Bank-specific, Industry-Specific, and Macroeconomic Determinants of Credit Risk: Empirical Evidence from the ASEAN5 Banking Sector

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ABSTRACT

The study utilized three regression estimations in evaluating the impact of bank-specific and industry specific indicators, macroeconomic indicators, their combined impact, and the impact of the selected interaction terms on the ASEAN5 banks' credit risk exposures. It employed aggregate available data that were extracted from the World Bank databases and bank supervisors. For all models, robust fixed effects estimation was utilized after performing diagnostic tests. Capital adequacy, profitability and interest rate spread negatively affect nonperforming loan ratios (NPL). This proves that as banks improve their capital adequacy and profitability, credit risk exposure decreases. However, NPL is directly sensitive to credit-to-deposit ratio, lending rates, inflation rate, and unemployment. As more deposits are allocated to loans, banks increased their lending rates due to higher inflation rate; hence, interest rate spread declined. As unemployment escalates, loan default arises, which exposes banks to credit risk. Mixed results were generated for the interaction terms used in the study. The full model that combined independent variables with interaction terms, insignificant interactions were found except for the impact of credit to deposit ratio and ROA on NPL ratio. Banks reduced their credit risk due to improved profitability, good asset portfolio, and their stringent implementation of regulatory policies. However, they must closely monitor their loan portfolio and other assets qualities, especially those related to the NPL recovery strategies after.

Keywords: Credit risk, ASEAN5, bank-specific indicators, macroeconomic indicators.

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1. INTRODUCTION

The Asian Financial Crisis provided structural imbalance in the financial system and highlighted the weaknesses among banks in the management of their operations. Likewise, the vulnerability of banks over the past three decades resulted in systemic risks from intermediation activities and overall business operations. Patiu (2006) reported that from 1997-2000, banks in Thailand and Indonesia recorded high NPL ratios, and they gradually improved in the succeeding years. Rosenkranz and Lee (2019) also noted significant NPL improvement after the crisis and mentioned that credit risk exposure in Asia can escalate due to the macroeconomic, global, and firm-specific factors. Managing credit and maintaining non-performing loans ratio at low levels are

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crucial. OECD (2023) cited that the level of NPL is high among developing countries compared to developed economies in ASIA. It follows a u-shaped trend which shows increases in NPL ratios before and after the crisis, followed by its reduction over time (Ari *et al*., 2019). They argued that poor macroeconomic underpinnings (e.g.: increasing economic growth, inflation, and credit boom) can escalate credit risk.

In many regions worldwide, studies were undertaken to examine bank-specific and macroeconomic factors influencing credit risk (Kjosevski *et al*., 2019; Tanasković & Jandrić, 2015, and Wood & Skinner, 2018). However, these studies either only focus on specific variables, or applied one or two regression estimations (pooled OLS, random effects, or fixed effects), among others. The studies conducted by Islam & Nishiyama (2016), and Nor *et al*. (2021) are limited in selected countries in Asia or East Asia. Islam & Nishiyama (2016) applied a Generalized Method of Moments estimator in examining 259 banks in Bangladesh, India, Nepal, and Pakistan and revealed that inflation has a significant negative effect. Bertsch *et al*. (2016, as cited in Wu *et al*., 2022) mentioned the impact of macroeconomic indicators (unemployment and economic growth) on credit risk (loan payment default) and loan rates. In studying the credit quality of commercial banks in Barbados, Wood & Skinner (2018) found that profitability (return on assets & return on equity), capital adequacy, and loan-to-deposit ratios are significant antecedents of NPLs. GDP growth, unemployment and interest rate were among the macroeconomic variables that significantly influenced credit quality.

Against this backdrop. this study aims to replicate the study of Wood and Skinner and include the interaction of selected bank-specific and macroeconomic variables with the independent variables on their impact of ASEAN5 banks' credit risk exposure. It also aims to determine the sensitivity of the non-performing loan ratio, as a measure of credit risk, to various bank and industry-specific and macroeconomic predictors. We believe that this study can help policymakers in identifying, implementing, or modifying monetary, fiscal, and other prudential policies. It also facilitates in one's understanding of the credit risk exposure.

2. LITERATURE REVIEW

2.1 Financial Soundness

Muthoni *et al*. (2020) mentioned that poor credit management and low capital adequacy, results in the rise in bank's credit risk exposure, which can result to its insolvency. Ashraf *et al*. (2016) revealed that regulatory capital ratio has a significant and negative effect on NPL ratio of selected commercial banks in Pakistan. Other studies supporting this were conducted among banks in Europe (Salvi *et al*., 2018), in Bangladesh (Rahman *et al*., 2016), in Eurozone (Makri *et al*., 2014), and in Tanzania (Malimi, 2017). Agwata (2021) revealed that higher capital adequacy improves loan interest rates, consistent with the view that larger capital ratios encourages banks to undertake risky investments.

In contrast, the finding of Koju *et al*. (2018) and Vatansever & Hepşen, (2015) showed positive association between capital adequacy and non-performing loan ratios. Vatansever & Hepşen, (2015) revealed that when it was used for the current year and those with lags of 1 up to 3 years, it has positive and significant effect on NPL ratio.

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H1: Financial Soundness (RWCa) has a negative impact on the non-performing loan ratios of banks in the ASEAN5 countries.

2.2 Profitability

Mixed results on the effect of a bank's profitability were generated. Compared to return on equity which provided a positive and insignificant effect on non-performing loans, return on assets has negative and significant effect on the European banking sector's NPL ratios (Salvi *et al*., 2018). The same result was evident in the study conducted by Koju *et al*. (2018), Malimi (2017) and Rahman *et al*. (2016) among banks in India, Tanzania, and Bangladesh, respectively.

Ideally, a bank's profitable operations decrease non-performing loans due to less risky investments that are undertaken. Beaton *et al*. (2016) applied Panel Vector Autoregression (PVAR) approach in investigating the determinants of NPLs in the Eastern Caribbean Currency Union (ECCU) and proved that profitable banks and banks with lower loan exposures to construction, tourism and household's sectors generated lower NPLs.

H2: Profitability (ROAa) has a negative impact on the non-performing loan ratios of banks in the ASEAN5 countries.

2.3 Financial Intermediation (Credit/Deposit Ratio, Lending rates, Lending-Deposit Spread)

Like Wood and Skinner (2018), Rahman *et al*. (2016) emphasized the importance of credit management in the stability of a financial system and revealed the sensitivity of NPL ratio to credit/deposit ratio. On the other hand, Hosen *et al*. (2020) found negative and significant impact of credit to deposit ratio using three NPL models among conventional and Islamic banks. The same findings were evident in the study conducted by Ekanayake (2019).

Since lending rates can adversely affect credit risk, Bahruddin & Masih (2019) revealed a short-run asymmetric relationship between lending rates and credit risk for the first 15 months of the financial crisis, but a long-run symmetric relationship between the two. Kjosevski *et al*. (2019) showed a positive impact of this predictor variable on credit risk, as the rise in volume of loans exposes the borrowers to systemic and or macroeconomic shocks through the bank's income. In Bangladesh, Mondal (2016) revealed that interest rates increase NPL ratios, but its effect was not significant.

Anjom (2021) discussed the importance of interest rate spread on the business of banking and noted that banks have different cost-income policies. This was also mentioned in the study of Feyen & Huertas (2020) where they revealed that many countries in the EMDE region exhibited high interest rate spread to compensate for the contraction of credit and lack of competition. Chege (2014) also confirms this lack of competition, and found that low profitability, poor credit quality, other institutional underpinnings, and low level of savings contributed to the high NPL ratios. Sheefeni (2016) and Kamunge (2013) found its positive and significant impact on credit risk exposure of banks in Namibia and mentioned that IR spread contributed to the increased credit risk exposure of commercial banks in Kenya. Kamunge (2013) also revealed that IR spreads are higher despite the greater proportion of loans vis-à-vis deposits.

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H3: Financial intermediation activities have positive/negative effects on the non-performing loan ratios of bank in the ASEAN5 countries.

H3a: Credit to deposit ratio has a negative impact on the non-performing loan ratios of banks in the ASEAN5 countries.

H3b: Lending rate has a positive impact on the non-performing loan ratios of banks in the ASEAN5 countries.

H3c: Interest rate spread has a positive impact on the non-performing loan ratios of banks in the ASEAN5 countries.

H3d: The interactions of credit to deposit ratio with return on assets and lending rates have significant impacts on the non-performing loan ratios of banks in the ASEAN5 countries

2.4. Bank Concentration

Islam & Nishiyama (2016) showed significant and negative effect of the concentration ratio on credit risk. This also corroborates the findings of Alnabulsi *et al*. (2022) but its effect on credit risk was insignificant. Since the industry is monopolized by big banks, competition declines and nonperforming loan ratios increase. Beck & De Jonghe (2013) utilized Herfindahl Hirschman Index (HHI) to measure bank concentration and determine its impact on credit risk (NPL ratio) among 466 largest banks worldwide and found its insignificant effect in the first stage.

H4: Bank concentration (IBCo) has a negative impact on the non-performing loan ratios of banks in the ASEAN5 countries.

2.5 Economic Growth (GDP growth rate)

Salvi *et al*. (2018) applied several regression models in analyzing economic growth's impact on credit risk (proxied by impaired loans/total assets ratio) and found a statistically significant and negative effect. Several authors (Ersoy, 2021; Islam & Nishiyama, 2016; Kjosevski *et al*., 2019; Makri *et al*., 2016; Okyere & Constance Mensah, 2022; Salvi *et al*., 2018, Skarica, 2014; Tanasković & Jandrić, 2015) also found statistical and negative relationship between GDP and non-performing loans. This only proves that as the economy deteriorates, non-performing loans ratio increases. On the other hand, when growth is evident, borrowers can pay their loan, and NPL levels decreases.

H5a: GDP growth rate has a negative impact on the non-performing loan ratios of banks in the ASEAN5 countries.

H5b: The interactions of GDP growth rate with unemployment and inflation rates have significant impacts on the non-performing loan ratios of banks in the ASEAN5 countries.

2.6 Unemployment

Alnabulsi *et al*. (2022) and Salvi *et al*. (2018) revealed that unemployment is positively and significantly related to NPL ratio due to its adverse effect on the purchasing power and payment of loans but its effect was. Feyen & Huertas (2020) mentioned that when debit repayment decreases, nonperforming loans increase. They applied Granger Causality test to measure the impact of unemployment shocks on NPL ratios or vice-versa. The results revealed a positive impact with 3 to 4 months lags after the shock.

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H6: Unemployment has a positive impact on the non-performing loan ratios of banks in the ASEAN5 countries.

2.7 Inflation Rate

Mondal (2016) applied Pearson Correlation in measuring the relationship between bank credit risk and inflation rate in Bangladesh. The study of Islam & Nishiyama (2016) also supported Mondal's findings and concluded that as inflation decreases, borrowers can pay their debts due to the increase in real income.

Skarica (2014) applied fixed effects model in examining the determinants of credit risk among banks in Central and Eastern European region and showed a positive effect of inflation on their credit risk exposure. This was also confirmed in the studies conducted by Alnabulsi *et al*. (2022) and Mondal (2016). Wood & Skinner (2018) argued that an increase in inflation rate increases expenses, and results to the borrower's inability of pay his debt and eventually increases NPL ratios. Similar findings were also evident in the study conducted by Anita *et al*. (2022) among banks in South Asian Association for Regional Cooperation countries; but its effect was weak as contrasted to their findings using other macroeconomic variables.

H7 : Inflation rate has a positive/negative impact on the non-performing loan ratios of banks in the ASEAN5 countries.

H7a: The interactions of inflation rate with return on assets and lending rates have significant impact on the non-performing loan ratios of banks in the ASEAN5 countries.

3 FRAMEWORK

3.1 Theoretical Framework

3.1.1 Moral Hazard hypothesis

Berger & Deyoung (1995) posit that less capitalized banks have moral hazard incentives that can adversely affect loan quality. On the other hand, well capitalized banks extend credit to good borrowers or invest their funds at lower interest rates to protect their resources (Tanasković & Jandrić, 2015). Seta (2022) noted that this is related to the principal-agent theory where the depositor/investor (principal) appoints an agent to protect his interest, which sometimes do not happen.

3.1.2 Agency Cost Theory

The theory emphasizes the role of the board of directors in monitoring the manager's performance of the manager, who acts as the shareholders' agent. When the CEO of the company has dual roles, credit contracts are adversely affected. According to Chen *et al*. (2022), decision management and control are lacking, as this action of the agent tends to reduce information transparency due to his personal motivation. This creates information asymmetry and exacerbates moral hazard problems in the credit transactions, since credit is the one of the primary activities in the financial intermediation.

3.1.3 Bad Management and Skimping Hypotheses

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Bad Management Theory posits that poor management practices leads to inefficiency (Tanasković & Jandrić, 2015). The problem loans are reflective of bad management, which results to low cost efficiency (Berger & Deyoung, 1995). Hosen *et al*., (2020) added that when bad managers are unable to conduct efficient loan scoring, loan quality are affected and results to higher expenditures. Skimping hypothesis indicates that the value of the company's resources can influence the quality of its resources and the bank's costs efficiency. In maximizing long-term profitability, a bank skimps on the supervision of loans and leads to the deterioration of its asset quality (e.g. credit activities) and available resources by selecting those that have short-term low-cost monitoring activities. Thus, management must weigh between short-term operations and long-term credit issues (Tanasković & Jandrić, 2015).

3.2. Conceptual Framework

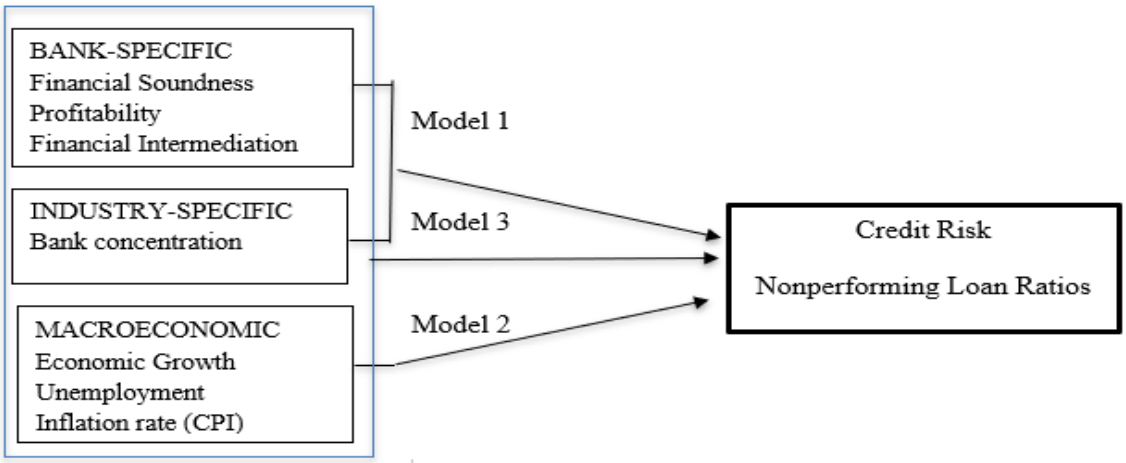

Figure 1: Conceptual Paradigm of the Study

The dependent variable (non-performing loan ratio) is explained by its predictor variables, namely, bank-specific variables: financial soundness (RWCA), profitability (ROAa), and financial intermediation (CRDR, LDSp and LIRa), industry specific variable (bank concentration), and macroeconomic variables (economic growth, unemployment, and inflation). As shown in Figure 1, three models were applied to answer the problems raised in the study. Model 1 utilizes the impact of bank-specific and industry-specific variables, and we added two control variables (bank size (TOAs) and liquidity Ratio LQAs), while Model 2 only considers the impact of the macroeconomic variables. Lastly, Model 3 measures the combined impact of the predictor variables utilized in Models 1 and 2 on the level of nonperforming loans of the banking sector in the ASEAN region. We also added the impact of the interaction of credit/deposit ratio, inflation rate and GDP growth rate on selected independent variables used in the study.

Table 1. Description of Variables Used in the Study

Variables	Description	Exp. Sign
NPL Ratio (IV)	It is the ratio of the defaulting loans and gross loans of the bank	
Capital Adequacy	A financial soundness measure by dividing the bank's total regulatory capital by its assets, which are weighted based on the assets' risks.	-

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Profitability	It is computed as a ratio of the banks net income to total yearly average assets held by the banks	-
Credit/Deposit Ratio	It represents the bank's financial resources given to the private sector as a percentage of the total deposits generated	+
Lending rate	It refers to the interest rates charged by the bank for the firm's short- and medium-term financing requirements.	+
Interest Rate Spread	It is the difference between the bank's lending rates provided to the private sector and deposit rates paid on 3-month deposits.	-
Bank Concentration	It represents the total assets of the three largest commercial banks as a percentage of the total commercial banks' assets.	-
Economic Growth	It is the annual % growth rate of the country's gross domestic product per capita based on constant local currency.	-
Unemployment	The portion of the unemployed labor but are looking for employment.	+
Inflation, CPI	It utilizes the consumer price index which provides the annual percentage change in the price paid for acquiring goods and services.	+/-

We applied three (3) regression estimations, namely, pooled ordinary least square (OLS), fixed effects (FE), and random effects (RE). Finally, we selected robust fixed effects estimation as the final model to control for unobserved heterogeneity found in the regression.

4 METHODOLOGY

4.1 Research Design

Quantitative research design was utilized in this study. Specifically, it utilizes explanatory and descriptive research designs to measure the impact of bank-specific, industry-specific, and macroeconomic variables on the credit risk exposure of the banks in the ASEAN5 countries, namely, Indonesia, Malaysia, the Philippines, Singapore, and Thailand.

4.2 Method of Data Collection

We utilized secondary sources to process the data and analyze them. This study contributes to the existing literature on the determinants of non-performing loans using a cross-country aggregate series of data culled from the World Bank database, Central Bank and/or Monetary Authority's website from 2000 to 2019. We used the World Bank Indicators and Global Financial databases. We consider the results to be robust, especially when examining the several factors that influence NPLs using three panel data estimations (pooled OLS, RE and FE models) to the annual country-aggregate data, while accounting for the impact of both time series and cross-country analyses. Shown below are the formula used in the study to answer the objectives and test the hypotheses formulated in the preceding discussion, using the three models to run the regression.

Pooled OLS:

$$NPL = \beta_0 + \overbrace{\overbrace{\beta_1 RWCa_i + \beta_2 ROAa_i + \beta_3 CRDR_i + \beta_4 LIRa_i + \beta_5 LDSp_i + \beta_6 IBCo_i}^{\text{Model 1}} + \beta_7 GDGg_i + \beta_8 UNEm_i + \beta_9 IFNC_i}^{\text{Model 3}} + u_i \quad \text{(Eq. 1)}$$

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Random Effects:

$$NPL = \beta_0 + \overbrace{\overbrace{\beta_1 RWCa_i + \beta_2 ROAa_i + \beta_3 CRDR_i + \beta_4 LIRa_i + \beta_5 LDSp_i + \beta_6 IBCo_i}^{\text{Model 1}} + \overbrace{\beta_7 GDGg_i + \beta_8 UNEm_i + \beta_9 IFNC_i}^{\text{Model 2}}}^{\text{Model 3}} + u_i + \varepsilon_{it} \quad \text{(Eq. 2)}$$

Fixed Effects:

$$NPL = \beta_0 + \overbrace{\overbrace{\beta_1 RWCa_i + \beta_2 ROAa_i + \beta_3 CRDR_i + \beta_4 LIRa_i + \beta_5 LDSp_i + \beta_6 IBCo_i}^{\text{Model 1}} + \overbrace{\beta_7 GDGg_i + \beta_8 UNEm_i + \beta_9 IFNC_i}^{\text{Model 2}}}^{\text{Model 3}} + \varepsilon_{it} \quad \text{(Eq. 3)}$$

where NPL represents the bank's credit risk, β_0 is the intercept of the regression line, β_1 *to* β_9 are the coefficients of the respective independent variables, $_i$ is the country's banking sector, $_t$ represents the time (period 2000-2019), ε is the error term, and *u* refers to the individual impact of ith country. For the independent variables, RWCa refers to the capital adequacy ratio, ROAa refers to the after-tax Return on Assets, CRDR refers to credit to deposit ratio, LIRa represents the lending rate, LDSp is the interest rate spread on loans and deposits, IBCo represents the industry bank concentration, GDGr refers to the economic growth, UNEm is unemployment, and IFNC refers to inflation rate.

In the last three models (5, 6 & 7), we allow for the interaction terms in the regression model. Model 4 adds the moderation effect of credit/deposit ratio where its interaction with profitability and lending rates are incorporated in the regression shown in Model 1. In Model 5, the interaction term between economic growth and unemployment (GDGr_UNEm), and economic growth and inflation rate (GDGr_IFNC), inflation rate and lending rate (IFNC_LIRa), and inflation and return on assets (IFNC_ROAa). Like Model 2, the impact of bank size and liquidity were excluded from the regression model. Lastly, Model 5 incorporates the impact of the 6 interaction terms derived from Models 4 and 5 in measuring the combined impact of independent variables and the control variables. We believe that the investigation of the moderation effect of credit/deposit ratio, inflation rate and economic growth matters, to specifically determine if the interaction terms used can improve empirical specification in the analysis.

To determine which estimation is better among the three models, we applied two diagnostic tests. For a comparison between pooled OLS and Random effects estimations, the Breusch-Pagan Lagrange multiplier (LM) was utilized. This test accounts for the variance across entities with the following specifications:

H_0 = OLS estimation is appropriate (p-value > α) (4)
H_1 = Random effects estimation is appropriate (p-value < α) (5)

If the probability is significant (less than 0.05), the null hypothesis is rejected, and the random effects estimation is better compared to OLS. When comparing fixed effects with random effects estimation, we applied Durbin Wu Hausman specification test for the exogeneity of the unobserved error component. The hypothesis is formulated as:

H0= Random effects model is appropriate (p-value > α) (6)

H1= Fixed effects model is appropriate (p-value < α) (7)

Which is derived using this formula derived from the results of the two estimations.

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$$H = (\beta^{FE}-\beta^{RE})\,[Var\,(\beta^{FE}) - Var\,(\beta^{RE})]\text{-}1(\beta^{FE}-\beta^{RE}) \quad \sim X2^{(k)} \tag{8}$$

5. RESULTS AND DISCUSSIONS

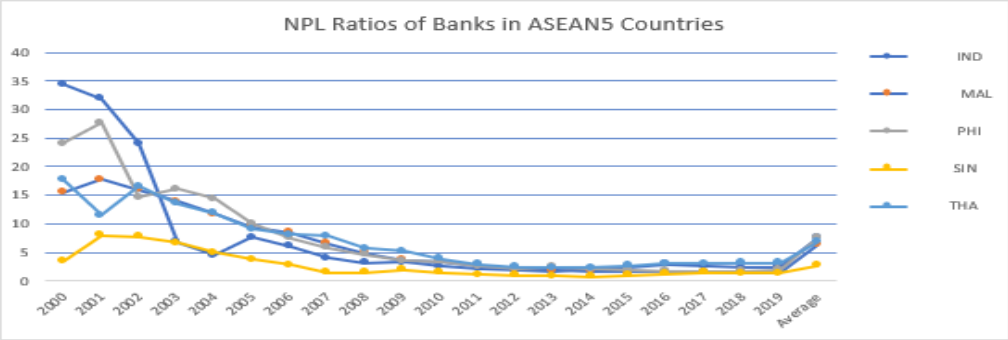

Figure 2. Non-Performing Loan Ratios of Banks in ASEAN5 Countries (2000-2019)

Figure 2 depicts the non-performing loan ratios of the banking sector in the ASEAN5 for the 20-year period. The NPL ratios of banks in the region were high from 2000-2004 due to the 1997 Asian Financial Crisis and drastically affected the ASEAN region (Patiu, 2006). Except for Singapore banks which recorded the lowest NPL ratios at increasing rates, credit risks in other countries were declining.

The Philippines and Indonesia recorded the highest average ratios of 7.483 and 7.431, respectively, especially from 2000-2003. Unlike other banks in other countries, the ratios were low and maintained at stable levels. This only proves that the stringent regulatory framework and policy reforms undertaken after the Asian Financial Crisis led to the resilience of the banking sector from credit risk exposure.

Table 2 shows the summary statistics of the independent and dependent variables utilized in the empirical analysis. The ASEAN5 banks' return on assets (ROAa) has a mean value of 1.248 and the lowest standard deviation of 0.5292 as contrasted to the mean value (61.597) generated for bank concentration (IBCo) with a standard deviation of 21.905. Risk weighted capital showed a low mean value of 11.3% and the high mean value of 23.31% and a mean value of 16.73%. This only proves that banks' compliance with Basel's minimum capital ratio of 8% percent was strictly implemented. As a result, ASEAN5 banks also recorded low after-tax return on assets ratios (ROAa).

Table 2. Descriptive Statistics

Variable	Obs	Mean	Std. dev.	Min	Max
NPL	100	6.146	6.823	0.757	34.400
RWCa	100	16.732	2.474	11.300	23.312
ROAa	100	1.248	0.529	-0.063	2.901
CRDR	100	85.331	18.239	39.316	112.298
LIRa	100	7.594	3.677	4.084	18.945
LDSp	100	3.946	1.261	1.431	7.681
IBCo	100	61.597	21.905	38.408	100.000
GDGr	100	4.993	2.336	-1.514	14.520
UNEm	100	3.571	1.718	0.250	8.060

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IFNC	100	3.238	2.749	-0.900	13.109

Source: Author's computation using Stata

Credit-to-deposit ratio showed a mean value of 85.331 (SD=18.239), which means that of the deposits that were generated, 85% are lent out to the borrowers. Interest rate spread showed a mean value of 3.946, with Indonesia banks having high interest rate spread of 7.68. GDP growth rate, Inflation rate and unemployment rate generated mean values of 4.993 (SD = 2.336), 3.238 (SD =2.749) and 3.57 (SD =1.718), respectively.

Table 3. Test for Multicollinearity

Independent Variables	Bank- & Industry Specific (Model 1)		Macroeconomic (Model 2)		Bank/ Industry-Specific & Macroeconomic (Model 3)	
	VIF	1/VIF	VIF	1/VIF	VIF	1/VIF
TASz	5.25	0.190			5.53	0.1809
LIRa	3.11	0.322			5.73	0.175
CRDR	2.96	0.338			3.04	0.329
RWCa	1.65	0.607			1.71	0.585
LDSp	1.61	0.620			1.87	0.536
IBCo	1.58	0.634			1.86	0.539
ROAa	1.45	0.689			1.58	0.585
LIQa	1.32	0.760			1.67	0.598
UNEm			1.35	0.74	4.33	0.2312
IFNC			1.03	0.97	2.65	0.378
GDGr			1.03	0.97	1.18	0.848
Mean VIF	**2.37**		**1.24**		**2.83**	

To measure the existence of multicollinearity among the predictor and control variables, the variance inflation factor test was conducted. As can be gleaned in Table 3, the mean VIF and the individual VIF values were generated for each of the three models, where bank-specific, industry-specific, and control variables (Model 1), macroeconomic variables (Model 2), and the combined effect of all the variables in Models1 and 2 were used. As a rule of thumb, the values should not exceed 10 (VIF≤ 10) to decide on the absence of multicollinearity. The values were below 5 and are within the acceptable levels; therefore, there is no multicollinearity among the predictor variables.

Table 4. Regression Results on the Impact of Bank-Specific, Industry-Specific and Macroeconomic Indicators on the Non-Performing Loan Ratios of Banks in ASEAN5

NPL Ratio	OLS	RE	FE	OLS	RE	FE	OLS	RE	FE
Constant	18.028	18.322	16.799	5.193	5.193	-2.839	18.205	18.351	17.137
RWCa	-.95***	.924***	-.194				-1.04***	-.993***	-.208
ROAa	-3.78***	-3.82***	-3.03***				-2.99***	-3.084***	-2.97***
CRDR	-4.160	.904	.769				-.096	-.096***	-.100***
LIRa	-.066*	.066*	-.077***				2.694***	2.626***	1.589***
LDSp	1.86***	1.81***	.926***				-1.76***	-1.718***	-1.22***
IBCo	-1.73***	-1.69***	-1.10***				.092***	.088***	.025
GDGr				-.276	-.276	-.216	.111	.101	-.516
UNEm				.161*	.161*	2.61***	-1.28***	-1.253***	-.680**
IFNC				.542	.542	.232	-.842***	-.828***	-.70***
TASz	.039*	.037*	.024*				.046**	.044**	.033**

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LIQa	-.0427	-.044	-.118***				.022	.018	-.09***
Diagnostic Tests	**Prob > Chi2 or Chibar2**	**Dec.**	**Conc.**	**Prob > Chi2 or Chibar2**	**Dec.**	**Conc.**	**Prob > Chi2 or Chibar2**	**Dec.**	**Conc.**
BPLM	0	RE	FE	0	RE	FE	0	RE	FE
DWH	0	FE		0	FE		0	FE	
MWald	0	hsdc	Robust FE	0	hsdc	Robust FE	0	hsdc	Robust FE

Source: Authors' computation using Stata
Notes: ***, **,* denote statistical significance at the 0.01, 0.05, .10 level, respectively
Model 1 measures the impact of bank-specific and industry specific variables on NPL Ratio,
Model 2 measures the impact of macroeconomic variables on NPL Ratio
Model 3 measures the impact of bank-specific, industry specific and macroeconomic variables on NPL Ratio
RWCA represents financial soundness measure (RWCa: risk weighted capital ratio, profitability, (ROAa: After-tax Return on Assets, Intermediation: (CRDR: Credit to Deposit Ratio; LIRa: nominal lending rates, LDSP: Interest rate spread), GDGr represents economic growth, IFNC represents inflation rate, and UNEm represents Unemployment rate. Control variables include TASz: bank size and LIQa: liquid assets to deposits and short-term funding.

Table 4 shows the summary of the regression results for the NPL and determinants. In Model 1, we measure the impact of firm-specific and industry-specific variables on NPL ratio and included the two control variables, namely, bank size (total assets ratio) and liquidity (liquid assets ratio). Five (5) ratios stood out to be significant at 1% and 5% levels, namely, RWCa, ROAa, IBCON, LDSp and LIRa.

Model 2 examines the impact of the macroeconomic variables, namely, unemployment (UNEm), GDP growth rate (GDGr), and Inflation Rate (IFNC) on the nonperforming loans of banks in the ASEAN5 countries and revealed that for all three regression estimations, unemployment is a significant indicator of credit risk exposures of banks and results corroborate the A-priori expectations.

Model 3 combines bank-specific, industry-specific, and macroeconomic indicators and measured their impact on non-performing loans ratios of banks. We again included the two control variables. Except for economic growth (GDGr) and liquidity ratio, other variables consistently showed significant impact on the NPL ratio of banks in the ASEAN region, for each regression estimation.

We use two diagnostic tests to choose the best regression to be used as the final model: Breusch-Pagan Lagrange Multiplier (BPLM) and Durbin-Wu-Hausman tests. The results generated by the Breusch-Pagan LM test reveals that we reject the null hypothesis and conclude Random Effects estimation as the appropriate estimation for all three models. The Durbin-Wu Hausman test shows that FE was chosen as RE is biased and the p-values generated for all models are greater than 0.05. This proves that the null hypothesis for each model is rejected, and the alternative hypothesis is accepted. Since all results for the three models proved that FE is the best estimation, the Modified Wald test was undertaken to determine the presence of heteroscedasticity in FE regression. As shown in Table 4, there is existence of heteroskedasticity and serial correlation over time for the panel data used for all models. Therefore, the robust fixed effects estimation will be used for the three models to test the hypotheses (Anita *et al*., 2022).

Table 5 provide the results generated from the the robust fixed effects regression to measure the effect of the independent variables on NPL ratios. We include bank size, represented by Total Assets ratio, and liquid assets ratio as control variables to eliminate uncontrolled variable bias, as these variable might have impact on the banks' credit risks. In Models 1 and 3, the effects of financial soundness (RWCa), profitability (ROAa),

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credit/deposit ratio (CRDR) and lending rates (LIRa) were supported. The results are consistent with the A-priori expectations for these variables and proved their significant effects on the ASEAN5 banks' credit risk exposures.

Table 5. Robust Fixed Effects Regression Models on the Impact of Bank/Industry-Specific, Macroeconomic, and their Combined Effects of Indicators on Non-Performing Loans in ASEAN

Hypo-theses	NPL Ratio	Model 1		Model 5		Model 6	
		β	Results	β	Results	β	Results
Independent Variables							
H1	RWCa	-.194	Supported			-.208	Supported
H2a	ROAa	-3.025**	Supported			-2.97***	Supported
H3a	CRDR	-.077**	Supported			-.100***	Supported
H3b	LIRa	.926***	Supported			1.589***	Supported
H3c	LDSp	-1.095***	not Supported			-1.223***	Not Supported
H4	IBCo	.015	not Supported			0.025	Not Supported
H5	GDGr			-.218	Supported	-.052	Supported
H6	UNEm			-.810**	Not Supported	-.680***	Not Supported
H7	IFNC			.871***	Supported	-.695**	Supported
Control Variables							
	TASz	.024				.033*	
	LIQa	-.118***				-.088***	
	Constant	16.799		6.843		17.137	

The result for the effect of financial soundness indicator (RWCa) is consistent with the findings of Ashraf *et al*. (2016), Malimi (2017), Muthoni *et al*. (2020), and Rahman *et al*. (2016) where increases in regulatory capital ratio decreases NPL ratios. As banks become cautious in safeguarding their resources, they are willing to forgo higher returns to protect their business. Hypothesis 2 on the negative impact of profitability on NPL ratio supports the findings of Malimi (2017), Rahman *et al*. (2016) and Salvi *et al*. (2018). We believe that the bank's financial soundness increases its profitability, which eventually affect its credit risk exposure.

The impacts of credit-to-deposit ratio and interest rate spread are negative. These are inconsistent with the findings of Wood & Skinner (2017) where they found a positive association between credit-to-deposit ratio and NPL ratios. Loan provision tends to be discretional, depending on the bank's risk appetite. The direct effect of lending rates (H3b) on NPL ratio is consistent with the findings of Kjosevski *et al*. (2019). This suggests that NPL growth or contraction is directly sensitive to the movement of lending rates. When banks have good loan portfolio, interest rates decrease, and credit risk is minimized. As shown in Table 5, the effect of interest rate spread is significant and negative (H3c is not supported). This is consistent with the findings of Chege (2014) among banks in Kenya. Despite the big gap between loan and deposit rate spread, nonperforming loans decreased. This is obvious considering the sudden drop in the NPL ratios of banks in the ASEAN5 countries from year 2000 to 2005.

Among the macroeconomic variables, mixed results were generated for Models 2 and 3, especially for unemployment (UNEm) which showed positive but significant effect on NPL ratio of ASEAN5 banks. This is consistent with the findings of Salvi *et al*. (2018) and Alnabulsi *et al*. (2022) where increase in unemployment results to a borrower's loan

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payment default. The hypotheses for the impact of GDGr and IFNC are supported (Ersoy, 2021; Mondal, 2016, Okyere & Mensah, 2022; Wood & Skinner, 2018) and prove that as economy improves, credit risk decreases and the decrease in inflation rate also decreases NPL ratios.

With the contraction of the GDP growth rate, unemployment increases and inflation rate increase. It drastically affects the quality of its loan portfolio and NPL increases. On the other hand, the impact of the bank's liquidity on NPL ratio is negative and significant. Banks hold more liquid asset to comply with the international standards and national regulatory requirements. This decreases their loan portfolio, which also have a favorable effect on the quality of its credit portfolio through the reduction of NPLs.

Table 6. Regression Results on the Impact of Bank-Specific, Industry-Specific and Macroeconomic Indicators with Interaction terms on the Non-Performing Loan Ratios of Banks in ASEAN5 Countries

NPL Ratio	Model 4			Model 5			Model 6		
	OLS	RE	FE	OLS	RE	FE	OLS	RE	FE
Independent Variables									
RWCa	-1.09***	-1.09***	-.30*				-1.14***	-1.14***	-.29*
ROAa	-7.29*	-7.29*	-12.05***				-7.97	-7.97	-12.25***
CRDR	.17	.17	-.08				.06	.06	-.20
LIRa	3.31***	3.31***	1.43***				3.88***	3.88***	1.43***
LDSp	-.76***	-.76***	-.76***				-1.65***	-1.65***	-1.0***
IBCo	.09***	.09***	.35				.10***	.10***	.02
GDGr				1.27**	.56	.13	.18	.18	-.20
UNEm				.63	.01	-.40	-.89	-.89	-.53
IFNC				.81	.75	1.00	-.67	-.67	-.71
Control Variables									
TASz	-0.320	-.320	-.006				-.004	-.004	.02
LIQa	-0.043	-.043	-.108***				-.012	-.012	-.08**
Interaction Terms (Moderation)									
CRDR_ROAa	.05	.05	.112***				.053	.053	.11***
CRDR_LIRa	-.03***	-.03***	-.010				-.020*	-.020*	-.00
GDGr_UNEm				-.19	-.13	-.06	-.002	-.002	-.01
GDGr_IFNC				-.28**	-.14	-.07	-.040	-.040	.00
IFNC_LIRa				.19***	.13***	.08***	-.029	-.029	.00
IFNC_ROAa				-1.2***	-.92***	-.78***	.241	.241	.05
Constant	22.05	8.18	22.05	2.18	5.41	6.84	12.81	12.81	29.26
Diagnostic Tests	**Prob > Chi2 or Chibar2**	**Dec.**	**Conc.**	**Prob > Chi2 or Chibar2**	**Dec.**	**Conc.**	**Prob > Chi2 or Chibar2**	**Dec.**	**Conc.**
BPLM	0	RE	FE	0	RE	FE	0	RE	FE
DWH	0	FE		0	FE		0	FE	
MWald	0	hsdc	Robust FE	0	hsdc	Robust FE	0	hsdc	Robust FE

Source: Authors' computation using Stata
Notes: ***, **,* denote statistical significance at the 0.01, 0.05, .10 level, respectively
Model 4 measures the impact of bank-specific, industry specific variables & moderation effect of CRDR
Model 5 measures the impact of macroeconomic variables and moderation effect of GDGr and IFNC on NPL Ratio
Model 6 measures the combined impact bank-specific, industry specific, macroeconomic variables and interaction of CRDR, GDGr and IFNC with selected independent variables on NPL Ratio; BPLM refers to Breusch Pagan Lagrange Multiplier test, DWH refers to Durbin Wu Hausman test, MWald refers to Modified Wald Test, and hsdc refers to the presence of heteroskedasticity.

Table 6 shows the regression results for the impact of the independent variables and the six (6) interaction terms with credit/deposit ratio (CRDR), economic growth (proxied by

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GDP growth rate), and inflation rate (IFNC) as the moderators. Like Model 1, we included bank-specific control variables (TASz and LIQa) in the regression estimation for Models 4 and 6, to derive an unbiased estimate of a causal effect that may be generated in the multiple regression model and to eliminate omitted variable biases.

The results for the impact of CRDR and LIQa on NPL ratio were not significant in Model 4 including the impact of the interaction of economic growth with unemployment and inflation rate in Model 5. Model 6 showed mixed results between the interaction of credit/deposit ratio (CRDR) and selected macroeconomic variables. However, their impacts on NPL ratio are insignificant and are consistent with A-priori expectations except for the interaction of economic growth with unemployment and inflation rate.

After presenting the three regression estimations used for the three models with interaction terms, we run the diagnostic tests. Between Pooled OLS and RE estimations, the latter is preferred using the BPLM test, while the Durbin Wu Hausman test results for the three models revealed the use of fixed effects over random effects model. Thus FE estimation will be utilized. We again conducted the Modified Wald test for the presence of heteroscedasticity in FE regression. The heteroscedasticity present in the model provide that the t-values generated and the standard errors could provide incorrect information, thus, we reject the null hypothesis as three models generated p-values < 0.05. With this, we perform the robust fixed effects regression estimations.

Table 7 provides the regression results generated for bank-specific, industry-specific, macroeconomic variables, and interaction term of CRDR, GDGr and IFNC with selected bank-specific and macroeconomic variables on NPL ratios of banks in ASEAN5. Except for the impact of GDGr on NPL ratio (H5 is not supported), similar results were generated for all the other hypotheses that were formulated in Model 1 to Model 3. The interaction terms of credit to deposit ratio (CRDR) with profitability (ROAa) and with lending rate (LIRa) are significant in the two regression models that are shown in Table 7. This proves that CRDR plays a direct and significant role with the profitability of the banks and the interest rates in influencing the contraction or increase in the NPL ratio.

Table 7. Robust Fixed Effects Regression Models on the Impact of Bank/Industry-Specific, Macroeconomic, the Combined Effects of Predictor Variables, and the Interaction Terms on Non-Performing Loans in ASEAN

Hypo-theses	NPL Ratio	Model 4		Model 5		Model 6	
		β	Results	β	Results	β	Results
Independent Variables							
H1	RWCa	-.297	Supported			-.293	Supported
H2a	ROAa	-12.05***	Supported			-12.25***	Supported
H3a	CRDR	-.082	Supported			-.203**	Supported
H3b	LIRa	1.433***	Supported			1.433***	Supported
H3c	LDSp	-.760***	not Supported			-.995***	Not Supported
H4	IBCo	.015	not Supported			.018	Not Supported
H5a	GDGr			.126	Not Supported	-.202	Not Supported
H6	UNEm			-.401	Not Supported	-.531	Not Supported
H7a	IFNC			.999	Supported	-.712**	Supported
Control Variables							
	TASz	-.006				.023	
	LIQa	-.108***				-.083***	
Interaction Terms							

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H3d	CRDR_ROAa	.112***	Supported			.112***	Supported
H3d	CRDR_LIRa	-.010*	Supported			-.001	Not Supported
H5b	GDGr_UNEm			-.062	Not Supported	.014	Not Supported
H5b	GDGr_IFNC			.069	Not Supported	.000	Not Supported
H7b	IFNC_LIRa			.081***	Supported	.003	Not Supported
H7b	IFNC_ROAa			-.783**	Supported	.047	Not Supported
	Constant	29.262		6.843		29.262	

Source: Authors' computation using Stata
Notes: ***, **,* denote statistical significance at the 0.01, 0.05, .10 level, respectively
Model 4 measures the impact of bank-specific, industry specific variables & moderation effect of CRDR
Model 5 measures the impact of macroeconomic variables and moderation effect of GDGr and IFNC on NPL Ratio
Model 6 measures the combined impact bank-specific, industry specific, macroeconomic variables and interaction of CRDR, GDGr and IFNC with selected independent variables on NPL Ratio

When the interaction of economic growth rate (GDGr) with unemployment (GDGr x UNEm) and inflation rate (GDGR x IFNC), the coefficients of the interaction term are positive but non-significant. This suggests the direct impact of as economic growth on unemployment and inflation rate is positive and thus affect the NPL ratios of banks in the region. However, when we estimated to combined effect of an increase in inflation and an increase in lending rates, non-performing loans increases, as shown in the p-value generated for the interaction term of inflation in the two models (Model 5 and 6) used. It is obvious that as inflation rate increases, banks increase their lending rates to compensate for the potential increase in the NPL ratios. Lastly, the combined effect of inflation and profitability provided mixed results. In Model 5, it provided negative and significant impact on the NPL ratio, which suggest that as inflation rate escalates, banks' profitability declines, which results to an adverse impact on the NPL ratios of banks. When we added more variables (bank-specific and industry-specific) in the empirical model, the combined effects of the interaction between IFNC and ROA becomes positive; hence, its effects are not significant. This only suggests that inflation rate can influence the impact of after-tax profitability of banks on NPL ratio, but its impact is non-significant.

Likewise, unemployment contributes to the fragility in the financial sector which leads to potential crisis or systemic problems. On the other hand, low inflation rate reduces loan rates which also decreases the level of nonperforming loans or if the amount of credit increases, even with low inflation rate, NPL especially when borrowers are unable to pay their debts. When we also added control variables, namely bank size (TASz) and liquidity ratio (LIQa) to eliminate omitted variable bias, Table 7 shows that both control variables have negative impact on credit risk exposure of banks in Model 5 but TASz provided its positive impact in Model 6.

6. CONCLUSIONS

Despite the various financial innovations that were introduced by banks to expand their business activities and make financial intermediation more inclusive, problems arise when other banks become more inclined to increase their profitability and/or maximize shareholders' wealth to recover the costs of these innovations.

This study contributes to the existing literature on credit risk and financial intermediation activities of the banks in the ASEAN5 countries. It examined micro (bank -specific & industry-specific indicators) and macro level (macroeconomic indicators) variables and proved how they affected the credit risk of banks. The impact of the interaction term was also positive considered in the analysis using three panel data regression estimations,

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namely, fixed effects, random effects, and pooled OLS. After performing diagnostic tests, the robust fixed effects estimation was utilized for the six models used to answer the problem.

On average, the average credit risk exposure of the ASEAN5 banks significantly vary across countries, especially during 2000-2005. Our findings also revealed that credit-deposit ratio, lending rates and inflation rate have positive effect on the credit risk of banks. Despite the increase in the credit/deposit ratios, ASEAN5 banks increase their lending rates as inflation rate and real interest rates increased over the 20-year period or vice versa. The ASEAN5 banking sector's nonperforming loan ratios significantly declined after the Asian Financial Crisis due to the introduction by the Monetary Authorities of policy reforms in the banking system to ensure financial stability. It can be deduced that the decline in the interest rates resulted to the contraction of nonperforming loans, as banks are able to generate more income from fee-based services and other operations. While credit remained stable and the main source of income of the banks, ASEAN5 banks managed their credit risk exposure well. However, other banks will be affected in an opposite direction and might have incentive to extend more credit to potentially bad creditors consistent with the moral hazard hypothesis.

GDP growth rate, profitability, and capital adequacy and interest rate spread have negative impact on the credit risk. These are consistent with the various literature that were reviewed and the A-priori expectations. As economic growth flourishes in the region, banks become more profitable but cautious in the use of their regulatory capital. This practice reduces the nonperforming loan portfolio of the banks to improve or maintain its assets quality and offer better financial services. These findings also mean that the increase in NPL ratios results from the decline in the banks profitability and the contraction in the economic activities. Hence, caution must be undertaken in looking at the impact of the micro and macroeconomic indicators on the nonperforming loans of banks in the ASEAN5 countries. While there were significant improvements in the NPL ratios of banks after the Asian financial crisis due to the various financial reforms that were implemented in the region, bank's policymakers should continuously monitor their activities, effectively manage their financial resources and capital to maximize their operations and mitigate the growth of nonperforming loans, especially when NPLs are sensitive to the changes in interest rates and the growth of credit.

When the interactions of the credit/deposit ratio, economic growth and inflation rate with selected bank-specific and macroeconomic variables were examined, mixed results were generated. Significant interactions were found between CRDR and ROAa in Models 4 and 6, and between IFNC and ROAa, and IFNC and LIRa in Model 5. However, when the full effects of the independent and control variables, and interaction terms were investigated in Model 6, there were no changes on the impact of the independent variables on NPL ratios. Compared to the interaction term of economic growth with macroeconomic variables, inflation rate can facilitate in affecting the impact of profitability and lending rates on the credit risk exposure of banks in the region.

Further studies can be undertaken in other regions such as South Asia, Europe, and Latin America to verify if the impact of the predictor variables is the same. It is also suggested that studies comparing pre-crisis and post crisis periods, and the pre-pandemic and post-pandemic periods be undertaken. The relationship among independent variables must be explored to measure their interaction. Other credit risk exposures such as bank Z-score,

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fraud risk and other measurements can be used as the dependent variable/(s) or as independent variables affecting a bank's profitability, credit activities, or investment. It is also recommended that different models can be explored to measure credit risk exposure such as granger causality and, other regression estimations such as Bayesian or quantile regression can be explored. When we consider the full impact of the three interaction terms (GDGr, credit/deposit ratio, and inflation) together with the independent variable presented in Model 1 to Model 3, results suggest significant impact of CRDR and IFNC on the NPL ratios of banks and the results are consistent with the results generated in the first three (3) models used in the study.

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