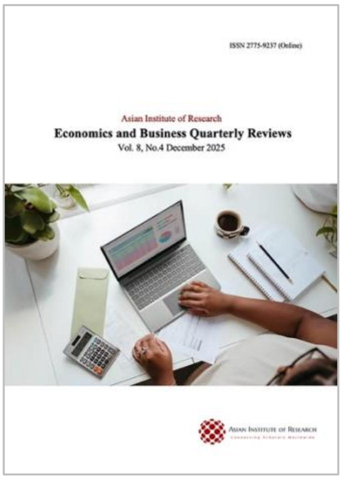

Economics and Business Quarterly Reviews

Kao, C. W., & Wan, J. Y. (2025). Bank Competition and Monetary Policy: Evidence from Taiwan. ***Economics and Business Quarterly Reviews*****, 8(4), 23-46.**

ISSN 2775-9237

DOI: 10.31014/aior.1992.08.04.690

Published by:
The Asian Institute of Research

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The Asian Institute of Research
Economics and Business Quarterly Reviews
Vol.8, No.4, 2025: 23-46
ISSN 2775-9237

DOI: 10.31014/aior.1992.08.04.690

Bank Competition and Monetary Policy: Evidence from Taiwan

Chung-Wei Kao[1], Jer-Yuh Wan[2]

[1] Department of Public Finance and Taxation, Takming University of Science and Technology, Neihu, Taipei, 11451, Taiwan. E-mail: cwkao@takming.edu.tw

[2] Department of Economics, Tamkang University, Tamshui Dist., New Taipei City 25137, Taiwan. Email: wan@mail.tku.edu.tw

Correspondence: Jer-Yuh Wan.

Abstract
This paper examines the role of bank competition for the transmission of monetary policy through the bank lending channel, using bank level data of Taiwan over the period from 2006 to 2020. And the parts of banks' characteristics, i.e., size, capitalization and liquidity, playing in the banks' response to monetary policy shocks are also considered. Our results suggest that banks with market power, which is proxied by the Lerner index, have a credit supply that is less sensitive to monetary policy shock. Therefore, increased competition enhances the effectiveness of monetary policy transmission through the bank lending channel. These findings are robust in relation to alternative measures of bank competition such as CR3, CR5 and HHI. In terms of policy implications, following the global financial crisis, the literature indicates the macroprudential policies requiring banks to raise capital to improve financial stability may have adverse effect on bank competition. Therefore, the monetary authority should be concerned and cope with the weakening impact on the efficacy of monetary policy from the increase in market concentration accompanied with the implementation of the macroprudential policies.

Keywords: Bank Competition, Bank Lending Channel, Monetary Policy Transmission, Lerner Index

1. Introduction

The literature suggests that the effects of monetary policy on the macroeconomy are transmitted through several channels, including the interest rate channel, the credit channel, and the risk-taking channel. These mechanisms enable policymakers to stabilize output fluctuations, control inflation, and smooth business cycle dynamics. The interest rate channel emphasizes the impact of monetary policy–induced interest rate changes on loan demand, whereas the credit and risk-taking channels highlight the lending behavior of financial intermediaries and the role they play in transmitting policy effects.

The credit channel can be further divided into the balance sheet channel and the bank lending channel. The balance sheet channel focuses on how interest rate fluctuations affect asset values and borrowers' net worth, thereby influencing repayment capacity and the cost of borrowing. The bank lending channel, in contrast, concerns the direct impact of monetary policy on the lending activities of depository institutions (Bernanke and Gertler, 1995). According to Bernanke and Blinder (1988), monetary policy alters banks' asset structures, which in turn affects loan supply. Monetary tightening (easing) reduces (increases) reserves and deposits, thereby lowering (expanding) the amount of funds available for lending and leading banks to curtail (increase) credit. Romer et al. (1990), however, argue that under tightening, banks may substitute toward market-based funding—for instance, by issuing certificates of deposit—to offset the decline in loanable funds, thereby weakening the lending channel. Stein (1988) notes that the extent of this offset depends on banks' access to, and the cost of, alternative funding sources. Bernanke (2007) and Disyatat (2011) further emphasize that banks' ability to raise external funds, as well as the size of the external finance premium, depends critically on their balance sheet strength and creditworthiness. Monetary tightening can erode asset quality and raise risk exposures, thereby weakening balance sheets, increasing the external finance premium, raising funding costs, and ultimately reducing banks' willingness to lend to firms and households.

Empirical work on the credit supply effects of monetary policy typically follows the framework of Bernanke and Blinder (1988), using aggregate lending data to test the existence and operation of the lending channel. A key challenge, however, is that aggregate data cannot disentangle whether declines in lending under monetary tightening reflect reduced supply or weaker demand, complicating interpretation (Kashyap and Stein, 2000). To address this limitation, Kashyap and Stein (1995) employ disaggregated, bank-level data, allowing them to examine the role of bank-specific characteristics in shaping the transmission of monetary policy to credit supply.

Evidence suggests that the strength of the lending channel depends on bank heterogeneity. Larger, better capitalized, and more liquid banks are less likely to contract lending under monetary tightening compared with smaller, weaker institutions. Beyond such bank-specific traits, competition in the banking sector is another key factor that can amplify or dampen the lending channel and, in turn, the effectiveness of monetary policy. Beck et al. (2004) and Cetorelli and Strahan (2006) find that competition reduces the cost of financial intermediation and improves access to credit for firms and households. By contrast, Pruteanu-Podpiera et al. (2008) argue that competition undermines lending relationships, reduces management efficiency, and may encourage risk-taking behavior. Kashyap and Stein (1995) also note that both concentration and soundness in the banking sector shape policy transmission.

The theoretical literature provides conflicting views on the role of bank competition. Olivero et al. (2011a) suggest that aggressive competition, particularly by large banks seeking greater market share, may weaken policy effectiveness. On the other hand, greater competition may also increase the responsiveness of lending rates to policy rate changes, thus strengthening transmission. Chong et al. (2013) advanced two explanations: the information hypothesis, which posits that credit supply increases with market concentration, and the market power hypothesis, which suggests that stronger competition enhances firms' access to credit and improves policy effectiveness. Similarly, Freixas and Rochet (1997) and Stiglitz and Greenwald (2003) argue that competition diminishes policy transmission, whereas Alencar and Nakane (2004) and Ghossoub et al. (2012) find that it strengthens it. Overall, theoretical contributions remain inconclusive.

Empirical findings are likewise mixed. Olivero et al. (2011b), Chong et al. (2013), Fungáčová et al. (2014), and Leroy (2014), using data from Asia, Latin America, China, and the euro area, report that greater banking concentration weakens the lending channel, implying that competition strengthens monetary transmission. In contrast, Olivero et al. (2011a), Amidu and Wolfe (2013), and Yang and Shao (2016) conclude that higher concentration enhances policy effectiveness, while competition undermines it. Khan et al. (2016), studying ASEAN countries, show that results vary depending on the competition measure. Using the top-five concentration ratio (CR), the Herfindahl-Hirschman Index (HHI), or the Lerner index, they find that competition strengthens the lending effect of monetary policy. However, using the Boone indicator yields the opposite conclusion. Thus, consistent with the theoretical debate, empirical evidence shows that the effect of bank competition on policy transmission varies across countries, datasets, and measurement approaches.

Research on Taiwan's banking sector has primarily relied on aggregate data. Lai (2002) finds little evidence for a significant credit channel. Wu (2004) reports that the credit, interest rate, and exchange rate channels all play a role in policy transmission. Wu and Chen (2010) identify both narrow and broad credit channels. Hung and Yu (2015) demonstrate that banks' lending portfolios are sensitive to monetary shocks, underscoring the importance of the lending channel. Chang et al. (2010), using bank-level panel data, confirms that monetary policy is transmitted via the lending channel.

Overall, whether based on aggregate or bank-level analysis, most studies conclude that the lending channel plays a non-negligible role in Taiwan. However, little attention has been paid to how bank size, capitalization, liquidity, and competition condition the strength of this channel. To fill this gap, this study uses bank-level panel data for Taiwan and proxies' competition using the Lerner index, the HHI, the three-bank concentration ratio (CR3), and the five-bank concentration ratio (CR5). Results based on the Lerner index indicate that the effectiveness of monetary policy in influencing lending declines as the Lerner index rises, implying that higher concentration or weaker competition diminishes the role of the lending channel in smoothing the business cycle. Conversely, greater competition strengthens policymakers' ability to manage cyclical fluctuations. Estimates using the HHI, CR3, and CR5 yield consistent results: higher concentration reduces the effectiveness of the lending channel, whereas competition enhances it. These findings remain robust even after controlling for the effects of the global financial crisis and interactions between bank characteristics and monetary policy.

The remainder of the paper is organized as follows. Section 2 reviews the related literature. Section 3 outlines the research methodology. Section 4 describes the data and presents empirical results. Section 5 concludes.

2. Literature Review

The impact of bank competition on the transmission of monetary policy through the lending channel has been widely debated, with scholars advancing competing hypotheses and empirical findings.

Olivero et al. (2011a), Chong et al. (2013), and Leroy (2014) present different perspectives. Olivero et al. (2011a) argue that if competition arises because large banks seek to expand market share, this will diminish the effectiveness of the lending channel. Large banks have easier access to external funding sources; as their market share rises with greater competition, the contractionary effect of monetary tightening on loan supply is weakened. Moreover, competition reduces information asymmetries among lenders regarding borrower creditworthiness. Traditionally, banks hold superior private information about their established clients, which, combined with switching costs, creates a lock-in effect that limits borrowers' ability to shift to other banks. When smaller banks are constrained under monetary tightening, their clients cannot easily be absorbed by larger banks. Thus, if competition reduces information asymmetries and lowers switching costs, the contractionary impact of monetary tightening is weakened. Finally, Olivero et al. note that competition also affects the degree of interest rate pass-through. With greater competition, loan rates are more responsive to changes in marginal costs, implying a stronger transmission of policy rate adjustments to lending rates. From these three perspectives, bank competition may either weaken or strengthen the lending channel, depending on the dominant mechanism.

Chong et al. (2013) apply two hypotheses-Petersen and Rajan's (1995) information hypothesis and the market power hypothesis-to explain the effect of bank competition. The information hypothesis suggests that when credit markets are more concentrated, lenders internalize the benefits of providing credit to opaque or credit-constrained firms, thereby expanding credit supply to these firms. By contrast, the market power hypothesis posits that as competition increases, lending rates decline, improving credit access for all firms regardless of transparency, and thus strengthening policy transmission.

Leroy (2014) offers yet another view, arguing that as banks' market power increases, they obtain funds from financial markets more easily and on better terms, enabling them to insulate their lending from monetary shocks. In this sense, greater competition enhances the transmission of monetary policy through the lending channel.

From a theoretical standpoint, conclusions also diverge. Freixas and Rochet (1997), using the Monti–Klein model of oligopolistic banking, show that the responsiveness of lending rates to interbank rates diminishes with stronger competition, implying weaker policy transmission. Stiglitz and Greenwald (2003), using a mean–variance framework, argue that monetary tightening has weaker effects on bank lending in competitive environments than in more restricted settings. Both studies suggest that competition weakens policy transmission. In contrast, Ghossoub et al. (2012), employing an overlapping generations model, find that monetary policy is more expansionary under perfect competition and less effective under monopoly structures. Similarly, Alencar and Nakane (2004), using a dynamic general equilibrium model, conclude that macroeconomic responsiveness to interest rate changes increases with competition. Overall, theoretical models, like the hypotheses above, offer no consensus on whether competition amplifies or diminishes monetary policy effectiveness.

Empirical studies have employed various measures of bank competition, including the Lerner index, CR3 and CR5 concentration ratios, the Herfindahl–Hirschman Index (HHI), Panzar and Rosse's (1987) PRH statistic, and the Boone indicator. Findings remain mixed.

Several studies support the view that competition strengthens monetary transmission. For example, Olivero et al. (2011b), using CR5 and HHI for a sample of 936 banks across eight Asian and ten Latin American countries (1996–2006), find that greater concentration weakens the lending channel, implying that competition enhances transmission. The effect is particularly pronounced for smaller banks, while liquidity and capitalization show no significant moderating role. Similarly, Chong et al. (2013), analyzing Chinese SMEs with CR3 and HHI as proxies, find that lower concentration eases credit constraints, suggesting that competition facilitates credit access and strengthens monetary transmission. Leroy (2014), using the Lerner index with euro area bank data (1999–2011), finds that greater market power reduces the responsiveness of lending to monetary policy, while smaller, less liquid, and undercapitalized banks are more sensitive to policy shocks. Fungáčová et al. (2014), using Lerner indices for 12 euro area countries (2002–2010), report that higher market power dampens the effect of monetary policy—although this effect is only evident before the global financial crisis, not afterward. They also find that smaller, more liquid, and better-capitalized banks are more resilient to shocks. Results remain robust when CR5 and PRH are used as competition measures.

By contrast, other studies conclude that competition weakens policy transmission. Olivero et al. (2011a), using the PRH statistic for banks in Asia and Latin America (1996–2006), find that competition reduces the effectiveness of the lending channel, particularly in Latin America and among smaller, less liquid, and undercapitalized banks. Amidu and Wolfe (2013), analyzing 978 banks in 55 countries across Africa, Asia, Europe, and the Americas, show that higher market power (measured by the Lerner index) strengthens monetary policy effects in the global sample. This result holds for Africa and the Americas but is statistically insignificant for Asia and Europe. Yang and Shao (2016), using Chinese bank data (2003–2014), also find that competition weakens the lending channel, with the dampening effect more pronounced for banks with higher liquidity and capitalization.

Still other studies yield inconclusive evidence. Khan et al. (2016), analyzing five ASEAN countries (1998–2014), find that when competition is measured by CR5, HHI, or the Lerner index, monetary policy transmission is strengthened with greater competition. However, when the Boone indicator is used, the opposite result emerges. They also find that banks with larger size, higher liquidity, and stronger capitalization show stronger responses to policy shocks.

Taken together, evidence from hypotheses, theoretical models, and empirical analyses shows no consensus. Even within similar regions, different measures of competition may yield opposite conclusions—for example, Olivero et al. (2011a) versus Olivero et al. (2011b) for Asia and Latin America. Nevertheless, studies using concentration ratios or HHI tend to consistently support the view that greater competition strengthens monetary policy transmission (Olivero et al., 2011b; Chong et al., 2013; Fungáčová et al., 2014; Khan et al., 2016). Regarding bank-specific characteristics, many studies conclude that smaller, less liquid, and undercapitalized banks are more sensitive to monetary policy shocks, although Khan et al. (2016) report the opposite.

Research on Taiwan has largely relied on aggregate data. Lai (2002), using a semi-structural VAR model, examines whether the credit channel remained significant following financial liberalization and innovation (1981–1999) and finds limited evidence for its existence. Wu (2004), using a VAR approach, shows that credit, interest rate, and exchange rate channels all transmit policy effects. Wu and Chen (2010), using a macroeconometric model, confirm the existence of both narrow and broad credit channels. Hung and Yu (2015), analyzing commercial bank lending by portfolio category (1997–2011), find that loan composition is significantly influenced by monetary shocks, underscoring the lending channel's importance. Chang et al. (2010), using bank-level panel data, find that monetary policy is transmitted through the lending channel, with asset size and liquidity also shaping transmission.

Overall, studies on Taiwan suggest that the lending channel plays an important role in transmitting monetary policy effects, and that balance sheet characteristics influence the strength of transmission. However, little attention has been paid to the role of bank competition or capitalization in this process. Moreover, while Chang et al. (2010) incorporate measures of bank size and liquidity, they use nominal values of assets and liquid holdings rather than standardized measures as recommended by Ehrmann et al. (2003) and Gambacorta (2005). These authors argue that nominal asset levels exhibit time trends that should be removed to avoid spurious effects.

In sum, the literature indicates that bank competition may either strengthen or weaken monetary policy transmission, depending on context, measurement, and bank-specific characteristics such as size, liquidity, and capitalization. This study contributes to the debate by using panel data for Taiwanese banks to analyze whether competition enhances or dampens the lending channel, how bank-specific traits condition policy effects, and whether these relationships change once competition is explicitly considered.

3. Research Methodology

The role of bank competition in the transmission of monetary policy can be examined through a regression framework that incorporates changes in bank lending, monetary policy variables, bank-specific characteristics, and key macroeconomic indicators. This relationship is specified as in equation (1):

$$\begin{aligned}\Delta \ln Loan_{i,t} &= \alpha_i + \beta \Delta \ln Loan_{i,t-1} + \sum_{j=0}^{1} \gamma_j \Delta M_{t-j} + \phi Comp_{i,t-1} \\ &+ \sum_{j=0}^{1} \eta_j \Delta M_{t-j} Comp_{i,t-1} + \lambda Size_{i,t-1} + \rho Cap_{i,t-1} \\ &+ \delta Liq_{i,t-1} + \sum_{j=0}^{1} \upsilon_j y_{t-j} + \sum_{j=0}^{1} \omega_j \pi_{t-j} + \sum_{j=0}^{1} \xi_j ex_{t-j} + \varepsilon_{i,t}\end{aligned} \tag{1}$$

where $i = 1, \cdots, N$ denotes the number of banks, and $t = 1, \cdots, T$ represents the time period. $\Delta \ln Loan_{i,t}$ refers to the logarithmic change in bank lending, while ΔM_{t-j} captures monetary policy shocks. $Comp_{i,t-1}$、$Size_{i,t-1}$、$Cap_{i,t-1}$ 以及 $Liq_{i,t-1}$ denote, respectively, bank competition, size, capitalization, and liquidity, measured at the bank level. y_t, π_t, and ex_t represent the key macroeconomic variables such as economic growth, inflation, and exchange rate fluctuations. Since shifts in the macroeconomic environment influence loan demand, these variables are included in the model to control for the impact of aggregate conditions and demand-side factors on bank lending.

In the specification of equation (1), the lagged change in lending is included as an explanatory variable to capture the inertial dynamics of loan growth (Leroy, 2014; Fungáčová et al., 2014; Yang & Shao, 2016). Since monetary policy itself exhibits inertia, both the contemporaneous and one-period lagged monetary policy variables are incorporated into the regression equation. To mitigate potential simultaneity bias, bank-specific characteristics—including competition, size, liquidity, and capitalization—are introduced with a one-period lag (Leroy, 2014).

Key macroeconomic variables, such as economic growth and inflation, are also added to control for demand-side influences on lending behavior (Olivero et al., 2011a). Furthermore, because banks' lending responses to monetary policy may depend on their individual characteristics and funding capacity, the inclusion of bank size, liquidity, and capitalization helps account for these heterogeneous effects.

The central question whether bank competition shapes the transmission of monetary policy through the lending channel is addressed by incorporating the interaction term between monetary policy and bank competition such as $\Delta M_{t-j} Comp_{i,t-1}$ in equation (1). A positive and statistically significant coefficient represented by η_j on this interaction would suggest that greater competition dampens the transmission of monetary policy via the lending channel. Conversely, a negative and statistically significant coefficient would indicate that competition enhances the effectiveness of monetary policy transmission through bank lending.

The construction of bank-specific variables namely size, liquidity, and capitalization follows the methodology of Ehrmann et al. (2003) and Gambacorta (2005), and is specified in equation (2):

$$\begin{aligned} Size_{i,t} &= \log A_{i,t} - \frac{1}{N_t}\sum_i \log A_{i,t} \\ Cap_{i,t} &= \frac{C_{i,t}}{A_{i,t}} - \frac{1}{T}\sum_t \Big(\frac{1}{N_t}\sum_i \frac{C_{i,t}}{A_{i,t}}\Big) \\ Liq_{i,t} &= \frac{L_{i,t}}{A_{i,t}} - \frac{1}{T}\sum_t \Big(\frac{1}{N_t}\sum_i \frac{L_{i,t}}{A_{i,t}}\Big) \end{aligned} \tag{2}$$

In equation (2), $A_{i,t}$ denotes the total assets of bank i at time t, $L_{i,t}$ represents its liquid assets, and $C_{i,t}$ refers to its equity. The specification in equation (2) indicates that each bank-specific variable is standardized by subtracting the corresponding sample mean. As noted by Ehrmann et al. (2003) and Gambacorta (2005), this standardization ensures that the sum of each bank characteristic across the sample equals zero. Consequently, the interaction terms between monetary policy and bank characteristics also sum to zero, allowing the estimated coefficient of the monetary policy variable to reflect the overall effect of monetary policy on loan supply.

With respect to the bank size variable, the standardization is performed period by period. This approach removes the trend component that may arise from the secular growth of bank assets over time, thereby ensuring that the size measure captures only relative differences across banks.

Regarding the selection of monetary policy variables, financial innovation and deregulation have rendered traditional monetary aggregates—such as the growth rates of M1, M2, or the monetary base—unsuitable as indicators of monetary policy stance (Bernanke & Mihov, 1998). Consequently, the literature has employed money market interest rates (Olivero et al., 2011a; Olivero et al., 2011b; Amidu & Wolfe, 2013; Khan et al., 2016) or the overnight interbank lending rate (Fungáčová et al., 2014) as alternative proxies. Changes in monetary policy are typically measured by interest rate variations (Olivero et al., 2011a; Olivero et al., 2011b; Amidu & Wolfe, 2013; Khan et al., 2016; Fungáčová et al., 2014), by the gap between the policy rate and the natural interest rate, or by the deviation of the policy rate from the rate implied by the Taylor rule (Altunabs et al., 2014; Özşuca & Akbostancı, 2016).

With respect to bank competition variables, this study employs several alternative measures, namely concentration ratios, the Herfindahl–Hirschman (HH) index, and the Lerner index (Olivero et al., 2011b; Khan et al., 2016). The concentration ratio and HH index are derived from the structural approach in traditional industrial organization literature, which infers the degree of competition from the market structure. In this framework, the concentration ratio is calculated as the asset share of the three (CR3) or five (CR5) largest banks relative to the total assets of the banking industry, while the HH index is obtained by summing the squared market shares of individual banks, measured in terms of their assets. Since both indicators rely on market concentration to infer competition, higher concentration ratios or HH index values indicate greater market concentration and thus lower levels of competition.

By contrast, the Lerner index is derived from the framework of the New Empirical Industrial Organization (NEIO), which adopts a non-structural approach by inferring the degree of market competition from firms' conduct rather than market structure. The Lerner index is calculated as follows:

$$Lerner_{i,t} = (price_{i,t} - mc_{i.t}) / price_{i,t} \tag{3}$$

where $price_{i,t}$ denotes the price of total assets for bank i at time t, defined as the ratio of total revenue to total assets. $mc_{i.t}$ represents the bank's marginal cost, which is derived from the transcendental logarithmic (trans-log) cost function after logarithmic transformation, as specified in equation (4) (Fernández et al., 2013).

$$\begin{aligned} \ln TC_{it} &= \beta_0 + \beta_1 \ln TA_{it} + \frac{\beta_2}{2}(\ln TA_{it})^2 + \sum_{j=1}^{3}\lambda_j \ln W_{jit} \\ &+ \frac{1}{2}\sum_{j=1}^{3}\gamma_j \ln TA_{it} \ln W_{jit} + \frac{1}{2}\sum_{j=1}^{3}\sum_{k=1}^{3}\delta_{ij} \ln W_{j,i,t} \ln W_{k,i,t} + \sum_{k=1}^{3}(\delta_i / 2)\ln W_{k,i,t} \\ &+ \theta_1 Trend + \frac{1}{2}\theta_2 Trend^2 + \theta_3 Trend \ln TA_{it} + \sum_{j=1}^{3}\varphi_j Trend \ln W_{jit} + u_{it} \end{aligned} \tag{4}$$

where TC_{it} denotes the total cost of bank i at time t, which includes the costs of funds, labor, and capital, while TA_{it} represents the bank's total assets. W_j captures the input prices, where W_1, W_2, and W_3 correspond to the prices of funds, labor, and capital, respectively. $Trend$ is included to account for the time trend of technological progress. The price of funds is measured as interest expenses on deposits divided by the sum of deposits and short-term borrowed funds; the price of labor is measured as personnel expenses relative to total assets; and the price of capital is calculated as total operating expenses net of personnel expenses, divided by total assets (Demirgüç-Kunt & Peria, 2010).

According to the trans-log cost function specified in equation (4), the marginal cost in equation (3) is defined as:

$$mc_{i.t} = \frac{TC_{it}}{TA_{it}}(\beta_1 + \beta_2 \ln TA_{it} + \sum_{j=1}^{3}\gamma_j \ln W_{jit} + \theta_3 Trend) \tag{5}$$

According to equation (3), under perfect competition, the output price equals the marginal cost, implying that the Lerner index is equal to zero. By contrast, in an imperfectly competitive market, the Lerner index takes a value greater than zero, with higher values indicating lower degrees of competition. By construction, the Lerner index ranges between 0 and 1.

Furthermore, to jointly examine how bank competition, size, liquidity, and capitalization influence the transmission of monetary policy through the lending channel, this study follows the analytical framework of Leroy (2014). Specifically, interaction terms between monetary policy and these bank characteristics are incorporated into equation (1), yielding the specification presented in equation (6).

$$\begin{aligned}\Delta \ln Loan_{i,t} &= \alpha_i + \beta \Delta \ln Loan_{i,t-1} + \sum_{j=0}^{1} \gamma_j \Delta M_{t-j} + \phi Comp_{i,t-1} \\ &+ \lambda Size_{i,t-1} + \rho Cap_{i,t-1} + \delta Liq_{i,t-1} + \sum_{j=0}^{1} \eta_j \Delta M_{t-j} Comp_{i,t-1} \\ &+ \sum_{j=0}^{1} \sigma_j \Delta M_{t-j} Size_{i,t-1} + \sum_{j=0}^{1} \tau_j \Delta M_{t-j} Cap_{i,t-1} + \sum_{j=0}^{1} \varsigma_j \Delta M_{t-j} Liq_{i,t-1} \\ &+ \sum_{j=0}^{1} \upsilon_j y_{t-j} + \sum_{j=0}^{1} \omega_j \pi_{t-j} + \sum_{j=0}^{1} \xi_j ex_{t-j} + \varepsilon_{i,t}\end{aligned} \tag{6}$$

The literature has extensively examined how bank-specific characteristics—namely size, capitalization, and liquidity—shape the transmission of monetary policy through the lending channel. With respect to bank size, the argument is that the external finance premium declines as bank size increases, enabling larger banks to obtain funds from alternative sources more easily when facing a contractionary monetary policy shock. This mitigates the adverse impact of rising interest rates on lending. Based on this reasoning, the effect of monetary policy tightening is expected to diminish with bank size, and hence the coefficient on size is anticipated to be positive (greater than zero).

Turning to bank capitalization, when interest rates rise, well-capitalized banks typically hold more ample lending capacity (Kashyap & Stein, 1995), or they may attract deposits and market funding on more favorable terms (Bernanke, 2007; Gambacorta & Shin, 2018). Strong capitalization also reduces the risk premium associated with debt financing, thereby enhancing banks' resilience to contractionary monetary policy. Accordingly, the impact of monetary tightening is expected to weaken as capitalization increases, implying that the coefficient on capitalization should likewise be positive (greater than zero).

The effect of liquidity, however, is more ambiguous. As summarized by Abuka et al. (2019), the expected sign may be either positive or negative. In advanced economies, highly liquid banks can adjust their asset portfolios to buffer against monetary tightening (Kashyap & Stein, 2000) or secure funding at lower costs (Bernanke, 2007). In such cases, greater liquidity attenuates the impact of monetary policy on the lending channel, suggesting a positive coefficient. By contrast, in developing economies, where financial intermediation is more costly, banks often hold substantial sovereign debt instruments such as treasury bills (Allen et al., 2011). When market interest rates rise, the costs associated with information frictions on loans also increase, encouraging banks to shift toward government securities to reduce risk exposure. This, in turn, constrains loan growth and amplifies the contractionary effect of monetary policy, implying a negative coefficient. Abuka et al. (2019) further note that such effects are magnified when banks are subject to moral suasion, whereby authorities pressure them to hold more government bonds.

In summary, the expected coefficients on size and capitalization are positive, indicating that monetary policy transmission through the lending channel weakens as banks become larger and better capitalized. By contrast, the expected sign of the liquidity coefficient is indeterminate, depending on the stage of economic development and the extent to which banks are influenced by moral suasion policies.

4. Empirical Analysis

This study employs a panel dataset comprising 33 domestic banks in Taiwan over the period 2006–2020. The data required to construct bank-specific characteristics and measures of competition were obtained from the Banking Bureau of the Financial Supervisory Commission (FSC) through its dynamic statistical database.

For the construction of bank-specific variables defined in equation (2), total assets are taken from the asset items reported in the balance sheet of domestic banks. Liquid assets are proxied by the sum of cash and cash equivalents, together with deposits with the central bank and interbank call loans, as reported in the balance sheet. Equity is drawn from the equity item of the balance sheet.

To compute competition indicators—including the concentration ratio, the Herfindahl–Hirschman (HH) index, and the Lerner index—the following data are used: total revenue is drawn from the income items in banks' income statements, while total cost is proxied by the expenditure items in the same statement. Total assets are again taken from the balance sheet. Interest expenses on deposits are obtained from the interest expense item of the income statement. The sum of deposits and short-term funding is proxied by the aggregate of central bank deposits, interbank deposits and borrowings, postal transfers, deposits, and remittances, as reported in the balance sheet. Personnel expenses are obtained from the income statement, while total operating expenses net of personnel costs are proxied by other expenses reported in the same statement.

In the computation of the Lerner index, it is first necessary to estimate the cost function defined in equation (4). Following Koetter et al. (2012) and Leroy (2014), this study employs stochastic frontier analysis to obtain the required estimates.

In equation (1), the dependent variable loan growth is alternatively measured by the monthly average of loans outstanding (L1), the end-of-month loan balance including non-performing loans (L2), and the end-of-month loan balance excluding non-performing loans (L3). The key macroeconomic control variables include economic growth, inflation, and exchange rate fluctuations. Specifically, economic growth is proxied by the official growth rate published by the Directorate-General of Budget, Accounting and Statistics (DGBAS); inflation is measured by the annual growth rate of the Consumer Price Index (CPI); and exchange rate fluctuations are captured by movements in the New Taiwan Dollar (NTD) against the U.S. Dollar (USD). These data are obtained from the DGBAS statistical database and the Central Bank of the Republic of China (Taiwan).

The monetary policy variable is proxied by the overnight interbank call loan rate, with monetary policy shocks represented by the deviation of the policy rate from the natural interest rate. The natural interest rate is estimated using the Hodrick–Prescott (HP) filter.

For the estimation of equations (1) and (6), the use of a bank-level panel dataset raises potential endogeneity concerns, given that loan growth may expand bank balance sheets, while capitalization may change alongside bank size. Such endogeneity may bias the estimates. To address this issue, the study employs the system generalized method of moments (system GMM) estimator developed by Arellano and Bover (1995) and Blundell and Bond (1998). Under the conditions that the chosen instruments are valid and that the residuals exhibit no second-order serial correlation, the resulting estimates are both consistent and efficient (Leroy, 2014; Khan et al., 2016). The set of instruments includes lagged values of both the dependent and explanatory variables, with their validity assessed using the Hansen test of over-identifying restrictions, which evaluates whether the instruments are uncorrelated with the error term.

4.1. Lerner Index and the Effects of Monetary Policy

Table 1 reports the estimation results of equation (1), where alternative measures of loan growth are employed as dependent variables and the Lerner Index is used to capture the degree of bank competition. Regarding the interaction between monetary policy and loan growth, the estimated coefficients of γ_1 and γ_2 are negative, indicating an inverse relationship: monetary policy easing (tightening) is associated with an expansion (contraction) of bank lending. This finding is not only consistent with theoretical expectations but also highlights the role of the bank lending channel as a key transmission mechanism of monetary policy. However, in terms of statistical significance, only parts of the estimated coefficients of γ_2 is significant.

The estimated coefficients of the interaction terms between monetary policy changes and the Lerner Index, η_1 and η_2, are positive, with the coefficient of η_2 shown statistical significance. This implies that as the Lerner Index increases, indicating higher market concentration and lower banking competition, the impact of monetary policy on loan growth is attenuated. In other words, weaker competition diminishes the effectiveness of the bank lending channel in transmitting monetary policy to the real economy. This result is consistent with the findings of Leroy (2014) and Khan et al. (2016), who conducted similar analyses for the Eurozone and ASEAN, respectively. Overall, the estimations using the Lerner Index as a proxy for banking competition suggest that enhancing competition in Taiwan's banking sector would strengthen the transmission of monetary policy through the lending channel, thereby improving the effectiveness of monetary policy in stabilizing the macroeconomy.

Regarding the effects of banking competition and bank-specific characteristics, namely size, capitalization, and liquidity, on loan growth, the estimated coefficient for banking competition (ϕ) is positive and statistically significant. This indicates that as the Lerner Index rises, implying greater market concentration and lower competition, loan expansion is facilitated. With respect to bank-specific characteristics, the coefficients for bank size (λ) and liquidity (δ) are negative and positive, respectively, but neither reaches statistical significance. By contrast, the coefficient for capitalization (ρ) is positive and statistically significant, suggesting that higher levels of capitalization contribute to loan expansion. This finding is consistent with prior literature, while the results for size and liquidity indicate that these factors do not exert a significant influence on loan growth.

With respect to the estimated coefficients of the main macroeconomic variables, those for economic growth, inflation, and exchange rate fluctuations are all positive. Among these, the coefficients for economic growth and exchange rate fluctuations are statistically significant, indicating that loan demand expands with stronger economic growth or with a depreciation of the New Taiwan Dollar, thereby contributing to higher loan growth in the financial system. Finally, the results of the Hansen test and the second-order serial correlation test show p-values exceeding the 10% level, suggesting that the instruments employed are valid and that the estimation results are robust.

Secondly, to account for the impact of the 2007–2008 global financial crisis, a dummy variable was introduced to capture the crisis effect and incorporated into equation (1) as an explanatory variable. Two alternative specifications were adopted. In the first specification, the years 2007 and 2008 were identified as the crisis period, with the dummy variable set to one during these years and zero otherwise; the corresponding estimation results are reported in Table 2. In the second specification, the crisis period was defined as spanning 2007 to 2009, with the dummy variable set to one during these years and zero otherwise; the results are presented in Table 3.

The results in Table 2 indicate that the estimated coefficients of the interaction terms between monetary policy and loan growth (γ_1 and γ_2) are negative, with γ_2 being statistically significant. The interaction terms between monetary policy and the Lerner index (η_1 and η_2) yield positive estimates, with η_2 being statistically significant. The coefficient for banking competition (ϕ) is positive, while bank size (λ) is negative, capitalization (ρ) is positive, and liquidity (δ) is positive; among these, the coefficients for ϕ , λ , and ρ are statistically significant. Regarding macroeconomic variables, the coefficients for economic growth and, in part, inflation are positive and statistically significant. The estimated coefficients for the crisis dummy variable are not statistically significant across different measures of loan growth. Overall, compared with the baseline estimates in Table 1, which do not account for the global financial crisis, the results in Table 2 remain largely consistent, with the exception that the coefficient for bank size attains statistical significance here.

The results in Table 3, which apply the second crisis dummy specification, are broadly consistent with those in Table 2. The coefficients for the interaction between monetary policy and loan growth (γ_1 and γ_2) remain negative, as in Table 2; however, γ_1 is statistically significant, while γ_2 is not, representing a slight departure from the findings in Table 2. Like Table 2, the estimated coefficients for the crisis dummy variable remain statistically insignificant across alternative loan measures.

Overall, when the impact of the global financial crisis is considered, the estimated coefficients of the crisis dummy variable under different specifications remain statistically insignificant. Regarding the effect of monetary policy on loan growth, the interaction between monetary policy changes and loan variation consistently exhibits a negative relationship, a finding that holds irrespective of whether the global financial crisis is considered. With respect to banking competition, the results indicate that the effectiveness of monetary policy declines as the Lerner index rises, implying that higher market concentration or reduced competition weakens the transmission of monetary policy through the bank lending channel in influencing macroeconomic activity. Hence, enhancing competition in the banking sector strengthens the effectiveness of monetary policy via the lending channel, and this conclusion remains robust even after incorporating the role of the global financial crisis. In terms of bank-specific characteristics, higher capitalization is found to facilitate loan expansion, whereas larger bank size may be less favorable to loan growth. By contrast, bank liquidity does not appear to exert a significant influence on changes in lending.

The analysis is further extended to examine how bank-specific characteristics, namely size, capitalization, and liquidity, affect the transmission of monetary policy, as well as how the effectiveness of monetary policy changes once these factors are incorporated alongside bank competition. To this end, equation (6) is estimated in a specification that excludes the competition variable and its interaction with monetary policy, thereby focusing solely on the role of bank characteristics. As reported in Table 4, the estimated coefficient of monetary policy variation (γ_1) is negative and statistically significant, whereas the coefficient of (γ_2) is statistically insignificant. Although this result differs from that in Table 1, loan variation continues to display an inverse relationship with monetary policy, thereby confirming that monetary policy transmits effectively through the bank lending channel. This outcome is consistent with the findings reported in Table 1.

Regarding the influence of bank characteristics on the effectiveness of monetary policy, the interaction term between bank size and monetary policy variation (σ_1) yields a statistically insignificant estimate, whereas the coefficient of (σ_2) is positive and statistically significant. This indicates that as bank size increases, the impact of monetary policy on loan variation diminishes, suggesting that the effectiveness of the bank lending channel weakens with larger banks. This finding is consistent with the literature, which posits that larger banks can more readily access alternative funding sources, thereby rendering their loan growth less sensitive to monetary tightening. For capitalization, the interaction term between bank capitalization and monetary policy variation (τ_1) is statistically insignificant, while the coefficient of (τ_2) is positive and statistically significant. This result implies that higher levels of capitalization attenuate the effect of monetary policy on bank lending, aligning with the view that well-capitalized banks, due to their more abundant internal funds or their ability to attract deposits on more favorable terms, are better equipped to withstand the adverse effects of monetary tightening on loan growth.

By contrast, the interaction term between bank liquidity and monetary policy variation (ς_1) produces a negative and statistically significant estimate at the 10% level, while the coefficient of (ς_2) is also negative but statistically insignificant. This suggests that the lending-channel effect of monetary policy is strengthened as bank liquidity increases. Following the reasoning of Abuka et al. (2019), this outcome implies that more liquid banks, in response to the heightened lending risks induced by contractionary monetary policy, are inclined to curtail loan growth and instead reallocate their portfolios toward relatively safer assets such as government securities, thereby reinforcing the contractionary effect of monetary policy transmitted through the bank lending channel.

With respect to the individual effects of bank size, capitalization, liquidity, and key macroeconomic variables on loan growth, the results reported in Table 4 indicate that the estimated coefficients of bank size (λ), capitalization (ρ), and liquidity (δ) are negative, positive, and positive, respectively, with only the coefficient ρ attaining statistical significance. These findings are consistent with those reported in Table 1. Regarding the macroeconomic variables, the coefficients of output growth, inflation, and exchange rate variation are all positive, with most estimates statistically significant. This suggests that loan growth increases with higher economic growth, rising inflation, and depreciation of the New Taiwan dollar, which is consistent with theoretical expectations as well as with the results in Tables 1 through 3.

Subsequently, bank competition is incorporated into the analysis to examine the joint effects of competition and bank characteristics on the transmission of monetary policy. According to the results in Table 5, after accounting for bank competition, the estimated coefficient of monetary policy variation (γ_2) is statistically significant and negative, while the coefficient of the interaction term between monetary policy and the Lerner index (η_2) is positive and statistically significant. This implies that as market concentration rises and bank competition declines, the effect of monetary policy on loan growth diminishes, thereby weakening the transmission of monetary policy through the bank lending channel. This result is consistent with the conclusions drawn from Table 1.

As for the interaction terms between monetary policy and bank characteristics, most of the coefficients for bank size and liquidity are not statistically significant. By contrast, the capitalization–monetary policy interaction yields a positive and statistically significant estimate, while the liquidity–monetary policy interaction produces a negative coefficient that is significant at the 10% level. Compared with the results in Table 4, bank size no longer exhibits a robust influence on monetary policy effectiveness, while the effects of capitalization and liquidity remain in the same direction as in Table 4 but with smaller absolute magnitudes. This indicates that, once bank competition is considered, the role of bank characteristics in mediating the impact of monetary policy on loan growth is attenuated. Furthermore, the coefficient of the Lerner index interaction is larger than that reported in Table 1, underscoring the central role of bank competition in shaping the operation of the lending channel of monetary policy. Finally, the individual effects of bank size, capitalization, liquidity, and macroeconomic variables on loan growth are broadly consistent with those in Table 4, though the statistical significance of macroeconomic variables is relatively weaker.

In summary, when the Lerner index is employed as a proxy for bank competition, the empirical results indicate that the effect of monetary policy on loan growth diminishes as the Lerner index increases. This implies that higher market concentration or lower bank competition weakens the influence of monetary policy on lending activity. Accordingly, fostering greater competition in the banking sector enhances the authorities' ability to stabilize macroeconomic fluctuations through monetary policy. Moreover, this inference continues to hold even after accounting for the impact of the global financial crisis.

With respect to bank characteristics, the evidence suggests that, in the absence of competition effects, the transmission of monetary policy through the bank lending channel is attenuated as bank size expands and capitalization strengthens. This outcome reflects the fact that larger banks have easier access to alternative funding sources and that highly capitalized banks possess abundant internal resources, thereby mitigating the adverse effects of contractionary monetary policy on lending. By contrast, higher bank liquidity strengthens the transmission of monetary policy, a result consistent with Abuka et al. (2019), who argue that, in response to the elevated credit risk associated with contractionary monetary policy, highly liquid banks reallocate their portfolios toward safer government securities.

Once bank competition is incorporated, however, the interaction effects of bank characteristics and monetary policy on loan growth are reduced, underscoring the central role of bank competition in shaping the effectiveness of the monetary policy lending channel.

4.2 Robustness Analysis and Policy Implications

As a further step, the study employs structural measures of competition—including the H-H index, CR3, and CR5 as alternative proxies for bank competition, to examine whether the impact of bank competition on the effectiveness of monetary policy is consistent with the results obtained using the non-structural Lerner index. Tables 6 through 8 present the estimation results of equation (1) when the H-H index, CR3, and CR5 are respectively adopted as indicators of bank competition.

The results in Table 6 show that the estimated coefficient of monetary policy changes on loan growth (γ_1) is negative and statistically significant, whereas the corresponding alternative specification (γ_2) is insignificant. This indicates that changes in monetary policy are inversely related to loan growth, a finding consistent with theoretical expectations and with the inference drawn from Table 1. However, the significance of certain coefficients differs from that reported in Table 1.

The estimated coefficient of the interaction between bank competition and loan growth (ϕ) is positive and statistically significant, suggesting that as the H-H index rises-implying higher market concentration and reduced bank competition-loan growth tends to expand. This finding is in line with the conclusion derived from the Lerner index. By contrast, the estimated coefficients of the interaction terms between bank competition and monetary policy changes yield mixed results: the first (η_1) is positive and significant, while the second (η_2) is negative but statistically insignificant. These results imply that as the H-H index increases, the effectiveness of the bank lending channel in transmitting monetary policy is weakened. Hence, greater bank competition enhances the ability of monetary policy to stabilize macroeconomic fluctuations, consistent with the inference of Table 1.

Regarding bank-specific characteristics, the estimated coefficients for size (λ) and liquidity (λ) are statistically insignificant, while capitalization (ρ) is positive and significant. This indicates that only capitalization exerts a significant effect on loan growth, a finding like that reported in Table 1.

Tables 7 and 8 present the estimation results using CR3 and CR5 as measures of bank competition. The significance and signs of the estimated coefficients for monetary policy changes, bank competition, and the interaction terms between bank competition and monetary policy are consistent with those reported in Table 6. This indicates that the inferences derived from structural measures of market structure are robust, and they align with the conclusions obtained from the non-structural Lerner index in Table 1. Taken together, whether bank competition is captured through non-structural or structural approaches, the results from Table 1 and Tables 6 through 8 uniformly demonstrate that greater bank competition strengthens the effectiveness of monetary policy through the lending channel, thereby enhancing the authorities' ability to stabilize business cycles.

An additional question concerns whether the interactions between bank characteristics and monetary policy may alter the role of structural measures of bank competition, such as the H-H index, CR3, and CR5, in shaping monetary policy effectiveness. To address this, the study further estimates equation (6), incorporating interaction terms between bank characteristics and monetary policy, to examine whether the effect of bank competition on monetary policy outcomes changes once these bank-specific factors are accounted for. The corresponding results are reported in Tables 9 through 11.

Table 9, which employs the H-H index as the proxy for bank competition, shows that after including the interaction terms between bank characteristics and monetary policy as explanatory variables, the significance and signs of the coefficients for monetary policy changes, bank competition, and the interaction between competition and monetary policy remain the same as in Table 6. This suggests that the inference regarding the impact of bank competition on loan growth and the effectiveness of monetary policy is unaffected by the inclusion of bank-specific interactions. Similarly, the results in Tables 10 and 11, where CR3 and CR5 are used as alternative measures of bank competition, are consistent with those in Table 9.

In addition, the results in Table 9 indicate that the estimated coefficients of the interaction terms between monetary policy changes and bank characteristics show that the signs of size and capitalization are positive and statistically significant, while liquidity is negative and significant at the 10% level. The results in Tables 10 and 11 are consistent with those in Table 9. These findings suggest that the effectiveness of monetary policy through the bank lending channel is weakened as bank size expands or capitalization increases, while it is strengthened as liquidity rises. This is consistent with the inferences drawn from Tables 4 and 5.

Taken together, whether the Lerner index or structural measures such as the H-H index, CR3, and CR5 are used as proxies for bank competition, the estimation results consistently show that the effectiveness of monetary policy through the lending channel diminishes as market concentration rises. Accordingly, enhancing bank competition would help strengthen the ability of the authorities to stabilize the business cycle through monetary policy. What policy implications does this carry? In Taiwan, the Financial Supervisory Commission (FSC) has designated six domestic banks as domestic systemically important banks (D-SIBs) and required them to raise their common equity tier 1 ratio, tier 1 capital ratio, and total capital adequacy ratio to 11%, 12.5%, and 14.5%, respectively, by 2025. While such macroprudential measures, aimed at increasing capital adequacy to reduce systemic risk and enhance the resilience of the financial system, are necessary, an important question arises: what are the potential consequences for bank competition?

Regarding the impact of macroprudential policy on bank competition, Mirzaei and Moore (2021), using data from 58 countries during 2000–2013 and employing the Lerner index as the measure of competition, find that liquidity- and capital-related macroprudential policies tend to weaken bank competition. However, this negative effect diminishes as institutional quality and supervisory power improve. Scalco et al. (2021), in their analysis of Brazil, show that the strengthening of macroprudential policy increases the markup of prices over marginal cost, thereby reducing bank competition. They argue that while macroprudential policies are implemented to promote financial stability, policymakers should remain attentive to their unintended adverse effects on competition. González (2022) highlights that capital-related macroprudential measures—such as higher capital adequacy requirements for systemically important financial institutions (SIFIs)—may hinder the growth of smaller banks, thereby strengthening the market power of large incumbents, raising barriers to bank entry, and ultimately reducing competition. Similarly, Li (2022), using the tier 1 and tier 2 capital ratios to capture capital structure and the Lerner index to measure competition, finds that banking market power increases with higher tier 1 capital ratios. Moreover, institutional factors such as activity restrictions, capital stringency, and supervisory strength also exacerbate market power, further diminishing competition.

These perspectives suggest that macroprudential policies aimed at stabilizing the financial system may unintentionally undermine bank competition. Since the empirical results in this study indicate that monetary policy effectiveness is strengthened by greater bank competition, the FSC's macroprudential measures—such as raising capital requirements—may simultaneously increase market concentration, reduce competition, and weaken the transmission of monetary policy through the lending channel. Therefore, the potential trade-off between enhancing financial stability through stricter macroprudential regulation and preserving the effectiveness of monetary policy should be carefully considered and addressed by policymakers.

5. Conclusion

The literature suggests that monetary policy influences aggregate economic fluctuations through the bank lending channel by affecting the lending behavior of depository institutions. Analyses using bank-level data indicate that bank-specific characteristics, such as size, capitalization, liquidity, and the degree of competition, play critical roles in shaping the transmission of monetary policy through this channel. However, the impact of bank competition on monetary policy effectiveness remains unsettled. Hypotheses and theoretical models offer divergent predictions, and empirical evidence shows that the effect of competition varies not only across samples but also with the choice of competition measures. In the context of Taiwan, existing studies confirm the presence of the bank lending channel in the monetary transmission process but provide little discussion on the role of bank competition.

To address this gap, this study employs panel data from 33 domestic banks in Taiwan spanning 2006 to 2020 and uses the Lerner index, the H-H index, CR3, and CR5 as alternative measures of bank competition. Estimates based on the Lerner index confirm a negative relationship between monetary policy changes and loan growth, consistent with the existence of the bank lending channel as documented in prior literature. More importantly, the transmission effect of monetary policy weakens as the Lerner index rises, indicating that higher market concentration and lower competition reduce the effectiveness of monetary policy through the lending channel.

Hence, promoting greater competition strengthens the ability of monetary policy to stabilize business cycles. Similar results are obtained when the H-H index, CR3, and CR5 are employed, showing that increases in market concentration weaken the lending channel. Even after incorporating interactions between bank characteristics and monetary policy, the conclusion remains robust: higher competition enhances the effectiveness of monetary policy transmission.

From a policy perspective, the findings have important implications. In the post-global financial crisis era, under the Basel III framework, regulators have implemented macroprudential policies requiring banks to raise capital to enhance financial stability. This development has triggered growing attention to the potential consequences of macroprudential policies for bank competition. Empirical studies such as Mirzaei and Moore (2021), Scalco et al. (2021), and Li (2022) document that capital-related regulations and structural constraints tend to weaken competition, while González (2022) finds that higher capital adequacy requirements for systemically important financial institutions strengthen the market power of large banks, thereby raising barriers to entry and reducing overall competition. In Taiwan, following the designation of five banks as domestic systemically important banks (D-SIBs) in 2019 and the addition of First Bank in 2020, the Financial Supervisory Commission (FSC) has mandated a gradual increase in their minimum capital requirements. While these measures are intended to improve resilience against unexpected shocks and enhance systemic stability, they may simultaneously raise market concentration and reduce competition, which in turn could weaken the ability of monetary policy to stabilize the economic cycle. Thus, policymakers must carefully balance the trade-off between enhancing financial stability through macroprudential regulation and preserving the effectiveness of monetary policy transmission through maintaining adequate levels of bank competition.

Table 1: Monetary policy and bank competition

estimate	L1	L2	L3
β	-0.094(0.327)***	- 0.134(0.037)***	-0.122(0.039)***
γ_1	-0.106(0.093)	-0.108(0.091)	-0.106(0.092)
γ_2	-0.051(0.028)*	- 0.072(0.026)***	-0.067(0.024)***
ϕ	0.377(0.194)*	0.387(0.176)**	0.367(0.178)**
η_1	0.108(0.095)	0.096(0.100)	0.096(0.099)
η_2	0.118(0.071)*	0.146(0.058)**	0.142(0.060)**
λ	-0.103(0.065)	-0.101(0.070)	-0.122(0.080
ρ	3.008(0.923)***	2.318(0.913)**	2.469(1.006)**
δ	0.282(0.257)	0.239(0.159)	0.213(0.183)
υ_1	0.012(0.007)*	0.010(0.006)	0.010(0.006)
υ_2	0.007(0.004)*	0.007(0.004)*	0..006(0.004)*
ω_1	0.018(0.016)	0.018(0.015)	0.016(0.015)
ω_2	0.011(0.014)	0.013(0.012)	0.011(0.012)
ξ_1	0.001(0.001)	0.002(0.001)	0.002(0.001) *
ξ_2	0.001(0.003)	0.002(0.002)	0.002(0.002)
α	-0.228(0.143)	-0.228(0.134) *	-0.230(0.132) *
Hansen test	0.853	0.996	0.942
AR(1)/AR(2)	0.006/0.206	0.012/0.178	0.008/0.226

Note: In the parentheses are standard deviations. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. AR(1) and AR(2) represent first-order and second-order autocorrelation tests on the regression residuals. The Hansen test and the AR(1)/AR(2) statistics correspond to the p-values of the tests.

Table 2: Monetary policy, bank competition and financial crisis

estimate	L1	L2	L3
β	-0.188(0.072)***	-0.137(0.040)***	-0.126(0.043)***
γ_1	-0.146(0.113)	-0.147(0.127)	-0.146(0.124)
γ_2	-0.102(0.047)**	-0.119(0.065)*	-0.114(0.064)*
ϕ	0.423(0.155)***	0.398(0.185)**	0.406(0.185)***
η_1	0.154(0.133)	0.097(0.100)	0.098(0.100)
η_2	0.146(0.036)***	0.141(0.057)**	0.137(0.059)**
λ	-0.090(0.040)**	-0.108(0.074)	-0.128(0.084)
ρ	2.064(0.934)**	2.392(0.963)**	2.551(1.051)**
δ	0.206(0.260)	0.215(0.188)	0.188(0.212)
υ_1	0.009(0.003)***	0.005(0.004)	0.006(0.005)
υ_2	0.007(0.002)***	0.005(0.002)**	0.004(0.002) *
ω_1	0.019(0.010)*	0.009(0.010)	0.008(0.011)
ω_2	0.015(0.011)	0.010(0.010)	0.008(0.010)
ξ_1	0.003(0.002)	0.003(0.002)	0.003(0.002)
ξ_2	0.002(0.003)	0.001(0.002)	0.001(0.002)
α	-0.245(0.099)**	-0.207(0.117)*	-0.209(0.116)*
Crisis dummy	0.057(0.096)	0.128(0.165)	0.126(0.159)
Hansen test	0.998	0.997	0.995
AR(1)/AR(2)	0.001/0.110	0.012/0.156	0.008/0.184

Table 3: Monetary policy, bank competition and financial crisis

estimate	L1	L2	L3
β	-0.085(0.035)**	-0.143(0.035)***	-0.123(0.037)***
γ_1	-0.150(0.089)*	-0.158(0.096)*	-0.161(0.097)*
γ_2	-0.172(0.144)	-0.167(0.094)*	-0.173(0.096)*
ϕ	0.418(0.199)**	0.476(0.182)***	0.493(0.188)***
η_1	0.169(0.130)	0.148(0.150)	0.152(0.146)
η_2	0.114(0.060)*	0.143(0.053)***	0.135(0.054)**
λ	-0.097(0.061)	-0.116(0.068)*	-0.133(0.073)*
ρ	3.085(0.793)***	2.694(0.789)***	2.846(0.879)***
δ	0.216(0.297)	0.258(0.163)	0.238(0.180)
υ_1	0.006(0.004)	0.004(0.007)	0.004(0.008)
υ_2	0.005(0.004)	0.004(0.005)	0.004(0.005)

ω_1	0.028(0.015)*	0.033(0.019)*	0.033(0.018)*
ω_2	0.028(0.018)	0.042(0.023)*	0.042(0.021)**
ξ_1	0.003(0.003)	0.001(0.004)	0.001(0.004)
ξ_2	0.006(0.004)	0.008(0.005)*	0.008(0.004)*
α	-0.256(0.133)*	-0.296(0.153)*	-0.306(0.156)**
Crisis dummy	0.094(0.128)	0.059(0.096)	0.076(0.097)
Hansen test	0.620	0.294	0.304
AR(1)/AR(2)	0.004/0.910	0.006/0.803	0.005/0.967

Table 4: Monetary policy and bank characteristics

estimate	L1	L2	L3
β	-0.140(0.049)***	-0.183(0.045)***	-0.177(0.050)***
γ_1	-0.083(0.050)*	-0.083(0.038)**	-0.087(0.038)**
γ_2	0.038(0.028)	0.015(0.028)	0.020(0.027)
λ	-0.010(0.027)	0.002(0.038)	-0.004(0.036)
ρ	2.280(0.683)***	1.973(0.834)**	1.973(0.839)**
δ	0.211(0.283)	0.027(0.190)	0.026(0.188)
σ_1	0.008(0.012)	0.010(0.011)	0.010(0.011)
σ_2	0.025(0.012)**	0.025(0.010)**	0.024(0.009)***
τ_1	-0.495(0.571)	-0.549(0.600)	0.533(0.595)
τ_2	0.527(0.125)***	0.473(0.135)***	0.471(0.138)***
ς_1	-0.825(0.604)	-0.986(0.583)*	-0.999(0.582)*
ς_2	-0.062(0.154)	-0.134(0.138)	-0.116(0.135)
υ_1	0.013(0.005)***	0.009(0.004)**	0.010(0.004)***
υ_2	0.009(0.003)***	0.008(0.003)***	0.009(0.003)***
ω_1	0.031(0.014)**	0.030(0.011)***	0.031(0.011)***
ω_2	0.017(0.011)	0.017(0.008)**	0.018(0.008)**
ξ_1	0.001(0.001)	0.002(0.001)*	0.002(0.001)*
ξ_2	0.002(0.003)	0.003(0.002)	0.003(0.002)
α	-0.068(0.048)	-0.048(0.033)	-0.053(0.033)
Hansen test	0.906	0.609	0.711
AR(1)/AR(2)	0.086/0.419	0.073/0.261	0.078/0.173

Table 5: Monetary policy, bank competition and bank characteristics

estimate	L1	L2	L3
β	-0.067(0.034)**	-0.086(0.043)**	-0.086(0.042)**
γ_1	-0.075(0.078)	-0.051(0.069)	-0.044(0.071)

γ_2	-0.082(0.036)**	-0.114(0.030)***	-0.101(0.031)***
ϕ	0.345(0.139)**	0.349(0.113)***	0.397(0.133)***
η_1	0.080(0.125)	0.030(0.120)	0.028(0.116)
η_2	0.166(0.091)*	0.210(0.072)***	0.216(0.079)***
λ	-0.093(0.049)*	-0.871(0.053)*	-0.119(0.068)*
ρ	2.628(0.985)***	1.871(0.904)**	2.332(1.072)**
δ	0.255(0.252)	0.180(0.163)	0.225(0.181)
σ_1	-0.004(0.023)	0.004(0.022)	0.006(0.021)
σ_2	-0.012(0.014)	-0.018(0.012)	-0.022(0.013)*
τ_1	-0.285(0.384)	-0.375(0.416)	-0.305(0.377)
τ_2	0.339(0.169)**	0.390(0.186)**	0.257(0.187)
ς_1	-0.513(0.385)	-0.727(0.375)*	-0.685(0.340)*
ς_2	0.206(0.130)	0.222(0.140)	0.148(0.138)
υ_1	0.010(0.005)*	0.008(0.005)	0.008(0.005)*
υ_2	0.007(0.004)*	0.005(0.003)*	0.005(0.003)*
ω_1	0.016(0.014)	0.0142(0.011)	0.010(0.012)
ω_2	0.009(0.012)	0.010(0.009)	0.005(0.010)
ξ_1	0.001(0.001)	0.002(0.001)	0.001(0.001)
ξ_2	0.001(0.002)	0.002(0.002)	0.001(0.002)
α	-0.204(0.105)*	-0.196(0.086)**	-0.212(0.089)**
Hansen test	0.998	0.997	0.990
AR(1)/AR(2)	0.004/0.327	0.007/0.394	0.004/0.373

Table 6: Monetary policy, bank competition and H-H index

estimate	L1	L2	L3
β	-0.124(0.054)***	-0.123(0.053)**	-0.106(0.059)*
γ_1	-10.77(3.123)***	-9.306(3.238)***	-9.064(3.345)***
γ_2	4.241(3.591)	2.161(3.776)	2.296(3.942)
ϕ	18.31(7.498)**	19.48(7.181)***	20.24(7.669)***
η_1	187.1(53.16)***	162.1(55.08)***	157.9(56.82)***
η_2	-72.31(61.21)	-36.79(64.32)	-39.18(67.09)
λ	0.001(0.030)	-0.002(0.039)	-0.005(0.038)
ρ	2.280(0.646)***	2.369(0.763)***	2.468(0.782)***
δ	0.080(0.181)	0.020(0.149)	0.016(0.163)
υ_1	0.021(0.011)*	0.016(0.012)	0.016(0.013)
υ_2	0.006(0.005)	0.004(0.005)	0.004(0.005)

ω_1	-0.016(0.013)	-0.019(0.013)	-0.019(0.014)
ω_2	0.017(0.020)	0.010(0.020)	0.010(0.021)
ξ_1	0.005(0.002)***	0.005(0.002)***	0.005(0.002)***
ξ_2	-0.005(0.003)**	-0.003(0.003)	-0.004(0.003)
α	-1.002(0.398)**	-1.037(0.376)***	-1.079(0.395)***
Hansen test	0.534	0.592	0.489
AR(1)/AR(2)	0.061/0.783	0.054/0.954	0.051/0.934

Table 7: Monetary policy, bank competition and CR3

estimate	L1	L2	L3
β	-0.115(0.057)**	-0.112(0.056)**	-0.104(0.062)*
γ_1	-5.079(1.980)***	-4.790(2.073)**	-4.483(2.090)**
γ_2	3.900(2.510)	3.658(2.536)	3.743(2.477)
ϕ	2.181(1.211)*	2.527(1.155)**	2.730(1.225)**
η_1	17.96(6.873)***	16.92(7.200)**	15.82(7.249)**
η_2	-13.81(8.780)	-12.99(8.862)	-13.31(8.646)
λ	-0.007(0.030)	-0.019(0.041)	-0.023(0.042)
ρ	2.383(0.559)***	2.410(0.764)***	2.470(0.774)***
δ	0.075(0.209)	-0.001(0.170)	-0.014(0.181)
υ_1	0.012(0.009)	0.010(0.009)	0.009(0.009)
υ_2	0.006(0.003)*	0.005(0.003)*	0.005(0.004)
ω_1	-0.006(0.013)	-0.007(0.130)	-0.007(0.013)
ω_2	0.017(0.018)	0.018(0.018)	0.018(0.018)
ξ_1	0.002(0.001)	0.002(0.001)*	0.002(0.002)
ξ_2	-0.005(0.002)**	-0.004(0.003)*	-0.004(0.002)**
α	-0.575(0.311)*	-0.659(0.299)**	-0.711(0.311)**
Hansen test	0.683	0.518	0.571
AR(1)/AR(2)	0.067/0.864	0.061/0.871	0.061/0.936

Table 8: Monetary policy, bank competition and CR5

estimate	L1	L2	L3
β	-0.111(0.057)*	-0.110(0.057)*	-0.101(0.062)
γ_1	-8.293(2.569)***	-7.717(2.655)***	-7.260(2.700)***
γ_2	2.404(3.066)	1.364(3.111)	1.310(3.181)
ϕ	1.941(1.047)*	2.205(0.992)**	2.374(1.045)**
η_1	20.02(6.080)***	18.65(6.287)***	17.55(6.383)***

η_2	-5.723(7.257)	-3.260(7.365)	-3.143(7.521)
λ	-0.009(0.030)	-0.021(0.041)	-0.025(0.041)
ρ	2.399(0.560)***	2.414(0.766)***	2.477(0.778)***
δ	0.079(0.214)	-0.001(0.173)	-0.013(0.184)
υ_1	0.015(0.010)	0.126(0.010)	0.012(0.010)
υ_2	0.004(0.003)	0.003(0.003)	0.003(0.003)
ω_1	-0.022(0.013)*	-0.024(0.013)*	-0.024(0.013)*
ω_2	0.008(0.019)	0.003(0.003)	0.004(0.019)
ξ_1	0.004(0.001)***	0.005(0.002)***	0.004(0.001)***
ξ_2	-0.005(0.003)*	-0.004(0.003)	-0.004(0.003)
α	-0.729(0.391)*	-0.818(0.372)**	-0.880(0.385)**
Hansen test	0.645	0.553	0.540
AR(1)/AR(2)	0.069/0.889	0.062/0.852	0.062/0.960

Table 9: Monetary policy, bank competition, bank characteristics and H-H index

estimate	L1	L2	L3
β	-0.150(0.056)***	-0.149(0.044)***	-0.140(0.049)***
γ_1	-11.37(3.321)***	-9.955(3.424)***	-9.717(3.519)***
γ_2	2.833(3.630)	0.507(3.967)	0.551(4.108)
ϕ	20.25(7.594)***	21.62(7.384)***	22.81(7.802)***
η_1	198.4(57.04)***	174.5(58.67)***	170.3(60.21)***
η_2	-47.96(61.94)	-8.195(67.67)	-9.023(70.02)
λ	0.005(0.031)	0.003(0.039)	-0.003(0.038)
ρ	2.248(0.670)***	2.342(0.800)***	2.355(0.839)***
δ	-0.060(0.230)	-0.156(0.210)	-0.167(0.213)
σ_1	0.012(0.012)	0.013(0.011)	0.014(0.011)
σ_2	0.027(0.011)**	0.026(0.011)**	0.027(0.011)**
τ_1	-0.377(0.603)	-0.476(0.582)	-0.461(0.578)
τ_2	0.547(0.142)***	0.476(0.138)***	0.477(0.146)***
ς_1	-0.903(0.614)	-1.056(0.590)*	-1.067(0.588)*
ς_2	-0.109(0.168)	-0.190(0.153)	-0.168(0.152)
υ_1	0.019(0.011)*	0.013(0.012)	0.013(0.013)
υ_2	0.005(0.004)	0.002(0.004)	0.002(0.005)
ω_1	-0.020(0.013)	-0.023(0.014)*	-0.023(0.014)
ω_2	0.012(0.020)	0.004(0.020)	0.004(0.021)
ξ_1	0.006(0.002)***	0.006(0.002)***	0.006(0.002)***
ξ_2	-0.004(0.003)	-0.003(0.003)	-0.003(0.003)

α	-1.089(0.395)***	-1.127(0.375)***	-1.192(0.390)***
Hansen test	0.509	0.845	0.494
AR(1)/AR(2)	0.079/0.174	0.056/0.479	0.057/0.336

Table 10: Monetary policy, bank competition, bank characteristics and CR3

estimate	L1	L2	L3
β	-0.139(0.061)**	-0.135(0.047)***	-0.127(0.053)**
γ_1	-5.766(2.202)***	-5.547(2.196)**	-5.248(2.218)**
γ_2	3.428(2.562)	3.005(2.609)	3.120(2.532)
ϕ	2.251(1.199)*	2.506(1.104)**	2.708(1.193)**
η_1	20.52(7.709)***	19.75(7.671)***	18.68(7.740)**
η_2	-12.12(8.962)	-10.65(9.119)	-11.08(8.836)
λ	-0.004(0.033)	-0.012(0.042)	-0.016(0.042)
ρ	2.315(0.705)***	2.300(0.774)***	2.343(0.832)***
δ	-0.570(0.260)	-0.160(0.225)	-0.171(0.228)
σ_1	0.012(0.012)	0.012(0.010)	0.013(0.010)
σ_2	0.028(0.011)**	0.027(0.011)**	0.027(0.010)***
τ_1	-0.392(0.610)	-0.498(0.603)	-0.483(0.597)
τ_2	0.539(0.154)***	0.469(0.171)***	0.459(0.181)**
ς_1	-0.895(0.614)	-1.038(0.586)*	-1.050(0.585)*
ς_2	-0.107(0.148)	-0.175(0.143)	-0.153(0.142)
υ_1	0.011(0.009)	0.009(0.009)	0.009(0.010)
υ_2	0.006(0.003)*	0.005(0.003)	0.004(0.003)
ω_1	-0.007(0.013)	-0.009(0.013)	-0.009(0.013)
ω_2	0.017(0.018)	0.017(0.018)	0.017(0.018)
ξ_1	0.003(0.002)*	0.003(0.001)**	0.003(0.002)*
ξ_2	-0.004(0.002)**	-0.004(0.002)*	-0.004(0.002)*
α	-0.587(0.301)*	-0.645(0.274)**	-0.696(0.290)**
Hansen test	0.755	0.871	0.563
AR(1)/AR(2)	0.083/0.231	0.058/0.620	0.059/0.437

Table 11: Monetary policy, bank competition, bank characteristcis and CR5

estimate	L1	L2	L3
β	-0.136(0.061)***	-0.133(0.047)***	-0.125(0.053)**
γ_1	-9.358(2.992)***	-8.940(2.926)***	-8.492(2.975)***
γ_2	1.206(3.374)	-0.027(3.500)	-0.038(3.557)

ϕ	1.943(1.015)*	2.115(0.921)**	2.285(0.990)**
η_1	22.69(7.145)***	21.71(6.975)***	20.63(7.078)***
η_2	-2.830(8.003)	0.105(8.305)	0.116(8.427)
λ	-0.005(0.032)	-0.013(0.042)	-0.017(0.042)
ρ	2.324(0.706)***	2.305(0.777)***	2.349(0.837)
δ	-0.051(0.265)	-0.157(0.227)	-0.168(0.231)
σ_1	0.011(0.012)	0.012(0.010)	0.013(0.010)
σ_2	0.028(0.011)**	0.027(0.011)**	0.027(0.010)***
τ_1	-0.398(0.069)	-0.502(0.602)	-0.488(0.596)
τ_2	0.538(0.153)***	0.466(0.172)***	0.455(0.183)**
ς_1	-0.889(0.615)	-1.032(0.587)*	-1.044(0.585)*
ς_2	-0.104(0.148)	-0.172(0.143)	-0.150(0.142)
υ_1	0.015(0.010)	0.012(0.010)	0.012(0.011)
υ_2	0.004(0.003)	0.002(0.003)	0.002(0.004)
ω_1	-0.026(0.014)*	-0.029(0.014)**	-0.029(0.014)**
ω_2	0.004(0.020)	0.001(0.019)	0.001(0.020)
ξ_1	0.005(0.002)***	0.005(0.002)***	0.005(0.002)***
ξ_2	-0.004(0.003)	-0.003(0.003)	-0.003(0.003)
α	-0.715(0.371)*	-0.765(0.334)**	-0.829(0.352)**
Hansen test	0.741	0.776	0.596
AR(1)/AR(2)	0.085/0.249	0.058/0.642	0.059/0.458

Author Contributions: All authors contributed to this research.

Funding: Not applicable.

Conflict of Interest: The authors declare no conflict of interest.

Informed Consent Statement/Ethics Approval: Not applicable.

Declaration of Generative AI and AI-assisted Technologies: This study has not used any generative AI tools or technologies in the preparation of this manuscript.

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