THE METHODOLOGICAL FOUNDATIONS FOR DEVELOPING NEW AND IMPROVING EXISTING METHODS FOR ASSESSING THE PROBABILITY OF BANKRUPTCY OF UKRAINIAN ENTERPRISES

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The Methodological Foundations for Developing New and Improving Existing Methods for Assessing the Probability of Bankruptcy of Ukrainian Enterprises

The article explores the methodological foundations for the development and improvement of bankruptcy probability assessment methods for Ukrainian enterprises. In the context of economic instability caused by global crises, warfare, and political uncertainty, accurate bankruptcy forecasting is critically important for ensuring financial stability at both micro and macro levels. The study analyzes the scientific works of Ukrainian economists, emphasizing the need to adapt existing models to Ukraine's unique economic conditions, particularly variable inflation, tax policy, and sectoral risks. The article highlights the importance of developing specialized methodologies for various sectors of the economy – such as agriculture, banking, and industry – to address their specific challenges. The article proposes the integration of both quantitative and qualitative indicators to enhance the accuracy of bankruptcy probability assessments. Additionally, a prospective direction for the use of modern tools, such as artificial intelligence and machine learning, has been identified, which allow for the analysis of large volumes of data and the identification of complex relationships. The article substantiates the necessity for developing a national bankruptcy model that will take into account the unique economic conditions, regulatory environment, and sociopolitical factors of Ukraine. This approach will enhance the accuracy of forecasting crisis situations, strengthen the resilience and financial stability of Ukrainian enterprises.

Keywords: methods for assessing bankruptcy probability, economic models, Ukrainian enterprises.

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Попов О. С., Леонов В. С. Методологічні засади розробки нових та вдосконалення існуючих методів оцінювання ймовірності банкрутства українських підприємств

У статті досліджено методологічні засади розробки та вдосконалення методів оцінювання ймовірності банкрутства українських підприємств. В умовах економічної нестабільності, спричиненої глобальними кризами, війною та політичною невизначеністю, точне прогнозування банкрутства є критично важливим для забезпечення фінансової стабільності як на мікро-, так і на макрорівнях. У дослідженні проаналізовано праці українських економістів, що підкреслює необхідність адаптації існуючих моделей до унікальних економічних умов України, зокрема змінної інфляції, податкової політики та галузевих ризиків. У статті акцентовано увагу на важливості розробки спеціалізованих методик для різних секторів економіки – таких як сільське господарство, банківська сфера та промисловість – для врахування їхніх специфічних викликів. Запропоновано інтеграцію як кількісних, так і якісних показників для підвищення точності оцінювання ймовірності банкрутства. Крім того, визначено перспективний напрямок використання сучасних інструментів, таких як штучний інтелект і машинне навчання, що дозволяють аналізувати великі обсяги даних і виявляти складні взаємозв'язки. У статті обґрунтовано необхідність розробки національної моделі банкрутства, яка враховуватиме унікальні економічні умови, регуляторне середовище та соціально-політичні фактори України. Такий підхід сприятиме підвищенню точності прогнозування кризових ситуацій, зміцненню стійкості та фінансової стабільності українських підприємств.

Ключові слова: методи оцінювання ймовірності банкрутства, економічні моделі, українські підприємства.

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Introduction. Assessing the probability of bankruptcy for enterprises is a crucial tool for ensuring economic stability at both macro and micro levels. In the context of economic instability caused by external factors such as the global economic crisis, war, and political uncertainty, Ukrainian enterprises face heightened financial risks. These risks can lead to decreased liquidity, loss of competitive positions, and, consequently, bankruptcy. In such conditions, it is critically important to have accurate and effective bankruptcy forecasting methods to timely identify companies in crisis and implement preventive measures.

Bankruptcy probability assessment methods allow the identification of early signs of crises in enterprises using financial and economic indicators. This is especially relevant for Ukrainian companies operating in a rapidly changing economic environment and facing limited access to financial resources. The use of such methods enables businesses and investors to make informed decisions about financial planning, risk management, and investment attractiveness. For creditors, these risk assessment methods help minimize credit risks and make balanced decisions regarding financing.

The relevance of these methods also lies in the need to adapt foreign bankruptcy forecasting models to the Ukrainian reality. Developing national models that take into account the specifics of Ukraine's economy, tax legislation, and sectoral risks is essential for more accurate predictions. In such a context, bankruptcy probability assessment methods can become an effective tool for crisis management, contributing to the financial stability of enterprises and the overall stability of Ukraine's economy.

Analysis of Recent Research and Publications. Assessing the probability of bankruptcy is a critical component of financial analysis, allowing the identification of early signs of financial difficulties within enterprises. Ukrainian researchers actively engage in the development of models and methodologies for bankruptcy forecasting, taking into account the specific economic environment of Ukraine.

Burkova L. [1] analyzes the specific challenges in assessing bankruptcy within the metallurgical industry. The author emphasizes the importance of adapting general financial models to the conditions of specific sectors, particularly considering market volatility and currency fluctuations. A key aspect of the work is the use of multifactor models that consider both internal (financial indicators) and external (market) factors.

Volkova N. and Stepanko O. [2] focus their work on bankruptcy risk forecasting using mathematical models and financial ratio analysis. The authors view logistic models as one of the most effective methods for assessing the financial stability of enterprises, especially in conditions of economic instability.

Ishchenko N. [3] suggests using multifactor models for diagnosing financial crises and enterprise bankruptcy. The author also highlights the necessity of considering not only financial indicators but also non-financial factors such as management effectiveness and macroeconomic conditions.

Kravchuk L. and Gava M. [4] explore the specifics of agricultural enterprises in the context of bankruptcy. They emphasize the need to use adapted models that account for the seasonality of the business and its dependence on natural and climatic conditions. An essential part of their analysis includes the influence of government subsidies and tax policies.

Kremen V. and Bochkaryova T. [5] develop a logistic model for forecasting the bankruptcy of banking institutions. They highlight the importance of a comprehensive risk assessment that considers the specific features of the banking sector, such as liquidity levels, reliance on external financing, and the impact of macroeconomic changes.

Povsteniuk N. [6] reviews modern methods for diagnosing bankruptcy, focusing on the use of multifactor models that account for not only financial indicators but also market and managerial factors. The author stresses the need to adapt foreign models to the realities of Ukraine.

Pohrebniak A. [7] conducts a comparative analysis of various foreign and domestic bankruptcy assessment methodologies, including Altman's and Taffler's models. The author concludes that these models need to be adapted to the specifics of Ukraine's economy and proposes a comprehensive approach to bankruptcy assessment.

Semenenko N. and Dorundyak K. [9] examine different methods for bankruptcy forecasting, including discriminant analysis and logistic models. They also analyze the effectiveness of applying these methods to Ukrainian enterprises and recommend using combined approaches for more accurate forecasts.

Fedorova V.A. and Vaskovska O.R. [10] propose the use of comprehensive diagnostic models that take into account financial ratios, macroeconomic conditions, and market trends. The authors also emphasize the need for econometric models to achieve more accurate predictions of crisis situations.

Khryniuk O.S. and Bova V.A. [11] develop bankruptcy forecasting models that incorporate both financial indicators and external factors such as market conditions and macroeconomic changes. They emphasize the importance of including indicators like debt volume and liquidity levels in the models.

Chibisova V. [12] analyzes the main approaches to bankruptcy forecasting, focusing on the application of foreign methods such as Altman's and Taffler's models. The author highlights the importance of adapting these models to the Ukrainian economic context, particularly due to high inflation and the peculiarities of tax legislation. Chibisova also notes that combining multiple models is necessary for more accurate forecasts, as this allows for capturing various aspects of financial stability.

Chumak V. and Gvizdzhinska I. [13] investigate the application of discriminant analysis for bankruptcy forecasting. They emphasize that this method helps identify the most significant financial indicators influencing bankruptcy risk. Discriminant analysis allows for constructing a mathematical model that effectively categorizes enterprises into those at risk of bankruptcy and those with stable financial positions.

Shvets Y. and Martyniuk N. [14] examine bankruptcy probability analysis methods specifically adapted for industrial enterprises. They focus on models that account for specific risks in the industrial sector, such as dependence on raw material prices, energy efficiency, and technological innovations. The authors also note that for industrial enterprises, it is essential to consider not only financial indicators but also operational and market factors.

Yankovets T. and Cherniuk Y. [15] conduct a comparison of foreign and domestic models for bankruptcy forecasting. They analyze the effectiveness of classical models, such as Altman's model, in comparison with newer methodologies that account for macroeconomic factors and the institutional characteristics of the Ukrainian business environment. The authors conclude that the best results can be achieved by combining elements from multiple models and adapting them to national realities.

Table 1 summarizes the key advantages and disadvantages of the ideas and models proposed by Ukrainian scholars.

A review of Ukrainian researchers' studies on methods for assessing the probability of enterprise bankruptcy indicates the following:

1. Many researchers believe that foreign models, such as Altman's and Taffler's models, can be effective for assessing the probability of bankruptcy for Ukrainian enterprises but require adaptation to the specific conditions of Ukraine's economy (inflation, tax burden, currency instability).

2. Specialized methodologies are needed for different sectors, such as agriculture, banking, and industry, to account for the characteristic risks of each industry.

3. The use of modern tools, such as discriminant analysis and logistic models, allows for a more accurate assessment of a company's financial condition.

4. Successful methodologies incorporate both quantitative and qualitative indicators, enabling the consideration of both financial and non-financial risk factors for bankruptcy.

Despite existing advancements, there is a need for further research and refinement of these models, especially considering the rapid changes in Ukraine's economy, including

Table 1

Ideas, Advantages, and Disadvantages of Bankruptcy Forecasting Approaches by Ukrainian Researchers

Researchers	Main Idea/Model	Advantages	Disadvantages
Burkova L.	Multifactor models for the metallurgical industry	Consideration of industry-specific risks, adaptation to Ukrainian conditions	High dependence on external factors
Volkova N., Stepanko O.; Kremen V., Bochkaryova T.	Logistic models for the banking sector and enterprises	High accuracy in risk forecasting, comprehensive risk assessment	Requires large datasets, limited applicability in financial institutions
Ishchenko N., Povsteniuk N.	Multifactor models for bankruptcy diagnostics	Consideration of both financial and non-financial indicators	Possible difficulties in assessing non-financial factors, need for adaptation to realities
Kravchuk L., Gava M.; Popov O.; Shvets Y., Martyniuk N.	Models for agricultural and industrial enterprises	Consideration of specific industry risks (seasonality, subsidies), operational indicators	Lack of universality for other sectors
Pohrebniak A.; Yankovets T., Cherniuk Y.	Comparative analysis of foreign and domestic methodologies	Ability to choose the most effective elements from different approaches	Requires significant time for adaptation
Semenenko N., Dorundiak K.; Chumak V., Gvizdzhinska I.	Discriminant analysis for bankruptcy diagnostics	High accuracy in forecasting, classification of enterprises by financial stability	Requires large datasets for accuracy, needs regular data updates
Fedorova V., Vaskovska O.; Khryniuk O., Bova V.	Comprehensive models for crisis diagnostics	Consideration of macroeconomic and market trends, external factors	Models can be too complex for small businesses, require extensive data
Chibisova V.	Altman's model, Taffler's model	Ease of use, effectiveness in foreign conditions	Need for adaptation to Ukrainian conditions

Source: A review of publications [1–15]

those related to global economic crises, the pandemic, and the ongoing war.

Results. Assessing the probability of bankruptcy for enterprises is a crucial tool for ensuring economic stability at both macro and micro levels. In the context of economic instability caused by external factors such as the global economic crisis, war, and political uncertainty, Ukrainian enterprises face heightened financial risks. These risks can lead to decreased liquidity, loss of competitive positions, and, consequently, bankruptcy. In such conditions, it is critically important to have accurate and effective bankruptcy forecasting methods to timely identify companies in crisis and implement preventive measures.

Bankruptcy probability assessment methods allow the identification of early signs of crises in enterprises using financial and economic indicators. This is especially relevant for Ukrainian companies operating in a rapidly changing economic environment and facing limited access to financial resources.

The use of such methods enables businesses and investors to make informed decisions about financial planning, risk management, and investment attractiveness. For creditors, these risk assessment methods help minimize credit risks and make balanced decisions regarding financing.

In addition to the works of domestic economists, the author in article [8] reviewed the most common foreign and domestic bankruptcy prediction models, including the Altman, Lise, Taffler, Springate, Tereshchenko models, the Ministry of Finance of Ukraine's methodology, and others. The primary advantage of foreign models lies in the simplicity of calculations and their applicability in external diagnostic analysis. However, the main drawback is that these models were developed based on data from companies in the U.S. and Western Europe, which does not account for the specifics of Ukraine's economy and accounting practices.

A comparative analysis of eight bankruptcy prediction models was conducted based on data from four companies in the machine-building industry: two bankrupt companies (PJSC "Drohobych Machine-Building Plant" and PJSC "Druzhkivka Machine-Building Plant") and two successful companies (JSC "Krasyliv Machine-Building Plant" and JSC "Kharkiv Machine-Building Plant 'Svitlo Shakhtarya'"). The results showed that models often fail to accurately predict bankruptcy or, conversely, mistakenly forecast a high risk of bankruptcy for functioning enterprises.

The most accurate was Altman's five-factor model, scoring 6 points out of 8. Less successful were the Springate and Tereshchenko models, each scoring 2 points. This suggests the higher effectiveness of older methodologies compared to newer ones.

Ukrainian models for diagnosing bankruptcy probability (Tereshchenko's and Matviychuk's models) have certain shortcomings related to insufficient accuracy and inconsistency with market realities.

Additionally, there are challenges in adapting existing models to the specifics of Ukraine's economy, which requires further refinement. Since most foreign models, such as Altman's, produced better results, a promising direction is the adaptation of these models to Ukrainian economic conditions.

This involves considering specific factors such as inflation, tax legislation, and the accounting practices of Ukrainian enterprises.

Thus, further research on adapting bankruptcy forecasting models to Ukrainian conditions and optimizing existing methodologies to ensure financial stability of enterprises is crucial.

The main promising directions of research include:

1. Development of a universal national bankruptcy forecasting model that accounts for the economic realities and specifics of Ukrainian enterprises. This will allow for more accurate bankruptcy probability forecasts and timely responses to crises.

2. Review and optimization of existing financial analysis methods to improve bankruptcy forecasting accuracy. Further research into the integration of qualitative indicators alongside quantitative ones in the analysis is particularly relevant.

3. Use of artificial intelligence (AI) and machine learning – the implementation of AI and machine learning techniques for bankruptcy prediction. This will enable the development of new models based on big data, which will increase the accuracy and efficiency of analysis.

Each of these directions offers opportunities for enhancing the accuracy and reliability of bankruptcy predictions, thereby supporting the financial stability of Ukrainian enterprises in an increasingly volatile global economy.

Opportunities for Adapting Foreign Bankruptcy Prediction Models

Adapting foreign bankruptcy prediction models to the conditions of the Ukrainian economy is an important task, as most of these models were developed for enterprises in developed economies with different accounting systems, legal frameworks, and macroeconomic conditions. To ensure more accurate predictions and to help Ukrainian enterprises manage crises, several key aspects must be considered when adapting foreign models.

First, it is important to consider the specific features of the national economy, including the following:

1. Inflationary Processes and Currency Instability. The Ukrainian economy is characterized by high inflation rates and national currency instability. These factors affect the financial indicators of enterprises, which are the foundation of foreign models. For example, the Altman and Lise models do not account for currency fluctuations and inflation, which can lead to incorrect conclusions about a company's financial stability.

2. Tax Legislation and Accounting Practices. The tax system in Ukraine differs significantly from those in Western countries. This is reflected in the financial reporting of enterprises and affects indicators such as net profit, gross assets, and others. Foreign models typically do not consider the specifics of Ukrainian tax accounting, which can distort the results of the forecasts.

3. Sectoral Specificities. Many foreign bankruptcy prediction models are developed for enterprises in various sectors of the economy, but they do not always

take into account the specifics of certain industries, such as machine-building or agriculture, which are crucial for the Ukrainian economy.

The characteristics of the national economy, associated challenges, and possible solutions for adapting bankruptcy prediction models are presented in Table 2.

Table 2

Opportunities for Considering National Economic Specifics

Feature	Problem	Adaptation Solutions
Inflationary processes and currency instability	High inflation rates and currency instability affect financial indicators, which are not accounted for in foreign models	Incorporate inflation-adjusted coefficients
		Recalculate indicators in more stable currencies
		Introduce currency risk factors
Tax legislation and accounting practices	The tax system in Ukraine differs from Western countries, potentially distorting financial forecasts	Adjust financial ratios considering Ukrainian tax legislation
		Account for tax benefits
		Introduce additional sector-specific coefficients
Industry-specific characteristics	Foreign models often do not consider the specifics of key Ukrainian industries such as machine-building or agriculture	Develop industry-specific versions of the models
		Include factors influencing industry risks (dependence on imports, weather conditions)

Source: Own elaboration

The most obvious approach in the case of discriminant models is to update the weight coefficients of the models. Most foreign models, such as Altman's model, are developed based on statistical data derived from the analysis of enterprises in the U.S. and Western Europe. The weight coefficients in these models are based on financial stability indicators of those enterprises, which may not correspond to the realities of Ukrainian businesses. There are two ways to make these models more relevant for Ukrainian enterprises:

Updating based on Ukrainian data. To adapt foreign models, it is necessary to update the weight coefficients based on data from Ukrainian enterprises. This will account for the specific characteristics of the Ukrainian business environment and improve the accuracy of the forecasts.

Using local indicators. Indicators that are significant in Western models may not have the same importance in the Ukrainian context. For instance, return on assets may carry different significance for Ukrainian enterprises, which often operate under conditions of limited access to credit resources and high interest rates.

These two approaches, along with the problems associated with them and the solutions that can be implemented, are outlined in Table 3.

Finally, it is advisable to improve the quality of the indicators used in the models. Most foreign models rely exclusively on quantitative indicators such as working capital, profit, assets, etc. However, in times of economic instability, qualitative indicators can be just as important as financial ones. For example, a company's reputation, stability of the management team, corporate culture, and other intangible assets can significantly impact a company's financial health. There are two main ways to improve the quality of indicators:

1. Considering social and political factors. In the context of Ukraine, political risks, war, and social instability can play a crucial role. Such factors are often not considered in financial models, but they directly affect a company's ability to survive in crisis conditions.

2. Integration with modern technologies. The use of artificial intelligence and machine learning allows for the modeling of more complex processes and the inclusion of many more factors. This can be used to create flexible forecasting models that can adapt to rapid market changes and take into account both quantitative and qualitative indicators.

These two approaches, along with the problems associated with them and the actions that can be taken to resolve these issues, are presented in Table 4.

Thus, adapting foreign bankruptcy prediction models to the Ukrainian economy requires a comprehensive approach that includes considering macroeconomic conditions, updating weight coefficients based on Ukrainian data, and introducing additional indicators that account for political, social, and industry-specific risks. The use of modern technologies, such as artificial intelligence, can become an essential tool for improving the accuracy of predictions and helping Ukrainian enterprises respond timely to crises.

Development of a National Bankruptcy Prediction Model

The development of a national bankruptcy prediction model for Ukrainian enterprises is an important step in ensuring the financial stability of domestic companies. Such a model should take into account the specifics of the national economy, socio-political conditions, as well as the differences in Ukraine's financial system compared to other countries. Existing industry methodologies recommended by the Ministry of Finance of Ukraine (MFU) provide general approaches to assessing the financial condition of enterprises, but they do not cover all the aspects necessary for comprehensive and effective risk diagnostics of bankruptcy.

Let's consider how a national bankruptcy prediction model can be developed and adapted to Ukrainian conditions and how it may differ from existing MFU methodologies.

Firstly, macroeconomic factors should be considered:

1. Inflation and currency fluctuations. In recent years, Ukraine has experienced significant economic

Opportunities for Adapting Western Models

Approach	Problem	Adaptation Solutions
Updating based on Ukrainian data	Need to update weight coefficients based on data from Ukrainian enterprises to account for business environment specifics	Collect and analyze bankruptcy data from the past 10–15 years
		Develop new models using discriminant analysis and regression
		Test models across various sectors of the economy
Using local indicators	Western indicators may not be relevant in the Ukrainian context due to different economic conditions and access to credit	Introduce coefficients that reflect local economic conditions
		Expand the analysis to include operational activity, market stability, and industry positioning

Source: Own elaboration

Opportunities for Adapting Western Models

Approach	Problem	Adaptation Method
Considering social and political factors	Political risks, war, and social instability, which are often not considered in financial models but significantly affect a company's survival ability	Adding indicators to models that account for political risks, social factors, and company reputation
		Using expert evaluation methods to incorporate qualitative indicators
Integration with modern technologies	The need to adapt models to rapid market changes by using artificial intelligence and machine learning to account for more factors	Developing machine learning-based systems for continuous model updates
		Using AI algorithms to analyze large volumes of data

Source: Own elaboration

fluctuations, including high inflation and an unstable national currency. These factors significantly affect the financial indicators used to assess a company's stability. Accordingly, to improve the national model, it is advisable to introduce coefficients that account for inflationary processes and currency differences. In particular, indicators should be used that adjust currency obligations into more stable currencies (such as the US dollar or euro) or index financial indicators according to inflation rates.

2. Impact of government regulation. Government support and regulation also play a significant role in the financial activities of enterprises. For example, changes in tax legislation, industry support programs, and other types of government intervention can influence a company's financial indicators. Therefore, to improve the national model, it is necessary to provide mechanisms that take into account changes in government policy and their impact on enterprises. For instance, a tool could be created to assess how changes in tax legislation or government subsidies might affect a company's financial stability.

Secondly, it is advisable to consider qualitative indicators and those that characterize intangible assets:

1. Corporate culture and management. Many companies that survive crises have a strong corporate culture and effective management. These are factors that cannot always be measured quantitatively, but they play a significant role in predicting financial stability. To improve the national model, it is necessary to:

· include qualitative indicators that reflect the level of management competence, corporate culture, com-

pany development strategy, and market reputation. Methods such as expert evaluation or special surveys for assessing intangible assets can be used for this purpose.

· consider intangible assets (such as reputation, innovation potential, corporate social responsibility), which can add a deeper level of analysis, allowing for the assessment of not only the financial but also the strategic stability of the company.

2. Social factors. Social factors, such as employee satisfaction, labor conflicts, and personnel policies, can also impact a company's financial stability. In an unstable market, the role of effective personnel management and corporate social responsibility grows. To improve the national model, it is necessary to:

· consider social aspects, such as employee turnover rates, job satisfaction, and the presence of labor conflicts or strikes. This would allow the identification of internal risks that could lead to a crisis before they affect financial indicators.

· develop indicators that account for these social risks and implement them into the overall bankruptcy prediction model.

Thirdly, bankruptcy forecasting can be significantly improved by implementing modern technologies for modeling:

1. Artificial intelligence and machine learning. One of the most notable differences between the national model and traditional industry methodologies of the MFU could be the use of modern technologies such as artificial intelligence and machine learning. This will allow for the processing of large volumes of data and

automatic model updates based on new information. To improve the national model, it is necessary to:

- use machine learning algorithms for the automatic collection and analysis of companies' financial data, which will help identify bankruptcy risks at early stages and quickly adapt models to new economic conditions;
- introduce the ability to automatically update model weight coefficients based on large data sets, which will make the model more flexible and accurate in its predictions.

2. Big data and analytics. Thanks to modern technologies, it is now possible to use large volumes of data, including not only financial indicators but also social, political, and market factors. To improve the national model, it is necessary to:

- utilize big data analytics for modeling complex systems and predicting bankruptcies based on a variety of factors;
- expand the range of indicators and data sources to improve forecasting accuracy and reduce the number of false signals.

Thus, the national bankruptcy prediction model must be more flexible and adaptive compared to existing industry methodologies of the MFU. It should account for macroeconomic conditions, industry-specific characteristics, qualitative indicators, and modern technologies to enhance forecasting accuracy. Such a model will help Ukrainian enterprises navigate complex economic conditions more effectively and respond promptly to potential crises, ensuring their financial stability and competitiveness.

Optimization of Financial Analysis Methods: Key Directions and Approaches

Financial analysis is a fundamental tool for assessing a company's economic status, solvency, and growth prospects. In the current environment of the Ukrainian economy, characterized by high volatility, financial analysis methods require constant improvement to ensure accuracy, efficiency, and flexibility in assessments. Optimizing these methods will contribute to more accurate crisis forecasting and help make informed management decisions at early stages of problems.

Let's explore the key directions for optimizing financial analysis methods and practical approaches to their enhancement, considering modern trends and challenges:

1. Using a comprehensive approach to financial analysis. Traditional financial analysis methods often focus on quantitative indicators such as liquidity, profitability, financial stability, etc. However, these indicators do not always fully reflect the actual state of an enterprise. Qualitative factors, such as management practices, market reputation, and innovation potential, can also have a decisive impact on performance outcomes. The situation can be improved by:

- including qualitative indicators in financial analysis methods, such as developing a methodology for evaluating the quality of management through the analysis of leadership experience, innovation implementation, and market reputation;
- using expert assessments to consider intangible assets, such as customer loyalty, corporate culture, and

intellectual property, which also affect competitiveness.

2. Multifactor approach. Instead of using one or several standard ratios, it is advisable to develop a comprehensive approach that covers a wider range of indicators and considers their interaction. This approach will allow for more accurate risk assessment and identification of potential threats at early stages. The situation can be improved by:

- creating comprehensive evaluation models that simultaneously include financial, operational, and strategic indicators. For example, in forecasting solvency, indicators such as asset turnover, accounts receivable, and cost management efficiency can be used;
- using multifactor analysis to assess a company's financial stability, allowing for the consideration of interconnections between different economic variables and the identification of trends.

3. Standardization and unification of financial methods. An important step toward optimizing financial analysis is the standardization of key indicators and methods for their calculation. This will ensure a unified approach to evaluating a company's financial condition, promoting transparency and comparability of analysis results.

Developing unified financial analysis standards for companies of different industries and ownership forms. This will allow for analysis based on the same criteria, ensuring comparability of results between companies. Introducing mandatory ratios for assessing financial stability and liquidity will help avoid subjectivity during the analysis.

4. Adapting international standards. One of the promising directions is the adaptation of Ukrainian financial analysis methods to international standards. This will make Ukrainian enterprises more competitive in the global market and meet global requirements for reporting and analysis.

Adapting financial analysis methods in accordance with International Financial Reporting Standards (IFRS) will provide a unified approach to calculating financial indicators and promote greater transparency of enterprises at the international level. Implementing international practices for assessing risks and crises in business operations will help optimize crisis management processes.

5. Optimization of risk forecasting and modeling. Traditional financial analysis often does not include scenario analysis, which allows for the assessment of different development options. Scenario analysis helps companies better prepare for possible crises and make more informed management decisions.

Implementing scenario analysis as a mandatory element of financial planning could be considered. For example, companies can develop "worst-case", "average", and "best-case" scenarios of economic developments to predict the impact of each on the company's financial situation.

In addition to scenario analysis, it is also important to use modern financial models for risk assessment. This will help companies better understand their financial indicators and their interrelationships, as well as identify the most critical areas.

Thus, the optimization of financial analysis methods is a necessary step for ensuring effective financial management of companies in modern conditions. A comprehensive approach that integrates qualitative and quantitative indicators, uses modern technologies, standardizes analysis methods, and incorporates scenario planning will significantly improve the accuracy and effectiveness of financial analysis. These steps will contribute to the timely identification of financial problems, enabling companies to respond quickly to changes and avoid crisis situations.

Using Artificial Intelligence and Machine Learning for Bankruptcy Prediction

Artificial intelligence (AI) and machine learning (ML) have become essential tools in modern data analysis, particularly in the financial sector. The application of these technologies for bankruptcy prediction opens new opportunities for improving the accuracy of financial analysis and the efficiency of crisis management. AI and ML can process vast amounts of information and uncover complex relationships between indicators, allowing for the creation of more accurate predictive models than traditional approaches.

Let's explore in detail the key aspects of using artificial intelligence and machine learning for bankruptcy prediction, including model types, key implementation stages, and opportunities for improving risk analysis.

Machine learning is a subset of artificial intelligence that involves training models on large data sets to identify patterns and correlations. In the context of financial analysis, ML can be used for bankruptcy prediction, credit risk assessment, market trend analysis, and other financial indicators. ML models are trained on historical data, allowing them to detect non-linear relationships between financial indicators and external factors that can impact a company's financial stability.

There are several types of ML algorithms that can be used for bankruptcy prediction. The most common are:

1. Classification algorithms (e.g., logistic regression, decision trees, neural networks) are used to predict categories or classes, such as "bankruptcy" or "non-bankruptcy." This allows for the prediction of a company's likelihood of bankruptcy based on its financial data.
2. Regression models predict the value of continuous variables, such as financial indicators, that may indicate the future financial health of a company. These models can be used to assess how strongly certain factors influence the probability of bankruptcy.
3. Neural networks, particularly deep learning, are capable of analyzing complex relationships between different financial indicators. The use of neural networks allows for the modeling of patterns that may not be apparent to traditional financial analysis approaches.
4. Ensemble methods combine several algorithms to enhance prediction accuracy. Popular ensemble methods include Random Forest and Boosting. They improve the precision of forecasts by aggregating the results of multiple models.

Using AI and ML for bankruptcy prediction enables the creation of highly accurate models that can assess a wide range of factors and help enterprises detect financial risks early, allowing them to respond proactively to potential crises.

To effectively implement artificial intelligence and machine learning methods, several stages must be followed, each with its own specific features:

1. Data collection and preparation. Data collection is the first and most important step in the machine learning implementation process. For bankruptcy prediction, it is necessary to collect historical financial data from companies, including balance sheets, income statements, profitability, and liquidity indicators. Key features of this stage:
   - it is important to gather not only financial data but also macroeconomic factors such as inflation, exchange rates, unemployment levels, and industry-specific indicators;
   - the data must be cleaned of any missing values, duplicates, and anomalies to ensure the accuracy of subsequent analysis;
   - after data cleaning, normalization must be performed since different financial indicators may have different units of measurement.

2. Model creation and training. Based on the collected data, machine learning models are developed and trained using the historical data of companies. Key features of this stage:
   - during model training, historical data on companies that have gone bankrupt and those that are successfully operating are used – the model learns to identify patterns that may indicate an increased risk of bankruptcy;
   - various machine learning algorithms (classification, regression, neural networks) are used to create the models;
   - different algorithms are tested to choose the most accurate and efficient prediction method.

3. Model validation. After training, the model must be tested for accuracy and robustness. Validation datasets, which were not used during training, are utilized for this purpose. Key features of this stage:
   - it is important to perform several validation rounds to ensure the model can accurately predict bankruptcy on new, unseen data;
   - validation includes checking for errors such as overfitting, which can occur when the model is too closely tailored to the training data but performs poorly on new data.

4. Testing and implementation in real conditions. After successful validation, the model is deployed in real-world conditions to predict the likelihood of bankruptcy for companies. Key features of this stage:
   - testing in real conditions will assess how the model handles predictions based on the current financial data of companies;
   - after testing, the model can be integrated into corporate systems for automatic monitoring of financial indicators and timely identification of risks.

The implementation of AI and ML in bankruptcy prediction offers several key advantages that make these methods significantly more effective compared to traditional approaches:

1. High prediction accuracy. AI and ML can process vast amounts of data and detect complex relationships between financial indicators that are not always apparent to traditional analysis methods. This allows for more accurate predictions of bankruptcy likelihood. The use of big data provides a more comprehensive picture of a company's financial condition, taking into account numerous different factors. Machine learning models can also detect non-linear relationships between financial indicators, allowing for a more precise assessment of bankruptcy risks.

2. Fast data processing. Automating processes through AI and ML enables the rapid analysis of large volumes of information and delivers prediction results almost in real time. This is especially important in situations of rapid market changes or economic crises, allowing companies to receive timely information about financial risks and make quick management decisions. Automated models can continuously update data and predict bankruptcy risks based on new information.

3. Flexibility and adaptability. ML models can adapt to new data, making them effective even in conditions of economic instability or changing market conditions. AI models can learn from new data, allowing them to account for changes in market situations or internal company processes. The flexibility of the algorithms enables them to be adapted to different industries and the specific activities of enterprises.

4. Integration with other systems. ML models can be integrated with existing enterprise management systems, such as ERP systems, CRM systems, and other tools for monitoring financial indicators. This means that automated models can become part of a comprehensive enterprise management system, providing accurate financial forecasts based on current data.

Despite the numerous advantages, the implementation of AI and ML in bankruptcy prediction comes with certain challenges and limitations:

1. Data quality and availability. One of the main issues is the quality and availability of financial data needed for model training. Incomplete or inaccurate data can lead to incorrect predictions. This problem can be addressed by creating centralized databases for collecting and processing financial information from various sources, as well as using data cleaning methods and handling missing values to ensure the accuracy of the analysis.

2. Model complexity. Some machine learning models, such as neural networks, can be very complex to interpret, making it difficult to explain the results to managers and investors. This problem can be solved by using more interpretable models, such as decision trees or linear models, in combination with more complex algorithms, as well as developing visualization tools that help understand the model's results.

Thus, the use of artificial intelligence and machine learning for bankruptcy prediction opens new possibilities for improving the accuracy and efficiency of financial analysis. ML models enable the rapid processing of large data sets, detecting complex relationships between indicators, and adapting to new market conditions. While the implementation of such technologies requires significant effort, particularly in data collection and model setup, their use greatly enhances the effectiveness of crisis management and financial planning.

Conclusions. Assessing the probability of bankruptcy is a critical tool for ensuring economic stability, especially in Ukraine's current context of economic instability and limited access to financial resources. Accurate forecasting methods are essential for timely identification of companies at risk and implementing preventive measures.

Effective assessment models must incorporate both financial and non-financial indicators. This includes integrating management quality, macroeconomic conditions, and other qualitative factors, which can enhance the predictive power of these models and allow for more accurate early detection of crises.

Developing a national model tailored to Ukraine's unique conditions is crucial for improving the accuracy of bankruptcy forecasts. This includes considering fluctuating inflation, taxation, regulatory factors, and industry-specific risks. A well-adapted national model would serve as an early warning system for financial crises, supporting timely interventions.

Current financial analysis models primarily focus on quantitative metrics, which may not fully capture a company's health. Optimizing these models by including qualitative indicators – like management effectiveness, corporate culture, and social factors – can offer a more comprehensive understanding of an enterprise's stability.

AI and machine learning offer significant potential for improving bankruptcy prediction by processing large data sets and uncovering complex relationships. These technologies can enhance prediction accuracy and adaptability, providing more dynamic forecasts and enabling proactive management of financial risks.

In conclusion, there is a need to adapt existing foreign bankruptcy assessment models to Ukraine's unique economic context, develop new national models, and leverage modern technologies like AI to improve the accuracy of predictions. These steps would enhance the financial stability of Ukrainian enterprises and support their resilience in an increasingly volatile economic environment.

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