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Larysa Zomchak[1,2]
Andriana Seniv[1]

Navigating Crisis: Logistic Regression for Predicting Bank Failure in Wartime Ukraine

[1]Ivan Franko National University of Lviv
[2]Slovak University of Technology in Bratislava

Abstract: *This paper develops a logistic regression model to predict bank bankruptcy in Ukraine during wartime, a period of heightened economic instability. Utilizing 22 financial indicators from the National Bank of Ukraine, the analysis identifies administrative expenses relative to assets and interest income relative to assets as significant predictors of bank failure. After applying correlation analysis and stepwise elimination, a logistic regression model was constructed, demonstrating a high degree of statistical significance ($p < 0.001$) and an overall classification accuracy of 88.9%. The model, represented by a logistic equation, allows for the calculation of bankruptcy probability, providing a valuable tool for early risk assessment and regulatory intervention in the Ukrainian banking sector amidst ongoing crisis. The findings underscore the importance of these specific financial metrics in evaluating bank stability during periods of extreme economic stress.*

Keywords: *bank, bankruptcy, financial health, financial distress, prediction, logistic regression, financial risk, risk management, bank stability, predictive modelling, machine learning*

The stability of the banking sector is paramount for economic resilience, particularly during periods of crisis such as wartime. In Ukraine, the ongoing war has placed unprecedented strain on financial institutions, necessitating the development of accurate predictive models to identify and mitigate potential bank failures. This research addresses the critical need for proactive risk assessment by constructing a logistic regression model to forecast bank bankruptcy, leveraging financial indicators specific to the Ukrainian banking landscape. The ability to anticipate and respond to financial instability is crucial for maintaining public trust and ensuring the continuity of essential financial services in a volatile environment, thereby contributing to the overall economic security of the nation.

Recent research has explored various facets of the Ukrainian financial and economic landscape, employing diverse methodologies. Blahun, Blahun, & Blahun [1] utilized fuzzy logic methods to assess the stability of the banking system, offering a non-linear approach to evaluating complex financial data. Zomchak & Miskiv [2] developed a structural model to analyze the interactions between GDP and industrial output, revealing key economic performance indicators. In a related study, Zomchak & Malets [3] applied a simultaneous equations approach to examine the dynamics of currency cross-exchange rates and their interdependencies. Kichurchak [4] investigated structural changes in the market of bank deposits using statistical analysis to understand household behavior. Bielinskyi et al. [5] employed high-order network analysis for financial crash identification, offering a complex systems perspective on financial risk. Vdovyn [6] used a statistical approach to examine the geographical structure and trade balance of Ukraine, focusing on descriptive analytics. Zomchak & Hakava [7] applied a multidimensional ranking approach and Rubakha et al. [8] conducted a risk-oriented integral assessment of Ukrainian bank effectiveness, providing a holistic evaluation of bank performance. Lobozynska, Skomorovych, & Vladychyn [9] analyzed the activities of the National Bank of Ukraine under martial law.

This study employed a quantitative approach, utilizing logistic regression to model the probability of bank bankruptcy. Data were sourced from the National Bank of Ukraine [10], encompassing 22 financial indicators across liquidity, solvency, profitability, and operational efficiency. Following an initial correlation analysis to address multicollinearity, a stepwise elimination method was used to identify the most significant predictors. The model was evaluated using omnibus tests, a confusion matrix to assess classification accuracy, and parameter significance testing. The logistic regression equation was then formulated to calculate the probability of bankruptcy based on the identified key indicators: administrative expenses relative to assets and interest income relative to assets.

The developed logistic regression model demonstrated a high level of statistical significance ($p < 0.001$) and an overall classification accuracy of 88.9%. Specifically, the model correctly classified 92.5% of stable banks and 70% of bankrupt banks. The key predictors identified were administrative expenses relative to assets, which exhibited a positive relationship with bankruptcy probability, and interest income relative to

assets, which displayed a negative relationship. The logistic equation derived from the analysis allows for the calculation of a bankruptcy probability score between 0 and 1, providing a practical tool for risk assessment.

The findings of this study underscore the efficacy of logistic regression in predicting bank bankruptcy during periods of extreme economic stress, particularly in the context of wartime Ukraine. The identification of administrative expenses and interest income as critical predictors highlights the importance of operational efficiency and revenue generation in maintaining bank stability. The model's high accuracy suggests its potential utility for regulatory bodies and financial institutions in implementing proactive risk management strategies. By providing a quantitative framework for assessing bankruptcy risk, this research contributes to the development of early warning systems that can mitigate the impact of financial crises on the broader economy.

Furthermore, this research demonstrates the adaptability of established statistical methodologies to address specific challenges posed by unique economic environments. The model's focus on readily available financial indicators from the National Bank of Ukraine ensures its practicality and accessibility for ongoing monitoring and assessment. Future research could enhance the model by incorporating macroeconomic variables or exploring alternative machine learning techniques to further improve predictive accuracy. Additionally, the model's performance should be continuously evaluated and updated as the economic landscape evolves, particularly in response to the ongoing war. Ultimately, the insights gained from this study can contribute to the development of a more resilient and stable banking sector in Ukraine, thereby bolstering economic security and fostering sustainable growth.

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Zomchak Larysa M. – candidate of economic sciences, associate professor, Ivan Franko National University of Lviv; Slovak University of Technology in Bratislava, Bratislava email: lzomchak@gmail.com

Seniv Andriana A. – master level student, Ivan Franko National University of Lviv, Lviv