# “The bidirectional relationship between capital adequacy and net interest margin in Indonesian banks: The mediating roles of loan growth and market power”


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# THE BIDIRECTIONAL RELATIONSHIP BETWEEN CAPITAL ADEQUACY AND NET INTEREST MARGIN IN INDONESIAN BANKS: THE MEDIATING ROLES OF LOAN GROWTH AND MARKET POWER

## Abstract

This study examines the bidirectional association between the capital adequacy ratio (CAR) and net interest margin (NIM) in Indonesian listed commercial banks, with loan growth and market power as potential transmission channels. Using annual data from 2000 to 2024, the study estimates simultaneous-equation models by a three-stage least squares (3SLS). The common FE-3SLS sample contains 268 bank-year observations from 28 banks. Bank and year fixed effects are implemented through indicator variables, and first lags of the endogenous variables are used as internal instruments to mitigate simultaneity. Bank-cluster bootstrap inference and Monte Carlo simulation are used to evaluate the indirect effects.

The full-sample results do not show a significant relationship between CAR and loan growth, either linearly or through CAR squared. CAR is positively associated with the Lerner index but negatively associated with NIM. In the reverse direction, NIM is positively associated with the Lerner index but is not significantly associated with loan growth, while its direct association with CAR is negative. The loan-growth mediation channel is not supported by the bank-cluster bootstrap and appears only at the upper tail of CAR under Monte Carlo inference. By contrast, the Lerner-index channel is positive and supported in both directions under both inference methods. Subsample results indicate additional heterogeneity across high- and low-CAR banks. The evidence therefore points to market power as the more consistent channel linking capital adequacy and interest margins.

**Keywords** Indonesia, CAR, NIM, mediation, nonlinearity, Lerner index, competition

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## INTRODUCTION

Indonesia provides an unusual setting for studying the relationship between bank capitalization and interest margins. Listed Indonesian banks maintain capital adequacy ratios (CAR) that are generally well above regulatory minima, while their net interest margins (NIM) also remain high relative to many regional peers (Trinugroho et al., 2014). This coexistence is not straightforward. Higher capital can be associated with lower margins when banks hold safer assets or face a higher cost of equity (Allen et al., 2011). Yet Indonesian banks have sustained both high capitalization and relatively wide interest margins for long periods.

This setting is also shaped by the structure of Indonesia's financial system. Banking remains the dominant source of financial intermediation, while corporate bond markets, pension funds, mutual funds, and insurance are comparatively less developed (Adelegan & Radzewicz-



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Bak, 2009; Begum & Kamal, 2018; Eichengreen & Luengnaruemitchai, 2004; Kim et al., 2025). The resulting dependence on banks may strengthen pricing power in credit markets. Market structure can therefore affect how additional capital is reflected in lending behavior and interest margins.

The coexistence of high CAR and high NIM creates tension between two mechanisms. On one side, stronger capitalization can be associated with more conservative asset allocation, lower risk-weighted assets, and larger liquidity buffers, which may compress margins (Le et al., 2023; Shahhosseini, 2022). On the other hand, banks with stronger franchise value or pricing power may maintain wider spreads even when capital requirements are high (Demirgüç-Kunt & Huizinga, 1999; Trinugroho et al., 2014). The reverse direction is also plausible because higher margins can generate internal resources, while the resulting balance-sheet expansion and risk-weighted assets may prevent those earnings from translating one-for-one into a higher CAR.

Based on the background discussed above, the purpose of this study is to what extent do Capital Adequacy Ratio (CAR) and Net Interest Margin (NIM) exhibit a bidirectional relationship among Indonesian commercial banks, and how do loan growth and market power (Lerner index) mediate this reciprocal interaction.

## 1. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENTS

Bank capital and profitability are linked through competing mechanisms. A conventional intermediation view predicts that tighter capital requirements can raise funding and equity costs, reduce risk-weighted asset expansion, and increase liquidity buffers. These adjustments can place downward pressure on net interest margins (Akhtar et al., 2019; Le et al., 2023; Linggadjaya et al., 2025; Malovaná & Ehrenbergerová, 2022). This prediction, however, need not hold uniformly when banks differ in market power, capitalization, and portfolio structure.

Begum et al. (2024) distinguish between a capital-pressure mechanism and a risk-pricing mechanism. Stronger regulatory capital can compress margins, while the ability to transfer risk premia to lending rates can work in the opposite direction. Olszak and Kowalska (2023) show that market concentration can reduce the sensitivity of bank profitability to the business cycle. Schreiber (2024) further shows that capital regulation can affect interest-based and overall profitability differently, particularly when income diversification is limited. Mirza et al. (2023) likewise emphasize that margins can reflect strategic portfolio adjustment rather than simple inefficiency. These findings suggest that the CAR–NIM relation depends on both balance-sheet adjustment and pricing conditions.

This tension is especially relevant in Indonesia. High capital and wide margins can coexist when banks operate in a financial system with limited non-bank alternatives and persistent pricing frictions (Demirgüç-Kunt & Huizinga, 1999; Trinugroho et al., 2014). In such a setting, market power may allow banks to preserve margins even when capitalization is high. The relationship between capital and NIM may therefore reflect market structure as much as regulatory cost.

The lending channel may also be nonlinear. Higher capital can expand lending capacity when capital constraints bind, but additional capital need not produce the same lending response once banks already hold substantial buffers (Carlson et al., 2013; Malovaná & Ehrenbergerová, 2022). This possibility motivates a quadratic CAR term in the loan-growth equation rather than imposing a linear response. The reverse direction also deserves attention because high margins can generate earnings, while loan expansion and changes in risk-weighted assets may alter the extent to which those earnings are reflected in CAR.

The unresolved issue is therefore not simply whether CAR and NIM are positively or negatively related. The more relevant question is whether

their contemporaneous association is transmitted through lending activity, market power, or both, and whether these channels differ by capitalization level. Indonesia provides a useful setting, combining high capital buffers, high interest margins, and a bank-dominated financial structure.

Higher capital adequacy ratio (CAR) generally enhances a bank's loss-absorbing and risk buffering capacity, thereby expanding its credit supply (Akhtar et al., 2019; Le et al., 2023; Linggadjaya et al., 2025). However, if capital adequacy exceeds certain optimal level, banks tend to scale back risk-weighted assets such as reducing loans to high-risk corporates, SMEs, and long-term projects move capital to liquid assets and low-risk loans to reduce regulatory and capital-holding burdens (Mateev et al., 2022). Conceptually speaking, a nonlinear (inverted-U) impacts of capital adequacy to loan growth has been suggested if the CAR level is excessively high (Carlson et al., 2013). In other words, if capital adequacy becomes excessively high, banks may become more cautious in asset expansion and tend to reduce loans to reduce risk-weighted assets (RWA).

Typically, a rising CAR increases the cost of capital, leading downward pressure on margins (Allen et al., 2011). However, in markets with oligopolistic market environment and low financial inclusion, this theoretical framework does not work well. In environments with high market concentration and low interbank substitutability, such as Indonesia, banks retain the power to set lending rates and can transfer on the increased cost of capital to borrowers (Angori et al., 2019; Islam & Nishiyama, 2016; Nugroho et al., 2022; Trinugroho et al., 2014). Namely, even if a rising CAR increases banks' costs, banks can sustain or even enhance their NIM by strengthening pricing power (Paroush & Schreiber, 2019).

High NIM strengthens CAR through several structural mechanisms. Larger margins enhance earnings retention as well as loan-loss provisions, strengthening capital buffers (Begum et al., 2024; Le et al., 2023; Schreiber, 2024). In Indonesia, where deposit interest rates are rigid, margin expansion directly leads to higher net income, further accelerating capital formation (Angori et al., 2019; Trinugroho et al., 2014). Furthermore, high margins induce restructuring portfolios toward lower-risk borrowers, lowering risk-weighted assets, and mechanically enhancing CAR denominator ratio (Mateev et al., 2022; Shahhosseini, 2022). High profitability makes external capital raising easier and supports further capital accumulation (Le et al., 2023b).

While high capital adequacy tends to restrict banks' risky asset expansion and strengthens the market power of relatively dominant banks. It reduces loan supply by small and medium-sized banks, consequently enhancing market concentration (Allen et al., 2011; Mateev et al., 2022). Simultaneously, this restricts access to credit, ultimately resulting in lower financial inclusion (Le et al., 2023; Nugroho et al., 2022). These two structural effects, highly concentrated market structure and reduced financial inclusiveness, enhance pricing power and their ability to transfer risk premiums, creating a mediating effect. In other words, CAR indirectly raises NIM through concentrated market and limited inclusiveness.

This study aims to examine the bidirectional association between CAR and NIM in Indonesian commercial banks and to evaluate loan growth and the Lerner index as potential mediating channels.

Based on the synthesis of the scientific landscape, this study proposes the following hypotheses:

*H1: The CAR–NIM relationship includes a statistically non-zero indirect association through loan growth, with the CAR-to-loan-growth path potentially nonlinear.*

*$H_2$: Capital adequacy ratio is positively associated with net interest margin after accounting for the mediating channels.*

*$H_3$: Net interest margin is positively associated with capital adequacy ratio after accounting for the mediating channels.*

*$H_4$: The CAR–NIM relationship includes a statistically non-zero indirect association through market power, measured by the Lerner index, in both directions.*


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The conceptual model is estimated as a simultaneous 3SLS system. CAR and NIM are allowed to be related directly and through two intermediate variables. Loan growth captures a potential balance-sheet expansion channel, and the CAR-to-loan equation includes both CAR and CAR squared to allow for nonlinearity. The Lerner index captures the market-power channel. The same two mediators are examined in the reverse NIM-to-CAR direction.

## 2. DATA AND METHODOLOGY

The study uses annual financial data for commercial banks listed on the Indonesia Stock Exchange (IDX) over 2000–2024. Bank-level variables are obtained from the London Stock Exchange Group (LSEG) database. The raw sample covers 44 listed banks. The efficiency-adjusted Lerner index can be constructed for 453 bank-year observations because detailed cost components are not available for every bank-year. After requiring the contemporaneous variables, first-lag instruments, and bank-specific controls used in the simultaneous system, the common FE-3SLS estimation sample contains 268 bank-year observations from 28 banks. The models include bank and year fixed effects. Because year fixed effects absorb shocks common to all banks in a given year, annual macroeconomic variables are not entered separately in the FE-3SLS equations.

Following Dam and Koetter (2012), and Coccorese (2014), market power is measured using an efficiency-adjusted Lerner index. Output is measured by total assets, and total cost is the sum of interest expenses, personnel expenses, and other operating expenses. The translog cost frontier uses three input prices: personnel expenses relative to total assets, interest expenses relative to deposits, and other operating expenses relative to total assets. The output price is interest income divided by total assets. The translog specification includes the squared output term, pairwise interactions among input prices, and output–input-price interactions. The frontier is estimated using the Battese and Coelli (1995) panel specification with a truncated-normal inefficiency component. Bank-specific inefficiency is removed from observed cost to obtain efficiency-adjusted cost, and marginal cost is derived from the estimated output elasticity. The efficiency-adjusted marginal cost is then used to calculate the Lerner index.

To examine the CAR-to-NIM direction, we estimate four simultaneous equations by three-stage least squares (3SLS). The system includes a CAR equation used to organize the internal instrument structure, a nonlinear loan-growth equation containing CAR and CAR squared, a Lerner-index equation, and a NIM equation containing CAR and both mediators. All equations include the same bank-specific controls, bank fixed effects, and year fixed effects.

$$CAR_{it} = \mu_i^{(CAR)} + \mu_t^{(CAR)} + \tau_{11} IV_{it-1} + \tau' C_{it} + \varepsilon_{it}^{(CAR)}, \quad (1)$$

$$\Delta Loan_{it} = \mu_i^{(\Delta Loan)} + \mu_t^{(\Delta Loan)} + a_{11} CAR_{it} + a_{12} CAR\,Square_{it} + \alpha_{1c}^{'} C_{it} + \varepsilon_{it}^{(\Delta Loan)}, \quad (2)$$

$$Lerner_{it} = \mu_i^{(Lerner)} + \mu_t^{(Lerner)} + a_{21} CAR_{it} + \alpha_{2c}^{'} C_{it} + \varepsilon_{it}^{(Lerner)}, \quad (3)$$

$$NIM_{it} = \mu_i^{(NIM)} + \mu_t^{(NIM)} + \beta_{11} CAR_{it} + \beta_{12} \Delta Loan_{it} + \beta_{13} Lerner_{it} + \beta_{2c}^{'} C_{it} + \varepsilon_{it}^{(NIM)}. \quad (4)$$

Equation (1) specifies the internal instrument structure used in the CAR-to-NIM simultaneous-equation system. The first lags of CAR, NIM, loan growth, and the Lerner index enter Equation (1) and are excluded from the contemporaneous transmission equations. Lagged CAR squared is used as an additional excluded instrument for contemporaneous CAR squared. Bank-specific controls and the full sets of bank and year indicators enter each structural equation as included exogenous regressors. The exclusion pattern supplies more excluded lag instruments than contemporaneous endogenous regressors in each transmission equation and therefore satisfies the basic order condition by instrument count. Identification nevertheless also requires the rank and relevance conditions and the exclusion assumption that the lagged instruments are uncorrelated with the contemporaneous structural disturbances. Because formal weak-instrument, rank, and overidentifi-

cation diagnostics are not reported, the lag strategy is used to mitigate simultaneity rather than to establish strict causal identification.

To examine the reverse NIM-to-CAR direction, we estimate a second four-equation 3SLS system. The system contains an auxiliary NIM equation with first-lag internal instruments, a loan-growth equation, a Lerner-index equation, and a CAR equation containing NIM and both mediators. The reverse-direction specification is linear because no quadratic NIM term is imposed.

$$NIM_{it} = \mu_i^{(NIM)} + \mu_t^{(NIM)} + \gamma_1 IV_{it} + \gamma_c' C_{it} + \varepsilon_{it}^{(NIM)}, \quad (5)$$

$$\Delta Loan_{it} = \mu_i^{(\Delta Loan)} + \mu_t^{(\Delta Loan)} + \delta_{21} NIM_{it} + \delta_{2c}' C_{it} + \varepsilon_{it}^{(\Delta Loan)}, \quad (6)$$

$$Lerner_{it} = \mu_i^{(Lerner)} + \mu_t^{(Lerner)} + \delta_{31} NIM_{it} + \delta_{3c}' C_{it} + \varepsilon_{it}^{(Lerner)}, \quad (7)$$

$$CAR_{it} = \mu_i^{(CAR)} + \mu_t^{(CAR)} + \lambda_{11} NIM_{it} + \lambda_{12} Lerner_{it} + \lambda_{13} \Delta Growth_{it} + \lambda_c' C_{it} + \varepsilon_{it}^{(CAR)}. \quad (8)$$

Equation (5) specifies the internal instrument structure for the NIM-to-CAR system. The first lags of NIM, loan growth, the Lerner index, and CAR enter Equation (5) and are excluded from the contemporaneous transmission equations. Bank-specific controls and the full sets of bank and year indicators enter every equation as included exogenous regressors. The exclusion pattern satisfies the basic order condition by instrument count, but identification still depends on instrument relevance, the rank condition, and the assumption that the lagged instruments are uncorrelated with contemporaneous structural disturbances. As in the CAR-to-NIM system, formal weak-instrument, rank, and overidentification diagnostics are not reported; the estimates are therefore interpreted as conditional associations rather than strict causal effects.

The empirical procedure has four steps. First, the efficiency-adjusted Lerner index is estimated using stochastic frontier analysis (Coccorese, 2014). Second, we estimate the CAR-to-NIM and NIM-to-CAR systems using 3SLS with bank and year fixed effects implemented through indicator variables (LSDV). The first lags of the endogenous variables serve as internal excluded instruments for the contemporaneous transmission equations; lagged CAR squared is additionally used for contemporaneous CAR squared in the CAR-to-NIM system. The structural-equation tables report the conventional 3SLS covariance estimates; these standard errors are not bank-cluster robust. Third, indirect effects are evaluated primarily with a bank-cluster bootstrap, which resamples at the bank level to preserve within-bank dependence, and are complemented by Monte Carlo simulation based on 10,000 draws from the joint asymptotic distribution implied by the 3SLS estimates and their variance-covariance matrix. Fourth, the sample is divided into high- and low-CAR groups around the median to examine heterogeneity in the structural paths. These subgroup estimates are treated as robustness evidence rather than as formal coefficient-difference tests.

## 3. EMPIRICAL FINDINGS AND DISCUSSION

Table 1 reports descriptive statistics after winsorizing continuous variables at the 1st and 99th percentiles to limit the influence of extreme observations. The average NIM is approximately 3.3%, which is high relative to many advanced economies. Indonesian banks have also been documented to maintain structurally high margins relative to regional peers (Nugroho et al., 2022; Trinugroho et al., 2014). The persistence of positive average NIM over a sample that includes the COVID-19 period is consistent with the structural importance of interest-based intermediation in Indonesia.

Looking at the asset and funding structure, both loan- and deposit-based assets are high, demonstrating a dominant traditional commercial bank model. The average capital adequacy ratio (CAR) exceeds 25.9%, significantly exceeding regulatory standards. This reflects strengthened capital regulations and conservative capital management following the crisis, suggesting banks have signifi-


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**Table 1.** Descriptive statistics

| Variables | Obs | Mean | SD | Min | Max |
|---|---|---|---|---|---|
| NIM | 813 | .033 | .036 | –.151 | .239 |
| CAR | 740 | 25.905 | 18.727 | 9.01 | 126.31 |
| Lerner Index | 453 | .194 | .23 | –.5 | .735 |
| Δ Loan | 726 | .203 | .345 | –.34 | 2.188 |
| Ln (TA) | 830 | 30.766 | 1.954 | 23.85 | 35.426 |
| Loan/TA | 815 | .588 | .127 | .216 | .812 |
| Deposit/TA | 822 | .762 | .133 | .096 | .922 |
| NPL | 648 | .037 | .034 | 0 | .207 |
| LLP | 741 | .017 | .037 | –.029 | .263 |
| NII | 785 | .156 | .131 | –.066 | .739 |
| Inflation | 832 | .049 | .033 | .016 | .171 |
| GDPG | 832 | .049 | .018 | –.021 | .063 |
| ER | 832 | .033 | .081 | –.132 | .263 |

*Note:* TA: Total Assets, NII: Non-Interest Income, ER: Exchange Rate, GDPG: GDP Growth.

cant buffering capacity (Allen et al., 2011; Berger & Bouwman, 2013). The Lerner index is constructed as described in the Methodology section. To limit mechanically extreme negative values when output prices approach zero, a lower bound of –0.5 is imposed, affecting approximately 4% of the Lerner observations. The relatively high standard deviation of the Lerner index compared to the average reveals significant heterogeneity in market power among banks. For some banks, markets are almost competitive, and prices are lower than marginal costs. While some other banks have very high market power. This suggests that the Indonesian banking sector is structurally competitive. However, market power is distributed asymmetrically based on size and is consistent with the interpretation of existing studies suggesting that a competitive structure can coexist with high NIM (Chaffai & Coccorese, 2023; Claessens et al., 2001; Trinugroho et al., 2014).

**Table 2.** Associations of loan and Lerner index from CAR to NIM

| Variables | (1)[1] | (2) | (3) | (4) |
|---|---|---|---|---|
| | CAR | Δ Loan | Lerner | NIM |
| $CAR_t$ | | .0060 | .0113*** | –.0025*** |
| | | (.0097) | (.0020) | (.0003) |
| $CARt^2$ | | .0000 | | |
| | | (.0000) | | |
| $\Delta Loan_t$ | | | | .0715*** |
| | | | | (.0052) |
| $Lerner_t$ | | | | .2615*** |
| | | | | (.0132) |
| $CAR_{t-1}$ | .2715*** | | | |
| | (.0461) | | | |
| $\Delta Loan_{t-1}$ | 2.697* | | | |
| | (1.472) | | | |
| $Lerner_{t-1}$ | 13.54*** | | | |
| | (3.980) | | | |
| $NIM_{t-1}$ | 98.49*** | | | |
| | (35.43) | | | |
| Controls | YES | YES | YES | YES |
| Bank FE | YES | YES | YES | YES |
| Year FE | YES | YES | YES | YES |
| Obs | 268 | 268 | 268 | 268 |
| Chi2 (p-value) | 1675(.000) | 178.3(.000) | 966.3(.000) | 1297(.000) |
| $R^2$ | .8554 | .3897 | .7550 | .1011 |

*Notes:* Conventional 3SLS standard errors from the specification with bank and year fixed effects are reported in parentheses. The fixed effects are implemented through bank and year indicator variables (LSDV). These structural-equation standard errors are not bank-cluster robust. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Equation (2) in Table 2 provides no evidence of a systematic CAR–loan-growth relationship in the full sample. The linear CAR coefficient is positive but statistically insignificant, and the coefficient on CAR squared is also insignificant. The full-sample results therefore do not support an inverted-U or U-shaped lending response. This weakens the lending-channel interpretation at the structur-

1 Equation (1) specifies the internal-instrument structure for the CAR-to-NIM system. The first lags of CAR, NIM, loan growth, and the Lerner index enter Equation (1) and are excluded from the contemporaneous transmission equations. Lagged CAR squared is used as an additional excluded instrument for contemporaneous CAR squared. Bank-specific controls and bank and year fixed effects enter every equation as included exogenous regressors.

al-equation stage and makes the mediation tests in Table 3 essential for evaluating $H_1$.

Equation (1) is not interpreted as a substantive behavioral equation. Its role is to organize the lag-based internal instrument structure for the simultaneous system. The lag coefficients therefore support the estimation architecture but are not used to evaluate the mediation hypotheses.

Equation (3) shows that CAR is positively and statistically significantly associated with the Lerner index. Higher capitalization may coincide with stronger franchise value, more stable funding conditions, or greater capacity to sustain pricing power (Allen et al., 2011; Mateev et al., 2022). The result is also consistent with evidence that market structure and bank capitalization are jointly related to competitive behavior (Chaffai & Coccorese, 2023; Mateev et al., 2022).

The positive CAR–Lerner association is economically relevant because market power is also strongly related to NIM in Equation (4). Whether this constitutes a statistically supported mediation path is evaluated directly in Table 3.

Equation (4) in Table 2 shows a negative and statistically significant direct association between CAR and NIM. The coefficient therefore does not support $H_2$, which predicts a positive CAR–NIM association after accounting for the mediators. The sign is consistent with the view that stronger capitalization can be accompanied by safer asset allocation or higher capital costs that place downward pressure on interest margins (Allen et al., 2011).

Loan growth is positively and significantly associated with NIM in Equation (4). This indicates that banks with stronger lending expansion also tend to exhibit higher interest margins, conditional on the other variables in the system. The coefficient alone, however, does not establish mediation because the CAR-to-loan link is statistically weak. $H_1$ is therefore evaluated using the indirect-effect tests reported in Table 3.

The Lerner index is also positively and significantly associated with NIM. Stronger pricing power is therefore associated with wider interest margins, consistent with Angori et al. (2019), Chaffai and Coccorese (2023), Claessens et al. (2001), and Coccorese (2014). Combined with the positive CAR–Lerner coefficient, this pattern motivates the formal Lerner-index mediation tests in Table 3.

Table 3 reports the indirect effects from CAR to NIM. Panel A uses a bank-cluster bootstrap, which resamples at the bank level and therefore preserves within-bank dependence. Panel B reports Monte Carlo confidence intervals based on 10,000 draws from the joint asymptotic distribution of the relevant FE-3SLS coefficients. The bootstrap is the primary panel-robust mediation inference, while the Monte Carlo results provide a complementary sensitivity check under the conventional FE-3SLS variance-covariance structure.

Panel A shows no evidence of loan-growth mediation at any CAR percentile because every percentile-bootstrap confidence interval includes zero. The Lerner-index indirect effect is positive, and its percentile-bootstrap confidence interval excludes zero. Under the panel-robust bootstrap, the market-power channel is therefore supported, whereas the lending channel is not.

Panel B yields the same qualitative conclusion over most of the CAR distribution. The Monte Carlo confidence intervals for the loan-growth indirect effect include zero at the 5th, 25th, 50th, and 75th percentiles. The interval excludes zero only at the 95th percentile. This upper-tail result should be treated as sensitivity evidence rather than as robust support for a general loan-growth mediation mechanism because the bank-cluster bootstrap does not confirm it. The point indirect effect rises slightly with CAR rather than declining across the distribution.

The Lerner-index indirect effect is positive under both procedures, and both confidence intervals exclude zero. $H_4$ is therefore supported more consistently than $H_1$ in the CAR-to-NIM direction. The direct CAR–NIM association is negative, whereas the Lerner-mediated association is positive, indicating competing mediation. The loan-growth path is not robust enough to support the same conclusion across inference methods.


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**Table 3.** Direct and indirect associations of loan growth and Lerner index from CAR to NIM

| Panel A: Indirect Association through Loan Growth (CAR → Loan Growth→ NIM) Using Bootstrapping | | | | |
|---|---|---|---|---|
| **CAR %-tile** | **Direct Association** | **Indirect Association** | **95% Bootstrap CI (Indirect)** | **Mediation Significance** |
| 5% | –.00247*** | .00051 | [–.00093, .00336] | No mediation |
| 25% | –.00247*** | .00053 | [–.00080, .00319] | No mediation |
| 50% | –.00247*** | .00055 | [–.00068, .00304] | No mediation |
| 75% | –.00247*** | .00058 | [–.00054, .00278] | No mediation |
| 95% | –.00247*** | .00070 | [–.00042, .00247] | No Mediation |
| **Indirect Association through Lerner Index (CAR → Lerner → NIM)** | | | | |
| CAR | –.00247*** | .00296 | [.00026, .00601] | Mediation (positive) |
| **Panel B: Indirect Association through Loan Growth (CAR → Loan Growth→ NIM) Using MC Simulation** | | | | |
| **CAR Quantile** | **Direct Association** | **Indirect Association** | **95% MC CI (Indirect)** | **Mediation Significance** |
| 5% (13.360) | –.00247*** | .00051 | [–.00062, .00156] | No mediation |
| 25% (16.980) | –.00247*** | .00053 | [–0.0005, 0.0015] | No mediation |
| 50% (20.600) | –.00247*** | .00055 | [–0.0004, 0.0015] | No mediation |
| 75% (25.150) | –.00247*** | .00058 | [–0.0003, 0.0014] | No mediation |
| 95% (45.750) | –.00247*** | .00070 | [0.0001, 0.0013] | Mediation (positive) |
| **Indirect Association through Lerner Index (CAR → Lerner → NIM)** | | | | |
| CAR | –.00247*** | .00296 | [0.0019, 0.0040] | Mediation (positive) |

*Notes:* The direct association is the contemporaneous CAR coefficient from Table 2, and its significance symbols refer to the conventional 3SLS covariance estimate. Indirect associations in Panel A are evaluated with 95% percentile bank-cluster bootstrap confidence intervals and constitute the primary mediation inference. Panel B uses 95% Monte Carlo confidence intervals based on 10,000 draws from the joint asymptotic distribution implied by the conventional 3SLS variance-covariance matrix. Mediation is classified as present when the relevant confidence interval excludes zero. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively, for the direct 3SLS coefficient.

**Table 4.** Associations of loan and Lerner index from NIM to CAR

| **Variables** | **(1)**[2] | **(2)** | **(3)** | **(4)** |
|---|---|---|---|---|
| | **NIM** | **Δ Loan** | **Lerner** | **CAR** |
| $NIM_t$ | | 1.033 | 6.483*** | –1198*** |
| | | (1.5862) | (.5368) | (135.1) |
| $\Delta Loan_t$ | | | | 53.27*** |
| | | | | (4.535) |
| $Lerner_t$ | | | | 205.9*** |
| | | | | (16.25) |
| $NIM_{t-1}$ | .7195*** | | | |
| | (.0497) | | | |
| $\Delta Loan_{t-1}$ | .0087*** | | | |
| | (.0021) | | | |
| $Lerner_{t-1}$ | –.0127** | | | |
| | (.0055) | | | |
| $CAR_{t-1}$ | .0001** | | | |
| | (.00006) | | | |
| Controls | YES | YES | YES | YES |
| Bank FE | YES | YES | YES | YES |
| Year FE | YES | YES | YES | YES |
| Obs | 268 | 268 | 268 | 268 |
| Chi2 (p-value) | 3859 | 192.1 | 2693 | 744.0 |
| | (.0000) | (.0000) | (.0000) | (.0000) |
| $R^2$ | .9339 | .4141 | .9142 | –.0897 |

*Notes:* Conventional 3SLS standard errors from the specification with bank and year fixed effects are reported in parentheses. The fixed effects are implemented through bank and year indicator variables (LSDV). These structural-equation standard errors are not bank-cluster robust. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

2 Equation (5) specifies the internal-instrument structure for the NIM-to-CAR system. The first lags of NIM, loan growth, the Lerner index, and CAR enter Equation (5) and are excluded from the contemporaneous transmission equations. Bank-specific controls and bank and year fixed effects enter every equation as included exogenous regressors.

Equation (2) in Table 4 shows that NIM is not significantly associated with loan growth. The first leg of the NIM-loan-growth-CAR path is therefore weak. This result does not support a loan-growth mediation mechanism in the reverse direction.

Equation (3) shows a positive and statistically significant association between NIM and the Lerner index. Higher margins are therefore closely related to stronger pricing power (Chaffai & Coccorese, 2023; Trinugroho et al., 2014). This finding establishes the first leg of the market-power channel, while Table 5 evaluates whether the corresponding indirect effect is statistically different from zero.

Equation (4) shows that both loan growth and the Lerner index are positively and significantly associated with CAR. The positive loan-growth coefficient does not by itself establish loan mediation because NIM is not significantly related to loan growth in Equation (2). By contrast, the positive NIM–Lerner and Lerner–CAR coefficients form a coherent market-power pathway. The mediation inference for both paths is reported in Table 5.

The contemporaneous NIM coefficient in Equation (4) is negative and statistically significant. $H_3$, which predicts a positive direct NIM-CAR association after accounting for the mediators, is therefore not supported. This result mirrors the negative direct CAR–NIM coefficient in Table 2 and shows that the two direct conditional associations are negative within the simultaneous system.

The negative direct NIM–CAR association should not be interpreted as evidence that higher margins causally reduce capital adequacy. NIM can coincide with changes in risk-weighted assets, balance-sheet expansion, and capital policy that affect the CAR denominator and numerator differently (Nugroho et al., 2022; Paroush & Schreiber, 2019; Schreiber, 2024; Trinugroho et al., 2014). The contemporaneous 3SLS specification, even with lag-based internal instruments and fixed effects, does not trace the full multi-year process through which retained earnings are converted into regulatory capital.

Table 5 confirms that the loan-growth channel is not supported in the NIM-to-CAR direction. The indirect effect through loan growth is positive at the FE-3SLS point estimate, but both the bank-cluster bootstrap interval and the Monte Carlo interval include zero. The absence of mediation is therefore consistent across the two inference procedures.

The Lerner-index channel is different. The indirect effect is positive, and both the percentile-bootstrap and Monte Carlo confidence intervals exclude zero. $H_4$ is therefore supported in the NIM-

**Table 5.** Direct and indirect associations of loan growth and Lerner index from NIM to CAR

| Panel A: Indirect Association through Loan Growth (NIM → Loan Growth→ CAR) Using Bootstrapping | | | |
|---|---|---|---|
| **Direct Association** | **Indirect Association** | **95% Bootstrap CI (Indirect)** | **Mediation Significance** |
| –1198*** | 55.01 | [–374.53, 559.46] | No mediation |
| **Indirect Association through Lerner Index (NIM → Lerner → CAR)** | | | |
| –1198*** | 1335 | [359.93, 3103.70] | Mediation (positive) |
| **Panel B: Indirect Association through Loan Growth (NIM → Loan Growth→ CAR) Using Monte Carlo Simulation** | | | |
| **Direct Association** | **Indirect Association** | **95% MC CI (Indirect)** | **Mediation Significance** |
| –1198*** | 55.01 | [–110.66, 227.51] | No mediation |
| **Indirect Association through Lerner Index (NIM → Lerner → CAR)** | | | |
| –1198*** | 1335 | [1051, 1650] | Mediation (positive) |

*Notes:* The direct association is the contemporaneous NIM coefficient from Table 4, and its significance symbols refer to the conventional 3SLS covariance estimate. Indirect associations in Panel A are evaluated with 95% percentile bank-cluster bootstrap confidence intervals and constitute the primary mediation inference. Panel B uses 95% Monte Carlo confidence intervals based on 10,000 joint parameter draws from the conventional 3SLS variance-covariance matrix. Mediation is classified as present when the relevant confidence interval excludes zero. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively, for the direct 3SLS coefficient.


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to-CAR direction. Because the direct NIM–CAR association is negative while the Lerner-mediated association is positive, the results again indicate competing direct and indirect pathways. The market-power channel is the only mediation mechanism supported consistently in both directions.

The association between bank capital and operating behavior may differ with the size of existing capital buffers (Berger & Bouwman, 2013; Carlson et al., 2013; Malovaná & Ehrenbergerová, 2022; Mateev et al., 2022). To examine this heterogeneity, the sample is divided into high- and low-CAR groups around the median, and the same 3SLS specification with bank and year fixed effects is re-estimated within each subgroup. Because the subgroup models require complete first-lag instruments within the relevant subsample, their estimation samples are smaller than the full-sample 3SLS sample. These estimates are used as robustness evidence; without a formal cross-group coefficient test, differences in point estimates are not interpreted as statistically significant differences between groups.

Equation (2) of Table 6 reveals different lending patterns across capitalization groups. In the High-CAR subsample, the CAR coefficient is negative, and the squared term is positive, and both are statistically significant. Thus, CAR is negatively associated with loan growth over most of this subgroup and becomes positive only at very high CAR levels. In the Low-CAR subsample, neither CAR nor CAR squared is statistically significant. The nonlinear lending pattern is therefore concentrated in the High-CAR group rather than the Low-CAR group.

Equation (3) shows no significant CAR–Lerner association in the High-CAR group. In the Low-CAR group, the CAR coefficient is positive and marginally significant at the 10% level. The point estimates suggest that additional capitalization is more closely related to market power among relatively lower-capitalized banks, although a formal cross-group coefficient test is required before claiming a statistically significant difference.

Equation (4) shows that the direct CAR–NIM coefficient is negative and significant in the High-CAR group but negative and statistically insignificant in the Low-CAR group. Loan growth and the Lerner index are positively associated with NIM

**Table 6.** Associations of loan and Lerner index from CAR to NIM

| Panel A: High CAR | | | | |
|---|---|---|---|---|
| **Variables** | **(1)** | **(2)** | **(3)** | **(4)** |
| | **CAR** | **Δ Loan** | **Lerner** | **NIM** |
| $CAR_t$ | | –.0858** | .0016 | –.0005*** |
| | | (.0381) | (.0019) | (.0002) |
| $CARt^2$ | | .0007** | | |
| | | (.0003) | | |
| $\Delta Loan_t$ | | | | .0384*** |
| | | | | (.0081) |
| $Lerner_t$ | | | | .1243*** |
| | | | | (.0218) |
| $CAR_{t-1}$ | .4894*** | | | |
| | (.0660) | | | |
| $\Delta Loan_{t-1}$ | –.9931 | | | |
| | (3.503) | | | |
| $Lerner_{t-1}$ | 14.76** | | | |
| | (6.3996) | | | |
| $NIM_{t-1}$ | –287.5*** | | | |
| | (95.42) | | | |
| Controls | YES | YES | YES | YES |
| Bank FE | YES | YES | YES | YES |
| Year FE | YES | YES | YES | YES |
| Observations | 88 | 88 | 88 | 88 |
| Chi2 (p-value) | 1405(.000) | 148.3(.000) | 524.0(.000) | 968.2(.000) |
| R-sq | .9398 | .6680 | .8566 | .8535 |

**Table 6 (cont.).** Associations of loan and Lerner index from CAR to NIM

| Panel B: Low CAR | | | | |
|---|---|---|---|---|
| **Variables** | **(1)** | **(2)** | **(3)** | **(4)** |
| | **CAR** | **Δ Loan** | **Lerner** | **NIM** |
| $CAR_t$ | | .0623 | .0205* | –.0021 |
| | | (.0456) | (.0106) | (.0014) |
| $CARt^2$ | | –.0005 | | |
| | | (.0012) | | |
| $\Delta Loan_t$ | | | | .0455*** |
| | | | | (.0166) |
| $Lerner_t$ | | | | .0956*** |
| | | | | (.0210) |
| $CAR_{t-1}$ | .2772*** | | | |
| | (.0757) | | | |
| $\Delta Loan_{t-1}$ | .6704 | | | |
| | (1.021) | | | |
| $Lerner_{t-1}$ | –3.548 | | | |
| | (2.325) | | | |
| $NIM_{t-1}$ | 89.64*** | | | |
| | (30.36) | | | |
| Controls | YES | YES | YES | YES |
| Bank FE | YES | YES | YES | YES |
| Year FE | YES | YES | YES | YES |
| Observations | 122 | 122 | 122 | 122 |
| Chi2 (p-value) | 1296(.000) | 147.4(.000) | 1285(.000) | 2676(.000) |
| $R^2$ | .9117 | .4800 | .9130 | .8918 |

*Note:* Standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

**Table 7.** Associations of loan and Lerner index from NIM to CAR

| Panel A: High CAR | | | | |
|---|---|---|---|---|
| **Variables** | **(1)** | **(2)** | **(3)** | **(4)** |
| | **NIM** | **Δ Loan** | **Lerner** | **CAR** |
| $NIM_t$ | | 1.3516 | 7.215*** | –3772*** |
| | | (6.6844) | (2.001) | (670.1) |
| $\Delta Loan_t$ | | | | 125.7*** |
| | | | | (10.9207) |
| $Lerner_t$ | | | | 447.3*** |
| | | | | (40.92) |
| $CAR_{t-1}$ | .00021** | | | |
| | (.00008) | | | |
| $\Delta Loan_{t-1}$ | .0043 | | | |
| | (.0043) | | | |
| $Lerner_{t-1}$ | –.0301*** | | | |
| | (.0083) | | | |
| $NIM_{t-1}$ | .6997*** | | | |
| | (.1327) | | | |
| Controls | YES | YES | YES | YES |
| Bank FE | YES | YES | YES | YES |
| Year FE | YES | YES | YES | YES |
| Obs | 88 | 88 | 88 | 88 |
| Chi2 (p-value) | 1315(.000) | 191.0(.000) | 1058(.000) | 229.7(.000) |
| $R^2$ | .9316 | .6816 | .9282 | –2.0220 |


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**Table 7 (cont.).** Associations of loan and Lerner index from NIM to CAR

| Panel B: Low CAR | | | | |
|---|---|---|---|---|
| **Variables** | **(1)** | **(2)** | **(3)** | **(4)** |
| | **NIM** | **Δ Loan** | **Lerner** | **CAR** |
| $NIM_t$ | | –2.846 | 10.38*** | –122.4 |
| | | (3.422) | (1.562) | (102.8) |
| $\Delta Loan_t$ | | | | 22.37*** |
| | | | | (4.008) |
| $Lerner_t$ | | | | 28.47*** |
| | | | | (7.901) |
| $CAR_{t-1}$ | .0001 | | | |
| | (.0002) | | | |
| $\Delta Loan_{t-1}$ | .0047 | | | |
| | (.0032) | | | |
| $Lerner_{t-1}$ | .0042 | | | |
| | (.0072) | | | |
| $NIM_{t-1}$ | .4016*** | | | |
| | (.0950) | | | |
| Controls | YES | YES | YES | YES |
| Bank FE | YES | YES | YES | YES |
| Year FE | YES | YES | YES | YES |
| Obs | 122 | 122 | 122 | 122 |
| Chi2 (p-value) | 3866(.000) | 228.2(.000) | 3004(.000) | 796.6(.000) |
| $R^2$ | .9694 | .6526 | .9620 | .7064 |

*Note:* Standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

in both groups. These results suggest that capitalization mainly changes the way CAR is linked to the intermediate channels, while the positive associations of lending activity and market power with NIM are more stable across capitalization groups.

Table 7 reports the corresponding NIM-to-CAR structural paths by capitalization group. NIM is not significantly associated with loan growth in either subgroup: the coefficient is positive but insignificant for High-CAR banks and negative but insignificant for Low-CAR banks. By contrast, NIM is positively and significantly associated with the Lerner index in both groups. The market-power first stage is therefore much more stable across capitalization groups than the loan-growth first stage.

In the CAR equation, NIM has a large negative and statistically significant coefficient in the High-CAR group but a negative and insignificant coefficient in the Low-CAR group. Loan growth and the Lerner index are positively and significantly associated with CAR in both groups. The point estimates are larger in the High-CAR subsample, but these differences should not be described as statistically stronger without a formal cross-group test. Overall, the subgroup results reinforce the full-sample finding that the Lerner-index channel is more consistent than the loan-growth channel.

## CONCLUSIONS

This study examines the bidirectional association between bank capital adequacy and net interest margins in Indonesia using simultaneous FE-3SLS systems with bank and year fixed effects. The full-sample results do not support a significant CAR-loan-growth relation, either linearly or through CAR squared. CAR is positively associated with the Lerner index and negatively associated with NIM. In the reverse direction, NIM is positively associated with the Lerner index, is not

significantly associated with loan growth, and has a negative direct association with CAR. Thus, the direct CAR–NIM and NIM-CAR coefficients do not support the positive direct relationships proposed in $H_2$ and $H_3$.

The mediation evidence is more informative than the direct coefficients alone. The bank-cluster bootstrap provides no evidence that loan growth mediates the CAR-to-NIM association across the CAR distribution, although Monte Carlo inference identifies a positive indirect association at the 95th percentile. Loan-growth mediation is also unsupported in the NIM-to-CAR direction. By contrast, the Lerner-index indirect effect is positive, and its confidence interval excludes zero under both the bank-cluster bootstrap and Monte Carlo procedures in both directions. Market power is therefore the more consistent transmission channel. Because the direct associations are negative while the Lerner-mediated associations are positive, the results are best characterized as competing mediation rather than as a simple reinforcing cycle.

The subgroup analysis indicates that these structural paths vary with capitalization. High-CAR banks exhibit a U-shaped CAR-loan-growth association with a turning point near the upper tail of their CAR distribution, whereas no significant CAR–loan-growth relation is found in the Low-CAR group. The CAR-Lerner association is marginally positive only in the Low-CAR group, while the direct CAR-NIM and NIM-CAR coefficients are statistically significant only in the High-CAR group. These patterns should be interpreted cautiously because the subgroup samples are smaller and no formal cross-group coefficient test is reported. More generally, the lag-based internal instruments and fixed effects reduce simultaneity and time-invariant heterogeneity but do not by themselves establish causal identification. Formal weak-instrument, rank, and overidentification diagnostics are not reported, and the structural coefficient tables use conventional rather than bank-cluster-robust 3SLS standard errors. The bank-cluster bootstrap therefore provides the primary dependence-robust inference for the indirect effects. Future research could use stronger external instruments, system estimators with cluster-robust inference, or dynamic panel designs to trace longer-run adjustment. The treatment of extreme negative Lerner-index values also remains a measurement limitation.

## AUTHOR CONTRIBUTIONS

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