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ASSESSMENT OF THE PROBABILITY OF BANKRUPTCY IN THE SYSTEM OF INCREASING THE EFFECTIVENESS OF ANTI-CRISIS MANAGEMENT OF AN ENTERPRISE

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ABSTRACT

Today, due to deep economic transformations, structural shifts, and high volatility of the macro environment, there is an objective need to implement effective anti-crisis analysis tools that allow not only to assess the risks of bankruptcy, but also to timely identify threats to financial security. The article presents the results of logistic modelling of the probability of bankruptcy of machine-building enterprises of Ukraine based on a combination of financial and management indicators in the period after the full-scale armed invasion of Ukraine (2022-2024). The main task was to conduct modelling on the example of five enterprises based on data for 2022-2024; analyse the results obtained, interpret the coefficients of the logit model, and determine the main determinants of the probability of bankruptcy; suggest areas for improvement. The paper substantiates the feasibility of including in the model both quantitative indicators (liquidity ratio, return on assets, debt level) and qualitative characteristics (availability of an anti-crisis management system, implementation of anti-crisis measures, the fact of a crisis situation). The constructed model allowed for assessing the probability of crisis events at five machine-building enterprises and to form an individual scenario of management response in the financial security system for each of them. The results obtained have practical significance for increasing the level of financial security, strengthening management flexibility, and implementing an early warning system in conditions of economic instability.

Keywords: financial security, machine-building enterprise, logistic regression, bankruptcy, anti-crisis management, risks, probability, management decisions, quantitative and qualitative indicators, crisis situation, anti-crisis measures, security aspects, full-scale armed invasion, financial indicators

JEL Classification: C25, G33, L60, M21, O25

INTRODUCTION

Analysis of the specifics of the activities of most industrial enterprises (including machine-building) today allows us to conclude that significant difficulties have arisen. In particular, we note that the level of economic security of the financial and economic activities of most machine-building enterprises has significantly decreased due to the rapid growth of the crisis and its direct impact on the final result. A large number of domestic enterprises have encountered problems in the supply and sales process. The imbalance between the timeliness of supply and direct production, insufficient resource potential, the closure of some channels of raw material receipt, and further sale of finished products, encourages enterprises to implement an updated policy of carrying out activities. Therefore, the global issue of introducing an appropriate level of anti-crisis management arises. In the past, today, and even in the future, machine-building enterprises will remain a basic sector of the Ukrainian economy, which depends on production capacities, logistics chains, and sales markets. At the same time, the conditions for ensuring financial security and preventing crisis situations become critical when war touches all this. There is an objective need to implement effective anti-crisis analysis tools that allow not only to assess the risks of insolvency, but also to identify threats in a timely manner. One of the most effective approaches is logistic modelling, which takes

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into account both quantitative financial indicators and management factors. Thus, this kind of approach to bankruptcy forecasting allows you to integrate risk assessment into daily management practice and increase the very security readiness of enterprises for new economic realities.

For modern Ukrainian enterprises, especially in the context of a full-scale military invasion in 2022, the issue of ensuring financial stability and forecasting manifestations in crisis situations is of critical importance. The period of deep economic transformations, structural shifts, and high volatility of the macroenvironment determines the urgent need to implement effective anti-crisis analysis tools that allow not only to assess the risks of bankruptcy, but also to promptly identify threats based on the integration of quantitative and non-quantitative data.

In this context, it is logistic modelling, which is one of the most effective methods of multivariate analysis, that may be appropriate in situations where it is necessary to take into account both financial ratios and management factors. In addition, it should be noted that a separate scientific value of the study is the focus on machine-building enterprises. It is machine-building enterprises that are the fundamental sectors of the Ukrainian economy, which suffered greatly during the full-scale invasion. Consequently, the destruction of production capacities, logistics problems, labour shortages, and a total reorientation of sales markets became the main factors that necessitated the transformation of approaches to financial management and anti-crisis policy. In these conditions, it is the development of adaptive models that is not only a pressing issue, but also a condition for the possible adaptation of Ukrainian enterprises to the new realities of the time. In addition, the relevance of the chosen topic is due to the need to form new approaches to organizing the anti-crisis management system. Consequently, if previously the anti-crisis policy was perceived mainly as a reactive response to already existing difficulties, today it must be proactive and integrated into everyday strategic planning.

LITERATURE REVIEW

Some researchers (Starosta, 2014; Novikov, 2014) reduce anti-crisis management mainly to a purely financial process, which is associated with the liquidation of the enterprise's debt; others reduce anti-crisis management to the activities of enterprise managers in bankruptcy; some experts focus this type of enterprise activity on quick financial measures that ensure the short-term economic efficiency of the enterprise. The success of anti-crisis management largely depends on compliance with its inherent functions and principles. In the anti-crisis management system, researchers distinguish the following functions: goal setting, planning, organization, motivation, and control.

Today, the assessment of the probability of bankruptcy of an enterprise is one of the most important analytical tools in the system of ensuring the financial system. Its relevance is due to the fact that it is the risk of loss of solvency that is the most striking manifestation of financial instability. The increase in the number of crisis phenomena both at the national and international levels, the impact of the pandemic, and hostilities across the planet cause significant problems in logistics and create political turbulence. This, in turn, creates a situation where traditional approaches to monitoring the activities of enterprises can no longer ensure the prompt detection of threats and other destructive factors. In this context, bankruptcy forecasting will serve not only as an indicator of the weakness of the enterprise, but also as a key component for the further formation of anti-crisis management strategies for early warning and prevention of financial losses (Dokiienko, 2021).

Financial security is based on the ability of an enterprise to withstand internal and external threats, adapt to environmental instability, while maintaining profitability and financial stability. At the same time, these complex processes cannot be assessed based on current indicators alone. For this, it is important to have dynamic, holistic, and predictive tools that allow identifying the tendency to a crisis state (Sova, et.al., 2021). It is the bankruptcy probability assessment models that allow a more objective measurement of the level of financial security by setting thresholds for management decisions, while integrating a risk-oriented approach into the daily practice of the enterprise. At the same time, the bankruptcy probability assessment system makes it possible to formulate more adaptive scenarios for the development of events, including the possibility of integrating measures long before the first manifestations of financial difficulties and problems. The above approaches are critical for enterprises in critical industries, which mechanical engineering undoubtedly is. It is in this area that the bankruptcy of one participant can cause a chain of negative effects on the entire economic system. In this context, bankruptcy forecasting can no longer be seen as one of the financial functions, but as part of the strategy for ensuring national economic security, employment stability, energy independence, and industrial development.

Kopczyński (2020) considers bankruptcy risk assessment models as a tool for diagnosing the financial condition of companies, emphasizing their usefulness for early detection of financial problems. A systematic review by Shi and Li (2019) notes the evolution of approaches to bankruptcy prediction - from classical financial ratios and discriminant analysis to modern methods based on artificial intelligence, although this is still in the initial stages. As of 2019-2020, technologies based on

artificial intelligence were extremely underdeveloped. However, for example, Kokczyński (2024) successfully built discriminant bankruptcy prediction models for Polish enterprises, which confirms the effectiveness of classical methods with proper adaptation to the specifics of the sample based on artificial intelligence systems.

In addition to purely financial models, scientists and practitioners focus on integrated approaches that take into account managerial and qualitative aspects of ensuring financial sustainability. Thus, Khrapkina et.al. (2022) investigate the dynamics of financial security and the security development of enterprises, emphasizing the need to take into account market factors and the adaptability of strategies in a hyper-turbulent external environment. Gonchar et.al. (2020) focus on assessing financial security in the context of managing the potential of an enterprise, which involves identifying internal indicators of crisis and risks as a component of a system of management decisions. Shpak et.al. (2022) consider practical tools for analyzing the financial security of enterprises, noting the importance of combining quantitative indicators with qualitative assessments for comprehensive monitoring of threats and the level of business security to increase the accuracy of bankruptcy prediction.

AIMS AND OBJECTIVES

The purpose of the article is to develop and test a logistic model for assessing the probability of bankruptcy of machine-building enterprises based on the integration of quantitative financial ratios and qualitative management indicators in the system of ensuring financial security. The object of the study is the financial and economic activities of enterprises in the machine-building industry of Ukraine in a crisis environment and increased risks of bankruptcy.

The main tasks are the following:

1. To conduct modelling on the example of five enterprises based on data for 2022–2024.
2. To analyze the results obtained, interpret the coefficients of the logit model, and determine the main determinants of the probability of bankruptcy.
3. To propose directions for improving the activities of machine-building enterprises that participated in the modelling.

METHODS

To study crisis phenomena at an enterprise, various methods and principles of diagnosing the onset of bankruptcy are used during the study of the company's financial condition. Timely detection of deviations from the norm makes it possible to avoid negative consequences at an early stage using anti-crisis management. At the same time, according to leading scientists and practitioners, both quantitative and qualitative indicators should be assessed (Karaim, 2014). Therefore, within the framework of our study, a combination of quantitative and qualitative indicators was used, which provided a more comprehensive approach to assessing the financial security of machine-building enterprises and made it possible to more accurately determine the probability of bankruptcy. Within the framework of the methodology, the financial indicators of the enterprise such as current liquidity ratio (calculated based on the analysis of financial statements), return on assets (calculated based on the analysis of financial statements), and debt ratio (calculated based on the analysis of financial statements). Therefore, we believe that these indicators provide an objective idea of the opportunities, problems, and level of financial security of the enterprise. In turn, qualitative variables signal the organizational potential of responding to risks, managerial readiness for anti-crisis actions, and the presence of an internal policy aimed at preventing destructive financial scenarios. Such data were converted into binary variables (0 or 1), which made them suitable for integration into formal analytical models.

The main method of the study was the method of mathematical modelling, namely logistic regression. Its essence lies in building a functional relationship between a set of explanatory variables (quantitative and qualitative) and the probability of an event. Therefore, the model itself is directly based on the logit function, which has the form (1):

$$P=1/(1+e^{-(Logit(P))}) \quad (1)$$

$$Logit(P)= \beta 0-\beta 1x1+ \beta 2x2..... \beta nxn$$

where P is the probability of bankruptcy, $Logit(P)$ is a logical function for determining the probability, $\beta 0$ is a constant, βi are estimated coefficients, and Xi are the values of variables (both financial and qualitative indicators).

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Thus, this method allows us to assess not only the presence of a relationship between indicators but also the degree of influence of each factor on the predicted probability.

RESULTS

Most enterprises are on the verge of liquidation or in a state of crisis. With the advent of high-quality products and the latest production technologies on the market, Ukrainian enterprises cannot provide themselves with new equipment for a larger volume of products and the ability to compete at the level of other international enterprises. In order to identify and prevent the emergence of bankruptcy risks, it is necessary to study the financial condition of the enterprise using economic methods and models for determining crisis phenomena. We believe that the problems of internal processes have intensified under the influence of external factors of war and the market. The supply of raw materials has been disrupted, effective demand has decreased, and credit burdens have increased, all under the influence of active hostilities (Figure 1).

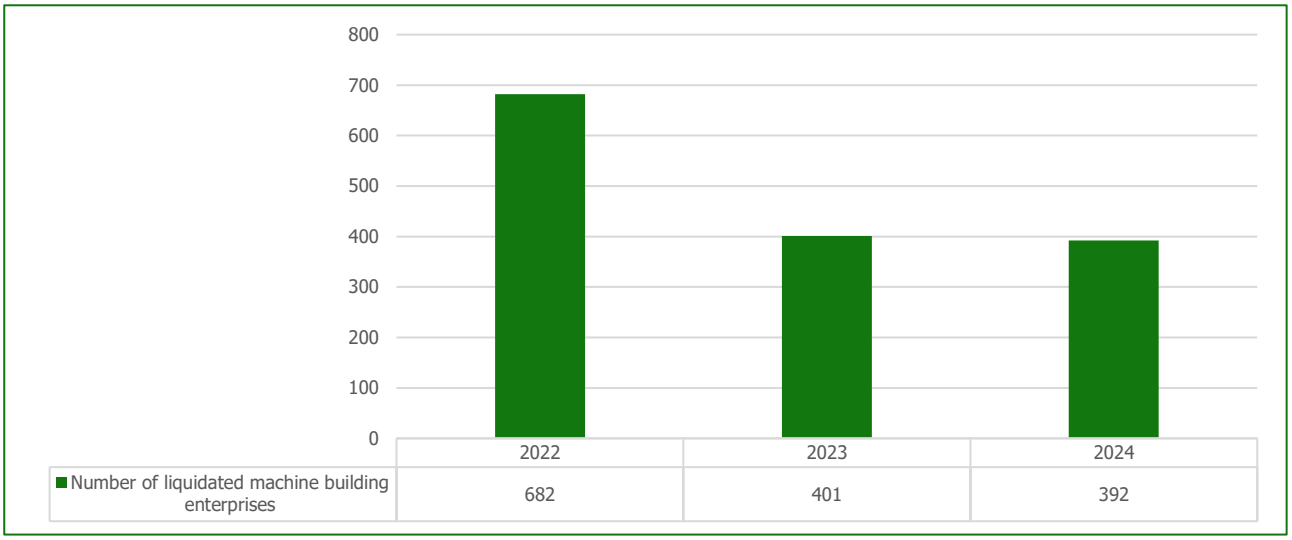

Figure 1. Number of liquidated machine-building enterprises in Ukraine from 2022 to 2024.

The choice fell on the years 2022-2024, since it was precisely starting in 2022 that full-scale armed aggression unfolded in Ukraine, which significantly affected the operating conditions of all business entities. For machine-building enterprises, these years have become a period of constant risk, disruption of supply chains, loss of sales markets, personnel shortages, and increased logistical and credit loads. As for the machine-building enterprises themselves, here we decided to select eight enterprises that belong to the same industry. Therefore, this kind of decision is justified by the fact that Machine-building as an industry is capital-intensive, oriented towards long-term production cycles, and very sensitive to any changes in the external environment of its own functioning. At the same time, precisely in the period 2022-2024, the industry underwent critical changes: loss of contracts, evacuation of production facilities, relocation of personnel, as well as in-creased dependence on defense orders or state funding. The machine-building enterprises we selected show different results according to the selected quantitative and qualitative indicators. Thus, some enterprises, such as PJSC "Conveyer", showed a significant improvement in liquidity and profitability, but still entered a pre-crisis state precisely in 2024, which may indicate external factors or disruptions in internal processes. At the same time, in our opinion, JSC "TEMP Plant" and JSC "Poltava Machine-Building Plant" are showing signs of recovery, while PJSC "Odesskyi Machine Building Plant" and JSC "Krasyliv Machine-Building Plant" are facing long-term problems. It is worth emphasizing that the implementation of anti-crisis measures was carried out only selectively. For example, the same PJSC "Conveyer" activated such measures only in 2024, while JSC "TEMP Plant" and JSC "Poltava Machine-Building Plant" demonstrate consistency in carrying out such actions throughout all three years (Table 1).

Table 1. Quantitative and qualitative indicators of the activities of selected mechanical machine-building enterprises for further modelling for the period 2022-2024.

Company/Year	Current liquidity ratio (Calculated based on financial statement analysis) X1	Return on assets (Calculated based on financial statement analysis) X2	Debt ratio (Calculated based on financial statement analysis) X3	Crisis situation (0/1). Fact of liquidation or large losses incurred (Obtained through interview and financial analysis) X4	Anti-crisis management system (0/1). Existence of a specific department or persons responsible for the anti-crisis policy of the enterprise (Obtained through interview) X5	Anti-crisis measure (0/1). Was a number of anti-crisis measures implemented during the year or not (Obtained through interview) X6
PJSC "Conveyer"						
2022	1,27	0,02	0,21	0	1	0
2023	2,2	0,25	0,18	0	1	0
2024	2,38	0,19	0,04	1	1	1
JSC "TEMP Plant"						
2022	1,41	-0,11	0,6	1	0	1
2023	1,72	0,12	0,48	1	0	1
2024	1,53	0,05	0,47	1	0	1
PJSC "Poltava Machine-Building Plant"						
2022	0,94	-0,04	0,49	1	0	1
2023	0,54	-0,03	0,89	1	1	1
2024	1,14	-0,01	0,46	0	1	1
PJSC "Odesskyi Machine Building Plant"						
2022	0,28	-0,29	2,06	1	0	1
2023	0,21	-0,1	0,72	1	0	1
2024	0,18	-0,15	0,84	1	0	0
JSC "Krasyliv Machine-Building Plant"						
2022	0,71	0,01	0,87	1	0	1
2023	0,36	-0,02	0,76	0	0	0
2024	0,35	0,01	0,75	0	0	0

Let's mark all six indicators as X (X1-X6). Next, we need to form coefficients for our logistic model for each X. Moreover, for this, we also involved experts. In general, this was achieved through statistical analysis of the main financial data of enterprises and qualitative assessment of management decisions collected through interviews with heads of financial and anti-crisis departments and financial reporting. The values of the coefficients reflect the average impact of the relevant factors on the probability of bankruptcy based on real cases from 2022 to 2024. The sign "+" means that an increase in the indicator increases the risk (for example, the debt ratio or the presence of a crisis situation), and "–" means that the relevant factor reduces the probability of bankruptcy (Table 2).

Table 2. Logistic model coefficients.

Indicator	Coefficient	Interpretation
Constant	–0.021	Basic bankruptcy risk with zero values of all X
X_1 – Liquidity	+0.180	The greater the liquidity, the higher the risk (here is a non-standard dependence)
X_2 – Return on assets	–0.132	Higher profitability reduces risk
X_3 – Debt	+0.326	Increasing debt increases risk
X_4 – Crisis situation	+0.446	If there is a crisis situation, the risk increases
X_5 – Anti-crisis management	–0.897	The presence of a system and measures reduces risk and the negative impact of threats
X6 – Anti-crisis measure	+0.874	

Next, by substituting the data from the coefficient and taking into account formula (1), we determine the immediate level of bankruptcy. When Class (P > 0.5) should be taken into account. Class (P > 0.5) in logistic regression is a binary classification that indicates whether the probability of bankruptcy P, calculated using the logit model, exceeds 50%.

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Table 3. Calculating Logit(P) and Probabilities.

Enterprise	Year	Logit(P)		Probability of bankruptcy (P)	P > 0.5
PJSC «Conveyer»	2022	-0.021 + 0.229 (0.180×x1) + -0.003 (–0.132×x2) + 0.068 (0.326×x3) + 0.0 (0.446×x4) + -0.897 (–0.897×x5) + 0.0 (0.874×x6)	-0,62358	P = 1 / (1 + exp(-(-0.62358))) = 34.90%	0
	2023	-0.021 + 0.396 (0.180×x1) + -0.033 (–0.132×x2) + 0.059 (0.326×x3) + 0.0 (0.446×x4) + -0.897 (–0.897×x5) + 0.0 (0.874×x6)	-0,49632	P = 1 / (1 + exp(-(-0.49632))) = 37.84%	0
	2024	-0.021 + 0.428 (0.180×x1) + -0.025 (–0.132×x2) + 0.013 (0.326×x3) + 0.446 (0.446×x4) + -0.897 (–0.897×x5) + 0.874 (0.874×x6)	0,81836	P = 1 / (1 + exp(-(0.81836))) = 69.39%	1
JSC «TEMP Plant»	2022	-0.021 + 0.254 (0.180×x1) + 0.015 (–0.132×x2) + 0.196 (0.326×x3) + 0.446 (0.446×x4) + -0.0 (–0.897×x5) + 0.874 (0.874×x6)	1,76292	P = 1 / (1 + exp(-(1.76292))) = 85.36%	1
	2023	-0.021 + 0.31 (0.180×x1) + -0.016 (–0.132×x2) + 0.156 (0.326×x3) + 0.446 (0.446×x4) + -0.0 (–0.897×x5) + 0.874 (0.874×x6)	1,74924	P = 1 / (1 + exp(-(1.74924))) = 85.19%	1
	2024	-0.021 + 0.275 (0.180×x1) + -0.007 (–0.132×x2) + 0.153 (0.326×x3) + 0.446 (0.446×x4) + -0.0 (–0.897×x5) + 0.874 (0.874×x6)	1,72102	P = 1 / (1 + exp(-(1.72102))) = 84.83%	1
PJSC «Poltava Machine-Building Plant»	2022	-0.021 + 0.169 (0.180×x1) + 0.005 (–0.132×x2) + 0.16 (0.326×x3) + 0.446 (0.446×x4) + -0.0 (–0.897×x5) + 0.874 (0.874×x6)	1,63322	P = 1 / (1 + exp(-(1.63322))) = 83.66%	1
	2023	-0.021 + 0.097 (0.180×x1) + 0.004 (–0.132×x2) + 0.29 (0.326×x3) + 0.446 (0.446×x4) + -0.897 (–0.897×x5) + 0.874 (0.874×x6)	0,7933	P = 1 / (1 + exp(-(0.79330))) = 68.85%	1
	2024	-0.021 + 0.205 (0.180×x1) + 0.001 (–0.132×x2) + 0.15 (0.326×x3) + 0.0 (0.446×x4) + -0.897 (–0.897×x5) + 0.874 (0.874×x6)	0,31248	P = 1 / (1 + exp(-(0.31248))) = 57.75%	1
PJSC «Odesskyi Machine Building Plant "	2022	-0.021 + 0.038 (0.180×x1) + 0.013 (–0.132×x2) + 0.235 (0.326×x3) + 0.446 (0.446×x4) + -0.0 (–0.897×x5) + 0.874 (0.874×x6)	1,58472	P = 1 / (1 + exp(-(1.58472))) = 82.99%	1
	2023	-0.021 + 0.032 (0.180×x1) + 0.02 (–0.132×x2) + 0.274 (0.326×x3) + 0.446 (0.446×x4) + -0.0 (–0.897×x5) + 0.0 (0.874×x6)	0,75104	P = 1 / (1 + exp(-(0.75104))) = 67.94%	1
	2024	-0.021 + 0.05 (0.180×x1) + 0.038 (–0.132×x2) + 0.672 (0.326×x3) + 0.446 (0.446×x4) + -0.0 (–0.897×x5) + 0.874 (0.874×x6)	2,05924	P = 1 / (1 + exp(-(2.05924))) = 90.69%	1
JSC «Krasyliv Machine-Building Plant»	2022	-0.021 + 0.128 (0.180×x1) + -0.001 (–0.132×x2) + 0.284 (0.326×x3) + 0.446 (0.446×x4) + -0.0 (–0.897×x5) + 0.874 (0.874×x6)	1,7091	P = 1 / (1 + exp(-(1.70910))) = 84.67%	1
	2023	-0.021 + 0.065 (0.180×x1) + 0.003 (–0.132×x2) + 0.248 (0.326×x3) + 0.0 (0.446×x4) + -0.0 (–0.897×x5) + 0.0 (0.874×x6)	0,2942	P = 1 / (1 + exp(-(0.29420))) = 57.30%	1
	2024	-0.021 + 0.063 (0.180×x1) + -0.001 (–0.132×x2) + 0.244 (0.326×x3) + 0.0 (0.446×x4) + -0.0 (–0.897×x5) + 0.0 (0.874×x6)	0,28518	P = 1 / (1 + exp(-(0.28518))) = 57.08%	1

Based on the constructed logistic regression, we obtained estimates of the probability of bankruptcy for five machine-building enterprises in the period 2022–2024. It is important to correctly interpret the obtained values of the probability of bankruptcy for 2022-2024. Therefore, the indicator "P" actually reflects a retrospective assessment of risk, that is, the probability of a crisis based on data from the same year, for example, 2024. That is, we determined how great the threat of bankruptcy was under the conditions that existed during this year. The calculated probability of bankruptcy for 2024 is valuable for retrospective testing and validation of the model. The above analysis helps to verify the model and prepare it for use for future forecasts. Also, on this basis, it is possible to more clearly form scenarios for development in the coming years. The obtained logits allowed us to classify enterprises by risk level: if P > 0.5, the enterprise is considered to have a high probability of bankruptcy and requires urgent management decisions. The results of logistic modelling can be used to create an early warning system for the loss of financial security of a machine-building enterprise. Thanks to the probability assessment based on key indicators, management receives a tool for monitoring critical financial zones (Table 4).

Table 4. Matrix for selecting scenarios for implementing anti-crisis management for 2025.

Enterprise	Scenario 1: Consolidation and restructuring	Scenario 2: External engagement	Scenario 3: Stabilization and flexibility	Scenario 4: Emergency intervention	Scenario 5: Local adaptation
PJSC "Conveyer"	+				
JSC "TEMP PLANT"		+			
PJSC "Poltava Machine-Building Plant"			+		
PJSC "Odesskyi Machine Building Plant"				+	
JSC "Krasyliv Machine-Building Plant"					+

For example, for PJSC "Conveyer", based on the results obtained (in 2024 the probability of bankruptcy exceeded 69%, even despite anti-crisis actions and 37% in the previous year), in 2025 it is advisable to concentrate resources, restructure debts, modernize financial planning with an emphasis on cash flow and introduce internal audit for preventive response. But, for example, for PJSC "Odesskyi Machine Building Plant", due to the high probability of bankruptcy (over 90%), External management (temporary administration), rehabilitation, suspension of new obligations, state support, or sale of assets is required. The goal is to save key production facilities (Figure 2).

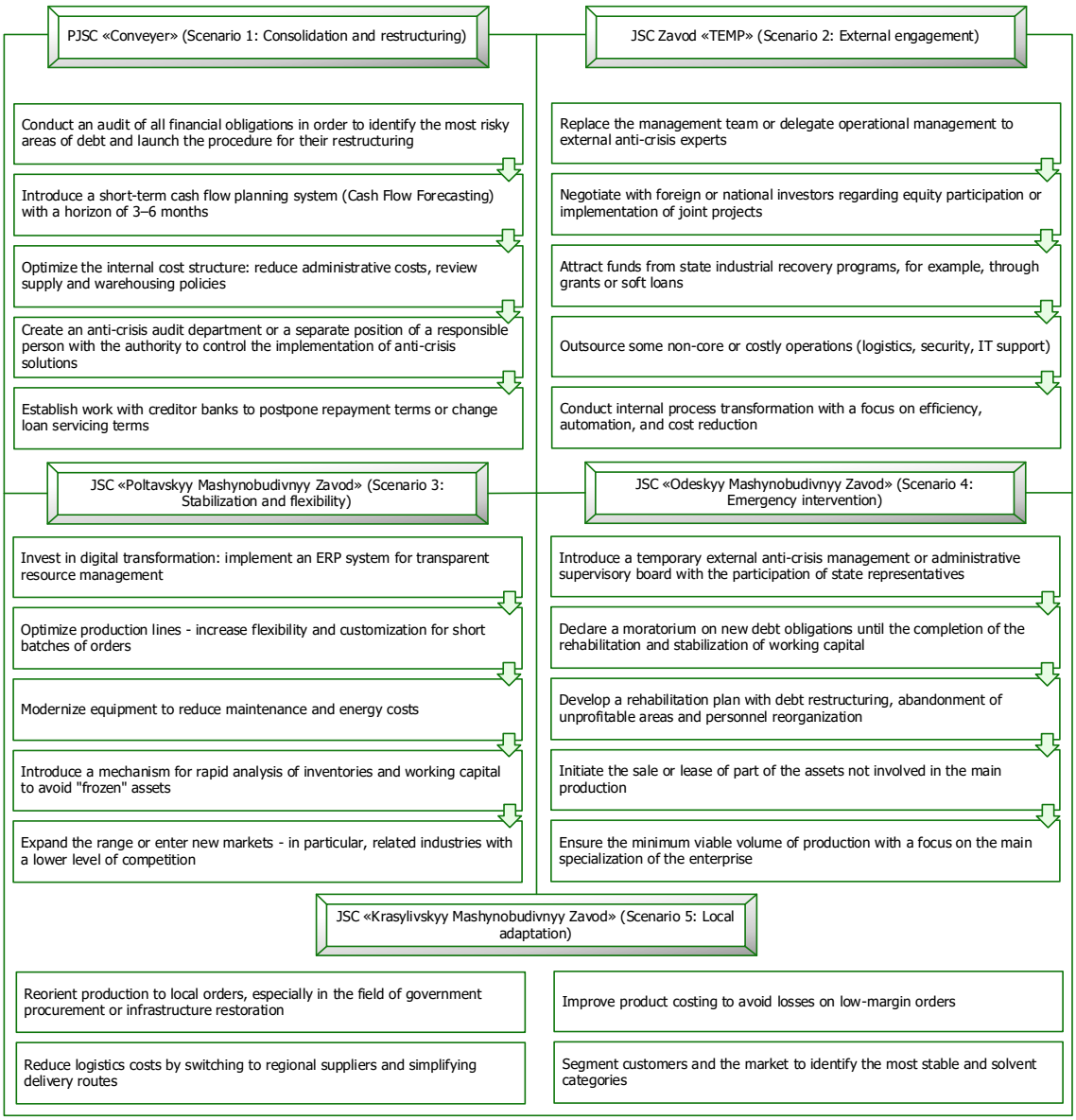

Figure 2. Characteristics of selected scenarios for the implementation of anti-crisis management for 2025 for mechanical machine-building enterprises.

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So, let's detail the proposed scenarios from Figure 2 in more detail:

1. PJSC "Conveyer", which, according to the modelling results, had about 69% probability of bankruptcy in 2024, for 2025, it is better to choose the consolidation and restructuring scenario. It involves the concentration of resources, debt restructuring, and strengthening of internal control to prevent the enterprise from slipping into the insolvency zone.
2. For PJSC "Odesskyi Machine Building Plant", which is in the most critical situation (the probability of bankruptcy exceeds 90% and there are no anti-crisis actions, this indicates that in 2025 it is necessary to propose the "emergency intervention" scenario. It is justified by the need for immediate radical steps. These include: the introduction of external management (temporary administration), a moratorium on debts, rehabilitation, or even partial liquidation of assets in order to preserve key production facilities.
3. Scenario 3 "Stabilization and Flexibility" was intended, for example, for PJSC "Poltava Machine-Building Plant". Thus, the justification was that this plant needs steps to consolidate positive changes: flexible production management, cost optimization, and gradual financial stabilization.
4. In 2025, scenario 5 should be applied to JSC "Krasyliv Machine-Building Plant". It is recommended to focus on adapting to new market conditions: review the range, sell unused assets, and focus on local orders to restore viability.
5. Scenario 2 is appropriate for enterprises that do not have sufficient resources to overcome the crisis on their own, but their risk has not reached a critical level. Thus, JSC "TEMP Plant", after a difficult 2022, showed a relative stabilization of indicators. In 2025, it is necessary to search for investors, participate in state recovery programs, and partnerships - in order to obtain additional financial and technological resources for safe development.

DISCUSSION

The results of the conducted logistic modelling for the machine-building enterprises of Ukraine, which we obtained, clearly demonstrate a number of methodological and applied advantages compared to the existing scientific achievements.

The study of Pohrishchuk et al. (2023), although it has a general focus on anti-crisis management in the field of machine building, focuses on general organizational measures (e.g., strategy review, cost optimization), without a statistically verified basis for their justification. Our model provides quantitative validity of scenarios for each enterprise through analysis of the impact of specific variables. In the work of Melnyk et al. (2020), attention is mostly paid to the key aspects of managing the HR component of an enterprise in a crisis, which, in the realities of modern times, is an important element of the mechanism for ensuring economic security. But at the same time, we believe that the lack of a direct connection between HR strategies and the financial indicators of an enterprise in practice can reduce the effectiveness and relevance of the results obtained. In our work, the emphasis is on the optimal integration of quantitative and qualitative management factors. This allows us to consider financial security as a complex and multidimensional concept (not only as an accounting one, but also as a management one). In turn, Zavidna et al. (2022) pay special attention to sustainable development in the post-pandemic period. Although the authors' work is relevant, their focus exclusively on the regional level, ignoring the individual level of the enterprise, makes the conclusions generalized and unified. In our approach, the enterprise level is more clearly identified and analyzed, which allows us to integrate individual action scenarios that are adapted to each individual business entity.

A feature of our study is the combination of quantitative and qualitative indicators. Thus, X1, X2, and X3 are quantitative financial ratios, directly calculated from the financial statements of the enterprise. In contrast, X4, X5, and X6 are qualitative, binary in nature, and obtained through expert survey and analysis of management information. Unlike financial ratios, such indicators are not measured directly in monetary units, but are extremely important for the model, because they take into account the human factor and management practices.

CONCLUSIONS

The conducted logistic modelling of the probability of bankruptcy of machine-building enterprises based on data for 2022–2024 showed the effectiveness of combining financial and management indicators within a single analytical model. The most significant determinants of the onset of crisis situations were a high level of debt, low asset profitability, and the absence of proper anti-crisis management systems at enterprises. Enterprises, not rarely, neglect the issue of forming an

anti-crisis management department or are not always able to appoint an appropriate person for this. Therefore, in conclusion, we believe that it was precisely the presence of an organized anti-crisis policy, on the contrary, that significantly reduced the probability of bankruptcy, which indicates the significance of not only financial reporting, but also the adopted and implemented management decisions. Thus, the results obtained confirm the hypothesis of the feasibility of using mixed models to diagnose the state of enterprises during periods of extreme economic instability. The model not only confirms the crisis events that occurred in reality, but also allows, with a certain degree of accuracy, to predict potential threats to enterprises in the next period. This opens up the possibility of practical application of the model for early crisis prevention and strategic risk management at the industry level, which in turn significantly makes it possible to maintain the level of financial security at an acceptable level for the management of the enterprise. In the future, it is advisable to expand the model by including new variables - in particular, indicators of the external environment, as well as assessments of managerial competence and digital literacy, etc. A promising option is to combine logistic regression with modern digital technologies based on artificial intelligence, in order to assess the level of the human factor and possible errors.

ADDITIONAL INFORMATION

AUTHOR CONTRIBUTIONS

All authors have contributed equally.

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CONFLICT OF INTEREST

The Authors declare that there is no conflict of interest.

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ОЦІНЮВАННЯ ЙМОВІРНОСТІ БАНКРУТСТВА В СИСТЕМІ ПІДВИЩЕННЯ ЕФЕКТИВНОСТІ АНТИКРИЗОВОГО УПРАВЛІННЯ ПІДПРИЄМСТВОМ

Сьогодні, у зв'язку з глибокими економічними трансформаціями, структурними зрушеннями та високою волатильністю макросередовища, існує об'єктивна потреба в упровадженні ефективних інструментів антикризового аналізу, які дозволяють не лише оцінювати ризики банкрутства, а й своєчасно виявляти загрози фінансовій безпеці. У статті представлено результати логістичного моделювання ймовірності банкрутства машинобудівних підприємств України на основі сукупності фінансових та управлінських показників у період після повномасштабного збройного вторгнення в Україну (2022–2024 рр.). Основним завданням було провести моделювання на прикладі п'яти підприємств на основі даних за 2022–2024 роки; проаналізувати отримані результати, інтерпретувати коефіцієнти logit-моделі та визначити основні детермінанти ймовірності банкрутства; запропонувати напрями для вдосконалення. У статті обґрунтовано доцільність включення до моделі й кількісних показників (коефіцієнт ліквідності, рентабельність активів, рівень заборгованості), і якісних характеристик (наявність антикризової системи управління, реалізація антикризових заходів, факт виникнення кризової ситуації). Побудована модель дозволила оцінити ймовірність настання кризових подій на п'яти машинобудівних підприємствах і сформувати для кожного з них індивідуальний сценарій реагування керівництва в системі фінансової безпеки. Отримані результати мають практичне значення для підвищення рівня фінансової безпеки, посилення гнучкості управління та впровадження системи раннього сповіщення в умовах економічної нестабільності.

Ключові слова: фінансова безпека, машинобудівне підприємство, логістична регресія, банкрутство, антикризове управління, ризики, ймовірність, управлінські рішення, кількісні та якісні показники, кризова ситуація, антикризові заходи, безпекові аспекти, повномасштабне збройне вторгнення, фінансові показники

JEL Класифікація: C25, G33, L60, M21, O25