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Financial Determinants and Liquidation Prediction of Indonesian Rural Banks: A Multi-Period Logit Analysis

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Abstract

Background: The Indonesian Rural Bank (BPR) sector faces increasing liquidation risk, with 81 BPRs/BPRS having been liquidated between 2016 and 2025, driven by stricter capital regulations, including Peraturan Otoritas Jasa Keuangan (POJK) No. 5/POJK.03/2015. However, most existing prediction models remain static and fail to capture the dynamic process of financial deterioration, creating a gap in the development of early warning systems.
Objective: This study developed a liquidation prediction model for Indonesian Rural Banks (BPRs) using a multi-period logit approach covering the period from 2013 to 2024.
Methods: A matched-pair design was applied, consisting of 67 liquidated banks and 134 healthy banks, resulting in 201 banks and producing 603 observations across three periods (t-1, t-2, and t-3).
Results: The model demonstrated strong explanatory power, with a Nagelkerke R^2 value of 79.1%. Simultaneously, financial ratios significantly influenced liquidation risk. Partially, Equity to Total Assets (ETA), Cash Ratio (CR), Loan to Asset Ratio (LAR), and Net Interest Margin (NIM) reduced the probability of liquidation, whereas Loan to Deposit Ratio (LDR), Cost of Funds (COF), and Non-Performing Loan (NPL) increased it. NPL emerged as the strongest predictor of failure (Wald = 71.463), triggering a chain reaction that reduced liquidity, increased funding costs, compressed profit margins, and weakened capital adequacy.
Conclusion: The model achieved an overall accuracy of 90.7%, with 95.5% sensitivity and 81.1% specificity, demonstrating strong performance as an early warning system for predicting BPR liquidation and supporting regulatory risk monitoring.

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INTRODUCTION

The resilience of Indonesia's financial system is heavily dependent on the performance of the national banking industry. Within this ecosystem, Bank Perekonomian Rakyat (BPR) plays a strategic role as a driver of the grassroots economy through credit distribution and liquidity support for the Micro, Small, and Medium Enterprises (MSMEs) sector, as well as communities in remote areas that remain underserved by commercial banks. Despite its strategic role, the BPR industry in Indonesia faces significant stability challenges. Data indicate an annual trend of BPR closures or liquidations conducted by the Financial Services Authority (OJK). Sukmana (2020) explained that BPR failures resulting in liquidation are generally caused by an inability to compete

and the occurrence of fraudulent practices committed by management.

The phenomenon of BPR liquidation in Indonesia has reached a critical stage over the past decade. Based on data from the Deposit Insurance Corporation (Lembaga Penjamin Simpanan [LPS]), at least 81 BPRs/BPRS, consisting of 67 BPRs and 14 BPRS, had their business licenses revoked (liquidated) between 2016 and 2025. A significant increase occurred in 2024, when 20 BPRs/BPRS were liquidated, representing the highest annual number of bank resolutions recorded by LPS. The BPR industry experienced substantial structural pressure in 2024 due to the obligation to fulfill a minimum core capital requirement of Rp6 billion based on POJK No. 5/POJK.03/2015. This policy functioned as a regulatory shock that eliminated underperforming BPRs experiencing persistent non-performing loans (NPLs), limited retained earnings, and shareholder reluctance to provide additional equity. Consequently, the inability to meet these regulatory requirements triggered solvency pressures and accelerated liquidation processes by LPS. This condition confirms that core capital is no longer merely an indicator of financial soundness but has become an essential prerequisite for business continuity.

To minimize liquidation risks, an Early Warning System (EWS) is required to comprehensively identify the determinants that trigger bank failure. Financial indicators often serve as the earliest signals before a bank is classified as unhealthy (Altman, 1968; Beaver, 1966). In the context of BPRs in Indonesia, early signs of failure can be identified through fluctuations in capital adequacy, liquidity, and asset quality indicators (Wicaksono, 2015). This perspective is reinforced by the bank soundness assessment standards established by the regulator (Services Authority (2022), which require BPR health evaluations to adopt a risk-based approach incorporating indicators of capital, asset quality, profitability, and liquidity. Therefore, prediction models aligned with financial performance data are needed to detect early signals of financial deterioration.

Banking insolvency is a manifestation of gradual and cumulative financial deterioration rather than a single sudden event. However, previous research on financial institution failure prediction has frequently relied on static cross-sectional approaches that overlook temporal dimensions. Such approaches often fail to capture volatility and longitudinal changes in financial conditions, resulting in limited long-term predictive accuracy (Shumway, 2001). Unlike previous studies that primarily applied single-period static observation models (cross-sectional models), this research introduces a Multi-Period Observation Model covering 2013–2024. The use of panel data spanning more than a decade does not merely expand the dataset but also enables the identification of economic disturbances, ranging from the commodity crisis period to the post-COVID-19 pandemic recovery phase. This approach facilitates the longitudinal identification of financial deterioration patterns that may remain undetected in static models.

Furthermore, this study employs Logistic Regression (Logit) as the primary analytical method. Logistic regression provides robust estimation for examining binary dependent variables in bank failure prediction studies. Its primary advantage lies in its mathematical flexibility, which does not require researchers to satisfy the multivariate normality assumption commonly required in classical discriminant analysis models (Altman et al., 2017). Through this approach, the study distinguishes between healthy Bank Perekonomian Rakyat (BPR) institutions, defined by sustainable positive profitability and an Interest Coverage Ratio (ICR) above 1 Ross (2022), and BPRs that have undergone liquidation. The integration of extended observation periods and precise classification criteria is expected to contribute new insights into financial stability research within the microbanking sector.

However, existing literature regarding Bank Perekonomian Rakyat (BPR) failures remains largely dominated by static cross-sectional designs, including conventional logit analysis and standard discriminant analysis. These static frameworks suffer from temporal inconsistency because they treat financial ratios as isolated observations, thereby failing to capture dynamic macroeconomic changes and multi-year processes of financial deterioration (Shumway, 2001). More importantly, static models lack temporal predictive capability because they estimate only the probability of bank failure without considering when such failure is likely to occur.

To address this research gap, this study applies a multi-period logistic regression framework aligned with the conceptual foundation of corporate hazard models. By treating each bank-year observation as a separate longitudinal unit, this dynamic approach effectively captures

the evolutionary trajectory of financial deterioration, from solvent conditions to regulatory liquidation. Consequently, incorporating a multi-period model not only improves predictive accuracy but also provides regulators, including the Financial Services Authority and the Deposit Insurance Corporation (Lembaga Penjamin Simpanan [LPS]), with a more precise and proactive early warning system for detecting potential insolvency events in the microbanking sector.

Unlike previous studies that predominantly employed conventional cross-sectional logit approaches or static discriminant analysis models such as the Altman Z-Score, which disregard temporal dynamics, this study contributes novelty through the implementation of a multi-period logistic regression framework. This model treats each observation year as a dynamic analytical unit, allowing the longitudinal capture of financial deterioration signals. In addition, the practical contribution of this study lies in its ability to map the chronological chain of structural financial failures (financial distress chain), which can be integrated into an early warning system that provides more predictive insights for the Financial Services Authority (OJK) and BPR management in mitigating liquidation risks.

The multi-period logit approach was selected over the Cox proportional hazards model because: (1) it does not require the proportional hazards assumption, which is frequently violated in heterogeneous microbanking datasets; (2) it naturally accommodates time-varying covariates without requiring complex stratification procedures; and (3) it generates directly interpretable odds ratios for each predictor, supporting practical implementation as an early warning system by regulators (Shumway, 2001).

Based on the identified research gap, this study addresses three main research questions. First, it examines how capital adequacy, liquidity, asset quality, and efficiency indicators predict the probability of BPR liquidation using a multi-period observation model covering 2013–2024. Second, it investigates the extent to which the integration of the Interest Coverage Ratio (ICR) and positive profitability criteria improves classification accuracy in distinguishing healthy BPRs from liquidated institutions. Third, it evaluates the accuracy of the logit-based prediction model in detecting early warning signals of BPR failure during the t−1 to t−3 periods preceding liquidation.

In line with these research questions, this study aims to analyze the dynamic effects of capital, liquidity, asset quality, and efficiency variables on BPR liquidation status over a ten-year observation period. It also evaluates the effectiveness of the Interest Coverage Ratio and profitability criteria as discriminatory indicators in bank failure prediction models. Furthermore, this study assesses the performance and sensitivity of a logit regression-based early warning system in predicting liquidation risks using multi-period historical financial data.

METHOD

This study used a quantitative approach with a causal-comparative design (Creswell & Creswell, 2018). The objective was to analyze the causal relationship between financial performance indicators and the liquidation status of Bank Perekonomian Rakyat (BPR) through the observation of longitudinal secondary data (multi-period data). Data in the form of BPR financial statements for the 2013–2024 period were obtained from the official website of the Indonesian Financial Services Authority (OJK).

The study population consisted of all conventional BPRs registered with the OJK during the observation period. The sampling technique employed purposive sampling using a matched-pair design approach. A 1:2 matching ratio was selected based on established methodological guidance indicating that ratios beyond 1:2 provide diminishing statistical power gains while increasing the risk of poor-quality matches. This ratio provided an optimal balance between sample size augmentation and match quality preservation within the limited population of liquidated BPRs (n = 67). The sample consisted of:

1. Target Group: 67 BPRs whose business licenses were revoked (liquidated) during the 2016–2025 period.
2. Control Group: 134 healthy BPRs with equivalent asset characteristics (peer groups) to those in the target group. The financial ratio observation points were aligned using a pseudo-collapse date. The pseudo-collapse date assignment procedure followed a systematic protocol: for each liquidated BPR with license revocation occurring in year Y, the financial ratios of the matched healthy BPRs were extracted at identical calendar

points (Y−1, Y−2, and Y−3), thereby creating temporally aligned observation windows. This procedure ensured that time-varying macroeconomic conditions (e.g., interest rate cycles and commodity price shocks) affected both the target and control groups symmetrically, minimizing potential confounding effects caused by period-specific economic fluctuations. The control BPRs were required to maintain healthy financial conditions, consistently record positive profits, and maintain an Interest Coverage Ratio (ICR) above 1 throughout the observation period.

Using a multi-period approach (t−1, t−2, and t−3), the study generated a total of 603 observation units (201 BPRs × 3 years). Shumway (2001) stated that symptoms of financial distress in financial institutions are generally detectable through consistent and patterned indicators up to three years before technical failure occurs. The dependent variable in this study was a dummy variable, with a value of 1 assigned to liquidated BPRs and a value of 0 assigned to healthy BPRs. The independent variables consisted of capital ratio, liquidity, asset quality, efficiency, and profitability indicators.

Table 1
Research Variables and Their Measurement

Variable	Indicator	Scale	Source
Capital	Equity to Total Assets (ETA)	Ratio	Kasmir (2017)
Liquidity	Cash Ratio (CR)	Ratio	Kasmir (2017)
	Loan to Deposit Ratio (LDR)	Ratio	Kasmir (2017)
	Loan to Assets Ratio (LAR)	Ratio	Kasmir (2017)
Asset Quality	Non-Performing Loan (NPL)	Ratio	Buchdadi (2020)
Efficiency	Cost of Fund (COF)	Ratio	Kasmir (2017)
Profitability	Net Interest Margin (NIM)	Ratio	OJK (2022)

This study used Logistic Regression (Logit) because the dependent variable was dichotomous and did not require the assumption of normality in the independent variable. The equation of the tested model is:

$$\ln\left(\frac{P}{1-P}\right) = \beta 0 + \beta 1 ETA + \beta 2 CR + \beta 3 LDR + \beta 4 LAR + \beta 5 NPL + \beta 6 COF + \beta 7 NIM$$

Description:

- $\ln\left(\frac{P}{1-P}\right)$: Logit or Log of Odds
- P : The Probability of BPR Being Liquidated
- β_0 : Constant; β1 ... β7 : Regression coefficient

Stages of Statistical Testing

The data analysis in this study was conducted through several statistical procedures. First, a multicollinearity test was performed to ensure that there was no strong correlation among the independent variables, using the criteria of a tolerance value > 0.10 and a variance inflation factor (VIF) value < 10. Second, descriptive statistics were applied to describe the characteristics of the data from the Liquidated BPR and Healthy BPR groups. Third, the model feasibility test (Goodness-of-Fit Test) was conducted using the Hosmer–Lemeshow Test, with the model considered feasible when the significance value was greater than 0.05. Fourth, the simultaneous significance test was carried out using the Omnibus Test of Model Coefficients to examine the overall influence of independent variables on the dependent variable. Fifth, the Wald test (partial test) was applied to evaluate the individual effect of each independent variable on BPR liquidation status, where statistical significance was determined when the p-value was less than 0.05. Finally, a classification matrix was used to assess the predictive accuracy of the model in classifying BPR liquidation status. In addition, future research is recommended to incorporate Receiver Operating

Characteristic (ROC) curve analysis and Area Under the Curve (AUC) measurements to provide a threshold-independent evaluation of the model's discriminatory capability and complement the classification accuracy findings obtained in this study.

RESULTS AND DISCUSSION

Results

Multicollinearity Test Results

Based on the test results presented in Table 2, the Variance Inflation Factor (VIF) values for all independent variables are below 10.00, and the Tolerance values are above 0.10.

Table 2
Multicollinearity Test Results

Coefficient			
Models		Collinearity Statistics	
		Tolerance	VIVID
1	Equity to Total Asset (ETA)	.723	1.384
	Cash Ratio (CR)	.864	1.158
	Loan to Deposit Ratio (LDR)	.802	1.248
	Loan to Asset Ratio (LAR)	.671	1.491
	Non-Performing Loan (NPL)	.689	1.450
	Cost Of Fund (COF)	.830	1.205
	Net Interest Margin (NIM)	.833	1.200
a. Dependent Variable: Rural Banks			

In detail, the Equity to Total Asset variable has a VIF of 1.384 and a tolerance value of 0.723; the Cash Ratio has a VIF of 1.158 and a tolerance value of 0.864; the Loan to Deposit Ratio has a VIF of 1.248 and a tolerance value of 0.802; the Loan to Asset Ratio has a VIF of 1.491 and a tolerance value of 0.671; Non-Performing Loans have a VIF of 1.450 and a tolerance value of 0.689; Cost of Funds has a VIF of 1.205 and a tolerance value of 0.830; and Net Interest Margin has a VIF of 1.200 and a tolerance value of 0.833. Thus, it can be concluded that there are no indications of multicollinearity among the independent variables in this regression model, indicating that the estimation model is feasible for further analysis.

Results of Descriptive Analysis of Independent Variables

The study examined the financial statements of 201 rural banks (Bank Perkreditan Rakyat or BPRs) during the period 2013–2024, comprising a total of 603 observations. Among these observations, 201 were classified as BPRs that experienced liquidation, while 402 were identified as healthy BPRs. Based on Table 2, the average Equity to Total Assets (ETA) of liquidated BPRs was -9.91%. This indicates that, technically, these banks had already experienced capital impairment, where equity was lower than total liabilities. Meanwhile, healthy BPRs recorded an average ETA of 30.27%, reflecting a very strong capital structure and adequate capacity to absorb risks.

BPR liquidity indicators (Cash Ratio [CR], Loan to Deposit Ratio [LDR], and Loan to Asset Ratio [LAR]) reveal notable differences between liquidated and healthy BPRs. Healthy BPRs demonstrated a higher Cash Ratio, with an average value of 45.54%, compared with 21.10% among liquidated BPRs. This suggests that healthy BPRs had approximately twice the capacity to meet short-term obligations. Meanwhile, liquidated BPRs recorded an average LDR of 86.95%, accompanied by a very high standard deviation of 297.62, indicating substantial liquidity fluctuations. In contrast, healthy BPRs exhibited a more stable average LDR of 80.69%. The average LAR of liquidated BPRs was 84.61%, higher than the average LAR of healthy BPRs at 70.77%. This finding indicates that a larger proportion of liquidated BPR assets was concentrated in loan portfolios. Conversely, healthy BPRs maintained a more balanced asset composition, where asset allocation was not solely concentrated in lending activities but also included other liquid instruments. Furthermore, the standard deviation of LAR among liquidated BPRs was considerably higher (42.07) than that of healthy BPRs (11.17), indicating greater volatility in asset

allocation.

The BPR group that ended with the revocation of business licenses recorded an average Non-Performing Loan (NPL) ratio of 33.25%, in contrast to the control group, which maintained a substantially lower risk level at 8.44%. This high NPL ratio confirms that approximately one-third of the loan portfolio of liquidated BPRs was classified as non-performing. The systemic implication is that management was required to allocate large amounts of Impairment Loss Reserves (Cadangan Kerugian Penurunan Nilai or CKPN), which directly reduced profitability and eroded the equity buffer (Equity to Total Assets [ETA]) until it reached a negative level.

The efficiency level of liquidated BPRs, assessed through Cost of Funds (COF), showed an average value of 18.61%. This indicates that liquidated BPRs incurred funding costs more than twice as high as those of healthy BPRs, which recorded an average COF of 8.09%. The elevated COF among troubled banks generally occurred because these institutions were required to offer unusually high deposit interest rates to attract customers and secure additional funds during liquidity crises. Due to high COF and NPL levels, liquidated BPRs recorded an average Net Interest Margin (NIM) of only 8.66%. This relatively low NIM was insufficient to cover other operational expenses, thereby increasing the likelihood of financial losses. In contrast, healthy BPRs recorded an average NIM of 14.99%, demonstrating their stronger ability to generate higher profitability margins.

Table 3
Result of Descriptive Analysis Independent Variables

Variable		N	Red	Std. Deviation
In Liquidation	ETA	201	-9.9174	117.06040
	CR	201	21.1072	24.43518
	LDR	201	86.9502	297.62190
	LARS	201	84.6133	42.06818
	NPL	201	33.2461	26.32005
	COF	201	18.6079	35.67869
	NIM	201	8.6630	12.45366
	Valid N (listwise)	201	-	-
Is Healthy	ETA	402	30.2751	18.69446
	CR	402	45.5484	61.53511
	LDR	402	80.6981	21.83705
	LARS	402	70.7706	11.17427
	NPL	402	8.4361	6.87052
	COF	402	8.0885	5.21648
	NIM	402	14.9960	8.95721
	Valid N (listwise)	402	-	-

Overall, banks entering the liquidation process are characterized by poor asset quality, as indicated by high non-performing loans (NPLs) of 33.25%, which subsequently trigger liquidity crises, reflected in low cash ratios (CR) and more expansive loan-to-asset ratios (LAR). To maintain liquidity, these banks implement unhealthy strategies by increasing deposit interest rates, as reflected in the high cost of funds (COF) of 18.61%, which ultimately erodes profit margins, as indicated by a low net interest margin (NIM) of 8.66%. The accumulation of loan loss provisions due to non-performing loans and high funding costs ultimately weakens bank capital, as reflected by the average equity-to-total-assets ratio (ETA) of -9.91% among banks undergoing liquidation.

Model Feasibility Test Results (Good of Fit Test)

Based on the test results presented in Table 4, the Goodness-of-Fit Test using the Hosmer–Lemeshow Test method shows a Chi-square statistical value of 4.714 with 8 degrees of freedom (df) and a significance value (p-value) of 0.788. Since the resulting significance value is considerably greater than the predetermined significance level (0.788 > 0.05), the null hypothesis (H0) is accepted. This indicates that there is no significant difference between the predicted values

generated by the regression model and the actual observed values. Therefore, it can be concluded that the logistic regression model proposed in this study satisfies the model feasibility criteria (model fit), demonstrates good classification accuracy, and is appropriate for hypothesis testing and further predictive analysis.

Table 4
Model Feasibility Test Results

Hosmer and Lemeshow Test			
Step	Chi-square	df	Sig.
1	4.714	8	.788

Omnibus Test Results and Logistics Model Summary

Based on the test results presented in Table 5, the Chi-square model value is 508.034 with 7 degrees of freedom (df) and a significance level of 0.000. Since the significance value is considerably lower than the significance threshold of 0.05 (0.000 < 0.05), H0 is rejected. This finding indicates that all independent variables included in the model simultaneously have a significant effect on the operational condition status of BPRs (whether healthy or undergoing liquidation).

Table 5
Output Omnibus Tests of Model Coefficients and Model Summary

Omnibus Tests of Model Coefficients				
		Chi-square	**df**	**Sig.**
Step 1	Step	508.034	7	.000
	Block	508.034	7	.000
	Models	508.034	7	.000

Model Summary			
Step	**- 2 Log likelihood**	**Cox & Snell R Square**	**Nagelkerke R Square**
1	259.602a	.569	.791

Source: SPSS output results

Furthermore, the quality and strength of the model's explanatory power are demonstrated through the estimation results presented in the Model Summary table. The generated value of −2 Log Likelihood is 259.602. The Cox & Snell R Square value is 0.569, while the Nagelkerke R Square value is 0.791. The Nagelkerke R Square value of 0.791 indicates a high degree of model fit. However, unlike the coefficient of determination (R^2) in ordinary least squares regression, the pseudo-R^2 in logistic regression should be interpreted as an index of model improvement over the null model rather than as the proportion of variance explained (Hosmer Jr et al., 2013). Therefore, the value of 0.791 signifies that the proposed model substantially improves prediction accuracy compared with a model without predictors. The remaining variation of 20.9% is explained by other factors outside the logistic regression model proposed in this study.

Results of Logit Binary Regression Test, Model Formation and Hypothesis Test

Logistic regression testing was conducted using the Wald test to examine the partial effects of the independent variables (Capital/ETA, Liquidity/CR, LDR, and LAR, Asset Quality/NPL, Efficiency/COF, and Profitability/NIM) on Bank Perkreditan Rakyat (BPR) liquidation.

Based on the results of partial testing using the Wald test presented in Table 6, it was concluded that all independent variables in this study had statistically significant effects on the probability of bank liquidation because they had p-values (Sig.) below the 5% alpha level (< 0.05).

The capital variable, namely Equity to Total Assets (ETA), showed a significant negative effect, with a coefficient of −0.113 and an Odds Ratio (Exp(B)) value of 0.893. Similar results were observed for the liquidity variables, namely the Cash Ratio (CR), with a coefficient of −0.066 and

an Exp(B) value of 0.936, and the Loan to Assets Ratio (LAR), with a coefficient of −0.069 and an Exp(B) value of 0.933. Furthermore, the profitability variable, Net Interest Margin (NIM), exhibited a negative coefficient of −0.096 with an Exp(B) value of 0.909. These results indicate that improvements in capital ratios, cash adequacy, asset placement efficiency, and profit margins significantly reduce the probability of bank liquidation.

Conversely, the variables Loan to Deposit Ratio (LDR), Non-Performing Loans (NPL), and Cost of Funds (COF) exhibited significant positive coefficients. The LDR ratio had a B coefficient of 0.010 with an Exp(B) value of 1.010. The COF variable recorded a B coefficient of 0.124 with an Exp(B) value of 1.132, indicating that an increase in funding costs raises the risk of bank failure. The most dominant influence was demonstrated by the asset quality variable, namely Non-Performing Loans (NPL), which had the largest Wald statistic value of 71.463, a B coefficient of 0.208, and an Exp(B) value of 1.232. This finding empirically demonstrates that a 1% increase in the NPL ratio has the most detrimental impact, increasing the risk of bank liquidation by 1.232 times or equivalent to a 23.2% increase in risk.

Based on the results of the logistic regression test and hypothesis testing, all proposed hypotheses were accepted. Overall, the bank liquidation prediction model developed using logistic regression effectively explains the probability of liquidation among Bank Perkreditan Rakyat (BPR) institutions.

Table 6
Results of Multiperiod Regression Estimation (Main Model)

Variable	Coefficient (β)	Standard Error (S.E)	Wald Statistics	Significance (p-value)	Exp (β)/ Odds Ratio
Capital:					
- Equity to Total Asset (ETA)	-0,113	0,021	28,996	0,000	0,893
Liquidity:					
- Cash Ratio (CR)	-0,066	0,012	28,656	0,000	0,936
- Loan to Deposit Ratio LDR)	0,010	0,003	15,332	0,000	1,010
- Loan to Asset Ratio (LAR)	-0,069	0,015	20.531	0,000	0,933
Asset Quality:					
● Non-Performing Loan (NPL)	0,208	0,025	71.463	0,000	1,232
Efficiency & Profitability:					
● Cost of Fund (COF)	0,124	0,028	19.097	0,000	1,132
● Net Interest Margin (NIM)	-0,096	0,022	18.850	0,000	0,909
Constant	4.469	1,287	12.057	0,001	87,261

Based on the coefficient values in table 6, a mathematical model to predict bank liquidation is:

$$\ln\left(\frac{P}{1-P}\right) = 4.469 - 0.113(ETA) - 0.066(CR) + 0.010(LDR) - 0.069(LAR) + 0.208(NPL) + 0.124(COF) - 0.096(NIM)$$

Results of Classification of Healthy BPRs and BPRs in Liquidation

To measure the level of accuracy or predictive accuracy of the logistic regression model in classifying bank conditions, an analysis of the Classification Table presented in Table 7 was conducted. This classification test was based on a cut-off value of 0.500.

The test results showed that, among the total banks that were in a healthy status, the model accurately predicted 384 banks, while the remaining 18 banks were misclassified, resulting

in a classification accuracy rate of 95.5%. Meanwhile, for the group of banks that were in the liquidation process (In Liquidation), the model correctly predicted 163 banks, while the remaining 38 banks were incorrectly classified as healthy banks, resulting in an accuracy rate of 81.1%.

Overall, the estimation results showed an Overall Percentage value, or total model accuracy, of 90.7%. This finding empirically demonstrates that the logistic regression model developed in this study has a high level of predictive accuracy and reliability, with 90.7% of the total bank sample being correctly classified according to their actual financial condition status.

Table 7
Classification of Healthy and Liquidated BPRs

Classification Table[a]

Observed			Predicted		
			Rural Banks		Percentage Correct
			Is Healthy	In Liquidation	
Step 1	Rural Banks	Is Healthy	384	18	95.5
		In Liquidation	38	163	81.1
	Overall Percentage				90.7

a. The cut value is .500

Discussion

The Ability of Financial Ratios in Predicting the Probability of BPR Liquidation

The logistic regression model developed in this study is proven to have a very high level of feasibility and reliability in predicting the probability of liquidation among People's Rural Banks (Bank Perkreditan Rakyat [BPR]) in Indonesia. Based on the results of the Hosmer–Lemeshow Test, the model was declared fit with the empirical data (Sig. = 0.788 > 0.05). Supported by the Nagelkerke R Square value of 79.1%, this model demonstrates very strong explanatory power, indicating that only 20.9% of the variability in BPR liquidation is influenced by other factors outside the model. The overall classification accuracy, which reached 90.7%, confirms that the selected financial ratios can function as a precise early warning system instrument for distinguishing between healthy BPRs and BPRs at risk of liquidation. The ability of capital adequacy, liquidity, asset quality, and efficiency/profitability indicators to predict BPR liquidation risk through a multi-period observation model is further confirmed by the partial test results (Wald Test), which demonstrate that the seven financial ratios examined have a significant effect on the probability of BPR liquidation (Sig. < 0.05).

The Equity to Total Asset (ETA) variable showed a significant negative effect on the probability of BPR liquidation, with a coefficient of -0.113; Sig. = 0.000; and Odds Ratio/Exp(B) = 0.893. The Odds Ratio value of 0.893 indicates that every 1% increase in the ETA ratio reduces the risk of a BPR entering the liquidation process to 0.893 times, representing an approximately 8.93% decrease in risk. Descriptively, there is an extreme disparity between healthy BPRs, which recorded a positive average ETA of 30.27%, and liquidated BPRs, which recorded a negative average ETA of -9.92%.

The negative equity condition among liquidated BPRs reflects the phenomenon of technical insolvency, where accumulated operational losses have eroded paid-in capital, causing total liabilities to exceed total assets. Capital serves as the ultimate risk buffer by absorbing potential losses. When this buffer is depleted, the bank's ability to maintain operational sustainability deteriorates significantly. The findings of Sistiyarini (2017) state that an increase in ETA reduces the risk of failure or liquidation. This finding is consistent with Karugu (2018), who stated that capital adequacy is one of the most fundamental predictors in determining bank survival.

Cash Ratio (CR) had a significant negative effect (coefficient = -0.066; Exp(B) = 0.936). A 1% increase in CR reduces the risk of liquidation to 0.936 times. The average CR of healthy BPRs (45.54%) was more than twice that of liquidated BPRs (21.10%), demonstrating that sufficient liquidity reserves protect banks from the risk of immediate withdrawal obligations. Loan to Deposit Ratio (LDR) exhibited a significant positive effect (coefficient = 0.010; Exp(B) = 1.010).

An increase in LDR reflects excessively aggressive lending beyond the capacity of third-party funds (Dana Pihak Ketiga [DPK]), thereby increasing liquidity vulnerability. LDR fluctuations among liquidated BPRs were highly extreme (Std. Dev. = 297.62), indicating unstable liquidity management practices.

Loan to Asset Ratio (LAR) had a significant negative effect (coefficient = -0.069; Exp(B) = 0.933). The average LAR of liquidated BPRs was relatively high (84.61%) compared with healthy BPRs (70.77%), indicating that a substantial proportion of liquidated BPR assets was concentrated in loans, leaving limited flexibility for diversification into more liquid instruments. The partial test results showed that LAR had a negative coefficient of -0.069 and was significant in explaining the probability of liquidation. This finding indicates that increased asset allocation toward productive lending activities can reduce liquidation risk, provided that the credit portfolio is managed prudently. These findings are supported by descriptive statistical evidence showing that the healthy BPR group maintained an optimal average LAR value (70.77%) with low variability (standard deviation of 11.17).

This low deviation reflects a stable, homogeneous, and measurable credit portfolio among healthy BPRs. Conversely, liquidated BPRs tended to demonstrate extreme asset management conditions, either through excessive idle funds that reduced profitability or aggressive credit expansion without adequate risk mitigation. Therefore, stability in credit-based asset allocation serves as an important foundation for BPR financial resilience. Oino (2021) found that managing risk profiles through liquidity indicators, such as cash availability and balanced LAR levels, significantly improves bank soundness and reduces the probability of default. Safitri (2020) findings indicate that LDR has a positive influence on the potential for bank failure, as banks unable to maintain a balance between fund withdrawal and credit distribution will face liquidity problems. These liquidity dynamics support the theory of banking intermediation and are consistent with Antwi (2019), who stated that a combination of low CR and excessively high LDR creates a severe liquidity mismatch in microbanking institutions.

Non-Performing Loans (NPLs) were proven to be the most dominant and destructive predictor contributing to BPR liquidation, as indicated by the highest Wald statistic value (71,463) and the largest positive coefficient (0.208; Sig. = 0.000; Exp(B) = 1.232). Every 1% increase in NPLs increases the probability of BPR liquidation by 1.232 times, equivalent to a 23.2% increase in risk. Descriptive statistics show that the average NPL ratio among liquidated BPRs reached a critical level of 33.25%, which was substantially higher than that of healthy BPRs at only 8.44%. This finding indicates that approximately one-third of the loan portfolio distributed by liquidated BPRs was classified as problematic.

These significant non-performing loans disrupted cash inflows from interest income and principal repayments and forced banks to establish substantial Penyisihan Penghapusan Kualitas Aktiva (PPKA) reserves. These findings are consistent with Harahap (2015) and Wea (2023), who demonstrated that rapidly increasing NPLs reduce ROA and core capital, which are among the most accurate predictors of banking liquidation. Furthermore, the findings align with Badunenko (2022), who emphasized that asset quality deterioration represents the primary trigger in the chain of banking failure (domino effect), where high levels of non-performing loans typically precede liquidity crises and capital deterioration.

Cost of Funds (COF) had a significant positive effect (coefficient = 0.124; Exp(B) = 1.132). Liquidated BPRs experienced a substantially higher average cost of funds of 18.61%, more than twice that of healthy BPRs (8.09%). When BPRs experience declining public confidence and liquidity pressure caused by high NPL levels, management may adopt unhealthy strategies by offering excessively high deposit interest rates to attract new customer funds. However, this strategy increases interest expenses and further weakens operational efficiency. Net Interest Margin (NIM) had a significant negative effect (coefficient = -0.096; Exp(B) = 0.909). Due to high funding costs and declining interest income caused by non-performing loans, the average NIM of liquidated BPRs declined to only 8.66%, considerably lower than healthy BPRs, which achieved a margin of 14.99%.

This narrow margin was insufficient to cover other operating expenses, resulting in persistent structural losses. The phenomenon of margin erosion caused by interest rate competition is consistent with Kustina (2019), who stated that BPR failures in Indonesia often

originate from inefficiencies in third-party fund management, particularly high funding costs that weaken internal bank profitability. These findings are further supported by Wea (2023), who explained that high COF indicates that banks must pay higher interest rates to attract depositors, thereby increasing liquidation risk, whereas healthy profitability reflected through NIM strengthens financial resilience and negatively affects liquidation probability.

The Causality Chain of BPR Financial Failure: Integration of Health and Profitability Criteria

The second problem formulation explores how the integration of various financial criteria forms a structured pattern that enhances the model's classification capability in distinguishing between different BPR conditions. Based on the synthesis of descriptive analysis and logistic regression results, BPR failure is not a single event that occurs suddenly but rather a chain of financial distress that develops systematically. The integration of these ratios provides substantial classification accuracy for the logistic regression model. The model does not only examine the capital aspect partially but also detects deterioration in operational profitability indicators. When positive profitability criteria are no longer achieved due to COF and NPL pressures, the model automatically assigns a higher risk weight, ultimately improving the accuracy of BPR classification in predicting liquidation risk. This chronic chain of financial deterioration is visualized through the following logical flowchart:

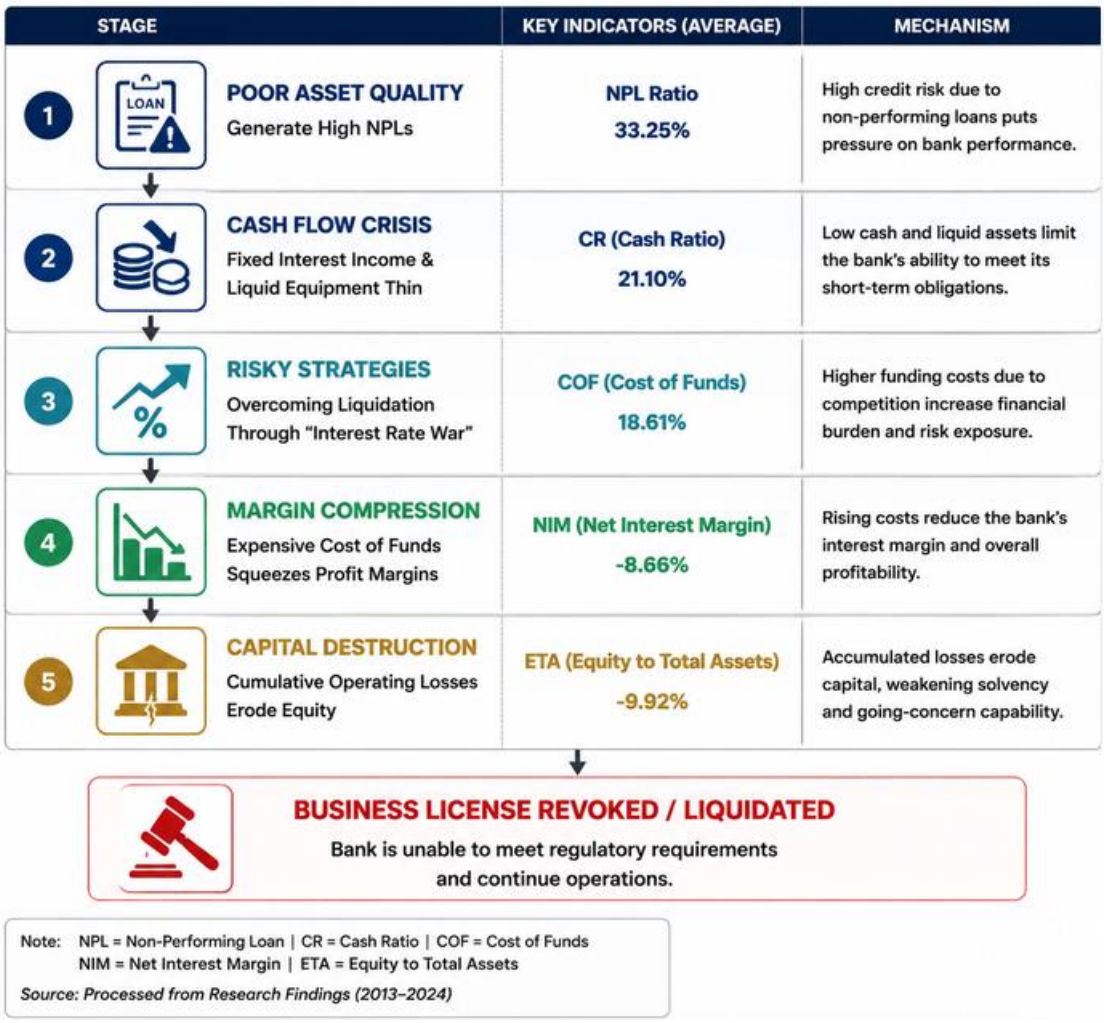

Figure 1. Bank Liquidation Chain Flow Chart

Accuracy of the Logit Regression Model as an Early Warning Signal of Liquidation

Evaluation of the Classification Table shows that the logistic regression model demonstrates highly satisfactory predictive performance, with an overall accuracy percentage of 90.7%. Out of a total of 603 multi-period observation data points, the model correctly classified

the actual status of BPRs in 547 cases. The predictive effectiveness of this model can be divided into two main aspects:

Specifically, the effectiveness of the model classification is divided into two aspects of predictive power:

1. Healthy BPR Prediction Sensitivity: The model demonstrates high reliability, with a sensitivity rate of 95.5% in identifying the health characteristics of banks. The model accurately classified 384 observations of healthy BPRs out of 402 actual healthy BPR observations, with only 18 observations being misclassified as distressed banks (Type I Error).
2. Predictive Specificity of BPR Liquidation: The model recorded a success rate of 81.1% (or 79.1% within the group of liquidated banks), accurately detecting 163 observations of BPRs progressing toward liquidation out of 201 actual cases. A total of 38 observations were misclassified as healthy banks (Type II Error/False Negative). From a banking supervision perspective, these 38 false-negative classifications represent the most critical limitation of the model, as each undetected failing bank potentially exposes depositors to losses and may undermine public confidence in the microbanking sector. Therefore, regulators implementing this model as an Early Warning System should adopt a conservative classification threshold (e.g., lowering the cut-off value below 0.500) to prioritize minimizing Type II errors, even at the expense of increasing Type I errors (false alarms). This approach is justified because the supervisory cost of failing to identify a potential bank failure is substantially higher than the cost of conducting additional prudential scrutiny of a healthy institution.

In banking supervision, minimizing Type II Error (failing to detect a bank that is approaching failure) is a critical priority. This predictive capability demonstrates that the multi-period logistic regression model using lagged indicators ($t-1$ to $t-3$) can provide concrete early warning signals to authorities before the financial condition of BPRs reaches an irreversible stage.

Compared with previous studies, the overall accuracy of 90.7% is comparable to the accuracy levels reported in the literature for classical bankruptcy prediction models, such as the Altman Z-Score Model and conventional Multiple Discriminant Analysis (MDA) models, which generally achieve accuracy rates ranging from 75% to 85% for microfinance institutions. the multi-period logistic regression approach is more adaptive in capturing the volatility of banking financial ratio data than conventional discriminant analysis models.

CONCLUSION

Based on the results of data analysis, hypothesis testing, and discussions presented regarding the ability of financial ratios to predict the probability of liquidation of Bank Perekonomian Rakyat (BPR) in Indonesia through a multi-period observation model (2013–2024), several main conclusions are obtained as follows:

The combination of all internal financial ratios simultaneously and partially has a significant effect on the probability of BPR liquidation. Increases in ETA, CR, LAR, and NIM significantly reduce the likelihood of liquidation. Conversely, increases in LDR, NPLs, and COF increase the risk of bank failure, with NPLs identified as the most dominant and detrimental predictor.

BPR failure is proven to occur through a systematic process of financial deterioration. The accumulation of NPLs triggers a liquidity crisis (low CR), which forces management to increase deposit interest rates excessively (high COF). This expensive funding burden subsequently compresses profit margins (low NIM), generates cumulative losses, and ultimately erodes capital adequacy until the bank fails (negative ETA).

The multi-period logit regression model demonstrates high reliability as an early warning system, achieving an overall accuracy rate of 90.7%. The model records a sensitivity rate of 95.5% in detecting healthy BPRs and a specificity rate of 79.1% in identifying BPRs with a high probability of liquidation during the t-1 to t-3 periods.

This study is limited to internal bank financial factors (idiosyncratic factors). Additionally, the use of matched-pair sampling, although methodologically appropriate for addressing class

imbalance, may introduce selection bias if the matching criteria do not fully represent the relevant dimensions of bank heterogeneity. The exclusion of macroeconomic variables, including inflation, GDP growth, and benchmark interest rates, represents another limitation because systemic economic conditions may interact with bank-specific financial ratios in influencing liquidation probability. Furthermore, this research does not incorporate macroeconomic variables or non-financial factors, such as good corporate governance and bank ownership characteristics, which may also influence BPR stability.

Based on the conclusions above, the results of this study provide several policy implications that are important for regulators, banking supervisors, and BPR management in maintaining the stability of the microfinance industry:

The Otoritas Jasa Keuangan (OJK) is advised to integrate this multi-period logit model into a formal supervisory framework (off-site supervision) to detect early symptoms of BPR financial distress from t-3 before entering the critical phase. OJK should strengthen enforcement measures against BPRs with NPL levels exceeding 5% and enhance supervision over the accuracy and reliability of credit quality reporting to prevent manipulation practices, including evergreening.

The OJK and Lembaga Penjamin Simpanan (LPS) should take firm actions against problematic BPRs that attempt to resolve liquidity pressures by offering excessive deposit interest rates beyond the guaranteed threshold. BPR management is required to strengthen credit governance based on prudent banking principles, diversify asset placements into safe and liquid instruments to maintain the Cash Ratio, and optimize the collection of low-cost funds to preserve the net interest margin (NIM).

Although the model developed in this study demonstrates strong explanatory power and high predictive accuracy, several limitations remain that can be addressed by future researchers: 1) Future researchers are encouraged to incorporate governance-related variables, such as the size of the board of commissioners, management competence, and GCG indicators, to capture potential managerial risks and fraud-related factors that cannot be identified through financial ratios alone. 2) Future studies may compare the effectiveness of this logit model with machine learning approaches, such as Artificial Neural Networks and Random Forest, to improve classification performance and reduce Type II errors. 3) Further research is also recommended to conduct cluster analysis based on geographical regions to examine differences in the sensitivity of financial ratios toward liquidation risk across various areas in Indonesia.

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AUTHOR CONTRIBUTION STATEMENT

All authors contributed substantially to the completion of this study. The first author was responsible for conceptualization, research design, data collection, and initial manuscript drafting. The second and third authors contributed to data analysis, interpretation of empirical results, and methodological refinement using the multi-period logit framework. The fourth and fifth authors supported the validation of findings, literature review development, and critical revision of the manuscript. All authors collectively participated in reviewing, editing, and approving the final version of the manuscript and agree to be accountable for all aspects of the work to ensure accuracy and integrity.

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