and Energomash-Project Research and Production Enterprise. A questionnaire was developed for them and they were asked to be interviewed. The questionnaire specified indicators describing the financial and economic situation of the enterprise. Experts selected six of the proposed indicators, which, in their opinion, most described financial and economic security of an enterprise. These indicators were used to calculate the integral indicator of financial and economic security of enterprises under study.

For further analysis, it is necessary to standardize the selected indicators of financial and economic security. Two indicator groups were chosen: incentives that help to increase economic security and disincentives that reduce economic security.

Having calculated the normalized values of financial and economic security indicators, the significance of individual indicators for each group and for the whole was determined. It should be noted that the development strategies of the surveyed enterprises assume the same level of significance of each indicator and, accordingly, the same impact on the integral indicator for the group:

$$r_{ji} = \frac{1}{M}, \quad i = 1, N, \quad j = 1, M. \qquad (1)$$

Weighting coefficients were used to determine the significance of the indicators. To determine the group weights, the Fishburn's rule (1978) was used, which provides for the significance level of indicator groups in the form of interval estimates, i.e.,

$$a_i \leq w_i \leq b_i, \quad i = \overline{1, m}. \qquad (2)$$

To calculate the group integral financial and economic security indicators, the Harrington's (1965) desirability function is used, which is a quantitative measure of the studied entity's quality.

Based on Harrington's approach, enterprises are grouped according to their levels of financial and economic security (very high, high, steady, satisfactory and unsatisfactory).

4. RESULTS

The proposed approach was implemented at the machine-building enterprises of Zaporizhzhia region (Zaporizhzhia Mechanical Plant, Zaporozhye Heavy Crane-Building Plant (Zaporozhcran), Berdianski Zhnyvarky, and Energomash-Project Research and Production Enterprise) according to the following algorithm:

Step 1: Analyze the statistical reporting of enterprises and systematize necessary information.

Step 2: Identify key financial and economic security indicators based on expert estimates.

Step 3: Normalize incentives and disincentives.

Step 4: Calculate the indicators' significance based on Fishburn's weights and determine interval weights.

Step 5: Group companies by their level of financial and economic security based on the Harrington's desirability function.

Step 6: Forecast the activity of the machine-building enterprises depending on the level of financial and economic security based on regression analysis.

Based on the analysis of the machine-building enterprises' statistical reporting, the necessary information has been systematized. Indicators were grouped on the basis of expert assessments, which were obtained based on a survey of management and financial and economic department representatives of machine-building enterprises in Zaporizhzhia region. This choice is due to the fact that these employees directly receive information on the results of their enterprise economic activity and determine the directions for further actions and management methods. The questionnaire identified key indicators of financial and economic security that characterize its essence, namely: indicators of financial strength; liquidity and solvency indicators; business activity indicators; profitability indicators; indicators of innovative development; and investment attractiveness indicators.

According to the strategic benchmarks and the main goals of the enterprises' activity, the possible intervals of their importance for each indicator group are determined:

$$w_1 \in [0.281; 0.554]; w_1 \in [0.281; 0.554];$$
$$w_2 \in [0.201; 0.471]; w_2 \in [0.201; 0.471];$$
$$w_3 \in [0.155; 0.387]; w_3 \in [0.155; 0.387];$$
$$w_4 \in [0.187; 0.466]; w_4 \in [0.187; 0.466];$$
$$w_5 \in [0.165; 0.401]; w_5 \in [0.165; 0.401];$$
$$w_6 \in [0.133; 0.298]; w_6 \in [0.133; 0.298].$$

Weighting parameters were calculated according to the Fishburn's rule (1978):

$$a_i a_i = 0.281 + 0.201 + 0.155 + \\ +0.187 + 0.165 + 0.133 = 1.1;$$

$$b_i b_i = 0.554 + 0.471 + 0.387 + \\ +0.466 + 0.401 + 0.298;$$

$$(b_i - a_i b_i - a_i) = (0.554 - 0.281) + \ldots \\ \ldots + (0.298 - 0.133) = 1.455.$$

The weighting parameters for each group will be as follows:

$$w_1 w_1 = 0.281 + \frac{1-1.1}{1.455} \cdot 0.273 = 0.258;$$

$$w_2 w_2 = 0.201 + \frac{1-1.1}{1.455} \cdot 0.27 = 0.178;$$

$$w_3 w_3 = 0.155 + \frac{1-1.1}{1.455} \cdot 0.232 = 0.136;$$

$$w_4 w_4 = 0.187 + \frac{1-1.1}{1.455} \cdot 0.279 = 0.164;$$

$$w_5 w_5 = 0.165 + \frac{1-1.1}{1.455} \cdot 0.236 = 0.145;$$

$$w_6 w_6 = 0.133 + \frac{1-1.1}{1.455} \cdot 0.165 = 0.116.$$

The following condition is fulfilled: the sum of

$$w_i w_i = 0.258 + 0.178 + 0.136 + \\ +0.164 + 0.145 + 0.119 = 1.$$

Thus, the weighting coefficients were obtained for each individual value of the financial ratios and the groups were formed (Table 2). The weight of the indicator of each individual group was set the same for each coefficient.

Table 2. Weighting coefficients of financial and economic security indicators' groups

Source: Calculated by the authors based on Fishburn (1978).

Group	Weight of a group	Indicators, $x_i x_i$	Weight of an indicator
Group integral indicators of financial sustainability (I_{FS})	0.258	Economic growth sustainability ratio	0.2
		Loan capital concentration ratio	0.2
		Financial sustainability (funding) ratio	0.2
		Financial autonomy ratio	0.2
		Equity maneuverability ratio	0.2
Group integral indicators of liquidity and solvency (I_S)	0.178	Absolute liquidity ratio	0.333
		Current ratio	0.333
		Quick liquidity ratio	0.333
		Overall liquidity ratio	0.333
Group integral indicators of business sentiment (I_{BS})	0.136	Equity turnover	0.333
		Asset turnover ratio	0.333
		Receivables turnover ratio	0.333
Group integral profitability indicators (I_P)	0.164	Return on assets ratio	0.143
		Return on equity ratio	0.143
		Return on production assets	0.143
		Return on sales	0.143
		Net operating margin	0.143
		Net Profit Margin	0.143
		Economic growth sustainability ratio	0.143
Group integral indicators of investment attractiveness (I_{IA})	0.145	Investment ratio	0.333
		Return on Investment	0.333
		Investment coverage ratio	0.333
Group integral indicators of innovative development (I_{ID})	0.119	Innovation rate	0.333
		Innovation-intensive ratio	0.333
		R&D performance ratio	0.333

Table 3 presents the calculations of group integrated indicators of financial and economic security of enterprises.

Table 3. Group integral indicators of the studied enterprises

Source: Calculated by the authors based on the official websites of Energomash-Project Research and Production Enterprise, Berdianski Zhnyvarky, Zaporozhye Heavy Crane-Building Plant, and Zaporizhzhia Mechanical Plant.

Group integral indicators	2014	2015	2016	2017	2018
Zaporizhzhia Mechanical Plant					
Profitability indicators	0.387	0.386	0.378	0.377	0.378
Indicators of financial sustainability	0.381	0.402	0.381	0.383	0.401
Indicators of liquidity and solvency	0.401	0.396	0.403	0.388	0.396
Indicators of innovative development	0.392	0.389	0.385	0.382	0.401
Indicators of investment attractiveness	0.381	0.386	0.387	0.392	0.376
Indicators of business sentiment	0.389	0.391	0.397	0.388	0.394
Zaporozhye Heavy Crane-Building Plant					
Profitability indicators	0.392	0.401	0.391	0.387	0.398
Indicators of financial sustainability	0.383	0.379	0.376	0.378	0.381
Indicators of liquidity and solvency	0.358	0.391	0.389	0.388	0.405
Indicators of innovative development	0.392	0.345	0.374	0.381	0.384
Indicators of investment attractiveness	0.381	0.39	0.372	0.373	0.383
Indicators of business sentiment	0.401	0.396	0.389	0.385	0.393
Berdianski Zhnyvarky					
Profitability indicators	0.64	0.647	0.641	0.645	0.657
Indicators of financial sustainability	0.623	0.651	0.679	0.58	0.632
Indicators of liquidity and solvency	0.656	0.688	0.701	0.7	0.702
Indicators of innovative development	0.643	0.682	0.675	0.671	0.679
Indicators of investment attractiveness	0.641	0.658	0.649	0.648	0.657
Indicators of business sentiment	0.646	0.671	0.659	0.662	0.656
Energomash-Project Research and Production Enterprise					
Profitability indicators	0.331	0.258	0.247	0.379	0.375
Indicators of financial sustainability	0.341	0.379	0.381	0.375	0.382
Indicators of liquidity and solvency	0.296	0.275	0.332	0.321	0.406
Indicators of innovative development	0.321	0.369	0.372	0.389	0.389
Indicators of investment attractiveness	0.323	0.369	0.38	0.381	0.379
Indicators of business sentiment	0.32	0.367	0.369	0.369	0.373

Thus, based on the proposed methodology, a regression model of the financial and economic security assessment of the enterprise was constructed:

$$I_{FS} = 0.258I_{FS} + 0.178I_{S} + 0.136I_{BS} + \\ +0.164I_{P} + 0.145I_{IA} + 0.119I_{ID},$$ (3)

where I_{FS} – general integral indicator of financial and economic security, I_{FS} – group integral indicator of financial strength, I_{S} – group integral solvency indicator, I_{BS} – group integral indicator of business activity, I_{P} – group integral profitability indicator, I_{IA} – group integral indicator of investment attractiveness, I_{ID} – group integral indicator of innovative development.

Based on the constructed model, general integral financial and economic security indicators for the studied enterprises are calculated and the levels of their financial and economic security are determined.

To define the level of financial and economic security, Harrington's desirability function is used. The Harrington's desirability function is roughly divided into five levels that correspond to the aforementioned variables of financial and economic security and characterize the dimensionless value of indicators. The coordinate point (0.00; 0.37) is a critical point that divides the indicator scale into two groups: satisfactory and unsatisfactory (Table 4).

Table 4. Classification of the levels of business financial and economic security

Source: Calculated by the authors based on Harrington (1965).

Index value	Characteristics of business financial and economic security level
1.00-0.81	Too high level of financial and economic security (TH)
0.80-0.64	High level of financial and economic security (H)
0.63-0.38	Steady level of financial and economic security (St)
0.37-0.21	Satisfactory level of financial and economic security (S)
0.20-0.00	Unsatisfactory level of financial and economic security (US)

Interval assessment of indicators characterizing the level of financial and economic security is as follows:

1. 0.00-0.20 – unsatisfactory level of financial and economic security (US), when an enterprise has low solvency and financial stability, conducts loss-making activity and is dependent on external sources of financing. The company is unable to meet its financial obligations and may be on the verge of bankruptcy;

2. 0.37-0.21 – satisfactory level of financial and economic security (S), a situation whereby an enterprise has an unstable capital structure, insufficient liquidity and uses its capital ineffectively. The enterprise attracts short-term loans to ensure its financing;

3. 0.63-0.38 – steady level of financial and economic security (St) – indicators describing the level of financial and economic security are within the recommended values;

4. 0.80-0.64 – high level of financial and economic security (H), the enterprise has a plentiful supply of competitiveness and is characterized by high financial stability;

5. 1.00-0.81 – too high level of financial and economic security (TH) – the enterprise has an extremely high level of solvency and profitability and conducts effective financial and economic activity.

Let us calculate the general integral indicators of financial and economic security of machine-building enterprises in Zaporizhzhia region and define the change in their financial and economic security (Table 5).

Table 5. General integral indicators of financial and economic security of mechanical engineering enterprises of Zaporizhzhia region, 2014–2018

Source: Calculated by the authors based on the official websites of Energomash-Project Research and Production Enterprise, Berdianski Zhnyvarky, Zaporozhye Heavy Crane-Building Plant, and Zaporizhzhia Mechanical Plant.

No.	Enterprise	Period				
		2014	2015	2016	2017	2018
1	Zaporizhzhia Mechanical Plant	0.388	0.391	0.387	0.384	0.390
		St	St	St	St	St
2	Zaporozhye Heavy Crane-Building Plant	0.385	0.384	0.382	0.382	0.390
		St	St	St	St	St
3	Berdianski Zhnyvarky	0.64	0.66	0.66	0.64	0.66
		St	H	H	St	H
4	Energomash-Project Research and Production Enterprise	0.32	0.33	0.34	0.37	0.38
		S	S	S	St	St

Table 5 shows that in 2014–2018, the surveyed enterprises had high (H) or steady (St) level of financial and economic security. Only Energomash-Project Research and Production Enterprise LLC

had a satisfactory level of financial and economic security (S) in 2014–2016, which is due to low values of financial strength, business activity and innovation development.

Given the regression model based on the values of the general integral indicator of machine-builder's financial and economic security in Zaporizhzhia region, a forecast of the financial security level will be made.

The forecasting involves the following steps:

Step 1: Selecting group indicators to build regression models.

Step 2: Building additive and multiplicative regression models and selecting the optimal model.

Step 3: Assessing the regression modeling adequacy and interpreting the results.

Step 4: Calculating the annual and average annual growth rates of the group indicators included in the regression models and determining the targets.

Step 5: Forecasting the general integral financial and economic security indicator of Zaporizhzhia region machine-building enterprises by 2020.

Step 1. The group integral and general integral indicators of financial and economic security of the machine-building enterprises in Zaporizhzhia region are the basis for forecasting. However, due to

the analysis of key metrics over the last five years, the study cannot use all six metrics to construct regression models.

According to the general methodology, two or three group indicators are indicative. Correlation analysis is used to select the required metrics. Table 6 presents the results.

As Table 6 shows, for almost every enterprise, it is possible to identify highly significant group financial and economic security indicators that can be further used to construct regression models. However, for the Zaporozhye Heavy Crane-Building Plant, all the group indicators analyzed were of medium significance (correlation coefficients from 0.25 to 0.64). In this case, the study selects indicators that are jointly significant in the regression models (group integral indicators of financial stability and solvency were chosen). Similarly, other business metrics were tested for consistent significance in the regression. It is found that for Zaporizhzhia Mechanical Plant, the group integral indicator of innovative development loses its significance along with the group integral financial stability index; it is replaced, therefore, by group integral indicators of business activity and solvency. For the Berdianski Zhnyvarky company, the regression model uses the group integral indicators of financial strength, profitability and innovative development as the most significant and demonstrative ones. For Energomash-Project Research and Production Enterprise, highly significant group solvency and innovation development indicators, when combined into a single model, supplant one another, so medium-significant group financial strength and profitability integral indicators are chosen for modeling.

Table 6. Correlation and regression analysis of group indicators of business financial and economic security

Enterprise	High value indicators	Multicollinearity indicators one by one	Indicators applied for forecasting
Zaporizhzhia Mechanical Plant	I_{FS} and I_{ID}	None	I_{FS}, I_S and I_{BS}
Zaporozhye Heavy Crane-Building Plant	none	I_{IA} and I_P; I_{FS} and I_{BS}	I_{FS} and I_S
Berdianski Zhnyvarky	I_{FS}, I_{IA} and I_{ID}	I_{IA} and I_P; I_S and I_{ID}; I_{ID} and I_{IA}; I_{BS} and I_{ID}; I_{BS} and I_{IA}	I_P, I_{FS} and I_{ID}
Energomash-Project Research and Production Enterprise	I_S, and I_{ID}	I_{FS} and I_{ID}; I_{FS} and I_{IA}; I_{FS} and I_{BS}; I_{IA} and I_{ID}; I_{BS} and I_{ID}; I_{BS} and I_{IA}	I_S and I_{FS}

Table 7. Types of mathematical correlation between general integral indicator of business financial and economic security and the selected group indicators

Type of correlation	R^2 of the models of the integral indicator of financial and economic security			
	Zaporizhzhia Mechanical Plant	Zaporozhye Heavy Crane-Building Plant	Berdianski Zhnyvarky	Energomash-Project Research and Production Enterprise
Linear	0.999841	0.912939	0.998764	0.972452
Stepwise	0.999834	0.908271	0.999345	0.968152
Exponential	0.999865	0.913285	0.998764	0.971849
Hyperbolic	0.999771	0.902740	0.999722	0.964387
Quadratic	0.999873	0.917843	0.997945	0.975131
Logarithmic	0.999808	0.907901	0.999345	0.968906
Root	0.999825	0.910436	0.999082	0.970794

Step 2. This step chooses the type of relationship between the general integral indicator of financial and economic security of an enterprise and its components. For this purpose, linear, stepwise, exponential, hyperbolic, quadratic, logarithmic and root regressions are calculated (Table 7). Given the determination coefficient (R2), the model is selected that best describes the dependency. For Zaporizhzhia Mechanical Plant, Zaporozhye Heavy Crane-Building Plant and Energomash-Project Research and Production Enterprise, it is quadratic model, and it is hyperbolic for Berdianski Zhnyvarky.

Step 3. Having chosen the dependence type, let us evaluate the adequacy of the regression models by the determination indicators and the Fisher test. All determination coefficients exceed 0.8, which indicates the model's visibility. Fisher's criterion (F) is an F-statistic whose value exceeds the table value; besides, all models are significant. Thus, the models can be considered adequate and indicative (Table 8).

Thus, models for Zaporizhzhia Mechanical Plant, Zaporozhye Heavy Crane-Building Plant,

Energomash-Project Research and Production Enterprise, and Berdianski Zhnyvarky demonstrate a direct relationship between the growth of group indicators of financial strength, solvency, profitability, and innovative development and an integral financial and economic security indicator. This is logical and does not need further clarification. One can observe only one inverse relationship: for Zaporizhzhia Mechanical Plant, the increase in the group business activity index causes a reduction in the integral indicator of financial and economic security. This is due to the increased uncertainty and risk related to the increase in the number of contractors, the volume of transactions and the sale of products. The strength of the relationship between the analyzed metrics for each enterprise is different and is defined by the significance coefficients.

Step 4. Determining the annual and average annual growth rates of the group integral indicators included in the regression models (Table 9). Suppose that the overall tendency for group integral indicators to fluctuate for two years is maintained. Substantial changes in the near term can only happen under the influence of external

Table 8. The models of correlation between the integral indicator of business financial and economic security and its components

Enterprises	Linear-regression model	R-squared	F-statistics
Zaporizhzhia Mechanical Plant	$I_{FS}^1 = 0.311 + 0.317 \cdot I_{FS}^2 + 0.461 \cdot I_S^1 - 0.282 \cdot I_{BS}^1$	0.99	18.84
Zaporozhye Heavy Crane-Building Plant	$I_{FS}^2 = 0.125 + 1.594 \cdot I_{FS}^2 + 0.2 \cdot I_S^1$	0.92	11.17
Berdianski Zhnyvarky	$I_{FS}^3 = 1.289 - \dfrac{0.213}{I_P} - \dfrac{0.084}{I_{FS}} - \dfrac{0.116}{I_{IA}}$	0.99	11.30
Energomash-Project Research and Production Enterprise	$I_{FS}^4 = 0.096 + 0.526 \cdot I_P^2 + 1.426 \cdot I_{FS}^2$	0.98	36.55

Table 9. Calculation of annual average growth rates of group integral indicators and their projected values

| Enterprise	Group indicators	Growth (loss) rates				Annual average growth	Projected group indicators' values	
		2015/2014	2016/2015	2017/2016	2018/2017		2019	2020
Zaporizhzhia Mechanical Plant	I_{FES}	1.055	0.948	1.005	1.047	1.014	0.407	0.412
	I_S	0.988	1.018	0.963	1.021	0.997	0.395	0.394
	I_{BS}	1.005	1.015	0.977	1.015	1.003	0.395	0.397
Zaporozhye Heavy Crane-Building Plant	I_{FES}	0.990	0.992	1.005	1.008	0.999	0.381	0.380
	I_S	1.092	0.995	0.997	1.044	1.032	0.418	0.432
	I_P	1.011	0.991	1.006	1.019	1.007	0.661	0.666
Berdianski Zhnyvarky	I_{FES}	1.045	1.043	0.854	1.090	1.008	0.637	0.642
	I_{ID}	1.061	0.990	0.994	1.012	1.014	0.689	0.698
Energomash-Project Research and Production Enterprise	I_P	0.779	0.957	1.534	0.989	1.065	0.399	0.425
	I_{FES}	1.111	1.005	0.984	1.019	1.030	0.393	0.405

economic and political factors, which are related to the change of power in Ukraine, military actions in the Donbas region, rising energy prices, etc. However, the analysis and evaluation of such changes are not the purpose of this study. Therefore, let us focus only on the baseline scenario, which assumes an extrapolation of the existing dynamics over the next two years (Table 9).

Step 5. Thus, given the dynamics of group integral indicators, projected values of financial and economic security integral indicator for the studied enterprises up to 2020 have been calculated (Figure 1).

The calculation data show that if the dynamics of changes in the group integral indicators are maintained and the external challenges
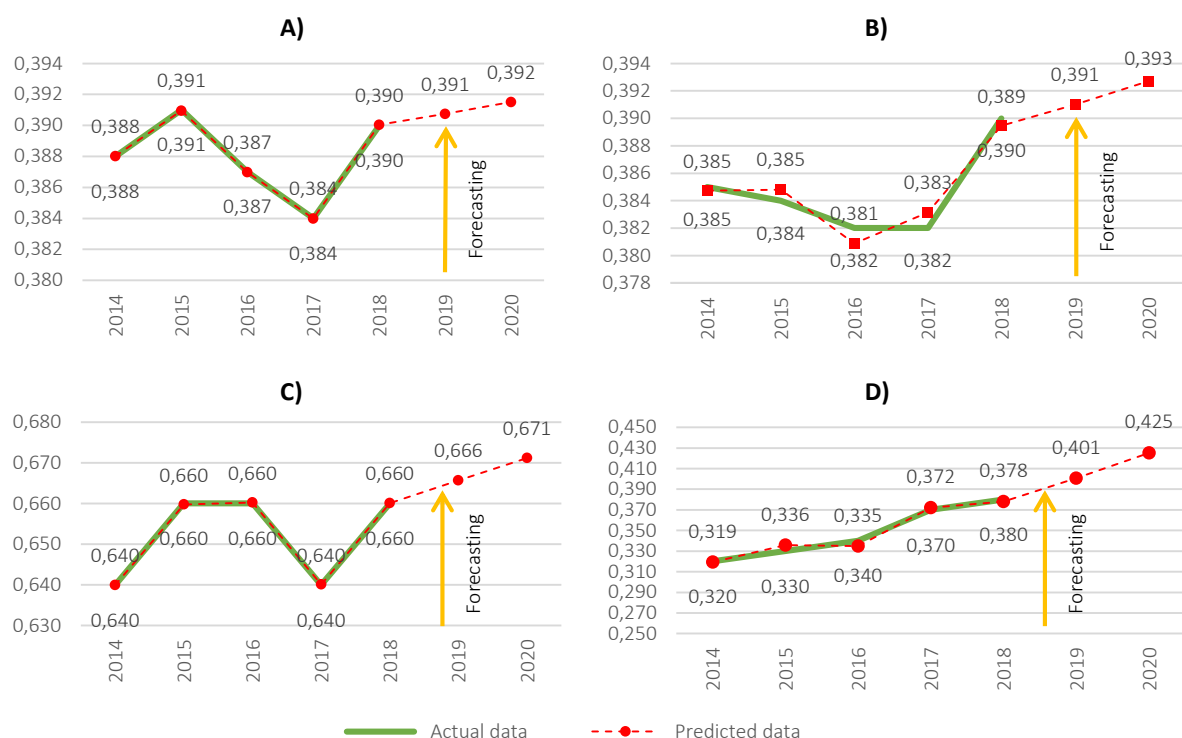
Note: A) Zaporizhzhia Mechanical Plant; B) Zaporozhye Heavy Crane-Building Plant; C) Berdianski Zhnyvarky; and D) Energomash-Project Research and Production Enterprise.

Figure 1. The forecast of financial and economic security integral indicator's value for enterprises under study

are insignificant, then the integral financial and economic security indicator for all analyzed enterprises will increase in the next two years. Energomash-Project Research and Production Enterprise demonstrates the largest growth, 11.9%, followed by the Berdianski Zhnyvarky company, 1.7%; they are followed by Zaporozhye Heavy Crane-Building Plant, 0.7%. Zaporizhzhia Mechanical Plant shows the lowest growth, 0.4%.

CONCLUSION

The ability to detect financial status allows the company to support its sustainable development. Creating financial and economic security assessment system for a company that needs to be used at each enterprise to systematize the diagnostic process and improve their effectiveness deserves further development.

The study includes the parameters of an enterprise's financial status in the group of indicators (factors) that determine financial and economic security, since the condition of fixed assets becomes very important for them. Deterioration of fixed assets is one of the most problematic indicators of property valuation in Ukraine. Therefore, it is important when assessing the level of financial component in the economic security of the enterprise. Besides, the methodology should include the coefficient of updating fixed assets that characterizes the asset management policy of the enterprise.

Despite various internal and external challenges, industrial enterprises not only try to function at the level of previous periods, they also show motivation for development. The study showed that, regardless of the enterprise size, the level of financial and economic security can change due to the effectiveness of the management system. Also, assessing the level of financial and economic security allows identifying weaknesses and strengths of the activity, and, accordingly, determining effective management methods. The importance of this study is also in identifying general features of financial and economic security; providing opportunities for effective managerial decisions and comparative assessment of enterprises in one industry, both nationally and internationally. This allows us to use positive foreign experience in financial and economic security and to build an effective management model.

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