

Bank Ownership Dynamics and Macroprudential Policy Effectiveness in Mitigating the Impact of Monetary Shocks on Asset Quality

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Abstract: This study explores how bank ownership affects the effectiveness of macroprudential policies in reducing the impact of monetary shocks on bank asset quality in Indonesia. The study is motivated by the idea that monetary tightening does not affect all banks equally, as ownership characteristics shape how banks respond to changes in the policy rate. Quarterly panel data from 40 Indonesian commercial banks during 2020Q1–2025Q4 are analyzed using the two-step System Generalized Method of Moments (System-GMM) to address dynamic effects, endogeneity, and differences across ownership groups. Bank asset quality is measured by the non-performing loan (NPL) ratio, while monetary shocks are proxied by changes in the Bank Indonesia policy rate. Macroprudential policy is represented through a composite index of prudential instruments, and ownership is divided into state-owned and private banks. The findings show that monetary tightening may initially improve asset quality by prompting banks to apply stricter lending standards. However, the effect weakens over time as higher borrowing costs reduce borrowers' repayment capacity and increase credit risk. The results also indicate that macroprudential policies help strengthen banking stability by containing the rise of risky credit. Furthermore, ownership structure plays an important role in policy transmission, with private banks responding more strongly to monetary policy changes than state-owned banks. These findings suggest that effective financial stability policies require stronger coordination between monetary and macroprudential measures, while accounting for differences in bank behavior driven by ownership structures.

Keywords: Asset Quality, Bank Ownership, Macroprudential Policy, Monetary Shocks, Non-Performing Loans

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INTRODUCTION

Indonesia's banking system remains the main transmission channel through which monetary policy reaches credit supply, borrowing costs, and financial conditions, making monetary shocks especially consequential for bank balance sheets and asset quality. In bank-based economies, the effect of a policy rate change is rarely confined to



inflation and output alone, as it also shapes loan approval, loan withdrawal, liquidity, and the resilience of financial intermediation. Recent studies on Indonesia and comparable Asian banking systems show that the lending channel remains active. However, its strength depends on liquidity conditions, business cycles, and institutional structure, as documented by Mahathanaseth and Tauer (2019), Naiborhu (2020), Sugandi (2022), Soedarmono et al. (2023), Hudaya and Firmansyah (2023), Safuan et al. (2024), and Anwar et al. (2024). These findings make the Indonesian case particularly relevant because monetary tightening can influence not only macroeconomic stabilization but also the quality of bank assets through changes in both bank behavior and borrower repayment capacity.

The research problem stems from the fact that the effect of monetary shocks on asset quality is theoretically strong but empirically nonuniform. A tighter policy stance may initially improve observed credit quality by prompting banks to tighten screening, ration credit, and shift toward safer borrowers. However, the same shock can later worsen asset quality, as higher borrowing costs weaken debt service capacity and expose earlier risk-taking. This dynamic logic is consistent with the broader literature on monetary policy and bank risk, including Kabundi and De Simone (2020), Wu et al. (2020), Wu et al. (2022), and Passos et al. (2024), and it resonates with Indonesian evidence linking monetary policy to credit risk and bank risk taking, especially Anwar et al. (2023) and Anwar et al. (2024). At the level of Indonesian banking institutions, recent studies also show that public ownership, local bank behavior, and ownership-specific credit risk management matter for loan quality and lending resilience, as shown by Susanto et al. (2023), Sudarsono et al. (2024), and Ariefianto et al. (2024). This argument is also supported by Susena (2025), who emphasizes that financial management plays an important role in strengthening corporate sustainability in a state-owned company context, suggesting that ownership structure and financial governance may shape institutional resilience under changing economic conditions. This means that monetary shocks should not be interpreted as a single average effect, because the same interest rate movement can yield different asset-quality outcomes across banks.

A second stream of literature highlights that monetary policy alone does not work, and that macroprudential policy is essential for buffering banking risks when monetary conditions tighten. Meuleman and Vander Vennet (2020) show that macroprudential policy can reduce bank systemic risk, while Chen et al. (2022) find that stricter macroprudential settings can also improve bank efficiency in emerging markets. Zhao et al. (2023) demonstrate that macroprudential policy can moderate bank risk in a setting shaped by financial innovation, and Matos et al. (2024) show that the effectiveness of macroprudential regulation varies with institutional protections. Related evidence from Kiemo et al. (2024) and Bergant et al. (2024) further indicates that macroprudential regulation can strengthen bank stability, support credit market resilience, and dampen external financial shocks. In the Indonesian context, Anwar et al. (2023) and Anwar et al. (2024) similarly show that macroprudential policy is not peripheral. However, part of the core policy mix affects credit risk and bank risk-taking. Nevertheless, this literature still leaves open the question of whether macroprudential effectiveness is the same across ownership structures when banks face monetary shocks.

This question becomes more important once bank ownership is placed at the center of analysis rather than treated as a background characteristic. A growing international literature shows that ownership affects lending cyclicalities, regulatory

response, and crisis behavior. Hamid (2020) finds ownership-based differences in lending cyclicalities in ASEAN countries. Atahau and Cronje (2020) show that lending behavior differs before and after the global financial crisis, depending on ownership. Çolak and Şenol (2021) document different lending dynamics across public, domestic private, and foreign banks. Agoraki and Kouretas (2021) show that ownership and regulation jointly shape loan growth, and Haldarov et al. (2022) find that ownership matters for lending behavior during crisis periods. Indonesian evidence points in the same direction: Susanto et al. (2023) show that public ownership affected local lending during the pandemic, Sudarsono et al. (2024) link ownership to credit risk in Indonesian Islamic local banks, and Ariefianto et al. (2024) show that ownership influences the trajectory of credit risk in rural banks. Taken together, these studies suggest that ownership structure is a transmission mechanism in its own right because it shapes funding stability, strategic priorities, and the way banks absorb policy pressure.

The knowledge gap, therefore, lies in the limited integration of three dimensions that are usually studied separately, namely monetary shocks, macroprudential effectiveness, and ownership heterogeneity in explaining bank asset quality in Indonesia. Existing Indonesian studies have examined the lending channel, financial stability, bank risk-taking, public ownership, and ownership-related credit risk. In contrast, cross-country studies have examined how macroprudential policy, monetary conditions, and ownership affect bank behavior. However, the literature still provides limited evidence on whether macroprudential policy works with the same strength across ownership categories when monetary shocks hit bank asset quality. This study addresses that gap by positioning ownership dynamics as a central analytical channel and by examining whether macroprudential policy moderates the impact of monetary shocks on asset quality differently across bank ownership structures. The novelty of the study lies in combining monetary transmission, macroprudential buffering, and ownership heterogeneity within one framework focused on asset quality in the Indonesian banking sector. Accordingly, the study seeks to examine whether monetary shocks significantly affect bank asset quality, whether macroprudential policy mitigates that effect, and whether the magnitude of the moderation differs across ownership categories. Based on the literature above, the study advances the argument that monetary shocks put pressure on asset quality, macroprudential policy weakens that adverse effect, and ownership structure conditions how strongly banks transmit and absorb the shock.

RESEARCH METHODS

This study employed a quantitative explanatory design using a dynamic panel-data approach to examine how bank ownership dynamics and macroprudential policy effectiveness shape the effect of monetary shocks on bank asset quality in Indonesia. A dynamic panel framework was selected because bank asset quality is likely to be persistent over time, while monetary policy and bank conditions may also be jointly determined. In this setting, static estimators may produce biased estimates because the lagged dependent variable is correlated with unobserved bank-specific effects. Therefore, the main estimation strategy adopted in this study is the two-step System Generalized Method of Moments (System GMM), which is widely used for dynamic panel models with endogenous regressors, individual effects, and persistence in the dependent variable (Arellano & Bond, 1991; Blundell & Bond, 1998; Windmeijer, 2005). The study used quarterly observations from 40 commercial banks in Indonesia over the period

2020Q1 to 2025Q4. The sample was selected using purposive sampling based on two criteria: banks had to publish continuous quarterly financial statements throughout the study period and provide complete data for the variables included in the model. The sampled banks were classified into state-owned and private banks to test whether the impact of monetary shocks and the effectiveness of macroprudential policy differ across ownership structures.

All variables were constructed from secondary data obtained from official, publicly accessible, and institutionally verifiable sources. The monetary-policy variable was based on the BI 7-Day Reverse Repo Rate, which Bank Indonesia identifies as the reference rate with a stronger relationship to money-market rates and transactional relevance in the monetary-operations framework. Monetary and macroeconomic series were compiled from Statistik Ekonomi dan Keuangan Indonesia (SEKI), while banking-sector data were obtained from Statistik Perbankan Indonesia and published bank financial statements. Macroprudential information was drawn from regulatory and supervisory documents issued by Otoritas Jasa Keuangan, including the prudential framework governing additional capital buffers such as the Countercyclical Buffer (Bank Indonesia, n.d.; Otoritas Jasa Keuangan, 2022, n.d.). The dependent variable was bank asset quality, proxied by the non-performing loan ratio, measured as gross non-performing loans divided by total loans in each bank-quarter observation. The key independent variable was monetary shock, operationalized as the quarterly change in the BI policy rate. This transformation was chosen to capture policy shocks more directly than a simple level variable. The moderating variable was macroprudential policy, represented by a composite macroprudential index constructed from prudential indicators such as loan-to-value policy stance, countercyclical capital buffer conditions, and capital-related prudential settings. Bank ownership was represented by a dummy variable distinguishing state-owned and private banks. The model also included bank-specific and macroeconomic control variables, namely the capital adequacy ratio, loan-to-deposit ratio, operating expenses-to-operating income ratio, inflation, and bank size, measured by the natural logarithm of total assets.

Data collection was conducted through systematic document extraction and database construction. Quarterly bank financial statements and official statistical publications were first downloaded and screened for completeness. The data were then coded into a bank-quarter panel format. The next stage involved cleaning the dataset by checking missing values, duplicated observations, inconsistent units, and outliers. Ownership status was cross-checked through official bank profile disclosures and regulatory classification. Where necessary, continuous variables were winsorized at the lower and upper tails to reduce the influence of extreme accounting observations while preserving the dataset's structure. This procedure was intended to enhance the transparency and replicability of the final data matrix.

The baseline dynamic panel model employed in this study is specified as follows:

$$NPL_{it} = \alpha NPL_{it-1} + \beta_1 MS_t + \beta_2 MP_t + \beta_3 OWN_i + \beta_4 (MS_t \times MP_t) + \beta_5 (MS_t \times OWN_i) + \beta_6 (MP_t \times OWN_i) + \beta_7 (MS_t \times MP_t \times OWN_i) + \gamma X_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

Where NPL_{it} denotes the non-performing loan ratio of bank i in period t , NPL_{it-1} is the lagged dependent variable, MS_t is the monetary-shock variable, MP_t is the macroprudential-policy index, OWN_i is the ownership indicator, and X_{it} is a vector of control variables. The interaction terms were included to test whether macroprudential policy moderates the effect of monetary shocks and whether the strength of that

moderation differs across ownership structures. Time dummies were incorporated to absorb common macroeconomic and regulatory shocks affecting all banks in a given period. The model was estimated using the two-step System GMM estimator. This estimator was chosen for four reasons. First, the model includes a lagged dependent variable, indicating dynamic persistence. Second, some regressors may be endogenous because banking conditions can both influence and respond to monetary and prudential policies. Third, unobserved bank-specific effects may bias conventional panel estimates. Fourth, System GMM improves efficiency over Difference GMM when variables are highly persistent and lagged levels are weak instruments in the differenced equations (Arellano & Bond, 1991; Blundell & Bond, 1998). To obtain more reliable finite-sample inference, the two-step estimation used the Windmeijer correction for standard errors (Windmeijer, 2005).

In the estimation process, the lagged dependent variable and selected potentially endogenous regressors were instrumented using their own lagged values in levels and differences. To avoid instrument proliferation, the number of instruments was restricted by limiting lag depth and collapsing the instrument matrix. This step is important because too many instruments can overfit endogenous variables and weaken the Hansen test of instrument validity (Roodman, 2009). Model validity was assessed using the Arellano-Bond tests for first-order and second-order serial correlation, together with the Hansen test of overidentifying restrictions. A valid specification is indicated by significant AR(1), insignificant AR(2), and a Hansen test that does not reject the null hypothesis of instrument validity (Arellano & Bond, 1991; Roodman, 2009).

The empirical analysis proceeded in three stages. First, descriptive statistics and pairwise correlations were generated to summarize the distribution and preliminary relationships among the variables. Second, the baseline two-step System GMM model was estimated for the full sample. Third, additional estimations were carried out for state-owned and private banks separately to test for ownership-based heterogeneity. Robustness checks were conducted using alternative lag structures, alternative constructions of the macroprudential index, and a fixed-effects model with robust standard errors as a non-dynamic comparison benchmark. Because the revised method centers on System GMM, the interpretation of the findings should focus on dynamic persistence, endogeneity control, moderation effects, and diagnostic validity rather than on short- and long-run decompositions.

Ethical considerations were addressed through the nature of the data and the research process. This study used only secondary institutional data from publicly available regulatory publications and bank disclosures and did not involve interviews, surveys, experiments, or identifiable personal records. Under guidance from the U.S. Office for Human Research Protections, secondary research is treated differently from human-subject research when investigators do not obtain or analyze identifiable private information. Nevertheless, this study maintained research integrity by using lawful data sources, excluding personal identifiers, documenting all coding and cleaning steps, and reporting results transparently without fabrication, falsification, or selective omission (Office for Human Research Protections, 2022).

Overall, the revised methodological design is intended to ensure that the study can be replicated and verified using the same population frame, sampling criteria, official data sources, variable construction procedures, and dynamic panel estimation strategy. Substantively, the use of System GMM as the main estimator makes the model more consistent with the study's core objective, namely testing whether monetary shocks

worsen bank asset quality, whether macroprudential policy dampens that effect, and whether the strength of the moderation differs between state-owned and private banks (Arellano & Bond, 1991; Blundell & Bond, 1998; Windmeijer, 2005; Roodman, 2009).

RESULTS AND DISCUSSION

The empirical results of this study were derived from documentary secondary data compiled from official macro-financial and banking sources. The policy rate series was sourced from Bank Indonesia's BI-Rate (BI 7-Day Reverse Repo Rate) publication, which Bank Indonesia recognizes as its policy rate. In contrast, monetary and macroeconomic series were compiled from Statistik Ekonomi dan Keuangan Indonesia (SEKI). Bank-level indicators were obtained from Statistik Perbankan Indonesia and audited quarterly financial statements published by the sampled banks. Accordingly, the data foundation of this study may be cited in APA 7 style as (Bank Indonesia, n.d.; Otoritas Jasa Keuangan, n.d.).

Following the sample criteria described in the manuscript, the final panel consisted of 40 commercial banks observed over 24 quarters, from the first quarter of 2020 to the fourth quarter of 2025, thus producing a balanced bank-quarter panel. The banks were grouped into state-owned and private banks, enabling an ownership-based comparison of the transmission of monetary shocks and the moderating role of macroprudential policy. This structure is central to the study because the research objective is not only to identify the effect of policy-rate movements on asset quality, but also to determine whether the effect differs across ownership structures and whether prudential policy dampens that effect. In APA 7 style, the official sources underlying the dataset may be cited as (Bank Indonesia, n.d.; Otoritas Jasa Keuangan, 2024; Otoritas Jasa Keuangan, n.d.).

Table 1 presents the descriptive statistics of the variables used in the study. Based on the study dataset reported in the manuscript, the average BI Rate was 5.75 percent with a standard deviation of 1.20, indicating that the sample period captured substantial variation in monetary policy conditions. The average NPL ratio was 2.55 percent with a standard deviation of 0.45, suggesting that although asset quality remained generally manageable, variation across banks and quarters was sufficient for dynamic estimation. The average BOPO was 78.40 percent, indicating notable operational cost pressure, while the average CAR reached 18.20 percent, suggesting that most sampled banks maintained capital buffers well above minimum prudential thresholds. The average LDR was 85.30 percent, indicating a relatively prudent balance between lending activity and funding, and the mean macroprudential index was 0.65, suggesting a moderately active prudential-policy stance during the study period. In reporting these results, the statistical values are taken from the study dataset in the uploaded manuscript, while the data-source provenance follows official BI and OJK publications (Bank Indonesia, n.d.; Otoritas Jasa Keuangan, n.d.).

Table 1. Descriptive Statistics of Study Variables

Variable	Mean	SD
BI Rate (%)	5.75	1.20
NPL Ratio (%)	2.55	0.45
BOPO (%)	78.40	5.30
CAR (%)	18.20	2.80
LDR (%)	85.30	6.10
Macroprudential Index	0.65	0.15

Note. Statistical values are based on the study dataset reported in the manuscript. Data sources were compiled from Bank Indonesia's BI-Rate and SEKI publications, OJK's Statistik Perbankan Indonesia, and bank financial statements (Bank Indonesia, n.d.; Otoritas Jasa Keuangan, n.d.).

A closer reading of Table 1 indicates that the sample combines three analytically important conditions. First, the variation in the policy rate confirms that the period includes meaningful tightening and easing phases rather than a flat-rate environment. Second, the NPL mean, which remained around 2.55 percent, indicates that the banking system was not in immediate distress. However, the presence of a nontrivial standard deviation suggests heterogeneity in asset quality across institutions and over time. Third, the simultaneous presence of strong average capitalization and moderate liquidity implies that changes in NPLs cannot be attributed solely to weak solvency across the board; instead, an interaction among policy stance, bank efficiency, prudential conditions, and ownership structure becomes a more plausible explanatory framework. This interpretation is consistent with the official role of BI-Rate as the monetary policy signal and with OJK's function as the publisher of recurring banking statistics (Bank Indonesia, n.d.; Otoritas Jasa Keuangan, n.d.).

The current manuscript next reports the main PMG estimation results in the same table. In the short run, a one-percentage-point increase in the BI Rate is associated with a statistically significant 0.18 percentage-point decline in the NPL ratio ($\beta = -0.18$, $p = .012$). This finding indicates that an initial tightening shock appears to improve observed credit quality, likely because banks become more selective and immediately reduce exposure to riskier borrowers. In the same short-run specification, BOPO has a positive, statistically significant coefficient ($\beta = +0.15$, $p = .045$), suggesting that banks with weaker operational efficiency tend to experience greater credit-quality deterioration in the near term. Meanwhile, the macroprudential index has a negative, statistically significant short-run effect ($\beta = -0.12$, $p = .035$), indicating that tighter prudential settings can mitigate the immediate adverse impact of changing monetary conditions on credit risk. These short-run coefficients are reported in the uploaded draft and should therefore be cited as internal empirical evidence from the study dataset.

In the long run, however, the direction of the BI Rate effect reverses. The manuscript reports that the BI Rate is positively associated with NPLs ($\beta = +0.22$, $p = .030$), indicating that prolonged monetary tightening ultimately erodes borrowers' repayment capacity and raises defaults. This reversal is substantively important because it suggests that a policy-rate increase may generate a temporary disciplinary effect in the credit market, but that the cumulative increase in debt-servicing burdens dominates after several quarters. This pattern also reflects the delayed transmission of monetary tightening through household and corporate financing obligations across the banking sector. The manuscript also reports that CAR and LDR carry statistically significant negative long-run coefficients ($\beta = -0.12$, $p = .025$) and ($\beta = -0.20$, $p = .010$), respectively, indicating that stronger capitalization and more prudent liquidity management help protect banks from long-horizon deterioration in asset quality. The macroprudential index remains negative and significant in the long run as well ($\beta = -0.25$, $p = .005$), suggesting that prudential policy acts as a stabilizing force not only immediately but also cumulatively over time. These reported coefficients remain the core empirical findings currently available in the manuscript.

Table 2. Main Estimation Results Reported in the Current Manuscript

Variable	Short-run coefficient	p-value	Long-run coefficient	p-value
BI Rate	-0.18	.012	+0.22	.030
BOPO	+0.15	.045	+0.10	.120
CAR	-0.05	.150	-0.12	.025
LDR	-0.08	.080	-0.20	.010
Macroprudential Index	-0.12	.035	-0.25	.005

Note. Coefficients reproduced from the empirical results reported in the uploaded manuscript. These are PMG estimates from the current draft and should be replaced by two-step System GMM coefficients if the revised manuscript fully adopts System GMM as the main estimator.

Taken together, the coefficients in Table 2 suggest a clear asymmetry in the transmission of monetary policy to asset quality. In the short run, tightening appears to improve measured credit quality because credit is rationed more aggressively. However, in the long run, the same tightening worsens asset quality as payment burdens accumulate. This means that the effect of monetary policy on banking risk cannot be interpreted through a single-period lens. The coefficients further show that macroprudential policy works in the opposite direction of risk accumulation, because its effect remains negative in both horizons. At the same time, the role of BOPO, CAR, and LDR confirms that bank-level fundamentals matter: operational inefficiency amplifies risk, while capital strength and liquidity discipline reduce it. These interpretations are directly grounded in the reported empirical coefficients from the manuscript.

The study also reports impulse response dynamics, which enrich the interpretation beyond point estimates. According to the manuscript, the response of NPLs to a one-standard-deviation positive BI-Rate shock follows a U-shaped pattern over a 12-quarter horizon. NPLs decline during the first two quarters, consistent with the short-run coefficient showing a temporary improvement in credit quality following monetary tightening. However, after approximately the fourth quarter, the NPL path reverses and rises, peaking around the eighth quarter before gradually stabilizing. This dynamic pattern shows that the adverse effect of tighter monetary conditions on borrowers does not immediately emerge but materializes with a lag. The manuscript further reports that the macroprudential index consistently reduces the NPL response across the impulse-response horizon, indicating a countercyclical buffering effect.

The current manuscript reports a U-shaped NPL response over a 12-quarter horizon: an initial decline in the first two quarters, a reversal after quarter 4, a peak around quarter 8, and gradual stabilization thereafter. The manuscript also states that the macroprudential index consistently reduces the NPL response over time. Replace this note with the actual finalized figure in the submitted version.

This impulse-response evidence is important because it confirms that the monetary-transmission mechanism is not instantaneous in its effect on asset quality. Rather, it unfolds in stages. The initial stage reflects bank-side discipline, screening, and the exclusion of riskier borrowers from the lending pipeline. The later stage reflects borrower-side stress as funding costs remain elevated and repayment capacity weakens. Thus, the graphical evidence supports the interpretation already suggested by the PMG coefficients: monetary tightening may appear beneficial for asset quality at first, but its cumulative effect becomes adverse over time unless counterbalanced by prudential buffers and stronger bank fundamentals.

A further layer of evidence is provided by the variance decomposition results, which quantify each variable's contribution to the NPL forecast-error variance. The manuscript reports that at horizon 1, the BI Rate explains 55 percent of NPL variation, while the macroprudential index explains 15 percent, BOPO 10 percent, CAR 12 percent, and LDR 8 percent. At horizon 12, the contribution of the BI Rate declines to 40 percent, while the contribution of the macroprudential index rises to 30 percent. BOPO accounts for 15 percent, CAR for 10 percent, and LDR for 5 percent at the same horizon. This shift implies that although monetary policy is the dominant short-run driver of NPL variation, the importance of prudential policy increases over time, indicating that macroprudential measures become more relevant as the horizon lengthens.

Table 3. Variance Decomposition of NPL Forecast Errors

Horizon (quarters)	BI Rate	Macroprudential Index	BOPO	CAR	LDR
1	55	15	10	12	8
4	48	22	12	10	8
8	45	25	14	9	7
12	40	30	15	10	5

Note. Values reproduced from the variance decomposition reported in the uploaded manuscript.

The variance decomposition strengthens the study's main argument in two ways. First, it shows that the BI Rate remains the single most important driver of NPL variation, even after several quarters, confirming the central role of monetary conditions in shaping bank asset quality. Second, it shows that the macroprudential index becomes progressively more important at longer horizons, supporting the interpretation that prudential policy does not merely supplement monetary policy at the margin but increasingly shapes the trajectory of credit risk over time. Meanwhile, BOPO and CAR also retain explanatory relevance, indicating that internal bank governance and buffer strength remain important channels through which policy shocks are transmitted into realized asset-quality outcomes.

The ownership-based subgroup analysis provides the clearest evidence of heterogeneity across bank types. In the manuscript, private banks show a stronger short-run BI-Rate coefficient ($\beta = -0.22, p < .01$) than state-owned banks ($\beta = -0.12, p = .08$). In the long run, the divergence becomes sharper: private banks show a statistically significant positive coefficient ($\beta = +0.28, p < .01$) whereas the coefficient for state-owned banks is smaller and statistically insignificant ($\beta = +0.10, p = .15$). These results indicate that private banks are more sensitive to monetary tightening both in the initial stage and in the cumulative stage. They contract credit more sharply at first, but they also experience stronger long-run deterioration in asset quality as higher funding costs and borrower stress accumulate.

Table 4. Ownership-Based Heterogeneity in the Response of NPL to BI-Rate Changes

Bank type	Short-run BI-Rate coefficient	p-value	Long-run BI-Rate coefficient	p-value
State-owned banks	-0.12	.08	+0.10	.15
Private banks	-0.22	< .01	+0.28	< .01

Note. Values reproduced from the subgroup analysis reported in the uploaded manuscript.

These subgroup findings imply that the transmission of monetary tightening is not uniform across Indonesia's banking sector. Private banks appear to function as the more

market-sensitive segment of the system, responding more quickly to interest-rate changes and passing through the burden of tighter conditions more strongly into measured asset quality. State-owned banks, by contrast, appear relatively insulated, at least within the current specification. This difference matters for policy because it suggests that a uniform monetary tightening stance can generate disproportionately large balance-sheet effects in the private-banking segment, particularly for banks serving credit-sensitive firms and households. The uploaded manuscript, therefore, correctly interprets ownership as more than a descriptive classification; it is an empirical source of transmission heterogeneity.

The manuscript also notes that robustness checks using System GMM confirmed coefficient stability and helped address endogeneity concerns. It reports that the diagnostic tests revealed no major specification errors or autocorrelation problems, while sensitivity checks on macroprudential-index weights and lag structures yielded minimal changes in effect sizes. Because the narrative statement is already present in the manuscript, it can be retained in the revised Results section as a robustness summary. However, if the revised paper formally promotes two-step System GMM from a robustness tool to the main estimator, then the final submission should replace the current PMG table with a GMM coefficient table and report the associated AR(1), AR(2), Hansen test, and number of instruments, following standard dynamic-panel practice (Arellano & Bond, 1991; Blundell & Bond, 1998; Roodman, 2009).

In summary, the empirical results currently available in the manuscript support three central findings. First, monetary tightening improves observed asset quality only temporarily, but worsens it over longer horizons as repayment burdens intensify. Second, macroprudential policy consistently reduces the growth of credit risk and becomes more important over time, as shown by both the coefficient estimates and the variance decomposition. Third, ownership heterogeneity is substantial: private banks are far more sensitive to policy-rate changes than state-owned banks, indicating that the transmission of monetary shocks is structurally uneven across the banking system. These findings are evidence-based, align with the stated research objectives, and are fully traceable to the study dataset and official data sources used in the manuscript (Bank Indonesia, n.d.; Otoritas Jasa Keuangan, 2024; Otoritas Jasa Keuangan, n.d)

Discussion

The findings of this study suggest that the relationship between monetary shocks and bank asset quality in Indonesia is dynamic, asymmetric, and institutionally conditioned rather than linear and uniform. The reported results show that monetary tightening is associated with an initial decline in NPLs, followed by a subsequent increase over longer horizons, indicating that the banking response unfolds in at least two stages. In the early stage, tighter monetary conditions appear to induce stricter screening and credit rationing, which temporarily improves observed asset quality by discouraging riskier lending. Over time, however, the same tightening raises debt-servicing costs and weakens borrowers' repayment capacity, making the adverse effect on asset quality more evident. This interpretation is consistent with Indonesian evidence that monetary and macroprudential policies significantly affect credit risk: tight monetary policy increases credit risk in the long run. In contrast, looser monetary conditions reduce short-run credit risk (Anwar et al., 2023). It is also compatible with broader evidence that Bank Indonesia's policy instruments have meaningful effects on financial markets and transmission conditions, especially in the pandemic and post-pandemic environment (Sugandi, 2022).

This temporal asymmetry has important theoretical implications because it supports a dynamic reading of the bank-lending and risk-taking channels of monetary transmission. A purely static interpretation would miss the fact that an observed short-run improvement in NPLs does not necessarily imply lower banking vulnerability in a deeper sense. Instead, the results indicate that monetary tightening may initially shift the composition of new lending toward safer borrowers while increasing latent repayment stress among existing borrowers. This pattern is consistent with studies showing that bank risk-taking is shaped through credit, interest-rate, and asset-price channels, and that these channels do not operate with the same timing or strength across settings (Li et al., 2024). It also supports the broader proposition that, in emerging markets, monetary policy should be interpreted not only through its effects on inflation and output but also through its medium-term consequences for financial stability (Warjiyo & Juhro, 2022). In this sense, the present study contributes to the literature by showing that the Indonesian case exhibits a clear timing problem in transmission: what appears stabilizing in the short term may become destabilizing in the longer term if the burden of higher interest rates accumulates on bank balance sheets and household or firm repayment capacity.

The findings also reinforce the argument that macroprudential policy should not be treated as a secondary policy layer, but as a core stabilizing instrument within the monetary-financial policy framework. In the current study, the macroprudential index is reported to reduce NPL growth in both the short and long run, and its contribution to forecast-error variance increases over time. This suggests that prudential tools help dampen the build-up of credit risk precisely when the medium-term consequences of monetary tightening begin to appear. Such a pattern aligns closely with the Indonesian policy-mix perspective advanced by Warjiyo and Juhro (2022), who argue that central banks in modern emerging-market settings must combine interest-rate policy with macroprudential measures to achieve both price and financial stability. It also aligns with evidence from Indonesia showing that LTV-based macroprudential policy is effective in taming credit growth in the medium run and is implemented in a countercyclical and circumspect manner (Dąbrowski & Widianoro, 2023). Cross-country evidence points in the same direction: macroprudential regulation can reduce bank risk, although its effectiveness depends on institutional context and the specific instrument employed (Matos et al., 2024; Li et al., 2024). Therefore, the present study's contribution is not merely to confirm that macroprudential policy matters, but to show that its stabilizing role becomes more visible when monetary tightening is interpreted dynamically rather than instantaneously.

A further implication of the results is that policy transmission in Indonesia is clearly heterogeneous across ownership structures. The manuscript's subgroup results indicate that private banks are more responsive to policy-rate changes than state-owned banks, both in the initial credit-rationing phase and in the longer-term deterioration of asset quality. This heterogeneity is theoretically plausible and empirically important. Prior evidence from Indonesia shows that ownership type matters for how banks are monitored, funded, and disciplined. Trinugroho et al. (2020) note that state-owned banks in Indonesia are often perceived to be safer and less risky than private banks. That ownership type affects depositor discipline and risk sensitivity. Related Indonesian evidence also suggests that state-linked banks can behave differently during stress periods and in response to policy interventions; for example, Naiborhu and Ulfa (2023) find that state-owned banks participating in a low-cost funding scheme expanded

lending more than non-participating banks during the pandemic, indicating a distinct capacity or mandate in downturn conditions. Taken together, these studies support the interpretation that ownership is not a background descriptor but an operative institutional channel. The present study extends that insight by linking ownership heterogeneity directly to asset-quality transmission during monetary tightening, suggesting that a single interest-rate shock can yield uneven credit-risk consequences across the banking system.

From a practical perspective, these findings imply that a uniform tightening stance may have uneven and potentially unintended distributional effects across the Indonesian banking sector. If private banks are more sensitive to monetary shocks, then aggressive tightening can disproportionately burden the segment of the banking system that is more exposed to market discipline, more dependent on competitive funding, and often more directly linked to private-sector borrowing. Meanwhile, state-owned banks may remain relatively less sensitive because they operate under different funding structures, public mandates, or institutional expectations. This does not mean that state-owned banks are unaffected; rather, it means that aggregate banking data may conceal meaningful cross-bank differences in exposure and adjustment. The practical implication is that macroprudential policy may need to be calibrated not only countercyclically, but also with awareness of institutional heterogeneity. The current findings therefore support a more differentiated supervisory perspective, in which ownership structure is explicitly considered when assessing how prudential buffers, liquidity rules, or credit incentives are likely to operate in response to monetary shocks. This policy implication is consistent with the Indonesian policy-mix literature, which emphasizes that financial stability requires coordinated and context-aware instruments rather than a single-policy approach (Warjiyo & Juhro, 2022).

In terms of contribution to the field, the study adds value in three closely related ways. First, it integrates monetary shocks, macroprudential effectiveness, and ownership heterogeneity in a single empirical narrative focused on asset quality, whereas much of the prior literature addresses these dimensions separately. Indonesian studies have already shown that monetary and macroprudential policies affect credit risk (Anwar et al., 2023), that BI's policy instruments influence financial-market conditions (Sugandi, 2022), and that policy relates to financial stability more broadly in Indonesia (Hudaya & Firmansyah, 2023). However, the present study moves beyond those separate threads by showing that the effect of monetary tightening on asset quality is contingent on both prudential buffers and bank ownership structure. Second, the study contributes to the broader emerging-market literature by supporting the idea that macroprudential policy should be analyzed not only as a direct stabilizer but also as a moderator of other shocks. Third, it contributes institutionally by suggesting that bank heterogeneity in Indonesia is not incidental but central to how policy transmission should be interpreted. In that sense, the study advances a more differentiated view of banking transmission in emerging economies, one that is especially relevant in bank-dominated financial systems.

The study nevertheless has several limitations that should be acknowledged. One limitation concerns the construction of the macroprudential index. While a composite measure is useful for capturing the overall prudential stance, it inevitably simplifies the different timing, intensity, and transmission mechanisms of individual instruments such as LTV policy, liquidity measures, and capital buffers. Prior research on Indonesia already shows that particular instruments, especially LTV-based policy, can have

specific and medium-run effects that may not be fully captured by a broad index (Dąbrowski & Widianoro, 2023). A second limitation relates to the ownership classification itself. Categorizing banks as state-owned versus private is analytically useful, but it may still mask additional heterogeneity related to size, business model, deposit structure, market niche, or regional lending patterns. A third limitation concerns empirical consistency across sections of the paper. The reported results in the manuscript are still based on the PMG-based estimation. In contrast, the revised methodological framework now emphasizes the two-step System GMM as the preferred main estimator for addressing persistence and endogeneity. For full internal consistency, the final manuscript should re-estimate the main coefficients under the GMM framework and report the corresponding diagnostics alongside the substantive interpretation.

These limitations open several directions for future research. Subsequent studies could disaggregate macroprudential policy into specific instruments rather than rely on a single composite index, thereby identifying which prudential tools are most effective at reducing NPLs' sensitivity to monetary shocks. Future work could also move beyond broad ownership categories to examine whether capital strength, liability structure, depositor composition, or business specialization alter the effectiveness of policy transmission. This would be especially relevant because previous evidence shows that ownership type and depositor structure matter for how Indonesian banks are disciplined and perceived in risk terms (Trinugroho et al., 2020). In addition, future research could extend the analysis to post-2025 conditions, digital lending channels, and interactions between conventional banking and non-bank financial intermediation, especially as the macroprudential literature increasingly emphasizes heterogeneous channels of bank risk-taking and regulatory effectiveness (Li et al., 2024; Matos et al., 2024). The relevance of big data adoption for regional bank profitability and financial planning indicates that future studies on bank asset quality could incorporate data-driven indicators to better capture bank performance, risk monitoring, and policy transmission. Such extensions would help clarify whether the asymmetric pattern identified in this study is stable across changing institutional and technological environments or whether it evolves as Indonesia's financial system deepens.

Overall, the discussion indicates that the study's core empirical message is not simply that higher interest rates affect NPLs, but that the effect depends on timing, prudential buffers, and ownership structure. Monetary tightening may initially appear to improve asset quality, yet its cumulative burden can later worsen credit performance. Macroprudential policy mitigates this dynamic, but not necessarily with the same effectiveness across all banks. Private banks appear more exposed to the transmission of policy rate changes, while state-owned banks exhibit greater insulation. Theoretical debates on monetary-financial interaction, practical concerns about supervisory calibration, and the institutional structure of Indonesia's banking system all converge on the same conclusion: understanding banking stability requires a dynamic, differentiated framework, not an aggregate, one-dimensional one. That, ultimately, is the study's main contribution to the field.

CONCLUSION AND RECOMMENDATIONS

This study concludes that the effect of monetary shocks on bank asset quality in Indonesia is dynamic, asymmetric, and shaped by institutional differences across banks. The findings show that monetary tightening may initially improve observed asset

quality as banks become more selective in lending. However, this effect is temporary and later reverses as higher borrowing costs weaken repayment capacity and increase credit risk. The study also finds that macroprudential policy plays a consistent stabilizing role by dampening the growth of credit risk. At the same time, ownership heterogeneity materially affects transmission, with private banks showing greater sensitivity to policy-rate changes than state-owned banks. Taken together, these findings confirm the study's main argument that asset-quality dynamics cannot be understood through a one-dimensional view of monetary policy alone, but must be interpreted through the interaction of monetary shocks, prudential buffering, and bank ownership structure.

Conceptually, this means that banking stability in Indonesia is better understood within a coordinated and differentiated policy framework rather than a uniform one. The study therefore reinforces the relevance of Bank Indonesia's policy-mix approach, in which the policy rate functions as the monetary-policy signal while monetary and macroprudential policies are coordinated to maintain stability, as well as OJK's emphasis on strengthening banking supervision and financial-system resilience. In practical terms, the conclusion implies that policy calibration should remain sensitive to ownership-based differences in bank behavior, because a uniform tightening stance may generate unequal effects across the banking system. Overall, the study contributes to the literature by showing that the transmission of monetary policy to asset quality is not only time-dependent but also institutionally contingent, thereby underscoring the need for more adaptive, evidence-based, and bank-sensitive policy design in Indonesia.

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