Volume 44, Issue 2

The effect of capital empowerment on the lending competence of banks: Evidence from segmental analysis

Phu Quang Tran
Ho Chi Minh National Academy of Politics Hanoi, Vietnam

Anh Phan
Banking Academy of Vietnam Hanoi, Vietnam

Dung V. Tran
Banking Academy of Vietnam Hanoi, Vietnam

Mohamad H. Shahrour
College of Business, Accounting & Finance Department, University of Doha for Science and Technology

Abstract

This paper investigates how bank capital affects the lending behavior, and whether this relationship varies with bank size. We examine a large sample of US bank holding companies and we document consistent evidence that well-capitalized banks are more likely to increase loan growth, especially with real estate loans, commercial and industrial loans and loans for individuals. However, this positive effect is not uniform across bank sizes. In particular, during the crisis, medium and large banks do not show this positive effect, while small banks do. Besides, our study contributes to the understanding of the impacts of capital on bank lending after the crisis, as we document one of the first pieces of evidence indicating the absence of a relationship between lending and capital for banks of all sizes during this period. Our results are of interest to regulators and policymakers when implementing policy actions and regulations regarding bank size, especially during uncertainty times. For instance, policymakers can use this information to design and implement policies that promote capital adequacy in the banking sector, which can contribute to a more robust and stable lending environment.

1. Introduction

Following the crisis of 2007-2009, characterized by bank failures and subsequent economic recessions, various explanations have been put forth to account for the turmoil. Among these, regulatory inefficiencies, elevated debt levels, and inadequate capital buffers have emerged as commonly cited factors (Hugonnier and Morellec, 2017). In response to this, several initiatives have emphasized the importance of robust capital buffers and a stable funding structure as critical requirements for facilitating the financial intermediation functions of banks.

This paper aims to analyze the impact of capital on bank lending. This topic has garnered considerable attention since the 2000s, with studies such as Kishan and Opiela (2000) laying the foundation. The importance of this inquiry persists among regulators and policymakers due to the observations made prior to the crisis of 2007-2009. During this period, there was a significant surge in bank credit and asset prices without corresponding evidence of an improvement in borrower quality (Acharya and Richardson, 2009). The subsequent sharp decline in asset volume and prices had a detrimental effect on the real sector.

The existing body of literature extensively explores the topic of bank capital and its implications. Adequate capital buffers have been found to play a crucial role in banks' ability to withstand negative shocks, absorb losses resulting from the liquidation of assets to meet debt obligations (Distinguin et al., 2013), and reduce the likelihood of failure (Coval and Thakor, 2005; Berger and Bouwman, 2013). Additionally, research on banking relationships suggests that lending behaviors are closely tied to the capital structure of banks. Specifically, banks with high capital buffers are better positioned to maintain lending relationships with firms experiencing temporary financial difficulties (Gambacorta and Mistrulli, 2004; Albertazzi and Gambacorta, 2009; Gambacorta and Marques-Ibanez, 2011; Bolton et al., 2016).

In the aftermath of the global financial crisis, regulatory authorities have placed significant emphasis on strengthening the capital and liquidity management of banks, as well as enhancing the overall stability of the banking system. These efforts have led to the development of frameworks aimed at improving the quality of bank capital and enhancing liquidity within the banking sector. In order to comply with these new standards, banks are required to enhance their capital buffers and make adjustments to their balance sheet structures, thereby improving the liquidity of their assets and the stability of their funding (Roulet, 2018). However the question on how banks adjust their balance sheets in response to various capital regulation changes remains unclear (Aiyar et al., 2014; Gropp et al., 2019).

Banks that possess sufficient funding liquidity are less susceptible to liquidity crunches and other liquidity-related issues. However, a consequence of these regulatory measures is that banks may exhibit more caution in originating new credits in order to meet the higher capital and liquidity requirements. Consequently, some argue that there may be a negative relationship between bank capital and lending, as the increased regulatory demands may lead to a reduction in credit availability. The two aforementioned strands of literature are not mutually exclusive. In this study, our primary goal is to examine the specific impact of bank capital on lending. To achieve this objective, we employ a comprehensive and extensive database of banking institutions, specifically focusing on the sample of US bank holding companies (BHC) from the period spanning 2000:Q1 to 2015:Q4. By utilizing this rich dataset, we aim to provide a thorough analysis of the relationship between bank capital and lending, shedding light on the dynamics and implications within the US banking sector during the specified time frame.

Building on existing literature, our study focuses on investigating the behavior of bank lending using the growth rate of loans as a proxy (Cornett et al., 2011; Ibrahim and Rizvi, 2017; Kim and Sohn, 2017). The key variable of interest in our analysis is the capital ratio (CAPITAL), which is calculated as the ratio of the book value of equity to gross total assets. By controlling for various bank characteristics and incorporating bank- and time-fixed effects, we consistently find evidence that well-capitalized banks exhibit higher loan growth rates.

Furthermore, we extend our analysis to explore the effects of capital on different loan components. Our findings indicate that well-capitalized banks tend to expand their loan portfolios in

the areas of real estate loans, commercial and industrial loans, and loans for individuals. This highlights the influence of bank capital on shaping the composition of lending activities across various sectors.

We contribute to the existing literature by providing robust evidence of the positive relationship between bank capital and loan growth, while also examining the specific impact of capital on different loan categories. These findings enhance our understanding of the role of capital in driving lending behaviors and shed light on the implications for bank management and regulators.

After establishing the positive relationship between loan growth and well-capitalized banks, we delve deeper into our analysis by conducting additional tests to explore potential variations in the effects of capital on lending under different circumstances. Specifically, we investigate the influence of bank size on this relationship.

Drawing on prior literature, we recognize that small banks tend to focus more on traditional banking activities, while large banks are more inclined to engage in non-traditional activities (Tran et al., 2019). Our findings reveal that well-capitalized and medium-sized banks are more likely to experience an increase in loan growth compared to their well-capitalized and small-sized counterparts. Interestingly, we do not observe a significant impact of capital on lending for the sample of large banks.

This analysis suggests that the relationship between capital and lending is influenced by the size of the bank. Well-capitalized and medium-sized banks appear to be more responsive to capital levels, resulting in higher loan growth, whereas large banks may be subject to other factors that mitigate the effect of capital on lending.

Furthermore, we examine the effects of the crisis on bank lending behavior, considering the potential difficulties and increased probabilities of failure that banks may face during such times. During crises, banks often adopt a cautious approach, prioritizing liquidity hoarding and capital protection, which can limit their ability to extend new loans. However, it is important to note that governments are more likely to intervene and reinforce safety nets for banks during periods of turmoil, recognizing the potential adverse consequences of bank failures.

Our findings indicate that banks with higher levels of capitalization exhibit an increase in loan growth, although the magnitude of this effect varies. Specifically, we observe that the positive impact of capital on lending is lowest during the crisis period and highest in the post-crisis period. Furthermore, we identify variations in this relationship across different bank sizes. Interestingly, during the crisis, we do not find any significant relationship between capital and lending for medium and large banks, but we do observe such a relationship for small banks. This observation emphasizes the amplification of the roles of capital and small banks during periods when businesses require additional funds to survive.

Our study contributes to the existing literature in several ways. Firstly, it adds to the bank capital literature by providing a comprehensive investigation into the effects of capital structure on bank lending decisions. The main results highlight that well-capitalized banks are more inclined to expand their loan growth, with this effect being particularly pronounced in small and medium-sized banks. Secondly, our study contributes to the understanding of the impacts of capital on bank lending after the crisis, as we document one of the first pieces of evidence indicating the absence of a relationship between lending and capital for banks of all sizes during this period.

Section 2 provides a detailed description of the data utilized in our analysis. Section 3 presents the main finding. Additional investigations are presented in Section 4. Section 5 concludes the article.

2. Data and Methodology

To conduct our analysis, we obtain data of US banks from the Y-9C reports. The data covers the period from 2000:Q1 to 2015:Q4. We remove bank-quarter observations with missing or incomplete financial data related to accounting variables. Consistent with prior studies (Berger and Bouwman, 2013; Tran and Ashraf, 2018; and Tran et al., 2019), we handle observations with a capital ratio of less than 1% by replacing them with 1%. This approach helps prevent distortion in ratios that involve equity when the capital ratio is extremely low. We exclude observations with negative or non-existent outstanding loans or deposits from our analysis. All financial ratios used in our analysis are winsorized at the 1% level, to mitigate the potential impact of outliers.

In this study, we employ a multivariate analysis to investigate the influence of bank capital on lending behavior, while accounting for other relevant control variables. Our empirical model is specified as follows:

$$Y_{it} = \alpha + CAPITAL_{it-1} + Z_{it-1} + \theta_t + \varepsilon_{it} \tag{1}$$

where Y_{it} is the measure of the bank lending behavior of bank i at time t. To capture the lending behavior of banks accurately, we employ various proxies in our analysis. Firstly, we measure the quantity of lending by using the growth rate of loans, which is a commonly used proxy in previous studies (Cornett et al., 2011; Ibrahim and Rizvi, 2017; Kim and Sohn, 2017). This serves as our primary measure of lending behavior. Additionally, we examine the quality of bank lending by investigating credit risk indicators, such as the credit risk of loans and the total risk of banks, in our robustness testing. These measures provide insights into the riskiness of the lending activities undertaken by banks. Our variable of interest is the bank capital (CAPITAL), which is defined as the ratio of book value of equity over gross total assets. Z_{it} is the vector of control variables that may influence bank lending behavior. To examine the impact of capital on bank lending, we control for several time-varying bank-specific factors, as suggested by prior literature (Tran, 2019; Tran, 2020). These factors include the size of the bank (SIZE), bank performance indicators (EARNINGS), and a binary indicator for losses (DUM_LOSS). We also incorporate variables that capture the bank's business model (NII) and funding structure (DEPOSIT) to control for differences across banks. Furthermore, we include a control variable related to the quality of the bank's loan portfolio. This is measured by the ratio of non-performing loans (NPL) over the total loans, which provides an indicator of loan quality. ε_{it} is the error term.

To account for information lags in the public availability of balance sheet data, we include the lag of one period for all explanatory variables, including CAPITAL and other control variables. This adjustment ensures that we consider the time delay in the availability of balance sheet information. To control for macroeconomic conditions that may affect banks' lending behavior uniformly, we incorporate time-fixed effects (θ_t) in our analysis. These effects allow us to capture and control for common macroeconomic factors experienced by all banks over time.

Given the potential correlation of CAPITAL within a bank over time, we address potential issues of heteroscedasticity and clustering at the bank level when assessing the significance of our results. This ensures robust statistical inference and accounts for potential dependencies within banks over time. By employing these methodological considerations, we aim to provide reliable and rigorous analysis of the relationship between bank capital and lending behavior, while mitigating any potential biases or confounding factors.

Table 1. Variables Definitions

This table presents definitions of all main variables used in the analysis.

Variables	Definitions
LENDING	The growth rate of loans
CAPITAL	Book value of equity over gross total assets
SIZE	Natural logarithm of bank assets
DUM_LOSS	A dummy variable that equals one if net income is negative, and zero otherwise
EARNINGS	Income before taxes, provisions recognized in income over gross total assets
NII	Non-interest incomes over the net operating incomes
NPL	The ratio of non-performing loans
DEPOSIT	The ratio of total deposits over gross total assets

3. Does bank capital affect lending behavior?

3.1. Main findings

Table 3 presents the main findings of our analysis, focusing on the relationship between bank capital and lending behavior. In Model (1), we observe a significant and positive coefficient on CAPITAL at the 1% level. Specifically, a one standard deviation increase in CAPITAL leads to a 0.5 basis point increase in bank lending, holding all other variables constant, suggesting a substantial and economically meaningful relationship between bank capital and lending. Banks with higher capital buffers are more inclined to expand their loan growth, demonstrating the importance of capital adequacy in facilitating lending activities. This finding aligns with the notion that well-capitalized

banks have greater capacity to support lending and provide financing to borrowers. The significance of the coefficient on CAPITAL reinforces the notion that bank capital plays a crucial role in determining lending behavior. By maintaining a larger capital buffer, banks are better positioned to meet regulatory requirements, absorb potential losses, and mitigate risks, thereby fostering a conducive environment for increased lending. Overall, the results emphasize the importance of capital adequacy for banks' lending activities and highlighting the role of capital as a key driver of bank lending decisions.

Table 2. Summary Statistics

This table reports summary statistics for the main sample of U.S. commercial banks used in the analysis. All financial variables are winsorized at 1% and 99% levels. Panel A reports the descriptive statistics of the employed variables while Panel B reports the Pearson pairwise correlation matrix.

Panel A:

Variables	N	Mean	Std.Deviation	Min	Max
Lending	60,919	0.020	0.045	(0.090)	0.224
Capital	60,919	0.090	0.029	0.019	0.220
Size	60,919	13.603	1.245	12.089	19.109
Earnings	60,919	0.016	0.009	(0.020)	0.051
DUM_LOSS	60,919	0.078	0.268	-	1.000
NII	60,919	0.226	0.130	0.000	0.814
Deposit	60,919	0.652	0.111	0.194	0.843
NPL	60,919	0.015	0.019	-	0.118

Panel B:

	LENDING	CAPITAL	SIZE	EARNINGS	DUM_LOSS	NII	DEPOSIT
Capital	0.0071***	1					
Size	-0.0326***	0.0501***	1				
Earnings	0.1074***	0.2562***	0.0667***	1			
DUM_LOSS	-0.1956***	-0.1286***	0.0580***	-0.4786***	1		
NII	-0.0176***	0.0666***	0.3807***	0.1480***	0.0096***	1	
Deposit	-0.0211***	-0.0583***	-0.3223***	-0.0253***	-0.0857***	-0.1954***	1
NPL	-0.3121***	-0.0707***	0.1054***	-0.3116***	0.4815***	0.0244***	-0.0718***

In Model (2), we employ a quartile ranking approach for the CAPITAL variable, creating a variable called CAPITAL_DQRT that ranges from 1 (lowest) to 4 (highest) quartile. This allows for greater variation in the distribution of bank capital, enhancing our analysis (Tran et al., 2024). We find a positive and significant coefficient on CAPITAL_DQRT, reaffirming the positive relationship between bank capital and lending.

Our findings indicate that well capitalized banks are more inclined to expand their loan growth, which contributes to the relevance of capital adequacy. One may have concerns a higher capital ratio may not be associated with higher capital adequacy due to the risk appetite of banks (i.e. risk-weighted-assets). Hence, in Model (3), we use TIER1, the ratio of Tier 1 capital to risk-weighted-assets as our explanatory variable. We obtain similar findings, indicating that banks with higher capital adequacy are more likely to expand loan growth.[1]

Including additional control variables in our analysis, such as macroeconomic indicators and economic uncertainty measures, is essential for capturing potential omitted and correlated variables that may influence lending behavior. In Model (4), we address this concern by incorporating variables such as UNEMPLOYMENT, EPU (economic policy uncertainty) based on Baker et al. (2016), as well as other economic uncertainty variables including VXO (implied volatility index), SD_PROFIT (cross-sectional standard deviations of profit growth), and GDP_FORE (GDP forecast data) as suggested by Tran (2020). By including these control variables, we are able to account for the potential impact of macroeconomic conditions and economic uncertainty on bank lending decisions. Despite the introduction of these additional factors, we continue to observe a positive relationship between bank capital and lending, indicating that well-capitalized banks are more inclined to increase their loan growth. This robustness check further strengthens our findings and provides more confidence in the positive effect of bank capital on lending behavior.

---

[1] CAPITAL and TIER1 are highly correlated (corr=0.7402***). In unreported tests, we also use alternative measures such as the ratio of Tier 1 capital to total assets, the total capital to risk-weighted-assets, and still find similar findings.

Table 3. Baseline Multivariate Analysis

This table reports regression estimates of the relation between LENDING and CAPITAL. The main independent variable is CAPITAL. All regressions include bank-, and time- (quarter) fixed effects. All financial variables are winsorized at the 1% and 99% levels. ***, **, * indicate significance at the 1%, 5%, and 10% level respectively. Standard errors are clustered at the bank level. Numbers in parentheses are t-statistics.

	Baseline model	CAPITAL_DQRT	TIER1	Additional variables	Excluding M&A	Excluding Crisis	Lag 2	Annual data	Balanced data
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Capital	0.177***	1.470**	0.148***	0.179***	0.120***	0.200***	0.058***	0.691***	0.097*
	(0.026)	(0.595)	(0.016)	(0.026)	(0.022)	(0.027)	(0.017)	(0.153)	(0.057)
Deposit	0.011*	0.258*	0.012*	0.012*	0.016***	0.010	-0.002***	-0.081**	0.031**
	(0.006)	(0.146)	(0.006)	(0.006)	(0.006)	(0.007)	(0.000)	(0.036)	(0.014)
Size	-0.029***	-0.484***	-0.028***	-0.030***	-0.020***	-0.027***	0.000	-0.179***	-0.016***
	(0.002)	(0.046)	(0.002)	(0.002)	(0.002)	(0.002)	(0.000)	(0.011)	(0.004)
Earnings	-0.182***	-3.617***	-0.163***	-0.183***	-0.184***	-0.221***	-0.191***	-0.647*	-0.065
	(0.047)	(1.347)	(0.047)	(0.048)	(0.043)	(0.053)	(0.043)	(0.358)	(0.095)
DUM_LOSS	-0.010***	-0.153***	-0.009***	-0.010***	-0.010***	-0.010***	-0.013***	-0.062***	-0.014***
	(0.001)	(0.040)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.006)	(0.002)
NII	0.010**	0.532***	0.008*	0.010**	0.008*	0.007	0.015***	0.017***	0.006
	(0.005)	(0.123)	(0.005)	(0.005)	(0.004)	(0.005)	(0.003)	(0.005)	(0.008)
NPL	-0.584***	-10.842***	-0.597***	-0.587***	-0.567***	-0.568***	-0.001	-1.835***	-0.605***
	(0.026)	(0.965)	(0.025)	(0.026)	(0.025)	(0.027)	(0.004)	(0.130)	(0.075)
Unemployment				-0.002					
				(0.096)					
EPU				-0.012***					
				(0.002)					
GDP_FORE				-0.001					
				(0.001)					
VXO				-0.000					
				(0.000)					
SD(Profit)				0.011***					
				(0.002)					
Constant	0.405***	8.743***	0.385***	0.431***	0.282***	0.374***	0.052***	2.523***	0.236***
	(0.027)	(0.629)	(0.027)	(0.030)	(0.025)	(0.028)	(0.007)	(0.153)	(0.055)
Obs	60,919	41,784	60,844	60,251	60,166	54,106	58,729	13,122	10,782
Adj.R2	0.168	0.020	0.170	0.169	0.182	0.162		0.321	0.152
BFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
QFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

In Model (5), we specifically address concerns regarding potential biases in our sample by excluding banks that have engaged in merger and acquisition (M&A) activities. We identify these banks based on their growth rate of assets over a quarter, and we exclude those with a growth rate higher than 20%. This exclusion allows us to mitigate any potential bias introduced by banks that may have different lending behaviors due to their involvement in M&A activities. By excluding these banks from our analysis, we ensure that our results are not driven by the lending activities of acquiring banks, which could differ from the lending behavior of other banks. Importantly, we find that the exclusion of M&A banks does not alter our main findings, and we continue to observe a positive relationship between bank capital and lending behavior. This additional analysis confirms that the relationship between bank capital and lending holds even when excluding banks involved in M&A activities.

In Model (6), we acknowledge the specificity of the crisis period, as addressed by prior research (Tran et al, 2024; Tran, 2020; Shahrour et al. 2021), and its potential impact of the financial crisis of 2007-2009 on the banking environment and the possibility of structural breaks in lending decisions and capital ratios during that period. To address this concern, we exclude the crisis period from our analysis and re-estimate our model using data from other time periods. By doing so, we aim to capture the lending behavior and its relationship with bank capital in a relatively stable economic environment. Despite excluding the crisis period, we find that our results remain qualitatively similar, indicating a consistent positive relationship between bank capital and lending decisions. This analysis further supports our main findings and suggests that the positive relationship between bank capital and lending is not solely driven by the period of financial crisis, but holds true even in other time periods with relatively stable economic conditions.

To assess the robustness of our findings, in Model (7), we introduce a lag of two periods for all explanatory variables, and similar results persist across different lag specifications. Additionally, in Model (8), we utilize annual data instead of quarterly data, while in Model (9), we employ balanced panel data to mitigate the potential influence of bank defaults and M&A activities, albeit with the caveat of potential over-representation of "successful" banks (Tran et al., 2020). The results remain robust and consistent across these alternative specifications.

In brief, we document the positive effect of bank capital on lending decisions. We find that well-capitalized banks are more likely to increase their loan growth, emphasizing the significance of capital adequacy in facilitating lending activities. These findings contribute to the existing literature and provide valuable insights into the relationship between bank capital and lending behavior.

3.2. Loan components

In this section, we focus on analyzing the association between bank lending decisions and their capital at the level of loan components. While the previous section demonstrated a positive and significant impact of bank capital on overall lending growth, it is important to understand how this relationship varies across different loan categories. To achieve this, we extend our baseline model to include different components of the bank loan portfolio. We analyze the growth rates of specific loan categories and examine their relationship with bank capital. The results of this analysis are presented in Table 4, which provides valuable insights into the effects of bank capital on individual loan components. By examining the loan components separately, we can gain a better understanding of how well-capitalized banks allocate their lending across different sectors. This information is of particular interest to policymakers and researchers who want to assess the impact of bank capital on specific areas of the economy.

Table 4 presents the findings of our analysis, highlighting the association between bank capital and the growth rates of various loan components. The results shed light on the differential effects of bank capital on different loan categories and provide further insights into the relationship between capital and lending decisions, and thus contributing to a more comprehensive understanding of the role of bank capital in shaping lending behavior across different sectors of the economy.

Our analysis reveals interesting findings regarding the association between bank capital and the growth rates of different loan components. Specifically, we find that well-capitalized banks tend to increase their loan growth in sectors such as real estate, commercial and industrial, and loans for individuals. This suggests that banks with a higher capital buffer are more willing to extend credit in these sectors.

Table 4. Loan components

This table reports regression estimates of the effect of CAPITAL on different components of loan portfolio. The main independent variable is CAPITAL. All regressions include bank-, and time- (quarter) fixed effects. All financial variables are winsorized at the 1% and 99% levels. ***, **, * indicate significance at the 1%, 5%, and 10% level respectively. Standard errors are clustered at the bank level. Numbers in parentheses are t-statistics.

	Real estate Loan	Agricultural Loan	Commercial and Industrial Loan	Loans to individuals	Loan to foreign government and institutions	Loan to Depository institutions
	(1)	(2)	(3)	(4)	(5)	(6)
Capital	0.175***	-0.006	0.289***	0.125***	0.944	-1.804**
	(0.027)	(0.115)	(0.041)	(0.047)	(1.662)	(0.807)
Deposit	0.006	0.004	-0.002	-0.016	-1.134**	0.330
	(0.006)	(0.031)	(0.011)	(0.012)	(0.546)	(0.235)
Size	-0.030***	-0.016*	-0.025***	-0.030***	-0.206	-0.100
	(0.002)	(0.009)	(0.003)	(0.003)	(0.149)	(0.069)
Earnings	-0.167***	-0.535*	-0.383***	-0.042	-1.947	-0.386
	(0.052)	(0.310)	(0.087)	(0.124)	(3.293)	(2.024)
DUM_LOSS	-0.009***	-0.011	-0.011***	-0.010***	-0.122	-0.031
	(0.001)	(0.008)	(0.002)	(0.002)	(0.084)	(0.055)
NII	0.006	0.051*	0.020**	0.008	-0.234	0.403**
	(0.005)	(0.027)	(0.009)	(0.011)	(0.285)	(0.188)
NPL	-0.598***	-0.492***	-0.568***	-0.285***	1.187	0.306
	(0.026)	(0.131)	(0.045)	(0.048)	(1.953)	(1.194)
Constant	0.416***	0.286**	0.347***	0.417***	4.343	1.551
	(0.029)	(0.122)	(0.040)	(0.046)	(2.760)	(1.109)
Obs	60,770	44,498	60,800	60,720	923	5,321
Adj.R2	0.148	0.036	0.040	0.027	0.060	0.018
BFE	Yes	Yes	Yes	Yes	Yes	Yes
QFE	Yes	Yes	Yes	Yes	Yes	Yes

Table 5. The effects of bank size

The table reports regression estimates of the relation between LENDING and CAPITAL across bank's size rages (under $1B, between $1B - $5B, over $5B). All financial variables are winsorized at the 1% and 99% levels. ***, **, * indicate significance at the 1%, 5%, and 10% level respectively. Standard errors are clustered at the bank level. Numbers in parentheses are t-statistics.

	Residual size	Size decile	Excluding Top 10th	Excluding TBTF	Small	Medium	Large
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Capital	0.195***	0.198***	0.186***	0.177***	0.165***	0.236***	0.064
	(0.025)	(0.026)	(0.028)	(0.026)	(0.029)	(0.064)	(0.094)
Deposit	0.024***	0.025***	0.011*	0.011*	0.015**	0.004	0.002
	(0.007)	(0.007)	(0.007)	(0.006)	(0.008)	(0.014)	(0.020)
Size	-0.005**		-0.030***	-0.029***	-0.035***	-0.053***	-0.041***
	(0.002)		(0.002)	(0.002)	(0.002)	(0.005)	(0.008)
Earnings	-0.351***	-0.295***	-0.213***	-0.182***	-0.329***	0.067	0.004
	(0.056)	(0.049)	(0.050)	(0.047)	(0.057)	(0.084)	(0.131)
DUM_LOSS	-0.012***	-0.010***	-0.009***	-0.010***	-0.008***	-0.008***	-0.013***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.003)
NII	0.000	0.017***	0.010**	0.010**	0.009*	0.006	0.009
	(0.008)	(0.004)	(0.005)	(0.005)	(0.005)	(0.009)	(0.016)
NPL	-0.600***	-0.598***	-0.586***	-0.584***	-0.598***	-0.589***	-0.638***
	(0.025)	(0.025)	(0.026)	(0.026)	(0.028)	(0.058)	(0.119)
Constant	0.005	0.003	0.404***	0.405***	0.461***	0.763***	0.698***
	(0.005)	(0.006)	(0.027)	(0.027)	(0.033)	(0.066)	(0.135)
Obs	59,085	60,919	55,779	60,919	41,568	14,543	4,808
Adj.R2	0.156	0.154	0.175	0.168	0.159	0.219	0.132
BFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
QFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The differential effects across loan sectors could be explained by various factors, including the margin and risk associated with lending in each sector. It is possible that banks perceive lending in real estate, commercial and industrial, and individual sectors to be more profitable or less risky, leading them to allocate more resources to these areas.

However, we do not observe any significant effect of bank capital on loans for agricultural and foreign government and institutions sectors. This could be due to specific characteristics of these sectors, such as their unique risk profiles or lower profitability, which may make them less attractive for well-capitalized banks. Interestingly, our analysis also shows that banks with higher capital buffers tend to decrease their lending to depository institutions. This finding suggests that banks prioritize allocating their capital towards other sectors rather than lending to other financial institutions.

Overall, these results highlight the heterogeneity in the relationship between bank capital and loan growth across different loan sectors. The findings suggest that the impact of capital on lending decisions is influenced by various factors specific to each sector, such as profitability, risk, and market conditions.

4. Additional Investigations

4.1. The effect of bank size

In this section, we explore the impact of bank size on the relationship between bank capital and lending, using additional approaches. The results are presented in Table 5.

In Model (1), we decompose bank size into two components to mitigate the autocorrelation effect. The first component captures the organic growth of the bank, while the second component represents the historical size of the bank. By orthogonalizing bank size with respect to other variables, we can examine the actual impact of size on the relationship between capital and lending. In Model (2), we incorporate size-decile fixed effects based on the approach used by Ellul and Yerramilli (2013). We further refine our analysis by excluding the top 10 largest banks in Model (3) and all too-big-to-fail (TBTF) banks with assets exceeding $100 billion in Model (4) to address concerns related to outliers. Notably, we obtain similar results across all specifications.

Existing literature suggests that bank size can influence lending decisions and market perceptions of bank risk. Small banks often focus on lending to small businesses that rely heavily on bank loans, while large banks tend to engage in non-interest generating activities in addition to traditional banking activities. Given these differences, we hypothesize that the effect of capital on lending would be more pronounced for small banks compared to larger banks.

Consistent with this hypothesis, our analysis, following the approach of Berger et al. (2016), Tran et al. (2024), and Tran et al. (2019), examines the relationship between capital and lending for different bank size ranges: small banks with assets under $1 billion, medium banks with assets between $1 billion and $5 billion, and large banks with assets over $5 billion. We find that the coefficients on CAPITAL are positive for all bank size ranges, but statistically significant only in Model (5) for small banks and Model (6) for medium banks. This indicates that well-capitalized and medium-sized banks are more likely to increase their loan growth compared to well-capitalized small banks. Interestingly, we do not observe a significant effect of capital on lending for the sample of large banks.

Overall, our findings suggest that the impact of capital on lending behavior varies across different bank size ranges. Well-capitalized and medium-sized banks exhibit a stronger relationship between capital and loan growth, while the effect is not statistically significant for large banks in our sample. These results highlight the importance of considering bank size when examining the relationship between capital and lending. However, we acknowledge that there may be other factors that affect the lending behavior of banks; Higher bank capital positively impacts consumer lending due to its profitability and lower regulatory constraints compared to other loans (Berrospide and Edge, 2010; Menicucci and Paolucci, 2016).

4.2. The effect of the crisis

In this section, we focus on analyzing how the relationship between bank lending and capital changes during crisis periods. While our previous analysis excluded the crisis period, we now include it in our study to gain insights into how banks manage their capital and adjust their lending decisions during times of financial turmoil. Our period of study covers the crisis period from 2007:Q3 to 2009:Q2, following the approach of Acharya and Mora (2015).

Table 6. The effects of the crisis

The table reports regression estimates of the relation between LENDING and CAPITAL before, during and after the crisis, and across bank size. All financial variables are winsorized at the 1% and 99% levels. ***, **, * indicate significance at the 1%, 5%, and 10% level respectively. Standard errors are clustered at the bank level. Numbers in parentheses are t-statistics.

	Full sample			Before crisis			During crisis			After crisis		
	Before crisis	During crisis	After crisis	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Capital	0.230***	0.177***	0.367***	0.263***	0.233**	-0.219	0.167**	0.169	0.329	0.397***	0.281***	0.539**
	(0.036)	(0.026)	(0.048)	(0.041)	(0.104)	(0.174)	(0.081)	(0.122)	(0.209)	(0.058)	(0.092)	(0.241)
Deposit	0.019**	0.011*	0.028*	0.025**	0.016	0.015	-0.000	0.004	-0.070	0.053**	0.003	0.021
	(0.009)	(0.006)	(0.016)	(0.010)	(0.019)	(0.033)	(0.025)	(0.034)	(0.056)	(0.023)	(0.028)	(0.061)
Size	-0.042***	-0.029***	-0.043***	-0.042***	-0.079***	-0.077***	-0.119***	-0.130***	-0.156***	-0.030***	-0.084***	-0.072***
	(0.003)	(0.002)	(0.006)	(0.004)	(0.009)	(0.013)	(0.015)	(0.020)	(0.030)	(0.009)	(0.012)	(0.022)
Earnings	-0.406***	-0.182***	-0.333***	-0.621***	0.099	0.352	-0.092	0.065	-0.077	-0.286***	-0.328**	-0.642*
	(0.077)	(0.047)	(0.079)	(0.082)	(0.186)	(0.317)	(0.118)	(0.119)	(0.167)	(0.094)	(0.139)	(0.382)
DUM_LOSS	-0.008***	-0.010***	-0.003**	-0.009***	-0.009**	0.008	-0.005**	-0.006**	-0.006	0.000	-0.005*	-0.009
	(0.002)	(0.001)	(0.001)	(0.002)	(0.005)	(0.011)	(0.002)	(0.002)	(0.005)	(0.002)	(0.003)	(0.006)
NII	0.006	0.010**	0.003	0.010	0.018	-0.013	0.011	0.035**	0.017	0.011	-0.019	0.075**
	(0.007)	(0.005)	(0.008)	(0.008)	(0.017)	(0.026)	(0.011)	(0.016)	(0.026)	(0.008)	(0.015)	(0.036)
NPL	-0.641***	-0.584***	-0.397***	-0.596***	-0.881***	-1.129**	-0.542***	-0.488***	-0.872***	-0.340***	-0.496***	-0.281*
	(0.056)	(0.026)	(0.040)	(0.057)	(0.181)	(0.537)	(0.052)	(0.101)	(0.182)	(0.047)	(0.079)	(0.152)
Constant	0.568***	0.405***	0.570***	0.541***	1.123***	1.317***	1.596***	1.871***	2.627***	0.337***	1.206***	1.144***
	(0.040)	(0.027)	(0.085)	(0.048)	(0.129)	(0.222)	(0.208)	(0.284)	(0.515)	(0.123)	(0.175)	(0.367)
Obs	39,359	60,919	13,028	30,283	6,627	2,449	4,392	3,187	953	6,893	4,729	1,406
Adj. R2	0.071	0.168	0.121	0.074	0.115	0.098	0.200	0.280	0.255	0.115	0.171	0.106
BFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
QFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

During banking crises, banks face heightened difficulties and an increased probability of failure. As a result, they tend to adopt more prudent measures, such as rationing credit and holding larger amounts of cash and liquid assets. These actions may come at the expense of their ability to make new loans. However, it is worth noting that during times of turmoil, governments are more likely to intervene and strengthen the safety nets for banks to mitigate the potential adverse effects of bank failures.

The banking crisis would be a unique occasion to analyze how banks effectively manage their capital when experiencing difficulties and higher probabilities of failure, and how banks adjust their lending decisions (Tran, 2020). By prudent, they are more likely to ration credit, and hold more cash and more liquid assets, in detriment of their capability to make new loans. However, during turmoil times, government is more likely to intervene to reinforce the safety nets of banks, due to the potential detriment effects of bank failures.

In line with the methodology employed by Tran et al. (2019) and Shahrour et al. (2021, 2022), we conduct a distinct analysis of the impact of LENDING in three distinct time periods: pre-crisis (2000:Q1-2007:Q2), during the crisis (2007:Q3-2009:Q2), and post-crisis (2009:Q3-2015:Q4). Table 6 reports our main findings.

The estimated coefficients on CAPITAL exhibit a positive and statistically significant association with LENDING before, during, and after the crisis, as evidenced by Model (1) to (3). This indicates that better-capitalized banks demonstrate an inclination towards increasing their loan growth, albeit with varying degrees of magnitude. Notably, the positive effect of capital on lending is observed to be the weakest during the crisis period and becomes the strongest in the post-crisis era.

Moreover, our analysis reveals that the relationship between capital and lending decisions is contingent upon bank size, as demonstrated in Models (4) to (12). Prior to the crisis, we find statistically significant positive coefficients on CAPITAL for small and medium banks, but not for large banks. Interestingly, during the crisis period, we do not observe any significant association between CAPITAL and LENDING for medium and large banks, but a significant positive relationship exists for small banks. This outcome emphasizes the heightened role of capital and small banks in facilitating lending activities during times of economic turmoil when businesses require additional financial support to sustain their operations.

In the post-crisis period, we find a positive and statistically significant relationship between CAPITAL and LENDING across all size classes. Notably, the effect is most pronounced for large banks, followed by small banks, while medium-sized banks exhibit the lowest magnitude of impact. This suggests that larger banks, which possess substantial capital buffers, are particularly inclined to expand their loan portfolios compared to their smaller counterparts, while medium-sized banks display a relatively moderate response.

Overall, our findings underscore the nuanced relationship between bank capital and lending decisions, considering both the impact of the financial crisis and the influence of bank size.

5. Conclusions

Using a sample of US banks, this study examines the impact of bank capital on lending behaviors. The findings indicate that well-capitalized banks are more likely to experience an increase in loan growth, particularly in the case of real estate loans, commercial and industrial loans, and loans for individuals. However, the effect of capital on lending varies across different bank size categories. For small and medium banks, higher levels of capital have a positive impact on loan growth. Furthermore, this positive effect becomes more pronounced as bank size increases. Conversely, the effect of capital on lending for large banks is either insignificant or negligibly positive. Interestingly, during the financial crisis period, when the

real economy requires additional funding for survival, the positive effect of capital on lending is not observed for medium and large banks, which are typically significant players in the credit market. Instead, the positive relationship between capital and lending is primarily found in small banks. These findings have important implications for regulators and policymakers, particularly in relation to bank size and the implementation of policy actions and regulations during turbulent economic times.

Overall, this study provides valuable theoretical insights and practical implications to promote a stable and efficient banking system.

In terms of theoretical contribution, firstly, it extends the existing literature by examining the relationship between bank capital and lending behaviors across different loan components. By specifically analyzing different sectors and types of loans, the study sheds light on the heterogeneity of the impact of bank capital on different types of lending. This adds depth to our understanding of how bank capital influences specific sectors of the economy through lending activities. Furthermore, the study contributes to the literature by considering the role of bank size in the relationship between capital and lending. By examining small, medium, and large banks separately, besides addressing different periods (i.e., pre-crisis, crisis, and post-crisis periods) the study reveals that the effect of capital on lending is not uniform across different bank size categories, and economic periods. This finding highlights the importance of taking into account bank size when analyzing the relationship between capital and lending decisions.

In terms of practical implications, our study offers valuable insights for regulators, policymakers, and banking practitioners. Firstly, the positive relationship between well-capitalized banks and increased loan growth underscores the importance of maintaining adequate levels of bank capital. Policymakers can use this information to design and implement policies that promote capital adequacy in the banking sector, which can contribute to a more robust and stable lending environment. Additionally, regulators can tailor their policies to address the specific lending needs and challenges faced by different sectors and bank sizes. For instance, during times of crisis, policymakers can focus on supporting small banks, which have demonstrated a positive relationship between capital and lending in such periods. This is also supported by the latest regional banks failure in 2023.

Disclosure
The authors have no conflict of interest to declare.

References

Acharya, Viral, and Hassan Naqvi, 2012, The seeds of a crisis: A theory of bank liquidity and risk taking over the business cycle, *Journal of Financial Economics* 106, 349–366.

Acharya, Viral V., and Nada Mora, 2015, A Crisis of Banks as Liquidity Providers, *The Journal of Finance* 70, 1–43.

Acharya, Viral V., and Matthew Richardson, 2009, Causes of the Financial Crisis, *Critical Review* 21, 195–210.

Aiyar, S., C. Calomiris, J. Hooley, Y. Korniyenko, and T. Wieladek, 2014, The international transmission of bank capital requirements: Evidence from the U.K. *Journal of Financial Economics* 113, 368–82.

Albertazzi, Ugo, and Leonardo Gambacorta, 2009, Bank profitability and the business cycle, *Journal of Financial Stability* 5, 393–409.

Baker, Scott R., Nicholas Bloom, and Steven J. Davis, 2016, Measuring Economic Policy Uncertainty, *The Quarterly Journal of Economics* 131, 1593–1636.

Berger, Allen N., and Lamont K. Black, 2011, Bank size, lending technologies, and small business finance, *Journal of Banking & Finance* 35. Australasian Finance Conference: Global financial crisis, international financial architecture and regulation, 724–735.

Berger, Allen N., and Christa H. S. Bouwman, 2013, How does capital affect bank performance during financial crises?, *Journal of Financial Economics* 109, 146–176.

Berger, Allen N., and Christa HS Bouwman, 2009, Bank liquidity creation, *Review of Financial Studies* 22, 3779–3837.

Berger, A., and G. Udell, 1994, Did risk-based capital allocate bank credit and cause a "credit crunch" in the United States? *Journal of Money, Credit and Banking* 26, 585–628.

Berger, Allen N., Sadok El Ghoul, Omrane Guedhami, and Raluca A. Roman, 2016, Internationalization and Bank Risk, *Management Science* 63, 2283–2301.

Bolton, Patrick, Xavier Freixas, Leonardo Gambacorta, and Paolo Emilio Mistrulli, 2016, Relationship and Transaction Lending in a Crisis, *The Review of Financial Studies* 29, 2643–2676.

Bonfim, Diana, and Qinglei Dai, 2017, Bank Size and Lending Specialisation, *Economic Notes* 46, 329–380.

Berrospide, J. M., 2011,. Effects of Bank Capital on Lending: What Do We Know, and What Does It Mean?, *DIANE Publishing*.

Cornett, Marcia Millon, Jamie John McNutt, Philip E. Strahan, and Hassan Tehranian, 2011, Liquidity risk management and credit supply in the financial crisis, *Journal of Financial Economics* 101, 297–312.

Coval, Joshua D., and Anjan V. Thakor, 2005, Financial intermediation as a beliefs-bridge between optimists and pessimists, *Journal of Financial Economics* 75, 535–569.

De Jonghe, Olivier, 2010, Back to the basics in banking? A micro-analysis of banking system stability, *Journal of Financial Intermediation* 19. Risk Transfer Mechanisms and Financial Stability, 387–417.

Diamond, Douglas W., and Raghuram G. Rajan, 2001, Liquidity Risk, Liquidity Creation, and Financial Fragility: A Theory of Banking, *Journal of Political Economy* 109, 287–327.

Distinguin, Isabelle, Caroline Roulet, and Amine Tarazi, 2013, Bank regulatory capital and liquidity: Evidence from US and European publicly traded banks, *Journal of Banking & Finance* 37, 3295–3317.

Ellul, Andrew, and Vijay Yerramilli, 2013, Stronger Risk Controls, Lower Risk: Evidence from U.S. Bank Holding Companies, *The Journal of Finance* 68, 1757–1803.

Gambacorta, Leonardo, and David Marques-Ibanez, 2011, The bank lending channel: lessons from the crisis, *Economic Policy* 26, 135–182.

Gambacorta, Leonardo, and Paolo Emilio Mistrulli, 2004, Does bank capital affect lending behavior?, *Journal of Financial Intermediation* 13, 436–457.

Gatev, Evan, and Philip E. Strahan, 2006, Banks' advantage in hedging liquidity risk: Theory and evidence from the commercial paper market, *The Journal of Finance* 61, 867–892.

Gropp, R., T. Mosk, S. Ongena, and C. Wix, 2019, Banks Response to Higher Capital Requirements: Evidence from a Quasi-Natural Experiment, *Review of Financial Studies* 32(1),266-299.

Hugonnier, Julien, and Erwan Morellec, 2017, Bank capital, liquid reserves, and insolvency risk, *Journal of Financial Economics* 125, 266–285.

Ibrahim, Mansor H., and Syed Aun R. Rizvi, 2017, Bank lending, deposits and risk-taking in times of crisis: A panel analysis of Islamic and conventional banks, *Emerging Markets Review*.

Kim, Dohan, and Wook Sohn, 2017, The effect of bank capital on lending: Does liquidity matter?, *Journal of Banking & Finance* 77, 95–107.

Kishan, Ruby P., and Timothy P. Opiela, 2000, Bank Size, Bank Capital, and the Bank Lending Channel, *Journal of Money, Credit and Banking* 32, 121–141.

Menicucci, E., & Paolucci, G., 2016, The determinants of bank profitability: empirical evidence from European banking sector, *Journal of financial reporting and Accounting*, 14(1), 86-115.

Roulet, Caroline, 2018, Basel III: Effects of capital and liquidity regulations on European bank lending, *Journal of Economics and Business* 95. Research in European Banking and Finance, 26–46.

Shahrour, Mohamad H., Girerd-Potin, Isabelle, Taramasco, Ollivier, 2021, Corporate social responsibility and firm default risk in the Eurozone: A market-based approach, *Managerial Finance* 47 (7), 975–997.

Shahrour, Mohamad H., Girerd-Potin, Isabelle, Taramasco, Ollivier, 2022, Corporate Social Responsibility and Firm Default Risk Mitigation: The Moderating Role of the Legal Context. *Finance Contrôle Stratégie* 25-1.

Tran, Dung Viet, and Badar Nadeem Ashraf, 2018, Dividend policy and bank opacity, *International Journal of Finance & Economics* 23, 186–204.

Tran, Dung Viet, Kabir M. Hassan, and Reza Houston, 2019, Activity strategies, information asymmetry, and bank opacity, *Economic Modelling* 83, 160–172.

Tran, Dung Viet, M. Kabir Hassan, and Reza Houston, 2020, Discretionary loan loss provision behavior in the US banking industry, *Review of Quantitative Finance and Accounting* 55, 605–645.

Tran, Dung Viet, N Hussain, DK Nguyen, TD Nguyen, 2024, How do depositors respond to banks' discretionary behaviors? Evidence from market discipline, deposit insurance, and scale effects. *International Review of Financial Analysis* 93,103205.