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Balancing Financial Stability and Credit Access: The Role of Capital Buffers and Bail-In Instruments in Indonesian Banking

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Abstract

The 2008 financial crisis pushed policymakers around the world to rethink how banks could manage risk, leading to the implementation of stricter regulations, including capital buffers and bail-in mechanisms, aimed at making the financial system more resilient. This study examines how three key regulations under Basel III, namely, the Countercyclical Capital Buffer (CCyB), the Capital Conservation Buffer (CCB), and the Capital Surcharge (CS), shape lending patterns in Indonesian banks. The effectiveness of the bail-in policy in helping banks strengthen their capital base is also examined. This study uses difference-in-differences analysis on panel data from 97 banks between 2010 and 2024 to examine the impact of stricter capital regulations on banks' ability to channel credit to the public and business sectors. Basel III aims to strengthen the resilience of banks; however, this policy could impact credit access and banking stability in Indonesia. This study found a positive impact on LDR of large banks after the treatment, which indicates the banks' efforts to use the funds collected through credit distribution. This study empirically examines the impact of capital buffer regulation and the bail-in instrument in Indonesia as an emerging-market country with a segmented banking sector and banks' classification by ownership and core capital value.

Keywords: capital buffer; bail-in; Basel III; credit access; credit allocation; MSMEs; difference-in-differences

1. Introduction

Since the 2008 global financial crisis, strengthening the resilience of the banking sector has become a top priority for financial regulators worldwide. The crisis revealed significant gaps in the design of capital rules, which led to the Basel III reforms, such as the Capital Conservation Buffer (CCB), the Countercyclical Capital Buffer (CCyB), and the Capital Surcharge (CS), for banks identified as essential for the financial system. These measures are designed to help banks better handle losses, stabilize credit growth over time, and reduce the chance of major financial troubles during difficult economic periods.

Recent studies have found that capital buffers play a crucial role in promoting bank stability and ensuring a sustainable credit capital allocation function. Auer et al. (2022) and Behn et al. (2016) showed that the CCyB effectively controls aggressive loan growth in phases of economic expansion, helping to mitigate financial risks. Similarly, the role of the CCB in strengthening capital bases to support banks in maintaining stability through financial disruption is highlighted (Basten, 2019; Jiménez et al., 2017). The capital surcharge

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has been adopted globally to reduce the systemic impact of the potential failures of large banks (Behn & Schramm, 2021; Cappelletti et al., 2024).

Most empirical evidence still focuses on advanced economies, leaving a critical gap in understanding how these instruments operate in the context of emerging markets. The implementation of capital buffers is not free from criticism and challenges. Research in developing countries, such as India (Swamy, 2018) and Zimbabwe (Chinoda et al., 2015), revealed that capital regulations can affect bank liquidity and hinder the ability to channel credit needed to drive economic growth in countries with lower economic resilience. Based on banking characteristics and the economic conditions in developing countries, this study fills a gap in the literature on the concept of capital buffers and bail. This study provides comprehensive evidence on the differential impact of capital buffers across Indonesia's heterogeneous banking landscape, classified by size, capital, and ownership. As a developing country, Indonesia has higher economic fluctuations, a more fragmented market, and more limited access to capital, which may influence the implementation of capital regulation and bail-in. Indonesian banks are categorized based on ownership type and the Core Capital Based Bank Group (KBMI). A few large banks are in the Bank Group based on Core Capital in KBMI III and IV categories, while smaller banks face limited access to capital in KBMI I and II. The ownership-based classification comprises commercial banks, state-owned banks, and local development banks. This study conforms to the study of Polizzi et al. (2020), which suggests that the impact of capital policy varies depending on the characteristics of the legal and institutional environment in each country.

Capital regulation plays an important role in Indonesian banking to maintain bank sustainability, improve bank liquidity, and mitigate risks if a global financial crisis occurs. The bank regulator in Indonesia issued the policy to increase the additional capital for the banks of POJK No. 11 of 2016 concerning the obligation to form additional capital, applied gradually since 2016. As mentioned in Table 1, the average ratio of minimum capital adequacy fulfillment was 19.13% and the average ATMR core capital ratio was 17.24% in commercial banks before the capital regulation by the financial services authority (POJK No. 11 of 2016). The implementation of the new regulation (POJK No. 11 of 2016) improved the average minimum capital adequacy fulfillment ratio to 24.79% and the average ATMR core capital ratio to 23.16% in commercial banks. After the implementation of additional capital in 2016, this study also compared the differences before and after based on bank ownership. Banks are classified as commercial banks owned by the private sector, state-owned banks, and local development banks. The state-owned bank with the lowest capital adequacy also has the lowest ATMR core capital compared with other banks.

Table 1. Capital adequacy before and after the POJK No. 11 of 2016.

Information	Pre-POJK Policy No. 11 of 2016 (2012–2015 Period)	Post-POJK Policy No. 11 of 2016 (Period 2016–February 2024)
Commercial Banks (group banks 1, 2, 3 and 4)		
Average fulfillment of the minimum capital adequacy ratio (%)	19.13	24.79
Average core capital ratio ATMR (%)	17.24	23.16
State-owned Bank		
Average fulfillment of the minimum capital adequacy ratio (%)	17.12	21.33
Average core capital ratio ATMR (%)	15.43	19.99

Table 1. *Cont.*

Information	Pre-POJK Policy No. 11 of 2016 (2012–2015 Period)	Post-POJK Policy No. 11 of 2016 (Period 2016–February 2024)
Local Development Bank		
Average fulfillment of the minimum capital adequacy ratio (%)	18.50	23.00
Average core capital ratio ATMR (%)	17.02	21.33

This shows that the implementation of capital regulation pushes banks to increase capital adequacy in various types of banks in Indonesia, as reflected by the improvement in the ATMR fulfillment minimum capital adequacy and core capital ratio, strengthening the bank's capital base. This policy aims to increase the resilience of the banking sector in the face of risks, as well as to support national financial stability. This study also includes the stages of the additional capital phase in Indonesia, which were fully initiated and implemented in 2026, as shown in Figure 1.

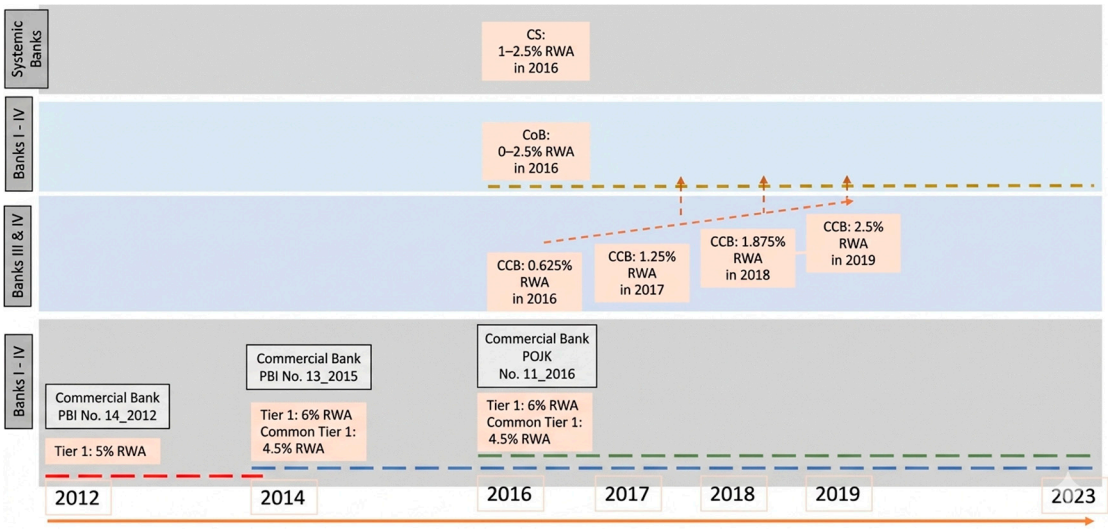


Figure 1. Stage flow of minimum capital requirements for banking in Indonesia.

The minimum capital requirement that must be met, starting 2 February 2016, for Tier 1 is 6% of ATMR, and for common Tier 1 is 4.5%. All Indonesian banks must add the required capital as a buffer. Capital Conservation Buffer (CCB) is additional working capital as a buffer against losses during the period of a mandatory crisis for KBMI 3 and 4. Second, a countercyclical buffer (CoB) is additional working capital that serves as a buffer for anticipated loss if credit growth is excessive, which could potentially affect the stability of the financial system for all banks. Third, CS for domestic systemically important banks (D-SIBs) is additional working capital to reduce the negative impact of bank failures that have a systemic impact by improving the bank's ability to absorb losses (Otoritas Jasa Keuangan, 2016). The following table shows the difference in banking performance in Indonesia before and after the implementation of capital regulation since 2016 (POJK No. 11 of 2016), which impacts bank performance and credit growth. Banks owned by the central government of Indonesia increased their loans by 1.73% after the 2016 regulation. The loans of banks owned by the local government of Indonesia decreased by 3.71% after the 2016 regulation.

Table 2 presents a comparison of key banking performance indicators before and after the implementation of POJK Policy No. 11 of 2016. The loan-to-deposit ratio (LDR)

shows a slight decrease in the ratio of credit distribution to third-party funds at commercial banks and local development banks, whereas the LDR experienced a slight improvement at state-owned banks. The decrease in LDR from 88.77% to 86.25% at commercial banks and from 88.21% to 84.50% at local development banks indicates a conservative strategy in credit distribution after the capital buffer regulation. This may be a response to capital requirements under the new additional capital policy, which encourages banks to maintain higher liquidity and minimize credit risk. However, the increase in LDR at state-owned banks from 84.71% to 86.44% may indicate that state-owned banks are more proactive in credit distribution to support the government's economic growth program for stability.

Table 2. Before and after the regulation's obligatory capital increase (POJK No. 11 of 2016).

Information	Pre-POJK Policy No. 11 of 2016 (2012–2015 Period)	Post-POJK Policy No. 11 of 2016 (Period 2016–February 2024)
Commercial Banks (Group Banks 1, 2, 3 and 4)		
Average NIM (%)	5.00	4.88
Average LDR (%)	88.77	86.25
State-owned Bank		
Average NIM (%)	5.69	5.22
Average LDR (%)	84.71	86.44
Local Development Bank		
Average NIM (%)	6.76	5.94
Average LDR (%)	88.21	84.50

Previous research has found that bank rescue instruments play a critical role in maintaining financial system stability in a global crisis through bailouts, where governments use public funds to rescue banks on the brink of bankruptcy. Acharya and Mora (2015) found that bailouts are often used as emergency fixes to prevent the entire system from collapsing. This policy has been criticized because it can encourage banks to take bigger risks, believing that the government will always step in to save them. Bail-ins have become a more market-friendly option for taxpayers because they require the bank's shareholders and creditors to take on the responsibility. In a bail-in, some of a bank's debts are converted into ownership to help its capital during tough times. According to Goodhart and Avgouleas (2015), bail-ins provide stronger incentives for creditors to exercise oversight and promote market discipline. Afonso et al. (2014) support the finding that the bail-in framework enables a fairer risk allocation and reduces the financial system's reliance on public funds.

This study is in line with A. Admati and Hellwig (2024) and A. R. Admati and Hellwig (2019a), who found that the bail-in process encourages the strengthening of autonomous capital structures, thus enhancing banks' resilience to external shocks, promoting improved risk governance, and incentivizing banks to maintain high-quality assets. Indonesian banks try to improve their asset quality by implementing capital buffer regulation. In Indonesia, bail-in regulation has been shown to improve core capital ratios and strengthen banks' asset structures. This is consistent with the findings of Aikman et al. (2018), who found that poorly executed bail-in mechanisms may trigger market panics but improve core capital ratios. The implementation of bail-in became effective in 2016, whereby shareholders, bondholders, and large depositors must hierarchically absorb banking losses to minimize the state's fiscal involvement in bank rescues (Fiordelisi et al., 2020). Fiordelisi and Scardozzi (2022) examined post-bail-in funding strategies and revealed that European banks

increasingly rely on lower-cost, more protected funding sources, such as deposits, while reducing their dependence on bonds, showing an adjustment in the financing composition shaped by the bail-in expectations of creditors. This study examines the effectiveness of capital regulation and bailouts in developing countries, such as Indonesia, which face heterogeneous banking structures and limited capital access among smaller-scale banks to support stability and credit access.

This study highlights how small banks face competitive challenges against large banks with access to capital, especially in a crisis economy. This study contributes to understanding the impact of capital buffer policy and bail in Indonesian banking as an emerging-market country with a segmented banking sector and banks' classification by ownership and core capital value. This study shows that the factors of size and ownership of banks have different behaviors in response to the new capital regulation. This study also contributes to the literature on how capital regulation and bail policies can be effectively implemented for bank stability and credit access in countries that have classified and segmented markets and maintain the power and competition between small and large banks in a competitive market.

2. Materials and Methods

Banks are categorized based on ownership type and the Core Capital Based Bank Group. Based on core capital, the bank regulator in Indonesia divides the banks according to their core capital. In Indonesia, this is called a bank group based on core capital (KBMI). The classification of banks using the KBMI framework in Indonesia divides banks into four groups: KBMI 1 (banks with core capital under Rp 6 trillion), KBMI 2 (banks with core capital between Rp 6 trillion and Rp 14 trillion), KBMI 3 (banks with core capital between Rp 14 trillion and Rp 70 trillion), and KBMI 4 (banks with core capital more than Rp 70 trillion). This study also defines the classification of banks based on ownership, which reflects each bank's systemic relevance and capital capacity, allowing for a more accurate assessment of the regulatory impact across various bank segments.

This study employs panel data analysis, which is designed to process data across time and entities. Panel data techniques and the DID approach are applied to enhance causal identification (Greene, 2018; Reichardt, 2019). This study divides two events: before the capital regulation (years 2010–2016) and after the capital regulation (years 2016–2024) since the banks in Indonesia must implement the regulation based on the 2016 regulation from the Financial Services Authority. This study examines how Indonesian banks can adapt more easily to changing economic conditions by requiring them to maintain additional capital requirements during growth periods. This study also measures financial stability using the Z-score, a widely adopted indicator, where lower values indicate a higher probability of financial distress.

2.1. Data

The source of data is the Financial Services Authority in Indonesia (OJK), covering 97 of 105 banks in Indonesia from Q1 2010 to Q1 2024. The bank sample includes conventional commercial banks, state-owned banks, and LD banks. Quarterly data on credit and capitalization are used to align with the research objectives to complete the data structure for each bank every quarter from 2010 to 2024. By applying the carry-forward method using the $t - 1$ value to address the issue of missing values, the data collection process ensures data structure consistency to avoid duplication, coding errors, or formatting inconsistencies. This step is often used for time series data because it considers continuity between periods (Little & Rubin, 2020). The next step is to handle outliers using winsorizing, which is applied by trimming extreme values at the 97.5th percentile for upper outliers and the

2.5th percentile for bottom outliers to obtain the data distribution (Maronna et al., 2019). To provide a clearer understanding of the bank grouping used in this study, Table 3 presents the classification of banks based on ownership structure, including state-owned banks, local development banks (BPD), and private commercial banks. Furthermore, Table 4 presents the classification of banks based on core capital categories (KBMI), which reflects differences in bank size, capitalization capacity, and operational scale.

Table 3. Bank classification based on ownership.

Bank Classification	Name of Banks
State-owned Bank	A bank whose majority shares (over 50%) are owned by the Indonesian government and plays a strategic role in supporting national economic programs. Bank Mandiri (Persero), Bank Negara Indonesia (Persero) (BNI), Bank Rakyat Indonesia (Persero) (BRI), Bank Tabungan Negara (Persero) (BTN)
BPD (local development bank)	A local government-owned bank with a focus on supporting the local economy. BPD Bali, BPD Bengkulu, BPD Special Region of Yogyakarta, BPD DKI, BPD Jambi, BPD West Java and Banten, BPD Central Java, BPD East Java, BPD West Kalimantan, BPD South Kalimantan, BPD Central Kalimantan, BPD East Kalimantan and North Kalimantan, BPD Lampung, BPD Maluku and North Maluku, BPD West Nusa Tenggara, BPD East Nusa Tenggara, BPD Papua, BPD Riau and Riau Islands, BPD South Sulawesi and West Sulawesi, BPD Central Sulawesi, BPD Southeast Sulawesi, BPD North Sulawesi Gorontalo, BPD South Sumatra and Bangka Belitung, BPD North Sumatra
Private sector banks or commercial banks	Banks whose majority shares are owned by individuals or institutions, both domestically and abroad. Allo Bank Indonesia, Bank Amar Indonesia Antardaerah, Bank Artha Graha Internasional, Bank Bisnis Internasional, Bank Bumi Arta, Bank Capital Indonesia, Bank Central Asia (BCA), Bank CIMB Niaga, Bank Danamon Indonesia, BCA Digital Bank, Bank Ganesha, Bank Jago, Bank Jasa Jakarta, Bank KB Bukopin, Bank Maspion Indonesia, Bank Mayapada International, Bank Mega, Bank OCBC NISP, Bank Permata, Bank Sinarmas, Bank Sahabat Sampoerna, Bank Sahabat Purba Danarta, Bank Victoria International, Bank Woori Saudara Indonesia 1906, Bank Panin Indonesia, Bank HSBC Indonesia, Bank IBK Indonesia, Bank ICBC Indonesia, Bank Mizuho Indonesia, Bank Sumitomo Indonesia, Bank Commonwealth, Bank DBS Indonesia, Bank Maybank Indonesia, Bank Resona Perdania, Bank Shinhan Indonesia, Bank SBI Indonesia, Bank UOB Indonesia, Bank BNP Paribas Indonesia

Table 4. Bank classification based on core capital.

Bank Classification	Name of Banks
KBMI I: Core capital < IDR 6 trillion	Allo Bank Indonesia, Bank Amar Indonesia, Bank Antardaerah, Bank Artha Graha Internasional, Bank Bisnis Internasional, Bank Bumi Arta, Bank Capital Indonesia, BCA Digital Bank, Bank Ganesha, Bank INA Perdana, Bank Index Selindo, Bank Interim Indonesia, Bank Jago, Bank Jasa Jakarta, Bank Maspion Indonesia, Bank Nationalnobu, Bank Neo Commerce, Bank Nusantara Parahyangan, Bank Sahabat Purba Danarta, Bank Sahabat Sampoerna, Bank Seabank Indonesia, Bank Shinhan Indonesia, Bank Victoria International, BPD Bengkulu, BPD Maluku and North Maluku, BPD Papua, BPD East Nusa Tenggara.

Table 4. *Cont.*

Bank Classification	Name of Banks
KBMI II: Core capital IDR 6 trillion–IDR 14 trillion	Bank BTPN, Bank Commonwealth, Bank CTBC Indonesia, Bank Ganesha, Bank ICBC Indonesia, Bank KEB Hana Indonesia, Bank Mega, Bank Resona Perdania, Bank Sinarmas, Bank Woori Indonesia, BPD West Kalimantan, BPD South Kalimantan, BPD Central Kalimantan, BPD East Kalimantan and North Kalimantan, BPD Lampung, BPD South Sulawesi and West Sulawesi, BPD Southeast Sulawesi, BPD North Sumatra.
KBMI III: Core capital IDR 14 trillion–IDR 70 trillion	Bank Danamon Indonesia, Bank Mayapada International, Bank Maybank Indonesia, Bank OCBC NISP, Bank Permata, Bank UOB Indonesia, BPD DKI, BPD Central Java, BPD East Java, BPD West Java and Banten, BPD South Sumatra and Bangka Belitung
KBMI IV: Core capital > IDR 70 trillion	Bank Central Asia (BCA), Bank Negara Indonesia (Persero) (BNI), Bank Rakyat Indonesia (Persero) (BRI), Bank Mandiri (Persero)

2.2. Model and Equation

This study applies the Difference-in-Differences (DID) method for assessing the cause-and-effect relationship of a policy. The DID approach was used to examine the impact of capital regulation on the treated group before the regulation (years 2010–2016) and after the regulation (years 2016–2024), since the regulation must be implemented by the banks in Indonesia based on the 2016 Financial Services Authority regulation. Applying the DID approach, this study can identify the causal impact of the implementation of the capital buffer regulation and credit access of Indonesian banks to ensure financial stability.

The application of the DID method relies on the key assumption of parallel trends, which posits that the treatment and control groups would have followed the same trajectory in the outcome variable over time in the absence of the intervention, based on previous research by Reichardt (2019). The control group was divided from the treatment group based on the bank classification that refers to the regulation. DID relies on the assumption of parallel trends. For capital buffer (CCyB), the control group (KBMI IV) and treatment groups (KBMI II, III, and IV) have the same trend before the intervention, making it possible to isolate the policy effect without requiring stricter assumptions about endogeneity (pre-regulation: 2010–2015 = 0; post-regulation: year 2016–2024 = 1).

The treated group for bail-in consists of banks in KBMI I with core capital under IDR3 trillion. The control group banks for bail-in are banks in KMBI IV, which have a core capital of more than Rp70 trillion. Large banks do not require additional capital for bail-in. Both the control and treated groups had the same trend before the intervention. The results of the DID analysis are expected to provide a clear causal picture of whether the increase in capital buffer affects credit access for small and large banks. This provides important insights for banks in balancing strategies to fulfill capital requirements and maintain growth in credit expansion. This study follows A. R. Admati and Hellwig (2019b) and Afonso et al. (2014). Bank size and loan-to-total asset ratio (the degree of lending activity) are the control variables.

The following hypotheses were examined:

H1. *Impact of the capital buffer role on banks' credit performance.*

H2. *Impact of capital buffer instruments on the effectiveness of the bail-in scheme on the treated group after 2016.*

H3. *Impact of capital regulation on banking stability (ROA, E + A, and Z-score) after 2016.*

The model equation using the DID method is as follows:

$$\begin{gathered} Y(LDR)_{i,t} = \beta_0 + \beta_1 \text{Post Reg}_t + \beta_2 \text{CCyB Treatment}_i, \text{CCB Treatment}_i + \\ \beta_3(\text{Post Reg}_t \text{x CCyB Treatment}_i, \text{CCB Treatment}_i) + \beta_4 \text{Bank Control}_{i,t-1} + \varepsilon_{i,t} \end{gathered} \quad (1)$$

$$\begin{gathered} Y(\text{Bail in})_{i,t} = \beta_0 + \beta_1 \text{Post Reg}_t + \beta_2 \text{non} - \text{KBMI IV}_i + \beta_3(\text{Post Reg}_t \text{x non} - \\ \text{KBMI IV}_i) + \beta_4 \text{Bank Control}_{i,t-1} + \varepsilon_{i,t} \end{gathered} \quad (2)$$

$$\begin{gathered} Y(\text{banking stability})_{i,t} \\ = \beta_0 + \beta_1 \text{Post Reg}_t + \beta_2 \text{CCB Treatment}_i, \text{CCYB Treatment}_i \\ + \beta_3(\text{Post Reg}_t \text{x CCB Treatment}_i) + \beta_4 \text{Bank Control}_{i,t-1} + \varepsilon_{i,t} \end{gathered} \quad (3)$$

Capital buffer is an independent variable. Credit performance variables are measured for bank i at time t. β_0 is the intercept, representing the initial value without the influence of credit performance variables. Post Reg_t is a dummy variable with a value of 1 after the capital regulation implementation in 2016 (POJK No. 11 of 2016) and 0 for previous years. CCyB treatment is a dummy variable indicating that bank i belongs to the CCyB category. CCB treatment_i is a dummy variable indicating that bank i belongs to the CCB category. Bail_in treatment is a dummy variable indicating that bank i belongs to the bail-in category (1 if CS, 0 otherwise). Bank stability variables are measured for bank i at time t. This study examines how capital regulation increases the loan-to-deposit ratio (LDR), indicating an increase in the bank's capacity to channel credit.

2.3. Variables

Table 5 presents the dependent and control variables used in this study, which is designed to evaluate capital adequacy, capital buffers, and the role of bail-in mechanisms within the Basel III framework. Capital adequacy is measured using the ratio of Tier 1 to RWA, Tier 2 to RWA, and the combined capital ratio (Tier 1 and Tier 2) to RWA. These indicators represent the ability of core and additional capital to cover operational, credit, and market risks (Acharya & Mora, 2015; Berger & Bouwman, 2013; Bitar et al., 2016). Table 6 presents the definitions of the dependent, treatment, post-regulation, and control variables used in the Difference-in-Differences (DID) approach to evaluate the impact of capital buffer regulation on bank credit performance.

The Capital Buffer was introduced by Indonesia's Financial Services Authority. The capital regulation (POJK No. 11/2016) is designed to help banks prepare for economic ups and downs by assisting them in building up surplus capital in times of growth. The DID method is used to evaluate the policy's influence on credit trends. Bank-level control variables, such as bank size log and loan-to-total asset ratio, provide insights into a bank's size and lending activity level (A. R. Admati & Hellwig, 2019b; Afonso et al., 2014). The capital buffer supports banks' ability to mitigate economic fluctuations and ensure a stable level of capital (Bahaj & Malherbe, 2020). Following Acharya and Mora (2015), a structured model for investigating the stability and operational capability of the banking sector is highlighted. The CAR is a primary indicator for evaluating a bank's financial health in the context of potential bail-in scenarios. Before conducting the empirical estimation, the study defines the variables used to represent the bail-in mechanism and other related indicators in the analysis. The detailed description and measurement of these variables are presented in Table 7, which serves as the basis for constructing the empirical model used in this research. To measure the condition of banking stability in this study, several indicators and proxy variables are employed based on previous empirical literature. The definitions and measurements of these variables are presented in Table 8, which provide the foundation for evaluating the stability performance of banks in the empirical analysis.

Table 5. Variables for measuring credit performance.

Variable	Indicator	Definition and Calculation	Reference
Credit performance	Total Credit/TA	Measures the total contribution of credit provided by the bank to total assets (TA). Total Credit/TA = (Total Credit/Total Assets) × 100%	Acharya and Mora (2015); A. R. Admati and Hellwig (2019a)
	Loan to Non UMKM/TA	Proportion of credit given to the non-MSME sector compared to total assets. Loan to Non-UMKM/TA = (Total Kredit Non UMKM/Total Aset) × 100%	A. R. Admati and Hellwig (2019b); Afonso et al. (2014); Bitar et al. (2016)
	Loan to UMKM/TA	The proportion of credit given to the MSME sector compared to total assets. Loan to UMKM/TA = (Total UMKM Credit/Total Assets) × 100%	Acharya and Mora (2015); Aikman et al. (2018)
	Growth TA	The total growth of bank assets from year to year, measuring the expansion or contraction of assets under management. Growth TA = ((Total Assets Year n − Total Assets Year (n − 1))/Total Assets Year (n − 1)) × 100%	Bahaj and Malherbe (2020); A. R. Admati and Hellwig (2019a); Berger and Bouwman (2013)
	Growth Debt	Total bank debt growth from year to year, measuring the expansion of bank liabilities. Growth Debt = ((Total Debt Year n − Total Debt Year (n − 1))/Total Debt Year (n − 1)) × 100%	Agarwal (2013); Auer et al. (2022)

Table 6. Definition of variable for the DID approach.

Y (credit performance) it	The dependent variables of bank risk include Total Credit/TA, Loan to MSME/TA, and Loan Non MSME/TA for bank i at time t.
β_0	Intercept, initial value without the influence of credit performance variables.
Post Reg_t	Dummy variable that has a value of 1 after the implementation of POJK No. 11 of 2016 and 0 for previous years. Pre-regulation: 2010–2015 = 0 Post-regulation: 2016–2024 = 1
CCyB $Treatment_i$	Dummy variable indicating bank i belongs to the CCyB category. Control CCyB: 0, Treated CCyB: >0
CCB $treatment_i$	Dummy variable indicating bank i belongs to the CCB category. Control CCB: KBMI = 0 Treated CCB: KBMI III & IV = 1
Bank $Control_{it-1}$	The independent variables of the control bank, and loan-to-total asset ratio for bank i at time t − 1.
$\varepsilon_{i,t}$	The error component that includes the variation not explained by the model.

Table 7. Variables for bail-in.

Variable	Indicator	Definition and Calculation	Reference
Bail in	CAR	Ratio of capital adequacy, reflecting the bank's ability to cover financial risks. CAR = $\frac{\text{Tier1+2}}{\text{Total ATMR}} \times 100\%$	Acharya and Mora (2015); Berger and Bouwman (2013)
	Loan to Total Asset	Ratio of total credit to total assets, measuring how much of the assets are used for lending. Loan to TA = $\frac{\text{Total credit}}{\text{Total asset}} \times 100\%$	Acharya and Mora (2015); A. R. Admati and Hellwig (2019b)
	Growth of Total Asset	Growth of total assets year-over-year, used to measure bank expansion. Growth TA = $\frac{\text{TAn}-\text{TA(n}-1)}{\text{TA(n}-1)} \times 100\%$	Bahaj and Malherbe (2020); Berger and Bouwman (2013)

Table 8. Variable for bank stability.

Variable	Indicator	Definition and Calculation	Reference
Bank Stability	Z-score (LENGTH)	Financial analysis used to measure the financial health of a bank. Z = (ROA + (E/A))/σROA	(Anginer et al., 2024; Behncke, 2023)

2.4. Parallel Trend

The lines are parallel, and the following assumption is met in this study, with the coefficient before the policy being insignificant and close to zero.

A. Pre-intervention period (before early 2016)

The treatment line (blue) is consistently well above the control line (red). The treatment group had a significantly higher capital ratio (Tier 1) than the control group. Trends (2010–2016) show relatively parallel movement for most of the study period.

B. Post-Intervention Period (After Early 2016)

There is clear divergence after the actual intervention (early 2016). A sharp and consistent divergence occurred in the treatment group (blue): The Tier 1 ratio increased substantially and continuously. The treatment experienced several spikes, reaching a high of ≈50 by the end of the study period. Control group (red): The Tier 1 ratio remained relatively stable at a low level (≈17–22), indicating only a minimal increase. To provide a clearer illustration of the empirical findings, this study presents graphical visualizations of the relationship between regulatory policies and banking performance indicators. Figure 2 illustrates the effect of capital buffer regulation on bank lending behavior, while Figure 3 presents the impact of the bail-in mechanism on the Tier 1 capital ratio across the observed banks.

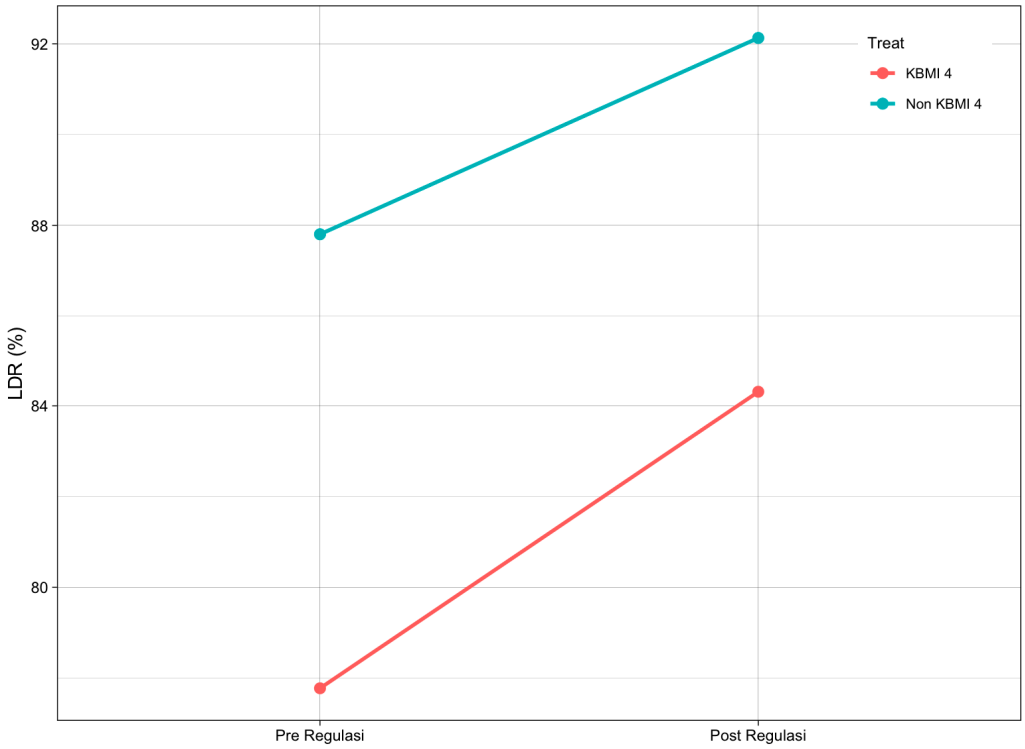


Figure 2. Visualization of the effect of capital buffer regulation on loans.

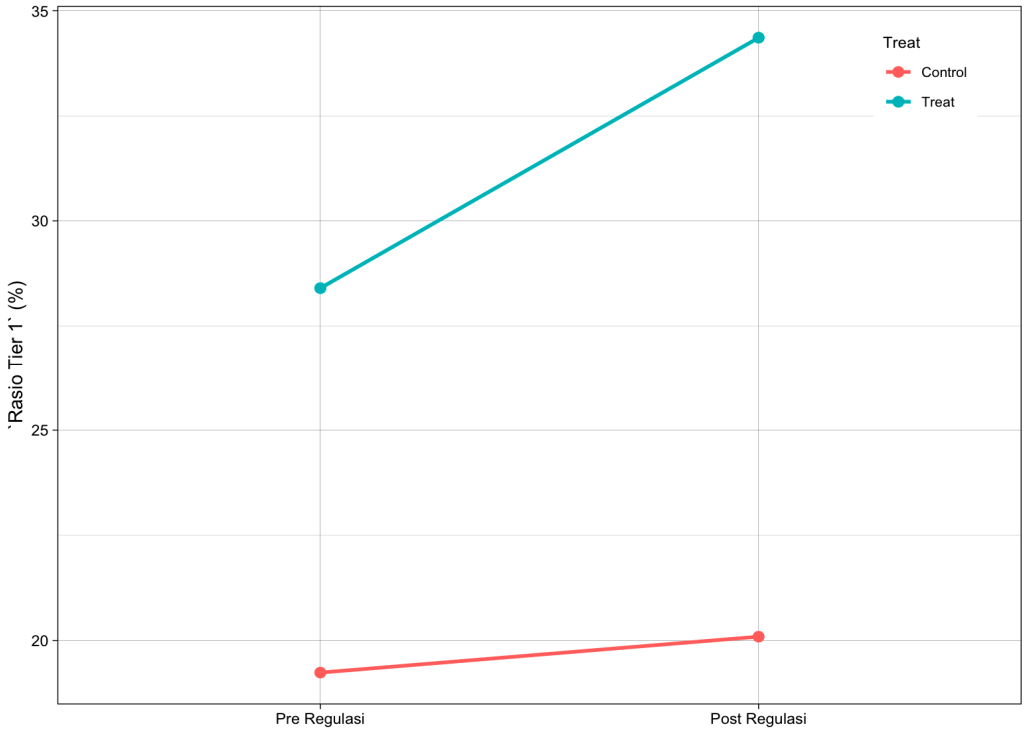


Figure 3. Visualization of the impact of bail-in to the tier 1 capital ratio.

3. Results and Discussion

3.1. Results in Credit Performance

This study applies the DID analysis to assess the impact of capital regulation implementation (POJK No. 11 of 2016) on credit in the Indonesian banking sector. This study finds that capital regulation has a significant impact on the loan-to-deposit ratio of Indonesia's banks, both large and small. The Countercyclical Capital Buffer was introduced

by Indonesia's Financial Services Authority. The capital regulation (POJK) No. 11/2016, designed to help banks prepare for economic ups and downs by assisting them in building up surplus capital in times of growth, was enacted in 2016.

Table 9 shows the results of the DID analysis of the implementation of POJK No. 11 of 2016, which aims to strengthen banks' capital. The results show a significant effect on the loan-to-deposit ratio (LDR) as a whole but do not produce a significantly different impact between the KBMI IV (control) and non-KBMI IV (treatment) groups. The PostReg variable shows that the regulation generally increases LDR by 6317 points ($p < 0.1$), indicating that banks tend to increase credit distribution of third-party funds collected after regulation. However, the PostReg × Treat interaction, with an insignificant coefficient of −0.277, indicates that the banks in the KBMI I, II, and III groups did not experience a substantially different change in LDR after regulation compared with the KBMI IV group. This finding indicates that regulation has a uniform impact on liquidity management in both banks. Variables such as the proportion of credit to total assets (Lag Loan to Total Asset) showed a significant positive relationship with an LDR of 0.449 ***. The implementation of the 2016 capital buffer regulation has a positive impact on LDR, reflecting the bank's efforts to utilize funds collected more productively through credit distribution.

Table 9. Difference-in-Differences output on the impact of capital strengthening on LDR.

Variables	LDR
(Intercept)	78.462 ***
PostReg	6.317 +
Treat	3.323
lag (Size)	−1.932 ***
lag (Loan to Total Asset)	0.449 ***
lag (Total Asset Growth)	−0.151
lag (Income Diversity)	25.037 ***
PostReg × Treat	−0.277
No. Obs.	5432
R^2	0.136
R^2 Adj.	0.135
AIC	51,315.9
BIC	51,375.3
Log.Lik.	−25,648.944
F	121.747
RMSE	27.19

Information: + shows $p < 0.1$ and *** indicates $p < 0.001$.

The analysis results also show that before the regulation, no significant difference in LDR was found between the control and treatment groups, with the treatment variable showing an insignificant coefficient of 3.323. This reflects the liquidity management patterns of both groups before the regulation. The analysis of the control variables revealed that bank size (Lag Size) had a significant negative effect on LDR (coefficient −1.932, $p < 0.001$), indicating that large banks tend to have lower LDRs, reflecting more conservative liquidity management. LDR had a significant positive relationship with income diversification (Lag Income Diversity) (coefficient 25.037, $p < 0.001$), indicating that banks with more diversified income sources had greater flexibility in distributing credit. Meanwhile, variables such as the proportion of credit to total assets (Lag Loan to Total Asset) showed a significant positive relationship with LDR, but total asset growth (Lag Growth Total Asset) did not have a significant effect on LDR.

This model has an R^2 of 0.136, indicating that the variables in the model can explain approximately 13.6% of the variation in LDR, while other factors, such as monetary policy,

macroeconomic conditions, or customer preferences, cannot. The implementation of the 2016 capital buffer regulation has a positive impact on LDR, reflecting the bank's efforts to use funds collected through credit distribution more productively.

3.2. Results of DID Capital on Banking Stability

Applying the DID approach, the results show that capital buffer regulation has a positive impact on the financial stability of banking in Indonesia, as measured by the Z-score. After the implementation of the capital buffer regulation, the Z-score increases by 0.053 points ($p < 0.001$), which reflects the strengthening of bank resilience to financial risks and potential bankruptcy. This impact indicates that the capital strengthening policy has succeeded in improving the banking sector's financial stability. To assess the impact of capital-related policies on banking stability, this study employs a DID approach to compare changes between the treatment and control groups over time. The estimation results are presented in Table 10, providing evidence on how capital adjustments influence the stability performance of banks during the observation period.

Table 10. Results of DID capital on banking stability.

Variables	Z Score
(Intercept)	0.824 ***
PostReg	0.053 ***
Treat	−0.069 ***
lag (Size)	−0.026 ***
lag (Loan to Total Asset)	−0.003 ***
lag (Total Asset Growth)	0.003 **
PostReg × Treat	−0.014
No. Obs.	5432
R^2	0.303
R^2 Adj.	0.302
AIC	−9817.5
BIC	−9758.1
Log.Lik.	4917.750
F	336.276
RMSE	0.10

Information: ** indicates $p < 0.01$ and *** indicates $p < 0.001$.

The ratio of credit to total assets (lag loan to total assets) shows a significant negative effect (−0.003, $p < 0.001$), indicating that increasing credit exposure can decrease a bank's financial stability. This also indicates that all banks face challenges in their credit allocation. The interaction between regulation and banks in the KBMI I, KBMI II, and KBMI III groups (PostReg × Treat) showed an insignificant coefficient of −0.014, which means that the impact of regulation on the stability of small and medium-sized banks was not substantially different from that of large banks in the KBMI IV group. Before the regulation, small and medium-sized banks had a lower Z-score level than large banks, as indicated by the Treat variable with a coefficient of −0.069 ($p < 0.001$). This indicates that small and medium-sized banks face greater challenges in maintaining financial stability. Bank size (lag size) has a significant negative effect on Z-score (−0.026, $p < 0.001$), indicating that large banks tend to have lower stability levels due to their exposure to systemic risk despite having larger capacity. Total asset growth (Lag growth total assets) has a significant positive effect (0.003, $p < 0.01$), indicating that asset expansion can support stability through portfolio diversification and increasing economies of scale. Larger banks in Indonesia tend to have broader access to wholesale markets and more diversified assets, making them more financially stable and reducing the relative cost of holding capital. Larger banks are

often perceived as less likely to fail due to implicit regulatory support, which can lower their funding cost compared to smaller peers.

3.3. Results of DID Capital Restructuring (Bail-In)

The bail-in policy aims to strengthen the banking system, requiring struggling banks' shareholders to help fix the bank's finances. The DID approach is used in this study to examine how this policy affects the growth of total assets and debt in two groups: smaller banks as the focus group and larger banks as the comparison group. The results show that the bail-in policy had a positive and meaningful effect on the growth of total assets for the smaller banks, as shown by the significant Bail-in treated group result (0.380, $p < 0.05$). This study also shows that the policy supports a stronger capital foundation for smaller banks, possibly by improving investor confidence and enabling better risk-weighted asset management. The observed growth in total assets reveals that small banks may have restructured their portfolios more efficiently in response to regulatory incentives, thereby enhancing their overall financial resilience.

To further analyze the effectiveness of the bail-in mechanism in encouraging changes in bank capital structure, this study applies a DiD estimation framework. The estimation results are summarized in Table 11, which illustrate the impact of the bail-in policy on banks' capital restructuring behavior between the treatment and control groups over the observation period. The interaction effect of the regulation and treatment is statistically insignificant, as reflected in the PostReg × Bail-In treated groups coefficient (−0.121). This result suggests that the marginal effect of the bail-in regulation on the asset growth of small banks is not sufficiently strong to generate a statistically discernible increase in their total assets. In contrast, the bail-in policy does not exert a significant influence on debt growth, either at the aggregate level or within the treatment group (KBMI I). The PostReg coefficient (−0.007) and the bail-in treat coefficient (0.000) imply no substantial shifts in debt-based financing patterns across small or large banks following the implementation of the bail-in regulation. Furthermore, the interaction term PostReg × BailInTreat (0.007) remains insignificant. These findings suggest that smaller banks may prioritize strengthening their asset structures over increasing their debt ratios, potentially as a more risk-averse response to regulatory pressure.

Table 11. Output of DID capital restructuring (bail-in).

	Growth Total Aset	Growth Debt
(Intercept)	−0.606 +	0.005
PostReg	−0.104	−0.007
BailInTreat	0.380 *	0.000
lag (Size)	0.067 ***	0.000
lag (Loan to Total Asset)	−0.852 ***	0.002
lag (Income Diversity)	−0.032	−0.001
PostReg × BailInTreat	−0.121	0.007
Num.Obs.	5432	5432
R^2	0.012	0.001
R^2 Adj.	0.011	0.000
AIC	19,184.2	−19,497.3
BIC	19,237.0	−19,444.5
Log.Lik.	−9584.098	9756.662
F	10.669	1.060
RMSE	1.41	0.04

Information: + shows $p < 0.1$, * indicates $p < 0.05$, and *** indicates $p < 0.001$.

The control variables offer further insight into the asset and debt growth determinants. Bank size (lag size) is positively and statistically significantly associated with asset growth (coefficient 0.067, $p < 0.001$), supporting the view that larger banks possess greater capacity and resources for asset expansion. The effect of bank size on debt growth is not significant, indicating that bank scale does not directly correlate with the propensity for debt financing. Conversely, the loan-to-total-assets ratio (lag loan to total assets) exerts a strong negative effect on asset growth (coefficient −0.852, $p < 0.001$), suggesting that banks with higher loan exposure may encounter capital constraints that hinder asset expansion. The DID analysis further confirms that the implementation of bail-in measures following the 2016 capital strengthening initiative had significant effects on Indonesian banks' capital structure, although the impact varied across the examined indicators.

The model statistically demonstrates strong explanatory power for credit loss provisions (Loan loss provision/reverse, $R^2 = 0.311$) and the Tier 1 capital ratio ($R^2 = 0.266$), indicating a solid model fit for these key regulatory metrics. However, it has a limited capacity to explain variations in total asset growth ($R^2 = 0.026$) and debt growth ($R^2 = 0.005$). The model's predictive accuracy is relatively high for Loan loss provision/reverse (RMSE = 1.44) and the Tier 1 ratio (RMSE = 14.03), reflecting a reliable estimation of changes in core capital indicators. In contrast, predictive performance for asset and debt growth remains limited, highlighting areas where further model refinement or inclusion of additional explanatory variables may enhance robustness.

To examine the causal effect of the bail-in policy on bank capital restructuring, this study employs a DiD approach by comparing the conditions before and after policy implementation between treatment and control groups. The estimation results are presented in Table 12, providing empirical evidence on how the bail-in mechanism influences banks' capital adjustment behavior. The bail-in policy has significantly increased the level of credit loss provisions (Loan loss provision/reverse) by 0.910 points ($p < 0.001$), indicating a strengthened credit risk management framework in response to the regulatory shift. This aligns with the policy's intended function to internalize risk among shareholders and creditors, thereby reducing systemic vulnerability. The interaction effect between the regulation and the group of banks under tighter regulatory supervision reveals a relatively lower increase in Loan loss provision/reverse compared to larger banks (interaction coefficient = −0.603, $p < 0.01$). This suggests that banks subject to closer regulatory oversight may already possess more robust credit risk management systems, enabling them to adjust with greater efficiency and less reliance on increased provisioning.

Table 12. Difference-in-Differences output: Impact of bail-in on capital restructuring.

Variable	Growth Total Asset	Growth Debt	Loan Loss Provision Reserve	Ratio Tier 1
(Intercept)	−6.614 ***	0.044	−2.245 *	143.719 ***
PostReg	−0.348	−0.006	0.910 ***	5.964 **
Bail-in treat	1.989 ***	−0.010	0.007	−21.122 ***
lag (Size)	0.359 ***	−0.002	0.186 ***	−5.493 ***
lag (loan to total asset)	−0.005	0.000	0.006 +	−0.182 ***
lag (income diversity)	−0.067	−0.008	2.104 ***	−9.253 ***
PostReg × Bail-in treat	−0.094	0.008	−0.603 **	4.610 *

Table 12. *Cont.*

Variable	Growth Total Asset	Growth Debt	Loan Loss Provision Reserve	Ratio Tier 1
Num.Obs.	1008	1008	1026	1026
R^2	0.026	0.005	0.311	0.266
R^2 Adj.	0.020	−0.001	0.307	0.262
AIC	4242.4	−2844.7	3679.0	8347.3
BIC	4281.8	−2805.4	3718.4	8386.8
Log.Lik.	−2113.213	1430.345	−1831.483	−4165.662
F	4.374	0.836	76.643	61.616
RMSE	1.97	0.06	1.44	14.03

Notes: + indicates $p < 0.1$, * indicates $p < 0.05$, ** indicates $p < 0.01$, and *** indicates $p < 0.001$.

4. Robustness Test

4.1. Robustness Test of the Effect of Capital on LDR

This study uses the fixed effects model for analyzing LDR variability because of its ability to capture cross-entity variation, provide accurate predictions, and produce economically and statistically significant results.

Based on the analysis using the fixed effects model, capital adequacy has a significant impact on LDR, which reflects banks' efficiency and capacity in channeling credit from third-party funds. Tier 1/RWA has a significant positive impact (0.492, $p < 0.001$), confirming that high-quality capital, such as Tier 1, which is adjusted for risk, supports an increase in LDR. This capital not only increases stability but also provides banks with greater flexibility in channeling credit. Meanwhile, Tier 2/RWA also provides a significant positive contribution (1.082, $p < 0.001$), but its impact is smaller than that of Tier 1, indicating that Tier 2 is more effective as supplementary capital than as the main source. Total capital/RWA provides a significant positive contribution (0.401, $p < 0.001$), confirming the importance of total capital in supporting credit activities, although its impact is still below Tier 1.

When capital adequacy is calculated against total assets (TA), the capital's contribution to LDR increases. Tier 1/TA has a significant positive impact (89.691, $p < 0.001$), indicating that the proportion of Tier 1 to total assets affects bank credit capacity. This confirms the importance of absolute capital in supporting credit activities. Tier 2/TA has a larger significant positive impact (103.394, $p < 0.01$) than Tier 1/TA; however, excessive dependence on Tier 2/TA can increase capital costs and operational risks. Total capital/TA also has a significant impact (95.666, $p < 0.001$), indicating that adequate and efficiently managed total capital plays an important role in supporting bank liquidity and credit activities.

The model's control variables provide additional relevant information. Bank size (Size) has a significant positive impact (5.845 to 6.667, $p < 0.001$), indicating that larger-scale banks have a greater capacity to channel credit, thereby increasing the LDR. Loan to Total Assets is the most determining variable with a significant positive impact (51.459 to 72.854, $p < 0.001$), reflecting that banks that focus more on channeling credit have higher liquidity efficiency. Conversely, total assets growth has a significant negative impact (−91.491 to −56.410, $p < 0.001$), indicating that asset growth that is not balanced with credit distribution can reduce the LDR. Income diversity has a small but significant positive impact on several models, indicating that income diversification can support LDR stability, although the impact is not always consistent. In general, Tier 1 is the most effective type of capital in supporting the increase in LDR, both in the context of RWA and TA, confirming its position as flexible and efficient, high-quality capital. Although Tier 2 makes a positive contribution, it is more suitable as a complement to Tier 1 due to its lower flexibility and higher costs. Total capital, both against RWA and TA, also plays an important role in supporting bank credit capacity. This finding suggests that banks must optimize their capital structure by

strengthening Tier 1 and ensuring a productive allocation of total capital while reducing dependence on Tier 2.

This follow-up study evaluates the interaction between capital variables in each KBMI 1 to 4, as shown in Table 13. The results show that the effect of capital adequacy on LDR varies among KBMI groups, reflecting different characteristics and capital management strategies. In KBMI 1, additional capital (Tier 2/RWA) significantly positively contributes to LDR (4.447, $p < 0.001$), confirming that additional capital is very effective in supporting the bank's ability to channel credit from funds collected. In addition, the ratio of total capital to RWA (Total Capital/RWA) also showed a significant positive effect (0.174, $p < 0.001$), indicating that overall total capital management drives an increase in LDR. However, the ratios of core capital to total assets (Tier 1/TA) and total capital to total assets (Total Capital/TA) are not significant, indicating that the role of capital to total assets in supporting LDR in KBMI 1 is still limited.

Table 13. Fixed effect on the LDR.

Variables	LDR	LDR	LDR	LDR	LDR	LDR
Size	5.857 ***	6.191 ***	5.845 ***	6.697 ***	6.117 ***	6.667 ***
Loan to Total Aset	60.329 ***	51.459 ***	69.306 ***	72.013 ***	52.021 ***	72.854 ***
Total Asset Growth	−91.491 ***	−95.771 ***	−90.562 ***	−60.267 ***	−95.135 ***	−56.410 ***
Income Diversity	3.377 **	2.964 *	3.166 **	0.827	3.006 *	0.807
Tier 1/RWA	0.492 ***					
Tier 2/RWA		1.082 ***				
Total capital/ATMR			0.401 ***			
Tier 1/TA				89.691 ***		
Tier 2/TA					103.394 **	
Total modal/TA						95.666 ***
No. Obs.	5432	5432	5432	5432	5432	5432
R2	0.197	0.138	0.215	0.259	0.137	0.273
R2 Adj.	0.181	0.122	0.200	0.245	0.121	0.260
AIC	46,051.2	46,442.5	45,925.7	45,681.7	46,438.2	45,506.1
BIC	46,090.8	46,472.5	45,965.3	45,651.7	46,477.8	45,545.7
RMSE	16.76	17.36	16.56	16.09	17.36	15.94

Information: * indicates $p < 0.05$, ** indicates $p < 0.01$, and *** indicates $p < 0.001$.

To further validate the robustness of the empirical results, an additional estimation was performed by incorporating the interaction between KBMI classification and capital adequacy on bank liquidity, as measured by the LDR. The detailed results of this robustness analysis are presented in Table 14, which provide further evidence regarding the relationship between bank capital structure and liquidity behavior across different bank categories. In KBMI 2, all capital components showed a negative contribution to LDR, as seen in Tier 1/RWA (−0.467, $p < 0.001$) and Tier 2/RWA (−3.679, $p < 0.001$). These results indicate that core and additional capital management in KBMI 2 do not support credit distribution, thereby reducing liquidity efficiency. Total Capital/RWA (−0.214, $p < 0.001$) also showed a significant negative effect, indicating the need to improve the overall CM strategy in KBMI 2. On the other hand, KBMI 3 showed different results, where core capital (Tier 1/RWA) and total capital to total assets (Total Capital/TA) positively contributed to LDR by 0.311 and 1.110 ($p < 0.001$). This confirms that core and total capital management in KBMI 3 support credit distribution efficiency. However, additional capital on ATMR (Tier 2/ATMR) and total assets (Tier 2/TA) showed a significant negative effect (−5.644 and −12.656, $p < 0.001$), indicating that additional capital is less effective in supporting the increase in LDR.

Table 14. Robustness test of KBMI interaction with capital on the LDR variable.

Variables	LDR		
	Coef	N	R^2 Adjust
Panel: KBMI 1			
Tier 1/RWA × KBMI1	0.409 ***	5432	0.221
Tier 2/RWA × KBMI1	4.447 ***	5432	0.142
Total Capital/ATMR × KBMI1	0.174 ***	5432	0.283
Tier 1/TA × KBMI1	−0.071	5432	0.317
Tier 2/TA × KBMI1	7.773 ***	5432	0.166
Total Capital/TA × KBMI1	−0.050	5432	0.340
Panel: KBMI2			
Tier 1/RWA × KBMI2	−0.467 ***	5432	0.222
Tier 2/RWA × KBMI2	−3.679 ***	5432	0.139
Total Capital/ATMR × KBMI2	−0.214 ***	5432	0.284
Tier 1/TA × KBMI2	−0.063	5432	0.315
Tier 2/TA × KBMI2	−4.247 ***	5432	0.154
Total Modal/ TA × KBMI2	−0.087	5432	0.339
Panel: KBMI3			
Tier 1/RWA × KBMI3	0.311	5432	0.219
Tier 2/RWA × KBMI3	−5.644 ***	5432	0.143
Total Capital/ATMR × KBMI3	0.487 *	5432	0.284
Tier 1/TA × KBMI3	1.009 ***	5432	0.317
Tier 2/TA × KBMI3	−12.656 ***	5432	0.168
Total Modal/TA × KBMI3	1.110 ***	5432	0.341
Panel: KBMI4			
Tier 1/RWA × KBMI4	−1.915 *	5432	0.220
Tier 2/RWA × KBMI4	−0.480	5432	0.136
Total Capital/ATMR × KBMI4	−0.554	5432	0.287
Tier 1/TA × KBMI4	−1154	5432	0.326
Tier 2/TA × KBMI4	−3726	5432	0.151
Total Modal/TA × KBMI4	−1069	5432	0.349

Information: * indicates $p < 0.05$ and *** indicates $p < 0.001$.

In KBMI 4, all capital components showed a negative effect on LDR, although only Tier 1/RWA (−1.915, $p < 0.05$) was significant. This result indicates that core and additional capital, both on RWA and total assets, do not support credit distribution efficiency in this KBMI. The negative coefficients on total capital/RWA and total capital/TA also indicate that total capital management in KBMI 4 requires further optimization to support LDR. Comparatively, KBMI 1 stands out in using additional capital to increase LDR, whereas KBMI 2 faces challenges in all capital components that show a negative effect. KBMI 3 shows the effectiveness of core and total capital in supporting LDR; however, additional capital needs to be better managed. KBMI 4 requires restructuring of capital management strategy to improve credit distribution efficiency.

Table 15 shows further analysis of the interaction between capital adequacy and bank ownership. The results found that the relationship between capital adequacy and bank ownership significantly affects banks' ability to manage liquidity. The impact on state-owned banks is that most capital adequacy indicators have a negative relationship with LDR. Tier 1/TA (−2.915 *) and Total Capital/TA (−3.089 ***) have a significant negative effect, indicating that increasing core capital or total asset-based capital tends to reduce LDR. This reflects the strategy of state-owned banks to maintain stable liquidity through conservative capital management. Similarly, Tier 2/TA (−8.756) * shows a significant negative impact, emphasizing that additional capital reduces liquidity pressures. However,

several indicators, such as Tier 1/RWA (−0.287), do not show a significant relationship, indicating that RBC is not the main determinant in LDR management at SOBs.

Table 15. Robustness test of bank ownership interaction with capital on the LDR variable.

Variables	LDR		
	Coef	N	R^2Adjust
Panel: Ownership of State-Owned Enterprises			
Tier 1/RWA × state-owned bank	−0.287	5432	0.216
Tier 2/RWA × state-owned bank	−0.004	5432	0.137
Total Capital/RWA state-owned bank	−0.777	5432	0.282
Tier 1/TA × SOE	−2.915 ***	5432	0.319
Tier 2/state-owned bank × state-owned bank	−8.756 *	5432	0.154
Total Capital/TA × SOE	−3.089 ***	5432	0.343
Panel: local government bank Ownership			
Tier 1/RWA × local government banks (BPD)	−0.629 ***	5208	0.245
Tier 2/RWA × local government banks (BPD)	−3.172 **	5208	0.171
Total Capital/ATMR × BPD	−0.388 **	5208	0.303
Tier 1/TA × BPD	−0.194	5208	0.330
Tier 2/TA × local government banks (BPD)	−6.426 ***	5208	0.181
Total Capital/TA × GDP	−0.238	5208	0.352
Panel: Private Ownership			
Tier 1/ATMR × Private	0.731 ***	5432	0.240
Tier 2/ATMR × Private	1.595	5432	0.164
Total Capital/ATMR × Private	0.445 ***	5432	0.298
Tier 1/TA × Private	0.542 *	5432	0.322
Tier 2/TA × Private	5.236 ***	5432	0.175
Total Capital/TA × Private	0.615 **	5432	0.344

Information: * indicates $p < 0.05$, ** indicates $p < 0.01$, and *** indicates $p < 0.001$.

The impact of capital adequacy on LDR on local government banks (BPD) is known to be more diverse but is still dominated by a significant negative relationship. Tier 1/RWA (−0.629 *) and Tier 2/RWA (−3.172) ** have a significant negative relationship with LDR, indicating that core and additional risk-based capital help BPD maintain healthy liquidity. Meanwhile, Total Capital/RWA (−0.388) ** and Tier 2/TA (−6.426 *) ** also show a significant negative effect, reflecting that local government banks utilize additional capital to reduce loan dependence. However, several indicators, such as Tier 1/TA (−0.194) and Total Capital/TA (−0.238), do not show a significant relationship, reflecting limitations in optimizing asset-based capital to consistently affect liquidity.

The impact on private banks reveals a significant positive relationship between capital adequacy and LDR. Tier 1/RWA (0.731 *) and Total Capital/RWA (0.445 ***) ** indicate that an increase in core capital and total risk-based capital increases LDR, reflecting the strategy of private banks in increasing credit expansion. In addition, Tier 1/TA (0.542) * and Total Capital/TA (0.615 **) ** have a significant positive impact on LDR, indicating that TABC encourages liquidity flexibility in private banks. Meanwhile, Tier 2/TA (5.236 *) ** shows a strong positive relationship, reflecting that additional capital plays a key role in enhancing private banks' ability to meet high credit demand.

A comparative analysis of bank ownership shows that state-owned banks tend to adopt a conservative approach to liquidity management by using capital to maintain low LDR. This strategy is in accordance with their role as a buffer for the national financial system's stability. Local government banks show a similar pattern to state-owned banks, but with a more significant impact on several capital indicators. This reflects the limitations in their funding diversification, which makes the BPD more sensitive to liquidity pressures.

Furthermore, private banks show the opposite behavior, with increased capital driving credit expansion, which is reflected in higher LDRs. This indicates their focus on growth and efficiency in funding.

4.2. Robustness Test of Financial Stability

The results of the analysis show that the impact of capital adequacy on stability differs significantly between types of bank ownership, reflecting each bank group's unique operational characteristics and risk management. In state-owned banks, core capital to RWA (Tier 1/RWA × state-owned bank) has a significant negative effect on the Z-score (coefficient −0.006 ***). Although core capital is important in supporting stability, state-owned banks face challenges in optimally utilizing this capital. Similarly, the ratio of core capital to total assets (Tier 1/TA × state-owned bank) and total capital to total assets (Total Capital/TA × state-owned bank) have a significant negative effect on stability. These results indicate that although state-owned banks play a strategic role in economic development, high-risk exposure and suboptimal operational efficiency can be obstacles in maintaining stability. To ensure the consistency and reliability of the main findings, a robustness test was conducted by examining the interaction between bank ownership and capital adequacy on bank stability. The results of this additional analysis are presented in Table 16.

Table 16. Robustness test of bank ownership interaction with capital on the Z-score variable.

Variables	Z-Score		
	Coef	N	R^2 Adjust
Panel: Ownership of State-Owned Bank			
Tier 1/RWA × state-owned bank (BUMN)	−0.006 ***	5432	0.594
Tier 2/RWA × state-owned bank (BUMN)	0.004	5432	0.278
Total Capital/RWA × state-owned bank (BUMN)	0.000	5432	0.993
Tier 1/TA × state-owned bank (BUMN)	−0.005 **	5432	0.767
Tier 2/SOB × state-owned bank (BUMN)	−0.014	5432	0.277
Total Capital/TA × state-owned bank (BUMN)	−0.004 **	5432	0.768
Panel: BPD Ownership			
Tier 1/RWA × local government bank (BPD)	−0.004 ***	5208	0.600
Tier 2/RWA × local government bank (BPD)	−0.002	5208	0.288
Total Capital/ATMR × local government bank (BPD)	0.000	5208	0.994
Tier 1/TA × local government bank (BPD)	0.001 *	5208	0.773
Tier 2/TA × local government bank (BPD)	−0.006	5208	0.287
Total Capital/TA × GDP	0.001 *	5208	0.777
Panel: Private Ownership			
Tier 1/ATMR × Private	0.005 ***	5432	0.600
Tier 2/ATMR × Private	−0.005	5432	0.277
Total Capital/ATMR × Private	0.000	5432	0.994
Tier 1/TA × Private	0.000	5432	0.773
Tier 2/TA × Private	−0.001	5432	0.274
Total Capital/TA × Private	0.000	5432	0.777

Information: * indicates $p < 0.05$, ** indicates $p < 0.01$, and *** indicates $p < 0.001$.

In contrast, the BPD banks show a more diverse pattern. Core capital to RWA (Tier 1/RWA × BPD) has a significant negative effect on the Z-score (coefficient −0.004 ***), reflecting the limitations of core capital in supporting BPD stability. However, the ratio of core capital to total assets (Tier 1/TA × BPD) and the ratio of total capital to total assets (Total Capital/TA × BPD) have significant positive effects on the Z-score. This finding indicates that asset-based capital is more relevant for BPDs in supporting stability, which may be influenced by the nature of their more concentrated and stable local markets.

In private banks, core capital to RWA (Tier 1/RWA × Private) has a significant positive effect on the Z-score (coefficient 0.005 ***), indicating that private banks can effectively utilize core capital to maintain their stability. This result reflects the flexibility and adaptability of private bank operations when compared with other bank groups. However, additional capital to RWA (Tier 2/RWA × Private) and other dimensions do not show a significant effect, indicating that private banks rely more on core capital than additional capital to support stability.

The following strategic implications can be taken: (i) State-owned banks must improve the efficiency of core capital and total capital management to support stability, especially in reducing high-risk exposure. A strategy to improve operational efficiency and more adaptive risk management can help overcome this challenge. The positive results of asset-based capital in BPD indicate the need to focus on strengthening core capital and total capital to total assets. This strategy is relevant to support stability in more concentrated local markets; (ii) private banks can continue to utilize core capital as the main support for stability by ensuring that additional capital is efficiently managed to face unexpected economic pressures; and (iii) regulators need to develop policies that are tailored to the characteristics of each bank's ownership. State-owned banks need support to improve operational efficiency, whereas BPD banks can be encouraged to strengthen core capital. Private banks, on the other hand, need supervision that encourages core capital optimization.

5. Conclusions

This study finds that the implementation of capital buffers among 97 Indonesian banks is characterized by selective and heterogeneous application across banking groups. The three analyzed capital buffer components, namely, CCyB and CCB, demonstrate that most institutions maintain buffer requirements relatively. This study highlights that the impact of capital adequacy on bank stability differs according to capital and bank ownership. Private banks have the advantage of using core capital against RWA to support stability, whereas local government banks rely more on asset-based capital. This study finds that asset-based capital is more relevant for BPDs in supporting stability, which may be influenced by the nature of their more concentrated and stable local markets.

The results of this study provide important implications for banking sector capital management strategies. KBMI 1 and KBMI 3 are advised to focus on effective core and total capital management while improving the efficiency of additional capital. To overcome the negative impact on LDR, KBMI 2 requires a thorough evaluation of capital management strategies, whereas KBMI 4 requires fundamental restructuring to maximize the contribution of core, additional, and total capital. The results of this study indicate that the bank's ownership structure influences the relationship between capital buffers. State-owned banks and local governments tend to use capital to maintain liquidity stability, whereas private banks are more proactive in using capital for credit expansion. This finding provides important implications for regulators to design policies that support liquidity management in accordance with the characteristics of each bank's ownership to maintain the financial system's stability.

The bail-in policy implementation yielded a significant positive effect, with an increase of 5.964 points ($p < 0.01$) following the regulatory intervention. Banks under enhanced supervision by the OJK exhibited a greater increase in Tier 1 capital than larger banks (interaction coefficient = 4.610, $p < 0.05$). This suggests that stringent regulatory oversight effectively incentivized more vulnerable banking institutions to strengthen their core capital, thereby supporting the broader objective of enhancing systemic resilience. The findings further indicate that the bail-in mechanism primarily improved capital adequacy, without

exerting a direct influence on banks' asset expansion strategies or short-term liability structures.

Furthermore, the findings highlight that the implementation of the bail-in policy in Indonesia has positively contributed to core capital stability and credit access, particularly among banks under the stringent supervision of the Financial Services Authority. Using a difference-in-differences (DID) approach, the study reveals a statistically significant improvement in Tier 1 capital ratios following the introduction of more rigorous capital requirements. This demonstrates a constructive response to regulatory mandates and underlines the role of bail-in mechanisms in enhancing the capital structure and financial resilience of Indonesian banks, particularly through an increase in provisions for expected credit losses (ECL). This study is in line with previous research by Fiordelisi and Scardozzi (2022), who examined post-bail-in funding strategies and revealed that European banks increasingly rely on lower-cost, more protected funding sources, such as deposits. This shows an adjustment in the financing composition shaped by the bail-in expectations of creditors.

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