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BALANCING CAUTION AND EXPANSION: THE NON-PERFORMING LOANS THRESHOLD FOR THE CREDIT-GROWTH NEXUS

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ABSTRACT

Introduction/Main Objectives: This research explores how non-performing loans (NPLs) affect economic growth while assuming that the economy can sustain a certain ratio of NPLs without disruption. **Background Problems:** Studies employing the threshold approach have not explicitly defined the upper limit of NPLs that supports economic growth. **Novelty:** This study adds to the existing literature by examining the non-linear relationship between NPLs and economic growth, grounded in two key assumptions: 1) the complete elimination of NPLs is unrealistic, and 2) a threshold level of NPLs exists. **Research Methods:** Based on this assumption, the study constructs a non-linear model with an inverted U-shape pattern, applying annual data from 33 provinces in Indonesia during 2010–2021 and employing dynamic panel data regression with the GMM estimator. **Finding/Results:** The results reveal that NPLs will have a negative impact on growth when the NPL ratio exceeds 5.8% in total credit and 2.4% for household credit. However, no inverted U-shaped pattern is observed for working capital and investment credit. In addition, bank credit in total, as well as working capital credit and household credit show a significant positive coefficient on growth, while investment credit has an insignificant negative coefficient. We also introduce the concept of NPLs-growth risk, categorizing it as risk-free, low-risk, moderate-risk, and high-risk based on the area under the curve. The findings indicate that the NPLs-growth risk in Indonesia is generally at a low level. **Conclusion:** Ensuring that NPLs remain within a safe threshold is essential for sustaining economic growth and avoiding financial instability.

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INTRODUCTION

Bank credit is a critical driver of economic growth, particularly in developing countries where access to alternative financial resources such as venture capital and capital markets is still limited. By providing funding to businesses, bank credit facilitates investments that enable expansion and enhance productivity (Malik et al., 2021; Yuli & Rofik, 2023a). Small and medium enterprises (SMEs) form the backbone of economies in developing countries, including Indonesia, and rely heavily on bank credit to finance their operations (Panjaitan et al., 2020; Yuli & Rofik, 2023b). Therefore, a well-functioning banking sector that efficiently allocates credit can stimulate economic activity and drive sustainable growth.

However, the potential of bank credit to drive growth hinges on good governance and prudent lending practices (Nizar & Karim, 2021; Pasaribu & Mindosa, 2021). While bank credit is essential for growth, it carries inherent risks, such as the possibility of loan defaults or non-performing loans (NPLs), particularly when credit is extended to non-viable projects or financially weak borrowers (Hughes & Moon, 2022). A high level of NPLs can burden a bank's balance sheet and reduce the availability of funds for further credit distribution. Moreover, imprudent credit distribution can not only disrupt a bank's financial stability but also precipitate a financial crisis, ultimately putting pressure on the entire economy (Tölö & Virén, 2021; Zhang et al., 2022; Zuhroh et al., 2022).

Figure 1. Time series data of GDP in nominal and log transformation and NPLs

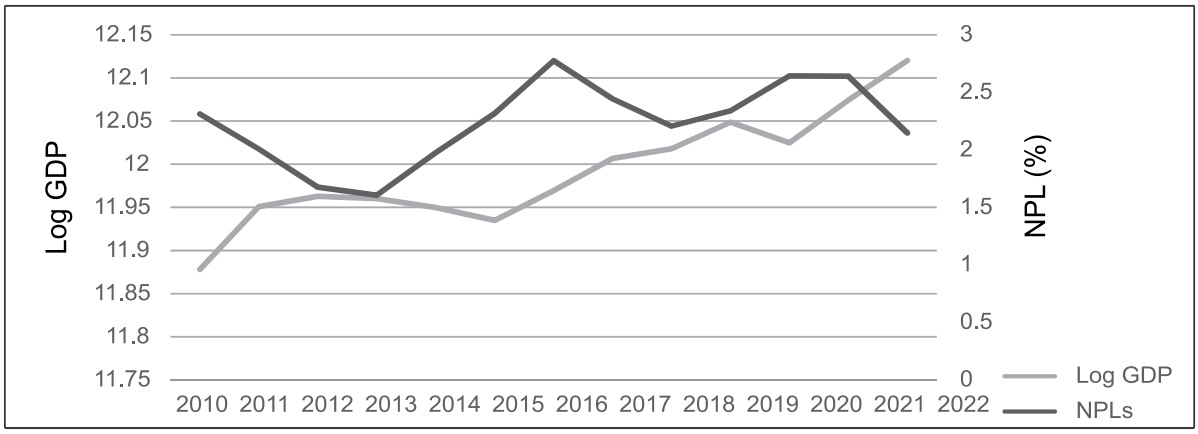

Figure 1.a. NPLs and Log GDP of Indonesia (current US$)

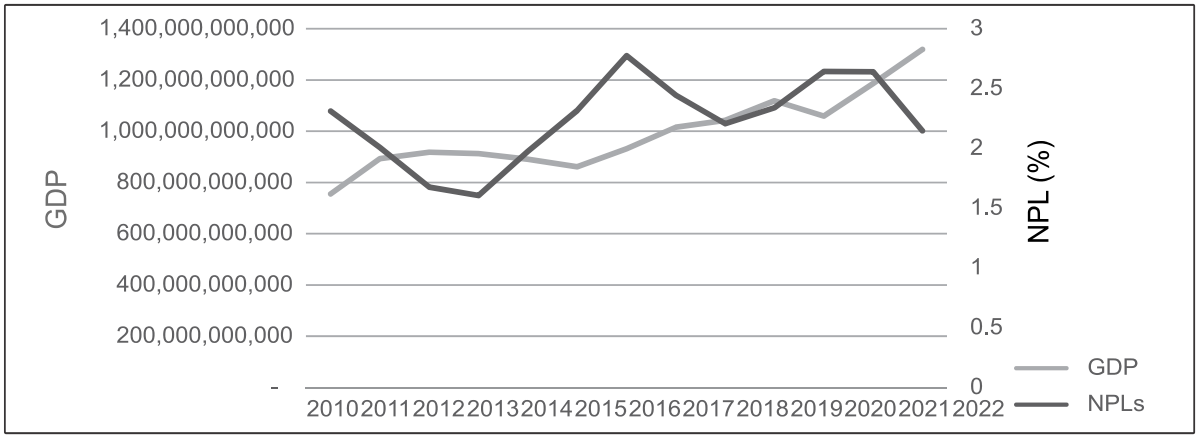

Figure 1.b. NPLs and GDP of Indonesia (current US$)

Source: World Bank.

Samargandi et al. (2015) studied 52 middle-income countries from 1980 to 2008, identifying an inverted U-shaped relationship in which excessive credit harms economic growth. In a similar vein, Arcand et al. (2015) provide evidence that credit starts to hinder growth when the credit-to-GDP ratio exceeds 100%. Law and Singh (2014) demonstrate a threshold effect in the relationship between finance and growth in their study of 87 developed and developing countries. Another cross-country study by Zhu et al. (2020) indicates that innovation's contribution to growth diminishes when the credit-to-GDP ratio surpasses 60%. Specific to Indonesia's banking sector, research by Soedarmono et al. (2017) based on quarterly data from 2000 to 2009 identifies a critical threshold for the credit-to-GDP ratio at 39%, beyond which credit's role as an economic driver tends to become negative.

The above studies by Arcand et al. (2015), Law and Singh (2014), Samargandi et al. (2015), and Soedarmono et al. (2017) highlight the potential risks associated with excessive financing. A further recurring concern across these studies is the potential dampening effect of NPLs on the role of credit in fostering economic growth. NPLs signify more than just an inability of debtors to repay; they burden both lenders and borrowers. For borrowers, NPLs tie up collateral in unresolved debts, complicating access to new funding (Hughes & Moon, 2022; Tölö & Virén, 2021). Concurrently, banks incur higher costs in managing NPLs, which can constrain their capital levels and restrict their ability to lend (Zuhroh et al., 2022). These distortions stemming from NPLs erode market confidence and ultimately hinder economic development (Jordà et al., 2013; Turan & Iyidogan, 2023).

While NPLs can indeed disrupt the intermediary role of banks, it is crucial to recognize that these loans do not vanish; borrowers continue to utilize them for business or personal expenditures, thus sustaining money circulation in the economy (Zuhroh et al., 2022). However, the sustainability of their impact varies, and they can pose systemic risks to the broader economy. This establishes a triangular relationship: NPLs arise from credit allocation, which in turn supports economic growth. Consequently, some level of NPLs is inevitable in any economy, and they do not always escalate into a significant issue. Achieving a zero NPL ratio is thus recognized as impractical (Axiom 1). Even with rigorous supervision by regulatory bodies and responsible lending practices by banks, there remains a residual risk of problematic loans. The crucial question now revolves around determining the threshold for NPLs. Given the phenomenon of excessive financing and the persistence of NPLs within the economy, we propose the existence of an upper limit. As long as NPLs remain below this threshold, they are unlikely to hinder economic growth. This proposition is formally articulated in Axiom 2.

Axiom 1. Every credit disbursement carries an inherent risk of non-performing loans.

Axiom 2. A threshold exists on the acceptable proportion of non-performing loans, beyond which they begin to hinder economic growth.

Previous studies have predominantly explored the linear relationship between NPLs and economic growth, with limited investigation within the threshold framework (Kartal et al., 2023; Turan & Iyidogan, 2023). In other words, studies utilizing the threshold principle have not explicitly defined the upper limit of NPLs in terms of supporting growth. For instance, a study by Piatti and Cincinelli (2019) in Italy found that below an endogenously determined threshold, the quality of monitoring has an insignificant positive impact on the NPL ratio, but this relationship becomes positive and significant once the NPL ratio surpasses the threshold. The

results of another study in Italy suggest that sustained economic growth above 1.2% for several years could reduce NPLs there (Mohaddes et al., 2017). In contrast, credit distribution through Fintech was found to initially reduce NPL levels in BRICS countries, but then subsequently contributed to NPL accumulation (Okoli, 2020). In the context of Indonesia, specific studies addressing the NPL threshold and its impact on economic growth are lacking. However, historical data depicted in Figure 1 suggest that an increase in NPLs to a certain level may actually suppress GDP.

Given the lack of empirical literature on the potential of NPLs to disrupt growth and considering the importance of encouraging bank credit while managing NPLs to optimize growth potential, this study aims to determine the NPL threshold in Indonesia. The study seeks to not only identify the NPL threshold for total credit but also for specific types of credit, including working capital, investment, and household loans. Furthermore, it explores how each type of credit and total credit affect economic growth. To obtain robust results, several control variables are considered as follows: inflation, interest rates, inequality, and unemployment.

Theoretically, this study contributes to the literature by exploring the non-linear relationship between NPLs and growth based on the axioms that 1) zero NPLs is impossible and 2) there exists a threshold for NPLs. This theoretical framework offers a fresh perspective on the role of NPLs in economic development, underscoring the importance of maintaining NPLs within manageable limits to optimize growth. Furthermore, the study provides valuable insights for policymakers, highlighting the need for monetary authorities and financial regulators to acknowledge credit's dual nature as both a driver of economic growth and a potential source of financial instability if not managed prudently. Additionally, banks can adopt the NPL ceiling approach to evaluate risk management practices in lending. This approach encourages banks to pursue controlled credit expansion, ensuring they contribute positively to economic development while safeguarding financial stability.

Based on the detailed background provided, this research aims to achieve two primary objectives. The first is to identify the threshold at which NPLs do not adversely impact economic growth, and second is categorizing the NPLs-growth relationship in Indonesia into four risk levels: risk-free, low-risk, moderate-risk, and high-risk.

The remainder of the paper is divided into four sections. The first section covers model construction, explaining the mathematical formulation of the threshold model. The second section details the methods used, describing the data and econometric model. The third section presents the results and discussion, and the fourth section provides the conclusion.

MODEL CONSTRUCTION

1. Threshold of non-performing loans (NPLs)

As Axiom 1 indirectly states that the proportion of NPLs cannot be zero for every credit disbursement, then S_η is a set that is bounded from below and above, where sup S_η is a member of S_η and inf $S_\eta$is not a member of S_η. Mathematically, the interpretation of Axioms 1 and 2 follows equations (1) and (2).

$$\forall \zeta \; \exists \eta \ni P(\eta = 0) = 0, \zeta, \eta \in R^+ \tag{1}$$

$$\exists S_\eta \coloneqq \{\eta \mid \eta_{lower} < \eta \leq \eta_{upper}, \forall \eta \in R^+\} \ni g(\eta) \geq 0. \tag{2}$$

Note: ζ is bank credit; η is ratio of NPLs; η_{lower} is the lower bound of S_η, η_{upper} is the upper bound and sup S_η of S_η; and $g(\eta)$ is a growth function with ratio of NPLs as the explanatory variable.

Referring to equation (2), we construct equation (3). Consequently, the growth function will have a unique maximum optimum value when the η^2 coefficient is negative and the η coefficient is positive. Assuming the discriminant value of $g(\eta)$ is not equal to zero, the function will have two zeros, namely $\eta_{lower}$and η_{upper}, where $\eta_{lower} = 0$. Based on these zero values, there exists $S_\eta \coloneqq \{\eta \mid \eta_{lower} < \eta \leq \eta_{upper}, \forall\, \eta \in R^+\}$. The value of η_{lower} is the lower bound, and η_{upper} is the upper bound of S_η. The zero values are obtained using formula (4). To find the maximum optimum point (η_{max}) of our model, we look for the zeros of its first derivative using the formula (5). Furthermore, when the value of $0 < \eta < \eta_{upper}$, economic growth is still positive mathematically; it is zero when $\eta_{lower} = \eta = \eta_{upper}$, and it is negative when $\eta > \eta_{upper}$.

$$g(\eta) = \beta_1\eta - \beta_2\eta^2 \tag{3}$$

$$\eta_{lower,}\eta_{upper} = -\beta_2 \pm \frac{1}{2\beta_1}\sqrt{{\beta_2}^2 - 4\beta_1} \tag{4}$$

$$\exists!\, \eta_{max} \leftrightarrow \frac{d}{d\eta}g(\eta) = 0 \tag{5}$$

For $0 < \eta < \eta_{max}$, the NPLs have a positive or zero marginal value, $\frac{d}{d\eta}g(\eta) \geq 0$. In other words, within this interval, every increase in NPLs will have a positive or at least a zero impact on economic growth. Conversely, for $\eta > \eta_{max}$, although growth is generally still positive, every increase in NPLs will reduce growth, as the marginal value is negative, $\frac{d}{d\eta}g(\eta) < 0$. For the purpose of simplification, we refer to $S_{\eta<\eta_{max}} \coloneqq \{\eta \mid 0 < \eta < \eta_{max}, \forall\, \eta \in R^+\}$ as the first area and $S_{\eta>\eta_{max}} \coloneqq \{\eta \mid \eta_{max} < \eta < \eta_{upper}, \forall\, \eta \in R^+\}$ as the second area. Using quartile concepts such as equation (6), we divide the first area into four equal-sized sections, namely $S_1, S_2, S_3 and S_4$, as formally defined in equation (7).

Since $\frac{d}{d\eta}g(\eta)$ is a linear function, it follows that for every $\varepsilon > 0$, and $(\eta + \varepsilon) \in S_{\eta\leq\eta_{max}}$, $\frac{d}{d\eta}g(\eta) > \frac{d}{d\eta}g(\eta + \varepsilon)$. As a result, $\frac{d}{d\eta}g(\eta)_{\eta\in S_1} > \frac{d}{d\eta}g(\eta)_{\eta\in S_2} > \frac{d}{d\eta}g(\eta)_{\eta\in S_3} > \frac{d}{d\eta}g(\eta)_{\eta\in S_4}$. In other words, for every increase in NPLs by ε, S_i has a greater positive impact than S_j for every $i > j$. This study also visualizes the NPLs–growth nexus through the area under the curve $\int_{0=\eta_{lower}}^{\eta_{max}} g(\eta)\, d\eta$. Dividing $\int_{0=\eta_{lower}}^{\eta_{max}} g(\eta)\, d\eta$ into four areas based on quartile principles yields four cumulative area intervals following equation (8).

$$\tfrac{q}{4}\eta_{max} \text{ for } q = 1,2,3,4 \tag{6}$$

$$\begin{aligned} S_{\eta_{max}} \coloneqq \Big\{ & S_1 \coloneqq \Big\{\eta \mid \eta_{lower} < \eta \leq \tfrac{1}{4}\eta_{max}\Big\}; S_2 \coloneqq \Big\{\eta \mid \tfrac{1}{4}\eta_{max} < \eta \leq \tfrac{1}{2}\eta_{max}\Big\}; S_3 \coloneqq \Big\{\eta \mid \tfrac{1}{2}\eta_{max} < \eta \leq \tfrac{3}{4}\eta_{max}\Big\}; S_4 \coloneqq \Big\{\eta \mid \tfrac{3}{4}\eta_{max} < \eta \leq \eta_{max},\Big\} \forall\, \eta \in R^+\Big\} \end{aligned} \tag{7}$$

$$\int_0^{\frac{1}{4}\eta_{max}} g(\eta)\, d\eta; \int_0^{\frac{1}{2}\eta_{max}} g(\eta) d\eta\,; \int_0^{\frac{3}{4}\eta_{max}} g(\eta) d\eta\,; and \int_0^{\eta_{max}} g(\eta) d\eta \tag{8}$$

2. NPLs-growth risk

Generally, risk is defined as the possibility of an undesirable event (something bad) happening, and thus credit risk is the possibility of loss due to the borrower's failure to meet contractual obligations. Referring to the general definition of risk, credit risk, and Axioms 1 and 2, we propose the following definition of NPLs-growth risk: the economic loss caused by the ratio of NPLs exceeding its upper threshold (η_{max}).

Table 1. NPLs-growth risk

Set	Risk Interval	Risk Area	Risk level
S_1 (Area 1)	$\eta_{lower} < \eta \leq \frac{1}{4}\eta_{max}$	$0 < \int_0^b g(\eta)\, d\eta \leq \int_0^{\frac{1}{4}\eta_{max}} g(\eta) d\eta$	Risk-free
S_2 (Area 2)	$\frac{1}{4}\eta_{max} < \eta \leq \frac{1}{2}\eta_{max}$	$\int_0^{\frac{1}{4}\eta_{max}} g(\eta)\, g d\eta < \int_0^b g(\eta)\, d\eta \leq \int_0^{\frac{1}{2}\eta_{max}} g(\eta)\, d\eta$	Low-risk
S_3 (Area 3)	$\frac{1}{2}\eta_{max} < \eta \leq \frac{3}{4}\eta_{max}$	$\int_0^{\frac{1}{2}\eta_{max}} g(\eta)\, d\eta < \int_0^b g(\eta)\, d\eta \leq \int_0^{\frac{3}{4}\eta_{max}} g(\eta)\, d\eta$	Moderate-risk
S_4 (Area 4)	$\frac{3}{4}\eta_{max} < \eta \leq \eta_{maxx}$	$\int_0^{\frac{3}{4}\eta_{max}} g(\eta)\, d\eta < \int_0^b g(\eta)\, d\eta \leq \int_0^{\eta_{maxx}} g(\eta)\, d\eta$	High-risk

Note: b is the actual value of the non-performing loans ratio

Suppose that the relationship between NPLs and economic growth has an inverted U-shape as shown in equation (3) and assuming NPLs-growth risk as the probability of NPLs having a negative impact on growth less than 1, $P\left(\frac{d}{d\eta} g(\eta) < 0\right) < 1$, then $S_{\eta_{max}}$ is the NPLs-growth risk. This condition is based on the probability $P\left(\frac{d}{d\eta} g(\eta) < 0\right) = 0$, as seen in equation (9). Furthermore, for $\forall \eta > \eta_{max} \ni P\left(\frac{d}{d\eta} g(\eta) < 0\right) = 1$, we no longer refer to it as a risk. This is because something bad has already happened (the NPL ratio has a negative impact on growth).

We have classified NPLs-growth risk into four categories based on the characteristics of $S_1, S_2, S_3 and S_4$, and the concept of the area under the curve as shown in equation (6). Our classification is based on the assumption that when the proportion of NPLs tends towards the upper limit, the positive impact experiences diminishing growth. We have classified the risk-free category of S_1 based on Axiom 1, which stipulates that the concept of risk-free does not require the NPL ratio to be zero. For practical purposes, we refer to the boundaries of each interval as the local lower (upper) bound. Therefore, η_{lower} and η_{upper}represent the lower boundary of the risk-free area and the upper boundary of the high-risk area.

$$P\left(g\frac{d}{d\eta}(\eta) < 0\right) = 0,\ \eta < \eta_{max} 1, \eta \geq \eta_{max} \quad \ldots(9)$$

METHOD

To ensure the validity of the results, this research does not solely rely on NPLs as the explanatory variable for economic growth. It is widely acknowledged that the NPL ratio depends heavily on the amount of credit distribution. Therefore, we include banking credit variables as the first control variable. Building on findings from Breunig and Majeed (2020), Hjazeen et al. (2021), and Mdingi and Ho (2021) highlighting the impact of socioeconomic conditions on growth, we incorporate two socioeconomic

variables—unemployment and inequality, as the second control variables. Given the diverse characteristics of each province in Indonesia, these inclusions are deemed appropriate.

Additionally, this study integrates macro-economic variables, specifically interest rates and inflation. Drawing from the IS curve approach, we argue that a high benchmark interest rate regime tends to reduce credit distribution, thereby potentially disrupting growth. Regarding inflation, several studies, including Rousseau and Wachtel (2002), have shown that high inflation impedes the effecti-veness of credit in driving growth. Furthermore, in addition to examining the overall impact of NPLs on economic growth, this study recognizes the importance of analyzing credit allocation heterogeneity based on its usage. Thus, along-side the comprehensive analysis of NPLs, a decomposition analysis is conducted that includes working capital credit, investment credit, and household credit.

1. Econometrics Model

We acknowledge that analyzing credit distribution and NPLs is complex due to their mutual influence, which can vary during economic downturns or expansions. Economic expansions typically result in increased credit and accelerated reduction in NPLs, whereas the opposite tends to occur during economic downturns. Given the high correlation between credit distribution and NPLs, issues of multicol-linearity may arise in some methods and models.

To address these challenges, we utilize panel data at the provincial level in Indonesia. This approach helps mitigate sample heterogeneity, reflecting varying levels of credit disbursement among provinces. Furthermore, to mitigate potential endogeneity stemming from unobserved exogenous variables, we employ dynamic panel data analysis, specifically the Generalized Method of Moments (GMM) introduced by Arellano and Bover (1995) and Blundell and Bond (1998). The GMM estimator is known for consistent and unbiased parameter estimation (Hasan & Gan, 2009). In this study, we adopt the two-step GMM approach, which is asymptotically more efficient (Blundell & Bond, 1998; Hasan &Gan, 2009). We employ the Arellano-Bond AR(2) test to detect autocorrelation and the Sargan test to assess instrument validity (Benchimol & Qureshi, 2020).

Table 2. Descriptive statistics

Variable(s)	Mean	Max	Min	Std. Dev.
Real GDRP (Billion IDR)	278,744,477	1,856,301,410	14,983,910	391,855,773
Total credit (Billion IDR)	130,430,000	2,780,889,000	3,365,676	374,095,200
Working capital credit (Billion IDR)	60,712,020	1,370,448,000	1,152,567	189,235,700
Investment credit (Billion IDR)	32,871,740	948,492,000	299,338	120,972,700
Household credit (Billion IDR)	36,846,200	461,949,400	1,851,297	68,597,780
NPLs Total Credit	0.025	0.073	0.005	0.011
NPLs Working Cap. Credit	0.039	0.116	0.006	0.019
NPLs Inv. Credit	0.032	0.172	0.002	0.022
NPLs Household Credit	0.012	0.040	0.004	0.006
Inflation (%)	4.283	8.380	1.680	2.286
Interest rate (%)	5.806	7.750	3.750	1.416
Gini	0.365	0.459	0.256	0.038
Poverty	0.115	0.315	0.034	0.060
Unemployment	0.052	0.105	0.014	0.020

The panel data regression model follows equation (10), where y represents the gross regional domestic product (GRDP), δ is the lag coefficient; β_i is the i-th coefficient of the main explanatory variable; η is non-performing loans; ζ is banking credit disbursement; θ_i is the i-th other coefficient of the control variable; x is the control variable; e is the error term, and $t$is the time. Furthermore, we estimate the long-run coefficient of the banking credit variable using equation (11).

$$log\ y_t = \delta\ log\ y_{t-1} + \beta_1\eta_t + \beta_2{\eta_t}^2 + \beta_3 log\zeta_t + \sum_{i=1}^{n}\theta_i x_{i,t} + e_t \quad (10)$$

$$\beta_{3_{longrun}} = \frac{\beta_3}{1-\delta} \quad (11)$$

2. Data

In this study, economic growth is proxied by real gross regional domestic product (GRDP), sourced from the statistical agencies of Indonesia. Concurrently, data on the amount of credit and NPLs for commercial banks are obtained from Indonesian Banking Statistics released by the Financial Services Authority. The unemployment rate variable is sourced from the second-semester unemployment rate for each year. Annual data on interest rates and inflation are derived from monthly averages over one year, while inequality is proxied by the Gini ratio. Data on the unemployment rate, Gini ratio, inflation, and interest rates are sourced from regional statistical agencies for each province. All data are cross-sectional and cover 33 provinces in Indonesia from 2010 to 2021, with the exception of the benchmark interest rate, which applies uniformly across all provinces.

RESULT AND DISCUSSION

Based on Table 2, during the period 2010–2021, the average NPL ratio of total bank credit was around 2.46%. Breaking this down, on average working capital loans represents the highest number of NPLs at 3.86%, while household credit makes up the lowest proportion at 1.28%, and investment credit contributes 3.17% of NPLs. Meanwhile, if viewed in terms of credit disbursement figures, on average, most bank credit is dominated by working capital, followed by consumption, and the rest is investment credit. Furthermore, Table 2 also shows that the value of the standard deviation of credit distribution for both total credit and its decomposition is always higher than the average value; this indicates that provinces in Indonesia have a high level of heterogeneity in bank credit disbursement.

1. Multicollinearity test

The multicollinearity test shows the correlation values for each independent variable are less than 0.8, so it can be concluded that each model constructed in this study is free from multicollinearity (see Table 3). Therefore, the models are suitable for further analysis of dynamic panel data regression with the GMM estimator. Table 4 shows that only the total credit analysis (Model 1) and the household credit analysis (Model 4) have an inverted U-shape pattern. This can be identified from the coefficients η and η_{kons}, which have positive coefficients, and η^2, ${\eta_{kons}}^2$, which each have significance levels below 10%. Models 1 and 4 have upper thresholds of 5.8% and 2.5%, respectively.

2. Robustness test

This study implements the Sargan test of over-identifying restrictions to evaluate the validity of the instruments used in the GMM model. Instruments are considered valid if they correlate with the explanatory variables but not with the residual errors. Since the probability value of the Sargan test is above 0.05, it can be stated that the

Table 3. Correlation matrix

	Total Credit	Working Capital Credit	Investment Credit	Household Credit	η	η_{work}	η_{inv}	η_{cons}	Un	Gini	IR	Inf
Total Credit	1.000											
Working Capital		1.000										
Investment Credit			1.000									
Household Credit				1.000								
η	0.040				1.000							
η_{work}		-0.113				1.000						
η_{inv}			-0.065				1.000					
η_{cons}				0.285				1.000				
Un	0.248	0.234	0.219	0.321	0.222	0.132	0.067	0.367	1.000			
Gini	0.224	0.223	0.195	0.263	0.035	-0.049	0.070	0.087	0.075	1.000		
IR	-0.072	-0.060	-0.064	-0.114	-0.071	-0.058	0.019	-0.095	-0.201	0.081	1.000	
Inf	-0.069	-0.057	-0.062	-0.107	-0.105	-0.105	0.012	-0.086	0.03	0.006	0.765	1.000

Table 4. Model estimation results

Variable(s)	Model(s)			
	Total credit (1)	**Working Capital (2)**	**Investment (3)**	**Household (4)**
$y(-1)$	0.781* (0.009)	0.772* (0.008)	0.898* (0.011)	0.748* (0.009)
η	1.243* (0.184)			
η^2	-10.652 (1.934)			
η_{work}		0.179* (0.083))		
η^2_{work}		0.747 (0.872)		
η_{inv}			-0.277** (1.092)	
η^2_{inv}			2.090** (0.155)	
η_{cons}				6.501* (0.493)
η^2_{cons}				-126.262* (8.599)
Total Credit	0.040* [0.182] (0.003)			
Working Capital Credit		0.053* [0.232] (0.002)		
Investment Credit			-0.005 (0.004)	
Household Credit				0.053* [0.210] (0.005)
Unemployment	-1.893* (0.107)	-1.907* (0.125)	-1.961* (0.009)	-1.943* (0.055)
Gini	-0.305* (0.032)	-0.400* (0.051)	-0.023 (0.041)	-0.309 (0.021)
Interest rate	0.138* (0.036)	0.236* (0.044)	0.175* (0.050)	0.210* (0.033)
Inflation	-0.197* (-0.197)	-0.198* (0.028)	-0.210* (0.025)	-0.228* (0.025)
Sargan test (Prob)	32.693 (0.138)	32.120 (0.154)	15.625 (0.944)	34.496 (0.122)
Prob. Arellano–Bond AR(2)	0.366	0.6778	0.999	0.978
η_{max} (%)	0.058 (5.80)	-	-	0.025 (2.5)
η_{upper} (%)	0.116 (11.6)	-	-	0.051 (5.1)

*Notes: *,**, (), [] respectively are the significance level below 5%; below 10%, the standard error and long-term coefficients.*

instruments in the four implemented models are valid. Additionally, this study evaluates the model using the Arellano–Bond Autoregressive Model of Order 2 (AR(2)) test, which checks for the presence of autocorrelation in the error term in the second order. In the dynamic GMM model, it is crucial to ensure there is no auto-correlation in the error term to achieve unbiased estimation. Since the probability value of the AR(2) test is above 0.05, it can be concluded that the estimations in the four models are unbiased.

Based on these two tests, the dynamic panel model with the GMM estimator used in this study are shown to be valid and reliable. Furthermore, the instruments selected in the model are valid and do not introduce bias into the estimation, and the estimates produced from the model are robust and not affected by unwanted autocorrelation.

3. NPLs Threshold

Based on Table 5, the upper NPL limits for Model 1 are as follows: 1.4% for the risk-free area and 2.9% for the low-risk area. Additionally, the upper limits for the medium-risk and high-risk ratios are approximately 4.3% and 5.8%, respectively. In total credit, an NPL ratio below 5.8% is not expected to suppress growth; thus, theoretically, NPLs still have a positive impact. However, ratios exceeding 5.8% are likely to have a negative effect on economic development. Meanwhile, for household credit, the upper limits are 0.6% for the risk-free area and 1.2% for the low-risk area. The upper limits for the medium-risk and high-risk ratios are 1.8% and 2.5%, respectively. According to this model, if the NPL ratio in household credit does not exceed 2.5%, it should not hinder growth.

By comparing NPLs-growth risk, as seen in Table 5, against the average non-performing loan data in Table 2, it can be concluded that during the observation period, Indonesia remains in the low-risk area. This condition can be interpreted as Indonesian banks applying prudential principles in lending. Based on the constructed model, Indonesia can still boost growth by increasing credit to optimize economic growth. However, we note that the relationship between NPLs and growth is more complex. Carelessness or complacence regarding NPLs that are considered low and assumed to be relatively safe can lead to significant risks. For instance, the current NPL ratio is still in Area 1, indicating a risk-free category. However, if precautions are not taken, there is a possibility that the NPL ratio may jump to Area 2, Area 3, or even Area 4 in the next period. Therefore, we recommend that banks be encouraged to ensure the NPL ratio falls within the upper limit of the low-risk area for conservative policy or the medium-risk area for expansionary policies. Meanwhile, when NPLs are in the high-risk area, extreme caution must be exercised. Considering the Financial Instability Hypothesis, carelessness and excessive optimism always create opportunities for a jump in the level of NPLs (Beshenov & Rozmainsky, 2015; Pedrosa, 2019).

Table 5. Result of NPLs-growth risk categories

Area	Risk Area		Risk level
	Total credit (1)	Household credit (4)	
S_1 (Area 1)	$0 < \eta \leq 0.014$	$0 < \eta \leq 0.006$	Risk-free
S_2 (Area 2)	$0.014 < \eta \leq 0.029$	$0.006 < \eta \leq 0.012$	Low-risk
S_3 (Area 3)	$0.029 < \eta \leq 0.043$	$0.012 < \eta \leq 0.018$	Medium-risk
S_4 (Area 4)	$0.043 < \eta \leq 0.058$	$0.018 < \eta \leq 0.025$	High-risk

Regarding our findings that NPLs, within a certain limit, do not disrupt growth and can coexist with economic expansion, similar results were observed in Turkey (Kartal et al., 2023). Conversely, a study of 21 OECD countries suggests that NPLs can hinder growth (Zhang et al., 2022). Furthermore, research using quarterly bank-level data spanning 2014–2019 from the European Banking Authority (EBA) and covering approximately 200 banks across 30 countries also indicates that NPLs have the potential to suppress economic expansion (Tölö & Virén, 2021). Meanwhile, a study in Indonesia indicates that NPLs can hinder growth in both the short and long term, especially during sudden large spikes in NPLs (Zuhroh et al., 2022).

Based on the findings of the current study in Indonesia and other research on the relationship between NPLs and growth in various countries, it is evident that NPLs in credit distribution are unavoidable, as stated in Axiom 1. However, effective management of NPLs is crucial to prevent them from reaching levels that can disrupt the economy, as highlighted in Axiom 2. Therefore, financial institutions and governments must implement robust risk management strategies and stringent supervisory policies. Effective coordination between the public and private sectors is also essential for maintaining financial stability and fostering sustainable economic growth (Kartal et al., 2023; Rofik et al., 2023). Thus, while NPLs are inevitable, their negative impacts can be mitigated through prudent management and sound policies.

4. Bank credit and growth

The findings of this study show that bank credit is a driver of economic growth, as seen in the estimation results presented in Table 4. Three out of four models demonstrate that credit has a significant positive impact on economic growth, while in the remaining model, investment credit has a negative but insignificant impact. Bank credit has a positive and significant coefficient value, with a magnitude that is relatively similar. A 1% increase in credit disbursement will result in short-term growth of 0.04% and long-term growth of 0.18%. Meanwhile, for working capital and household credit, each 1% increase in lending will lead to around 0.05% growth in the short term. In the long term, a 1% increase in working capital credit or household credit will drive growth by 0.23% and 0.21%, respectively.

Other studies, including by Afrizal et al. (2021), indicate that investment credit in Indonesia does not significantly drive economic growth. The potentially insignificant negative impact of investment credit on growth may stem from the nature of investment projects, which are typically long term and may take time to yield substantial returns. Therefore, the immediate observable effects of investment credit on growth may be limited, necessitating long-term analysis to fully understand its impact. Moreover, the literature suggests a link between investment credit and public debt, where high levels of public debt can diminish the effectiveness of investment credit in stimulating the economy (Ncanywa & Masoga, 2018; Turan & Iyidogan, 2023). However, further research is required to conclusively determine these relationships.

Credit distribution, in general, stimulates factors of production, scales up operations, creates jobs, boosts consumer spending, and enhances aggregate supply and demand (Rofik & Golec, 2022; Zuhroh et al., 2022). This consensus is supported by empirical literature indicating that financial instruments such as bank credit are fundamental drivers of economic development (Bui, 2020; Ivanovic, 2016; Liang, 2016). Based on this literature we argue that the distribution of bank credit in Indonesia is

generally on a positive trajectory. Nonetheless, the observed minimal impact of investment credit on growth underscores the need for deeper investigations, including analysis over longer time spans and policy reviews to fully harness the potential of credit in maximizing Indonesia's economic development.

5. Socioeconomic, monetary variables and growth

The unemployment variable in the four constructed models exhibits a significant negative coefficient, indicating that unemployment tends to hinder growth. Similarly, inequality, as represented by the Gini Ratio, has a significant negative impact on Models 1 and 2, and a negative but insignificant effect on Models 3 and 4. The coefficients of these socioeconomic variables offer valuable insights into the significance of government intervention in alleviating unemployment and reducing inequality. Authorities can play a crucial role by employing fiscal policies such as incentives and subsidies to promote labor-intensive investment and foster development convergence.

The finding that interest rates have a positive and significant impact on growth underscores their crucial role in shaping economic dynamics in Indonesia. Although interest rates have historically been higher in emerging economies compared to more mature economies over the past two decades, all four models constructed for this study reveal that interest rates have a significant impact on Indonesia's economic growth. This suggests the central bank's policy on interest rates has been quite accommodative, effectively stimulating economic activity and investment (Srithilat et al., 2022; Twinoburyo & Odhiambo, 2018). Conversely, the inflation variable shows a contrasting effect on growth across all models, with a negative and significant coefficient. This suggests that inflationary pressures are constraining economic growth in Indonesia. High inflation rates can erode consumer purchasing power, increase uncertainty in financial markets, and disrupt business planning and investment decisions, all of which collectively hinder economic expansion (Ezako, 2023; Niken et al., 2023).

Overall, these findings highlight the dual role of monetary policy in managing interest rates to boost growth while closely monitoring inflation to maintain economic stability. This underscores the importance of prudent monetary policy decisions in fostering sustainable economic development in Indonesia.

6. Policy implications

Based on the results and associated discussions, monetary authorities could consider adjusting interest rates to maintain NPLs within manageable limits. Lowering interest rates could incentivize increased credit distribution alongside vigilant monitoring of NPLs to prevent them from surpassing critical thresholds. From a macroprudential standpoint, implementing stricter reserve requirements for credit allocation in medium and high-risk sectors could help mitigate financial fragility. Regulatory bodies must therefore enhance supervision of banks to ensure adherence to prudential lending principles, including rigorous monitoring of NPL ratios and the prompt implementation of corrective actions as NPLs approach higher risk thresholds.

It is also essential for both central banks and financial regulators to promote transparency and accuracy in reporting NPL ratios and bank asset quality to facilitate precise risk assessments. A cautious and calibrated policy approach will help ensure that increased credit does not pose systemic risks that could destabilize economic and financial stability. Applying prudential principles and effective risk management

practices is crucial for harnessing the potential for economic growth without compromising financial resilience.

CONCLUSION AND SUGGESTION

Our study supports Axiom 1 and Axiom 2 and confirms the existence of an inverted U-shaped curve in the relationship between non-performing loans (NPLs) and economic growth for both total credit and household credit. The identified NPL thresholds are 5.8% for total credit and 2.5% for household credit. Our models indicate that when total credit and household credit remain below these thresholds, NPLs do not hinder growth and may even stimulate it. Additionally, three out of four models, the exception being the model of investment credit, demonstrate that bank credit has a beneficial impact on growth. These findings suggest that coupled with effective NPL management, increasing credit distribution can bolster not only growth but also financial stability and the broader economy.

However, our study's determination of the NPLs threshold value relies heavily on the specific data sample used, making it sensitive to extreme data fluctuations. Therefore, future research should incorporate consideration of business cycle phases, including booms and recessions, to obtain more precise insights into how the dynamics around the NPL threshold influence the economy. Tracking these dynamics across different business cycle phases will deepen our understanding of the effect of NPLs on economic growth and facilitate the development of more targeted policies to uphold financial stability while fostering sustainable economic development.

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