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Three essays in banking

usury law, climate risk and bank equity capital

Three Essays in Banking: Usury Law, Climate Risk and Bank Equity Capital

By

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Abstract

This dissertation consists of three essays in the field of banking. Chapter 1 examines the effects of interest rate deregulation on banks. Exploiting the passage of Gramm-Leach-Bliley Act, I find that the removal of state interest rate ceiling in Arkansas motivates Arkansas-chartered banks reallocating lending to riskier categories of loan. As a result, the deregulation increases the marginal cost and credit risk of the Arkansas-chartered banks. This finding highlights a caveat to interest rate deregulation. Yet, contrary to the key objective of the deregulation, I find no evidence that the deregulation on interest rate enhances local bank competition.

Chapter 2 studies the heterogeneous effects of natural disasters on local banks and national banks. Local banks may better support communities weathering the shocks with their specialized local knowledge and relationship, but they could be vulnerable to the limited geographic diversification. Exploiting natural disasters in the US in 2018-2019, I find that natural disasters affect local banks and national banks banks differently in terms of deposit-taking and lending. Natural disasters increase (decrease) deposits supply of local (national) banks, leading to an increase (decrease) in deposit volume and lower (higher) deposit rate. The deposit allocation is particularly pronounced in counties with higher social connectedness. With the additional deposit supply, local banks increase more loan supply after natural disasters.

Chapter 3 investigates the role of bank's equity capital in affecting loan terms. Employing the syndicated loan data set of US borrowers in 1996-2015, I find a non-linear relationship between banks' equity capital and the amount of loans they produce. Both high-capitalized and low-capitalized banks originate facilities with higher amount, but low (high)-capitalized banks originate loans with more (less) stringent loan terms, driven by the matching between higher credit risk borrowers and lower-capitalized lenders.

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Author's declaration

I declare that the work in this dissertation was carried out in accordance with the requirements of the University's Regulations and Code of Practice for Research Degree Programmes and that it has not been submitted for any other academic award. Except where indicated by specific reference in the text, the work is the candidate's own work. Work done in collaboration with, or with the assistance of, others, is indicated as such. Any views expressed in the dissertation are those of the author.

Signed: *Jiaxuan Wang*

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Table of Contents

List of Tables

Table **Page**

LIST OF FIGURES

FIGURE **Page**

Chapter 1

Interest rate deregulation and bank lending: an empirical study in Arkansas

1.1 Introduction

Usury law, one of the oldest and ubiquitous forms of financial regulation in the US history, prohibits loans at excessive interest rates by setting limits on interest rate that lenders can charge. While it is an important question to address the impacts of usury law on bank lending, limited studies examined an all-rounded effects of the usury laws on bank lending, e.g.,Bodenhorn (2007); Temin and Voth (2008); Benmelech and Moskowitz (2010); Rigbi (2013). Empirical evidence is rare because it requires an exogenous change in usury limit and a comparable group of banks that is not affected by the change.

This chapter employs an unique provision of the US Gramm-Leach-Bliley Act (GLBA) in 1999 as an appealing setting to study the effects of reversal of usury laws on bank lending. The key and nationally applicable objective of the GLBA is removing barriers of commercial banks, imposed by the Glass–Stegall Act of 1933, combining securities companies, and insurance companies to form financial conglomerates (Akhigbe and Whyte, 2004; Ellul and Yerramilli, 2013). Additional to this key objective, Section 731 of the Gramm-Leach-Bliley Act (GLBA) directly targets the state with the strictest usury limit, Arkansas, to remove its usury limit. Because the act only affects the usury limit of Arkansas-chartered banks, it allows me to assess the impacts of the removal of usury cap by comparing the change in lending behaviours between Arkansas-chartered banks and the other banks after the passage of the Act. This chapter also employs a matching technique to ensure that the banks (Arkansas and non-Arkansas chartered banks) in the sample are equally affected by all components of the GLBA, apart from the impacts on usury limit of

Arkansas-chartered banks.

Under this setting, this chapter examines three questions. First, I investigate the relation between relaxation of usury law and bank lending. Although an extremely restrictive usury law is less common nowadays in developed countries such as the US, Japan and Canada, it still wildly exists in different parts of the world, especially in countries such as Sub-Saharan Africa, Latin America and the Caribbean (Maimbo and Henriquez Gallegos, 2014). This question is policy-relevant in evaluating the potential cost of usury law in affecting lending. Second, I evaluate whether the reverse of usury law imposes threat to bank soundness and profitability. The result provides an insight to policy makers when they consider abandoning the usury law, to a less extent adjusting the ceiling of the usury limit. Lastly, I examine the effect of the reverse of usury law on the competition of the banking system. The finding reveals a conceivably unintended effect of the usury law.

The empirical analysis shows that the reversal of usury law does not affect total lending of banks, but it contributes to a reallocation among different categories of loan. The results suggest that construction and land development loans of Arkansas-chartered banks decrease, while their commercial and industrial lending records increase after the reversal of usury limit.

While Arkansas-chartered banks do not increase total lending following the deregulation, the charge-off ratio of Arkansas-chartered banks increases and the Z-score of Arkansas-chartered banks decreases after the reversal of usury law. It highlights the pitfall of the deregulation. Before the deregulation, the origination of risky lending by Arkansas-chartered banks is largely restricted by the usury limit. Therefore, the relaxation of usury limit allows them to originate risky lending and exposes them under greater risk. The chapter also finds that the reversal of usury law reduces the profitability of Arkansas-chartered banks.

I also identify a novel effect of usury law on bank competition. Before the passage of Gramm-Leach-Bliley Act, only non-Arkansas-chartered banks could originate loans with a rate exceeding the usury ceiling in Arkansas. From another perspective, this group of banks residing in Arkansas was more like oligopoly in supplying riskier loans. Arkansas-chartered banks did not have any power to compete with this group of banks. After the reversal of usury law, I find that the Lerner index of Arkansas-chartered banks even slightly decreases. The decrease is not strongly significant, statistically speaking, because both the price and marginal cost of Arkansas-chartered banks significantly increase after the reversal of usury law.

This chapter contributes to following strands of literature, namely the impact of the usury law on banks, real economic activities, and social welfare. For the rest of the section, I go through literature related to the study.

The effects of usury regulation on banking sector have remained controversial. Several scholars in the 20th century argue that usury caps have damaging consequences and that this conclusion applies to both the prohibition of interest as well as to limitations on maximum rates. Tawney (1960); Weber and Kalberg (2013) argue that the Catholic Church's restrictions on interest slowed capital accumulation and growth. Ekelund Jr et al. (1989) examine medieval restrictions on maximum interest rates, finding that lower interest rates served to extract rents from lenders. In addition, Wesson (2001) points out that some states set strict limitations on interest rates to protect their citizens, however, have proven harmful to banks. Bank can only provide credit to those customers who meet the risk guidelines for a loan that charges the restrictive legal interest rate, so they cannot charge a higher rate to provide credit to high-risk customers. Meanwhile, theses ceilings are preventing some lenders from raising rates commensurate with the increase in their cost of funds (Federal Reserve Bank of Chicago, 1983).

In terms of lending, with a binding price ceiling, total quantity transaction should theoretically be reduced (Friedman, 2021). In this case, interest rate ceiling is expected to reduce total lending. Empirical evidence supports this theoretical expectation (Robins, 1974; Peterson, 1983; Benmelech and Moskowitz, 2010). Some scholars point out that the usury limits influence the allocation of credit. Temin and Voth (2008) examine the effects of interest rate restrictions on loan allocation after the British government tightened the usury laws in 1714, finding significant re-distributive effects in London credit markets. However, Alessie et al. (2005) provide a conflicting result that credit allocation did not change markedly after the change in the law by studying the introduction of legal maxima on interest rates for consumer credit in Italy in 1996. In the meanwhile, another question which draws the attention is which type of borrowers are more adversely affected by the credit rationing? Are there even some borrowers can benefit from the usury law? Benmelech and Moskowitz (2010) find that small, risky borrowers who are likely the first to be credit rationed. Those who can obtain credit at low rates (e.g., large, collateralized borrowers with established reputations) can even be benefited by the lower cost of capital. In other words, the middle- and upper-income groups benefit from a legal limit on interest rates and, yet, they do not have to worry about being prohibited from obtaining a loan. Therefore, usury limits lower lending activities, particularly for small, risky borrowers, and it may have effect on allocation of credits.

Although there is evidence that the usury law reduces total quantity of lending, I cannot conclude that the interest rate ceiling will unfavourably affect the real economic activities. Potential borrowers might be capable to find alternative ways to circumvent the usury law such as borrowing from neighbour states. Considering the extra transaction cost involved in the circumvention of the law, it is still very likely that the usury law has negative impact on the real economy. Most of the literature which study the concern with usury laws, have examined their effect on mortgage loans, and most of the findings have focused on home building. Majority of the studies find that building permits to be severely affected by usury limits (Austin and Lindsley, 1976; Robins, 1974; Rosen, 1975; Ostas, 1976; France, 1975; Brophy, 1970). Brophy (1970) insists that in states where usury ceilings lie below market interest rates, there is a significant reduction in the level of home-building. Dahl et al. (1977); Yandle and Proctor (1978) also support the negative impact of rate ceilings on mortgage loans and housing construction markets. However, McNulty (1979) finds that usury limits had very little effect on building permits but did significantly reduce loan volume. There are some evidences that usury laws have the effect of squeezing first time home buyers and/or low wealth, low income, low job-stability individuals out of the home buying market (Boyes and Roberts, 1981). Brimmer (1968) has taken a similar position stating: the adverse effects of usury ceilings-while most evident in the behaviour of lenders are particularly harsh on builders of new houses.

Apart from the effects of the usury law on commercial activities, the interest limit, at the same time, restricts the access to credit of individuals, and restricts the low-income, less wealthy individual for accessing credits (Boyes and Roberts, 1981). There are a few empirical literatures on the effects of access to credit on borrowers. Some of the studies find that access to credit exacerbates individual financial distress (Skiba and Tobacman, 2019; Melzer, 2011; Carrell and Zinman, 2014). These findings suggest that psychological biases lead consumers to do themselves more harm than good when handling expensive liquidity, and hence that restricting access will help consumers by preventing overborrowing. But several other studies suggest otherwise. They find that, on average, access to risky consumer loans helps borrowers make productive investments, broadly defined: smoothing negative expenditure shocks (Wilson et al., 2010; Morse, 2015), preventing negative income shocks (Karlan and Zinman, 2009), or otherwise managing liquidity to alleviate financial distress (Morgan and Strain, 2008). These findings suggest that restricting access will harm borrowers by preventing them from financing valuable consumption smoothing and investment opportunities.

This chapter is proceeded as follows. Section 1.2 describes the institutional background that the changes in the Arkansas usury law in its historical content, and Section 1.3 introduces testable predictions. Section 1.4 describes the methodology and the data, respectively. Section 1.5 introduces the matching procedure. The regression results are presented in Section 1.6. Section 1.7 concludes.

1.2 Institutional background

Nearly every US state imposed an usury on loans at some point in its history. In 1978, 48 states and the District of Columbia had statutory limits on interest rates (Boyes and Roberts, 1981). Even nowadays, the legal cap of interest rate still commonly exists in many states, such as Illinois, District of Columbia, Washington etc. The continuing controversy over an appropriate rate limit has been likely to remain an issue over at least the last 100 years. While various states have different restrictions on usury limit, some of them are more lenient, some of them are relatively harsh. Arkansas is undoubtedly one of the states with a harsher usury restriction. In an attempt to remedy banking problems brought by the strict usury laws, state legislatures have repeatedly changed state usury laws.

In Arkansas, the 1874 constitution set the usury limit at 10% and it did not vary with the type of loan or its terms, which was a high ceiling at that time, because the prime rate was fluctuating between 9% and 11% by September of that year. The relatively high prime rates in this period put banks and other lending institutions under tremendous pressure. It simply was not profitable to lend money at 10% in Arkansas when the same money could earn the market rate in other states that were not hampered by a strict usury law (Galchus et al., 1989).

Amendment 60 was passed in 1982 and provided that the interest rate on consumer loans as well as business loans could be a maximum of 5% points per annum above the federal discount rate. However, in 1987-1988, the prime rate experienced a slow upward drift. By the end of 1988, the maximum rate under Amendment 60 was only one percentage point higher than the prime rate. This made Arkansas being the state having the strictest usury law compared to its neighbouring states (Galchus and Vibhakar, 2002). For example, Oklahoma limited business loans to 45% interest. In Missouri, there was no usury limit. Texas had a set of ceilings for different kinds of loans without setting the usury limit. In addition, Tennessee's usury rate was 24% and Kansas caped interest at 15% (Wesson, 2001).

Later, after the passage of Riegle-Neal Interstate Banking and Branching Efficiency Act in 1994, national-chartered banks were able to export the usury limit from their home state to other states. In other words, branches in Arkansas of out-of-state banks would not be constrained by the residing state's usury law, while Arkansas-chartered banks would be constrained. Obviously, banks based in Arkansas would be at a competitive disadvantage compared with branches of their out-of-state rivals.

As an inconspicuous part of the Gramm-Leach-Bliley Act (GLBA) which was enacted on 12th November 1999, the GLBA allowed Arkansas banks to charge interest at the same rate as any out-of-state branches that may be operating in the state. The conceivable purpose of the related enactment is to enhance competitiveness of Arkansas-chartered banks. Section 731 of GLBA directly targeted Arkansas, the only remaining state with a constitutional provision that set the maximum lawful annual percentage rate of interest at not more than 5% above the Federal Reserve discount rate (discount rate) for 90 days commercial paper (Galchus and Vibhakar, 2002; Hill, 2002). Section 731 of GLBA provides:

> *"[A]ny State that has a constitutional provision that sets a maximum lawful annual percentage rate [APR] of interest on any contract at not more than 5 percent above the discount rate... upon the establishment in such State of a branch of any out of-State insured depository institution in such State under this section, the maximum interest rate... that may be charged... by any insured depository institution whose home State is such State shall be equal to not more than the greater of-*
>
> *(A) the maximum interest rate . . .that may be charged... [in] the home State of the out-of-State insured depository institution establishing any such branch ... or*
>
> *(B) the maximum rate . . . that may be charged... in a similar transaction by a State insured depository institution chartered under the laws of such State or a national bank or Federal savings association whose main office is located in such State ...."*

As a result, if an out-of-state bank whose home state had no interest rate limit opened a branch in Arkansas, there would be no limit in Arkansas. For example, a Texas bank with a 24% cap and a Kansas bank with a ceiling at 15% are operating in the state of Arkansas, then the Texas bank, the Kansas bank, and all Arkansas banks would be able to charge 24%.

To evaluate the economical importance of the GLBA, panel A of Table A1.2 in the appendix compares the size between Arkansas banks and non-Arkansas banks in terms of total assets and total loans before the passage of the Act. The comparison suggests that the size of Arkansas and non-Arkansas banks is similar. However, the total market share, in terms of total assets and total loans, of Arkansas banks only accounts for around 1%. Therefore, despite the GLBA offers an excellent setting in examining the effects of the reversal of usury ceilings, the economic impact of reversal of the usury law in Arkansas is marginal at national level.

1.3 Hypothesis development

This section illustrates 4 testable hypotheses of this chapter. I first develop the potential effect of the reversal of usury law on lending. Then, I discuss the potential effect on bank credit risk and profitability. Lastly, I evaluate the potential influence on bank competition.

1.3.1 Hypothesis 1

The starting point of my prediction is the theory developed by Vandenbrink et al. (1982).They argue that usury law is a form of price control which restricts the upper limit for the price of loans. In other words, the market price cannot reach the equilibrium to clear the market. As a result, the quantity transaction of the market is expected to be below the equilibrium level, thus resulting an excess demand of loans in the market. Boyes and Roberts (1981) also point out that usury ceilings have had the effect of reducing the quantity of credit and squeezing the high-risk borrowers out of the loan market.

With the reversal of the usury law in Arkansas, the excess demand of loans should be mitigated. After the reversal, Arkansas-chartered banks can set the equilibrium price for loans to clear the market, to a less extent, be able to set the price closer to the equilibrium, therefore, I expect that the reversal of usury law increase lending of Arkansas-chartered banks.

However, the expansion of lending is largely conditional on the availability of additional funding. If there is a lack of additional funding, I would expect a reallocation of lending. Arkansas-chartered banks would be expected to increase loans with an equilibrium rate above the usury ceiling, while reduce loans with an equilibrium rate below the usury ceiling. To test this effect, I additionally classify loans into different categories to examine whether there is a redistribution among different categories of loans, depending on their risk level.

Hypothesis 1: Following the passage of Gramm-Leach-Bliley Act, total lending of Arkansas-chartered banks does not change.

1.3.2 Hypothesis 2

Following the discussion on the potential effect of the reversal of usury law on lending in section 1.3.1, I expect Arkansas-chartered banks increase riskier lending. With this expected raise in risky lending, credit risk of these banks is expected to increase. Apart from the mechanically positive relationship between risky lending and credit risk, the lack of relevant skills and experience worsen the credit risk of Arkansas-chartered banks after the reversal of usury law. Therefore, I come up with the hypothesis 2:

Hypothesis 2: Following the passage of Gramm-Leach-Bliley Act, credit risk of Arkansas-chartered banks does not change.

1.3.3 Hypothesis 3

While Arkansas-chartered banks are expected to record a surge in risky lending and credit risk after the reversal of usury law, its effect on the profitability of Arkansas-chartered banks is uncertain. According to McKinnon (1973) and Cole (1974), restrictions on regulations reduce the profitability of providing intermediation services. In Arkansas, the reversal of the restrictions of usury law enables Arkansas-chartered banks to participate in risky lending, which enables banks to expand their income sources and borrower base. Additionally, the profit margin of riskier lending is plausibly higher because profit is a reward for risk taken in business (Hawley, 1893). From this perspective, the reversal of usury law could enhance the profitability of Arkansas-chartered banks.

However, if credit risk of Arkansas-chartered banks indeed increases after the reversal of usury law, these banks must spare a proportion of their profit to deal with the charge-off. From this perspective, the reversal of usury law could harm the profitability of Arkansas-chartered banks. With these 2 opposing factors, I examine the actual effect of the reversal on Arkansas-chartered banks based on hypothesis 3.

Hypothesis 3: Following the passage of Gramm-Leach-Bliley Act, profitability of Arkansas-chartered banks does not change.

1.3.4 Hypothesis 4

Prior to the reversal of the usury restriction, non-Arkansas-chartered banks were able to lend with interest rate exceeding the usury ceiling in Arkansas, while Arkansas-charted banks were not allowed to compete with them due to the usury ceiling. Thus, this group of non-Arkansas-chartered banks may exist in a form of monopoly, to a less extent oligopoly in the segment of riskier loan market. It implies that the bank competition in Arkansas was compressed by the usury law.

The deregulation frees Arkansas-chartered banks competition from the restriction. Arkansas banks can compete with non-Arkansas-chartered banks in the segment of riskier lending. Based on the rationale of Lerner index, I expect the price charged by Arkansas-chartered banks increase after the reversal of usury law. However, the marginal cost is expected to increase, caused by the lack of skills and experience in handling riskier lending. Taken the opposing forces into consideration, the effect of deregulation on bank competition is uncertain, depending on the relative force of both sides.

Hypothesis 4: Following the passage of Gramm-Leach-Bliley Act, market power of Arkansas-chartered banks does not change.

1.4 Methodology and data

1.4.1 Methodology

I use difference-in-difference approach to exploit the plausibly exogenous reversal of usury limit in Arkansas. Under the context of this chapter, there are 2 groups of banks, namely the Arkansas-chartered banks and non-Arkansas-chartered banks. Before the reversal of usury law, Arkansas-chartered banks are not allowed to originate a loan with exceeding the usury ceiling and this restriction is released after that passage of Gramm-Leach-Bliley Act, while non-Arkansas banks are constantly not subject to the usury limit imposed by the Arkansas usury law. Under this setting, difference-in-difference is appropriate for evaluating the effect of removing the usury caps. Arkansas-chartered banks are the treated group, while non-Arkansas banks are the control group. The Gramm-Leach-Bliley Act is enacted in November 1999; thus, I define the treatment period as 2000Q1-2002Q4 since the treatment is assumed to be enforced in a quarter after to the enactment. I estimate the following equation to study hypotheses 1-4:

$$Y_{i,t} = \beta_0 + \beta_1 Treat_i * Post_t + \delta X_{i,t} + \gamma_i + \gamma_t + \varepsilon_{i,t} \tag{1.1}$$

where $Y_{i,t}$ is the value of respective dependent variable of bank i at time t; $Treat_i$ implies the dummy variables for Arkansas-chartered banks; $Post_t$ is the dummy variables for the observation which within the period of 2000Q1-2002Q4. Therefore, the interaction term $Treat_i * Post_t$ equals to 1 if the observation is an Arkansas-chartered banks in 2000Q1-2002Q4, 0 otherwise. β_1 is the coefficient of interest. The examination of the 4 hypotheses depends on the result of the estimated β_1.

To control for bank-level and state-level characteristics, I insert a battery of control variables $X_{i,t}$ in different specifications. These bank-level control variables include the logarithm of total assets to measure size; the ratio of total equity to total assets; loan loss provisions over total interest income; return over equity; proportion of total deposits to total assets; the level of overheads over total assets; quarterly growth of total assets and proportion of non-interest income over total incomes.

The state-level control variables include the logarithm of real gross domestic product; the logarithm of per capita personal income; the logarithm of total personal consumption expenditures; the logarithm of real median household income; the logarithm of resident population and the logarithm of unemployment rate. I start the analysis with the specification without any control variables and gradually insert bank-level and state-level control variables to check the robustness of the results.

In all the specifications, I control for bank fixed effect and time fixed effect through the variable of γ_i and γ_t respectively. I also cluster the standard errors at the bank-level to account for serial correlation within each panel (Bertrand et al., 2004).

1.4.2 Data

I obtain quarterly bank-level data for commercial and savings banks in the US from their Quarterly Reports on Condition and Income (Call Report), available from the Federal Reserve Bank of Chicago for the period 1997Q1 to 2002Q4. It requires each US banks to fill in related financial information. Although some information is only required to be filled in by banks with 100 million assets, most of the financial information are available for all banks. The detailed financial information of each banks in Call report allows me to conduct the analysis. I collect the macroeconomic state-level data from Bureau of Economic Analysis from 1997 to 2002 annually.

Regarding the measurement of competition, I follow the competition-stability literature (Beck et al., 2013; Forssbæck and Shehzad, 2015), using the Lerner index as a proxy for bank market power. The Lerner index captures a bank's profits over and above its marginal cost. It is defined as:

$$L_{i,t} = \frac{(P_{i,t} - MC_{i,t})}{P_{i,t}} \tag{1.2}$$

where P is the price of the bank output (ratio of total income to total assets) and MC is the marginal cost of the production of this output. The marginal cost is estimated on the basis of a translog cost function with one output (total assets) and three input prices (personnel expenses, operating costs, and interest expenses). It is estimated following Beck et al. (2013). The marginal cost for each bank is obtained by differentiating the cost with the bank output (total assets). A higher value of the Lerner index indicates that the bank extracts more rents and has higher market power. The variables used in calculating the Lerner index are from the Call report.

The detailed definition of all variables is recorded in Table A1.1 in the appendix, while the summary statistics of respective bank-level variables and state-level variables are detailed in the panel A and panel B of Table 1.1. The summary statistics in Table 1.1 is based on the matched sample. The reasons of doing a matching and the details of the matching procedure are described in the following section.

1.5 Matching

The first 3 columns (Pre-Match) in Panel A and the first column (Pre-Match) in panel B of Table 1.2 present the reasons that I undertake a matching approach when comparing our treatment and control groups. The first 3 columns (Pre-Match) in Panel A highlight that the non-Arkansas-chartered banks are different from the Arkansas-chartered banks in two dimensions. On average, treatment banks have higher deposits over assets ratio and lower overheads cost-to-assets ratio. These differences plausibly lead to different exposures between the treatment and control groups to other components of the GLBA. Thus, a comparison of Arkansas-chartered banks to non-Arkansas-chartered banks may provide an inaccurate estimate of the impact of the reversal of the usury law.

The matching procedure relies on a nearest neighbour matching of propensity scores, originally developed by Rosenbaum and Rubin (1983). The matching begins with a probit regression at the bank level of a binary variable indicating whether a particular bank is chartered in Arkansas on a host of bank characteristics. Specifically, I include averages over the pre-treatment era (i.e., pre-2000) of variables identified by previous studies examining the distinction between these two groups.

The probit model is estimated on a cross section of 248 Arkansas-chartered (treatment) banks and 10,321 non-Arkansas-chartered (control) banks containing non-missing data for all the variables included in the specification. The estimation results are presented in the first column of Panel B in Table 1.2, labelled "Pre-Match," and reveal differences that are more significant than those found in the pairwise comparison in Panel A. I then use the predicted probabilities, or propensity scores, from this probit estimation and perform a nearest-neighbour match without replacement, which means that a neighbour can only be used once. That is, each bank in the treatment group is paired with the bank in the control group whose propensity score is closest. Because the number of non-Arkansas-chartered banks is so large relative to the number of Arkansas-chartered banks (approximately 42 times as large), I choose to find 2 control banks matches for each treatment bank. I note that changing the number of matches to any number between 1 and 5 has little effect on the results.

The accuracy of the matching process is also shown in the columns denoted "Post-Match" in Panels A and B of Table 1.2. Specifically, Panel A reveals no statistically significant differences across any of the bank characteristics after the matching process. Similarly, Panel B reveals that none of the determinants are statistically significant in a probit regression restricted to the matched sample. Further, I note that the magnitudes of the coefficient estimates decline significantly from the Pre-Match estimation to the Post-Match estimation, ensuring that findings are not simply an outcome of a decline in degrees of freedom. In sum, the matching process has removed any meaningful differences along observables from the two groups of banks.

Despite using the matched sample tackles the empirical challenge caused by the difference between the Arkansas-chartered banks and non-Arkansas chartered-banks, it is crucial to recall that difference-in-differences approach also requires the satisfaction of the parallel trend assumption. That is, whether Arkansas-chartered banks would have evolved similarly to non-Arkansas-chartered banks in the absence of the deregulation in the matched sample. I follow Roberts and Whited (2013) to conduct t-tests to verify parallel trends. I examine differences in the growth rate between the Arkansas-chartered banks and non-Arkansas-chartered banks during each pre-treatment quarter. Table 1.3 shows that the null of equality of means cannot be rejected in any but 10 out of 80 cells at 5% significance level, suggesting the parallel trends assumption plausibly holds.

1.6 Results

In this section, I present the empirical results of my hypotheses. First, I discuss the results on lending in section 1.6.1. Then, the results for credit risks and profitability are shown in section 1.6.2 and 1.6.3, respectively. Lastly, I discuss the results of competition in section 1.6.4.

These results are corroborated by the following structure. In column 1, I only run the estimation with a univariate regression with the treatment variable as the only independent variable, to determine whether the reversal of the usury law affect the respective dependent variable. In column 2, I add the bank-level variables, such as: the bank size (logarithm of total assets); loan loss provisions over total interest income; return over equity; proportion of total deposits to total assets; and proportion of non-interest income over total incomes to determine whether the result is robust to the inclusion of the control variable. I further include state-level control variables for an additional test in column 3.

1.6.1 Effect of the reversal of usury law on bank lending

I start the analysis on the effect of the reversal of usury law on total lending of Arkansas-chartered banks. Across all specifications and samples in column 1-3 of Table 1.4, the results show that total lending of Arkansas-charted bank has no significant changes after the reversal. The results are robust to the inclusion of control variables. The logarithm of total assets is added into the specification in column 2 and all state-level control variables are further included into the specification in column 3. The estimated coefficient of interest in these respective 2 columns are similar to the specification without any control variables.

Although I show that the reversal of usury limits has no statically significant effects on total lending of Arkansas-chartered banks, I focus on the heterogeneous effects of the reversal on different categories of lending. To do so, I break down total lending into the 3 most common categories of loans: residential mortgages; construction and land development loans; and commercial and industrial loans.

Among these 3 categories of loans, residential mortgage is the one with lowest risk, following by construction and land development loans and commercial and industrial lending (Berger and Bouwman, 2009). Does the reversal of the usury law tend to have significant effect on these three types of loans?

In column 1-3 of Table 1.5, I show that the ratio of construction and land development loans-to-total assets of Arkansas-chartered banks decrease significantly after the reversal of the usury limit, regardless of the inclusion or exclusion of bank-level and state-level control variables. In column 1-2 of Table 1.5, I show that the ratio of construction and land development loans-to-total assets of Arkansas-chartered banks decrease 0.6% (t-statistic -2.77 and -3.21, respectively) and after controlling for state-level variables, the ratio decrease 0.5% (t-statistic -2.34) following the year of the deregulation.

The ratio of commercial and industrial loans-to-total assets of Arkansas-chartered banks surges following the reversal of the usury law, shown in the column 4-6 of Table 1.5. The results are robust to the inclusion of bank-level control variables. With the model in the column 4-5, the results suggest that the reversal of usury law contributes to an increase of around 0.5% to the ratio of commercial and industrial loans-to-total assets of Arkansas-chartered banks. After controlling for the state-level variables, the result still shows that the ratio increases 0.4% (t-statistic 1.35), but marginally insignificant at commonly used significance level.

In column 7-9 of Table 1.5, I show that the reversal of the usury limit increases ratio of mortgages-to-total assets of Arkansas-chartered banks, irrespective the inclusion or exclusion of control variables. With the most saturated specification in the column 9 of Table 1.5, I show that Arkansas banks increase 0.1% (t-statistics 0.25) in the ratio of mortgages-to-total assets quarterly following the reversal of usury limit. However, the results are statistically insignificance at commonly used significance level.

1.6.2 Effect of the reversal of usury law on bank risk-taking

In the previous section, I show that the reversal of usury law has no significant effect on total lending of Arkansas-chartered banks, but it has significant negative effect on the construction and land development loans and positive effect on the commercial and industrial loans. Subject to data constraints, I cannot clearly identify the total amount and number of loans with market rate over the usury limit after the reversal of usury limit, therefore, I cannot compare the change of this type of loans before and after the deregulation. However, the effect of the reversal of usury law should theoretically be stronger for riskier lending. With the plausibly increase in risky lending, I conjecture that the riskiness level of Arkansas-chartered banks increases after the removal of usury limit. To verify this conjecture, I estimate equation 1.1 with three different measures of bank risk taking of Arkansas-chartered banks, namely charge-off ratio, Z-score and probability of failure.

The results in column 1-3 of Table 1.6 support that the reversal of usury law increases the credit risk of Arkansas-chartered banks during the three years following the deregulation, no matter in the specifications with or without bank-level and state-level control variables. In the most saturated specification in column 3, the results suggest that the deregulation leads to 1.7% (t-statistics 1.72) increase of charge-off over total assets ratio for Arkansas-chartered banks during the 3 years following the deregulation. The results on the logarithm of Z-score also consistently suggest that the Act increases the risk level of Arkansas-chartered banks. The results are consistent throughout specifications in column 4-6 of Table 1.6. In the most saturated specification in column 6, the reversal of usury law reduces Arkansas-chartered banks' Z-score by around 20%. However, there is no evidence in column 7-9 suggesting the Act increases Arkansas-chartered banks' probability of failure. The results imply that the Act adversely affects Arkansas-chartered banks soundness level, but the adverse effects do not translate to higher probability of failure during our sample period.

1.6.3 Effect of the reversal of usury law on bank profitability

As the previous results suggest that the reversal of usury law changes the borrower base of Arkansas-chartered banks (shown in section 1.6.1), but at the same time increases the credit risk (discussed in section 1.6.2), the actual effect of the deregulation on bank profitability is uncertain. As a result, I estimate equation 1.1 with the dependent variable of the net income to total assets to investigate hypothesis 3.

The results are presented in column 1-3 of Table 1.7. Across all specifications, the evidence suggests that the usury law negatively affects the profitability of Arkansas-chartered banks. For the first 2 column in Table 1.7, the net income to total assets significantly decreases approximately 2.3% (t-statistics -1.77) for Arkansas-chartered banks after the reversal of usury limit. With controlling for the state-level variables, results in column 3 suggest that the profitability of Arkansas-chartered banks decreases around 0.6% (t-statistics -0.54). However, this result is statistically insignificance at commonly used significance level.

1.6.4 Effect of the reversal of usury law on bank competition

In this section, I examine the effect of the reversal of usury law on bank competition. Bank competition in this chapter is measured by Lerner index, which captures the pricing power of banks. A higher Lerner index implies a higher market power of banks, vice versa. The reversal of usury law has an uncertain effect on the Lerner index of Arkansas-chartered banks for 2 major reasons. First, the deregulation allows Arkansas-chartered banks to charge higher interest rate, thus it potentially increases total income of Arkansas-chartered banks. Second, the deregulation increases the marginal cost of Arkansas-chartered banks. Arkansas-chartered banks lack the skills and experience in originating riskier loans, because they were restricted to do so before the deregulation. Thus, I expect the removal of usury limit increases the marginal cost of Arkansas-chartered banks. To test this hypothesis, I first analysis the effect of the deregulation on the Lerner index of Arkansas-chartered banks. Following this step, I proceed the study by decomposing the Lerner index to identify the key drivers.

In Table 1.8, the dependent variable is Lerner index, which is a proxy for bank market power. The lower Lerner index indicates weaker market power. The Lerner index represents the mark-up of price over marginal costs and is an indicator of the degree of market power. The results in column 1, 2 and 3 show that the respective estimated coefficient of interest is negative. The coefficient is statistically significant in column 2 yet insignificant in column 1 and 3. The most saturated specification in column 3 shows that the Lerner index of Arkansas-chartered banks reduce 0.7% (t-statistics -1.44) during the 3 years following the deregulation.

To better understand the drivers of the overall impact from Lerner index, I conduct separate analysis on various components of the Lerner index to identify which components contribute to the finding in the regression results.

The price charged by Arkansas-chartered banks is expected to be higher after the deregulation, because of the removal of interest rate ceiling. The results in column 1-3 of Table 1.9 are consistent with the conjecture. The finding is robust to the inclusion of bank-level and state-level control variables. The results in column 3 suggest that the average price charged by Arkansas-chartered banks increases 1.3% (t-statistics 2.34) during the 3 years following the deregulation.

Lerner index should increase based on the finding in the previous paragraph, if marginal cost of Arkansas-chartered banks is not affected by the deregulation. However, I expect the marginal cost of Arkansas-chartered banks increases following the deregulation. The findings in column 4-6 of Table 1.9 show that marginal cost of Arkansas-chartered banks indeed increases after the deregulation, and the magnitude of increase is larger than the increase in price, thus Lerner index of Arkansas-chartered banks even decreases after deregulation. In column 6, it shows that Arkansas-chartered banks record an increase of 2.0% (t-statistic 2.96) in marginal cost.

1.7 Conclusion

Usury law has long been a controversial policy in the society. However, its effects on bank behaviours impose steep empirical identification challenges. The reason lies in the lack of an empirical setting that allows a properly constructed empirical research. This chapter exploits an econometrically appealing setting, the passage of the Gramm-Leach-Bliley Act, to shed light on the potential effects of the oldest form of financial regulation-usury law. I test the effects of the reversal of usury limit on bank lending, bank risk-taking and profitability, and bank competition.

My results show that the reversal of usury limit generates a reallocation of lending in different categories of loans for Arkansas-chartered banks. This chapter also reveals an undesirable consequence for the deregulation in the increased bank risk driven by the increase of riskier loans in bank portfolio. Additionally, it shows a surprising effect of the deregulation on bank competition: Lerner index stays constant for affected banks. At the beginning, one would expect the market power of affected banks increases, because of the higher price charged by those banks. However, this conjecture neglects the increase in marginal cost for them in originating risky loans. I find that the effect on marginal cost is actually very strong, to an extent that exceeding the influence of the increased price.

The findings offer three implications to policymakers. First, the finding shows that the reversal of usury law does not necessarily lead to an increase in bank lending, therefore it suggests lowering usury limit is not a panacea to increase the supply of credit in the society. Second, the result shows that the reversal of usury limit increases credit risk of affected bank, and it highlights the need of strengthening regulation after the relaxation of usury ceilings. Third, this chapter documents an unexpected effect of the relaxation of usury limit in increasing the marginal cost of affected banks.

1.8 Tables and figures

Table 1.1: Summary statistics

Panel A	Bank-level variables				
Variable	N	Mean	SD	P5	P95
TLTA	14,190	0.596	0.143	0.332	0.807
MGTA	14,190	0.327	0.138	0.115	0.566
CLDLTA	14,190	0.027	0.042	0	0.098
CILTA	14,190	0.092	0.063	0.008	0.218
COTA100	14,171	0.07	0.227	0	0.245
LnZscore	14,190	3.739	0.935	2.139	5.234
Fail	14,190	0.000	0.017	0.000	0.000
NITA100	14,171	0.277	0.249	-0.02	0.537
Lerner index	13,130	0.281	0.097	0.128	0.416
lnP	14,171	-3.928	0.155	-4.15	-3.73
lnMC	13,130	-4.253	0.189	-4.529	-3.983
lnTA	14,163	11.408	1.041	9.844	13.219
TETA	14,163	0.106	0.038	0.068	0.169
CR	14,142	0.036	0.105	0	0.13
ROE	14,142	0.028	0.025	-0.002	0.059
DOA	14,163	0.857	0.056	0.752	0.917
NIT	14,142	0.094	0.083	0.026	0.199
OverheadsTA	14,142	0.005	0.002	0.003	0.008
GrowthTA	14,163	1.026	0.103	0.959	1.114
Panel B	State-level variables				
Variable	N	Mean	SD	P5	P95
RGDP	11,486	12.149	0.934	11.21	13.814
PCPI	14,190	10.125	0.168	9.876	10.424
PCE	11,486	11.466	0.903	10.544	13.071
RMHI	14,190	10.884	0.178	10.62	11.157
RP	14,190	8.438	0.809	7.499	9.889
UR	14,190	1.484	0.213	1.03	1.74

Notes: This table reports the summary statistics for all variables with matched sample. This table presents the number of observations, mean, standard deviation, p5, and p95 of bank-level variables in Panel A and state-level variables in Panel B. Definition of all variables are detailed in Table A1.1. All bank-level control variables are 1 quarter lagged. All state-level control variables are 1 year lagged.

Table 1.2: Propensity score matching diagnostics

Panel A	Pre-Match			Post-Match		
Variable	Control	Treatment	T-Diff	Control	Treatment	T-Diff
lnTA	11.340	11.344	0.004	11.346	11.344	-0.002
TETA	0.113	0.108	-0.005	0.107	0.108	0.001
CR	0.036	0.039	0.003	0.035	0.039	0.003
ROE	0.027	0.028	0.000	0.028	0.028	0.000
DOA	0.832	0.860	0.028***	0.864	0.860	-0.004
NIT	0.100	0.094	-0.006	0.091	0.094	0.003
OverheadsTA	0.006	0.005	-0.001**	0.005	0.005	0.000
GrowthTA	1.058	1.036	-0.022	1.031	1.036	0.005
No. of banks	10321	248	-	466	248	-

Panel B		
Dependent variable	AR=1 if bank is headquartered in AR, 0 otherwise	
Variable	Pre-match	Post-match
lnTA	0.027	-0.041
	(0.026)	(0.052)
TETA	2.885***	-0.516
	(0.884)	(1.817)
CR	0.462	0.534
	(0.291)	(0.930)
ROE	-3.178**	0.500
	(1.245)	(2.898)
DOA	3.967***	-1.061
	(0.785)	(1.321)
NIT	1.716***	1.075
	(0.390)	(0.991)
OverheadsTA	-135.082***	-48.989
	(28.697)	(38.547)
GrowthTA	-0.003	0.796
	(0.004)	(0.860)
No. of banks	10,569	714
Treatment	248	248
Control	10321	466

Notes: Panel A of this table presents pairwise comparisons of the variables before and after the matching. Panel B presents parameter estimated form the probit model used in estimating the propensity scores for the treatment and control groups. The treatment means that the banks are chartered in Arkansas. The control means that banks are not chartered in Arkansas. The probit is run at bank level, and all covariates included in the regression are averages over the pre-treat period (1997-1999). The pre-match column contains the parameters of the probit estimated on the entire sample, prior to matching. This model is used to generate the propensity scores for matching. The Post-Match column contains the parameters of the probit estimated on the subsample of matched treatment and control observations after matching. The matching procedure is a one-to-two nearest-neighbour match of treatment and control banks falling in the common support of estimated propensity scores. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 1.3: Tests for parallel trends

Quarter	1998q1	1998q2	1998q3	1998q4	1999q1	1999q2	1999q3	1999q4
$\triangle TLTA$	0.010*	0.017*	0.012**	-0.009	-0.007	0.013	-0.008	-0.019***
$\triangle MGTA$	0.016**	0.004	0.002	-0.018	-0.023	0.012	-0.016	-0.010
$\triangle CLDLTA$	0.267*	0.315	-0.095	0.114	-0.067	-0.323	0.558	0.145
$\triangle CITLA$	0.004	1.437	-0.005	0.031	0.028	-0.007	-0.051	0.043***
$\triangle COTA100$	-3.277	0.246	-1.117	3.159**	0.173	1.278	-0.845	0.371
$\triangle LnZscore$	0.020	-0.016	-0.010	-0.046	-0.014	-0.040	-0.090	-0.106
$\triangle Fail$	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
$\triangle NITA100$	-0.409	0.080	-1.742	-0.092	-0.777	-0.140	-0.160	0.012
$\triangle Lernerindex$	-0.174	-0.052	1.718	0.028	-0.028	0.078	0.104	-0.008
$\triangle lnP$	0.003	-0.003*	0.001	-0.002	0.002	-0.002	0.000	0.001
$\triangle lnMC$	0.002	0.004*	-0.001	-0.007**	0.001	0.003	-0.003	0.002

Notes: This table shows the difference and the significance level of the difference in the growth rate of various dependent variables in 8 quarters (2 years) prior to the reversal of the usury law. Definition of all variables are detailed in Table A1.1. *, ** and ***indicate significance at the 10%, 5% and 1% levels, respectively.

Table 1.4: Effect of the reversal of usury law on total lending

	1	2	3
Dependent variable		TLTA	
Treat×Post	0.004	0.002	0.001
	(0.55)	(0.29)	(0.22)
lnTA		0.040***	0.048***
		(3.58)	(4.46)
TETA		-0.194	-0.090
		(-1.46)	(-0.65)
CR		0.019*	0.016
		(1.96)	(1.61)
ROE		0.252***	0.253***
		(3.89)	(3.77)
DOA		-0.021	-0.044
		(-0.38)	(-0.97)
NIT		-0.057**	-0.103***
		(-2.18)	(-2.62)
OverheadsTA		4.127***	4.088***
		(3.93)	(4.07)
GrowthTA		-0.024**	-0.030***
		(-2.31)	(-2.82)
RGDP			0.136
			(1.25)
PCPI			-0.094
			(-0.64)
PCE			-0.104
			(-0.61)
RMHI			-0.021
			(-0.70)
RP			-0.019
			(-0.13)
UR			0.014
			(0.71)
No. of obs.	14,190	14,142	11,464
No. of banks	714	714	664
R-squared	0.095	0.135	0.139
Bank FE	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes

Notes: This table reports the estimation results of the equation 1.1. The dependent variable is total loan over total assets (TLTA) in column 1-3. The treatment variable (Treat) is an indicator variable that takes the value of 1 if the bank is chartered in Arkansas, 0 otherwise. Post is an indicator variable that takes the value of 1 if the time period is from 2000Q1-2002Q4, and 0 otherwise. Definition of all variables is detailed in Table A1.1. All control variables are 1 period lagged. *, ** and ***indicate significance at the 10%, 5% and 1% levels, respectively. Robust standard errors in parentheses are clustered at the bank level.

Table 1.5: Effect of the reversal of usury law on different categories of loan

	1	2	3	4	5	6	7	8	9
Dependent variable		y=CLDLTA			y=CILTA			y= MGTA	
Treat×Post	-0.006***	-0.006***	-0.005**	0.005*	0.005*	0.004	0.004	0.003	0.001
	(-2.77)	(-3.21)	(-2.34)	(1.84)	(1.83)	(1.35)	(0.68)	(0.52)	(0.25)
lnTA		0.020***	0.020***		0.001	0.002		0.030***	0.034***
		(4.23)	(4.14)		(0.31)	(0.31)		(2.84)	(3.28)
TETA		-0.008	-0.004		-0.020	0.004		-0.028	0.022
		(-0.15)	(-0.06)		(-0.59)	(0.12)		(-0.32)	(0.23)
CR		0.003	0.004*		0.006*	0.003		0.010*	0.012*
		(1.19)	(1.76)		(1.83)	(0.99)		(1.69)	(1.84)
ROE		0.036**	0.051***		0.031	0.031		0.164***	0.187***
		(1.98)	(2.94)		(1.21)	(1.06)		(3.91)	(3.89)
DOA		-0.030	-0.034		0.022	0.017		0.021	-0.001
		(-1.37)	(-1.49)		(1.17)	(0.81)		(0.48)	(-0.03)
NIT		-0.013	-0.030**		-0.009	-0.010		-0.029	-0.062*
		(-1.20)	(-2.17)		(-1.13)	(-0.58)		(-1.29)	(-1.85)
OverheadsTA		0.258	0.461*		0.585*	0.391		1.341	1.742*
		(0.97)	(1.74)		(1.80)	(1.26)		(1.33)	(1.81)
GrowthTA		-0.003	-0.004		0.003	0.001		-0.012	-0.020**
		(-1.08)	(-1.35)		(0.93)	(0.18)		(-1.46)	(-2.20)
RGDP			0.134***			0.010			0.005
			(3.61)			(0.19)			(0.05)
PCPI			-0.071			0.054			-0.187
			(-0.89)			(0.62)			(-1.26)
PCE			-0.135			0.037			-0.021
			(-1.36)			(0.47)			(-0.13)
RMHI			-0.016*			0.003			-0.014
			(-1.83)			(0.23)			(-0.50)
RP			0.012			-0.051			0.040
			(0.14)			(-0.73)			(0.29)
UR			-0.006			0.001			0.027
			(-0.88)			(0.08)			(1.53)
No. of obs.	14,190	14,142	11,464	14,190	14,142	11,464	14,190	14,142	11,464
No. of banks	714	714	664	714	714	664	714	714	664
R-squared	0.079	0.125	0.128	0.016	0.017	0.017	0.101	0.122	0.130
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table reports the estimation result of the equation 1.1. The dependent variable is construction and land development loans over total assets (CLDLTA) in column 1-3; and the dependent variable is commercial and industrial loans over total assets (CILTA) in column 4-6. The dependent variable is Mortgage over total assets (MGTA) in column 7-9. The treatment variable (Treat) is an indicator variable that takes the value of 1 if the bank is chartered in Arkansas, 0 otherwise. Post is an indicator variable that takes the value of 1 if the time period is from 2000Q1-2002Q4, and 0 otherwise. Definition of all variables is detailed in Table A1.1. All control variables are 1 period lagged. *, ** and ***indicate significance at the 10%, 5% and 1% levels, respectively. Robust standard errors in parentheses are clustered at the bank level.

Table 1.6: Effect of the reversal of usury law on risk-taking

	1	2	3	4	5	6	7	8	9
Dependent variable		y= COTA100			y= LnZscore			y= Fail	
TreatxPost	0.026***	0.020**	0.017*	-0.192***	-0.176***	-0.192***	0.000	0.000	-0.001
	(2.62)	(2.27)	(1.72)	(-3.29)	(-3.17)	(-3.01)	(0.32)	(0.24)	(-0.51)
lnTA		0.025	0.021		0.253**	0.363***		0.001	0.001
		(1.59)	(1.03)		(2.35)	(3.15)		(1.04)	(1.12)
TETA		-0.226	-0.305		2.699***	2.853***		-0.024	-0.016
		(-1.55)	(-1.54)		(2.72)	(2.79)		(-0.95)	(-0.85)
ROE		-0.783***	-0.797***		4.686***	4.018***		-0.029	-0.034
		(-3.50)	(-3.55)		(7.03)	(5.92)		(-0.98)	(-0.94)
DOA		-0.047	-0.104*		0.043	-0.272		0.003	0.005
		(-0.91)	(-1.81)		(0.10)	(-0.63)		(1.18)	(1.28)
NIT		0.114	0.193*		-1.157***	-0.923***		-0.007	-0.015
		(1.31)	(1.87)		(-3.65)	(-2.75)		(-0.94)	(-1.08)
OverheadsTA		5.185	4.194		-1.001	-0.101		0.543	0.733
		(0.87)	(0.66)		(-0.21)	(-0.02)		(0.98)	(0.98)
GrowthTA		-0.056***	-0.064***		-0.468***	-0.470***		-0.001	-0.001
		(-3.17)	(-2.75)		(-5.10)	(-4.23)		(-0.94)	(-0.92)
RGDP			0.096			0.189			-0.006
			(0.43)			(0.17)			(-0.48)
PCPI			-0.104			-1.155			-0.055
			(-0.36)			(-0.66)			(-1.36)
PCE			0.321			1.470			0.018
			(0.82)			(0.80)			(0.52)
RMHI			0.056			0.448			0.008
			(0.97)			(1.48)			(0.66)
RP			-0.630			-1.637			-0.007
			(-1.22)			(-1.00)			(-0.30)
UR			-0.007			-0.325*			-0.002
			(-0.15)			(-1.66)			(-1.29)
Observations	14,171	14,141	11,463	13,450	13,449	11,458	14,190	14,142	11,464
R-squared	0.017	0.032	0.037	0.189	0.223	0.092	0.002	0.006	0.008
Number of bank	714	714	664	698	698	664	714	714	664
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table reports the estimation result of the equation 1.1. The dependent variable in column 1-3 is the ratio of charge-off over total assets (COTA100). The dependent variable in column 4-6 is the logarithm of Z-score (LnZscore). The dependent variable in column 7-9 is the dummy variable indicating bank failure (Fail). The treatment variable (Treat) is an indicator variable that takes the value of 1 if the bank is chartered in Arkansas, 0 otherwise. Post is an indicator variable that takes the value of 1 if the time period is from 2000Q1-2002Q4, and 0 otherwise. Definition of all variables is detailed in Table A1.1. All control variables are 1 period lagged. *, ** and ***indicate significance at the 10%, 5% and 1% levels, respectively. Robust standard errors in parentheses are clustered at the bank level.

Table 1.7: Effect of the reversal of usury law on net income

	1	2	3
Dependent variable		y=NITA100	
Treat×Post	-0.023*	-0.021*	-0.006
	(-1.77)	(-1.88)	(-0.54)
lnTA		-0.025	-0.020
		(-0.75)	(-0.58)
TETA		-1.549***	-1.561***
		(-4.07)	(-3.65)
ROE		1.414***	1.779***
		(6.25)	(5.15)
DOA		0.173*	0.198*
		(1.70)	(1.89)
CR		0.089**	0.100**
		(1.97)	(1.97)
OverheadsTA		-8.117***	-8.533**
		(-3.44)	(-2.09)
GrowthTA		-0.068***	-0.080***
		(-3.33)	(-3.99)
RGDP			0.525*
			(1.73)
PCPI			0.009
			(0.03)
PCE			-0.567
			(-1.30)
RMHI			0.069
			(1.13)
RP			-0.104
			(-0.21)
UR			0.087
			(1.55)
No. of obs.	14,190	14,142	11,464
No. of banks	714	714	664
R-squared	0.024	0.081	0.089
Bank FE	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes

Notes: This table reports the estimation result of the equation 1.1. The dependent variable is the ratio of net income over total assets (NITA100). The treatment variable (Treat) is an indicator variable that takes the value of 1 if the bank is chartered in Arkansas, 0 otherwise. Post is an indicator variable that takes the value of 1 if the time period is from 2000Q1-2002Q4, and 0 otherwise. Definition of all variables is detailed in Table A1.1. All control variables are 1 period lagged. *, ** and ***indicate significance at the 10%, 5% and 1% levels, respectively. Robust standard errors in parentheses are clustered at the bank level.

Table 1.8: Effect of the reversal of usury law on Lerner index

	1	2	3
Dependent variable		y=Lerner index	
Treat×Post	-0.008	-0.009**	-0.007
	(-1.56)	(-2.22)	(-1.44)
lnTA		0.030***	0.040***
		(2.92)	(3.54)
TETA		-0.433***	-0.420***
		(-4.35)	(-4.11)
ROE		0.057***	0.063***
		(4.10)	(4.33)
DOA		0.660***	0.649***
		(7.07)	(6.56)
CR		0.038	0.042
		(1.12)	(1.15)
NIT		-0.026	-0.059
		(-0.65)	(-1.26)
OverheadsTA		-2.680***	-2.888***
		(-3.06)	(-2.98)
GrowthTA		-0.053***	-0.062***
		(-5.19)	(-5.37)
RGDP			0.073
			(0.67)
PCPI			0.057
			(0.39)
PCE			0.013
			(0.47)
RMHI			0.031
			(0.20)
RP			-0.126
			(-0.85)
UR			-0.013
			(-0.81)
No. of obs.	13,130	13,100	10,422
No. of banks	714	714	664
R-squared	0.080	0.177	0.190
Bank FE	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes

Notes: This table reports the estimation result of the equation 1.1. The dependent variable is the Lerner index (Lerner index). The treatment variable (Treat) is an indicator variable that takes the value of 1 if the bank is chartered in Arkansas, 0 otherwise. Post is an indicator variable that takes the value of 1 if the time period is from 2000Q1-2002Q4, and 0 otherwise. Definition of all variables is detailed in Table A1.1. All control variables are 1 period lagged. *, ** and ***indicate significance at the 10%, 5% and 1% levels, respectively. Robust standard errors in parentheses are clustered at the bank level.

Table 1.9: Effect of the reversal of usury law on price and marginal cost

	1	2	3	4	5	6
Dependent variable		y=lnP			y=lnMC	
Treat×Post	0.018***	0.013***	0.013**	0.030***	0.027***	0.020***
	(2.84)	(2.63)	(2.34)	(4.04)	(4.27)	(2.96)
lnTA		0.027**	0.040***		-0.008	-0.001
		(2.11)	(2.70)		(-0.71)	(-0.07)
TETA		-0.548***	-0.516***		0.073	0.184
		(-4.54)	(-3.82)		(0.57)	(1.27)
CR		-0.009	-0.002		-0.080***	-0.082***
		(-0.56)	(-0.13)		(-4.25)	(-3.90)
ROE		0.224**	0.251*		-0.645***	-0.634***
		(2.30)	(1.96)		(-5.71)	(-5.17)
DOA		-0.142***	-0.137***		-0.135**	-0.115**
		(-3.06)	(-2.79)		(-2.57)	(-2.09)
NIT		0.383***	0.409***		0.416***	0.484***
		(5.21)	(3.26)		(4.44)	(3.31)
OverheadsTA		4.073**	3.585*		4.217	3.168
		(2.19)	(1.86)		(1.45)	(1.18)
GrowthTA		-0.044***	-0.036***		0.023*	0.043**
		(-4.85)	(-3.27)		(1.77)	(2.55)
RGDP		0.013***	-0.062			-0.047
			(-0.37)			(-0.22)
PCPI			0.009			-0.303
			(0.05)			(-1.24)
PCE			-0.034			-0.045
			(-0.90)			(-0.91)
RMHI			-0.089			-0.033
			(-0.44)			(-0.13)
RP			0.175			0.103
			(1.12)			(0.54)
UR			0.043**			0.039*
			(2.03)			(1.73)
No. of obs.	14,171	14,141	11,463	13,130	13,100	10,422
No. of banks	714	714	664	714	714	664
R-squared	0.394	0.448	0.471	0.357	0.400	0.443
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table reports the estimation result of the equation 1.1. The dependent variable is the logarithm of price (lnP) in column 1-3; and the dependent variable is the logarithm of marginal cost (lnMC) in column 4-6. The treatment variable (Treat) is an indicator variable that takes the value of 1 if the bank is chartered in Arkansas, 0 otherwise. Post is an indicator variable that takes the value of 1 if the time period is from 2000Q1-2002Q4, and 0 otherwise. Definition of all variables is detailed in Table A1.1. All control variables are 1 period lagged. *, ** and ***indicate significance at the 10%, 5% and 1% levels, respectively. Robust standard errors in parentheses are clustered at the bank level.

1.9 Appendix

Table A1.1: Variables definition

Variable	Definition
TLTA	Total value of total loans over total assets.
CILTA	Total value of commercial and industrial loans over total assets.
CLDLTA	Total value of construction and land development loans over total assets.
MGTA	Total value of mortgages over total assets.
NITA100	The ratio of net income over total assets times 100.
COTA100	The ratio of charge-off over total assets times 100.
LnZscore	The logarithm of Z-score, the calculation of Z-score follows Beck et al. (2013).
Fail	Dummy variable indicating bank failure. Fail=1 if a bank failed, 0 otherwise.
Lerner index	Lerner index, the calculation process of Lerner index is detailed in section 1.4.2.
lnP	The logarithm of price, the calculation process of price is detailed in section 1.4.2.
lnMC	The logarithm of marginal cost, the calculation process of marginal cost is detailed in section 1.4.2.
Treat	Treat=1 if the observation is an Arkansas-chartered bank, 0 otherwise.
Post	Post=1 if the observation is within the period of 2000Q1-2002Q4, 0 otherwise.
lnTA	The logarithm of total assets.
TETA	The ratio of total equity over total assets.
ROE	The ratio of net income over total equity
CR	Loan loss provisions over total interest income.
OverheadsTA	The level of overheads over total assets.
GrowthTA	Quarterly growth of total assets.
DOA	The ratio of deposits over total assets.
NIT	The ratio of non-interest income over total income.
RGDP	The logarithm of real total gross domestic product
PCPI	The logarithm of per capita personal income
PCE	The logarithm of personal consumption expenditures
RMHI	The logarithm of real median household income
RP	The logarithm of resident population
UR	The logarithm of unemployment rate

Table A1.2: Comparison between bank size and market share of Arkansas-chartered and non-Arkansas-chartered banks

	1	2	3	4
	AR banks		Non-AR banks	
Panel A: Bank level- bank size				
Variable	Mean	SD	Mean	SD
Total assets (ln)	11.344	0.913	11.340	1.348
Total loans (ln)	10.749	0.991	10.803	1.455
Panel B: State level- Market share				
Share of total asset	0.008	0.001	0.992	0.001
Share of total loan	0.008	0.001	0.992	0.001

Notes: Panel A of this table compares bank size of Arkansas-chartered banks and non-Arkansas-chartered banks in the pre-treatment period. Panel B of this table compares total market share of Arkansas banks and non-Arkansas banks in the pre-treatment period.

CHAPTER 2

Do natural disasters affect exposed banks differently?

2.1 Introduction

Since the early 1900's, there had been a long-lasting discussion over unit banking and branch banking. While branch banking benefits from geographical diversification, unit banking allows banks specializing in local communities, thus more capable to provide banking services that require local knowledge and local social network. After the branching deregulation was gradually introduced from 1978 to 1992 (Kroszner and Strahan, 1999), the number of local community banks keeps declining. The number of local community banks dropped by 30 percent from 2012 to 2019.[1] In this context, the chapter answers whether local banks could better weather local communities from adverse regional shocks.

In examining this question, I need regional shocks to local economies. There are two criteria for the shocks. The shocks must be unexpected and exogenous to banks' behaviours. From this perspective, natural disasters offer an ideal setting. Apart from the econometrics setting, investigating how banks respond to natural disasters gets more timely than ever. Global climate change increases the severity and frequency of natural disasters. In year 2021, about 1 in every 10 homes were impacted by natural disaster in the US. [2] Therefore, natural disaster is one of the most common regional shocks to local economy. In weathering such shock, banks play a key role. However, do all banks respond to natural disasters in the same way?

To be specified, this chapter focuses on the two fundamental functions of banks, deposit-

[1] https://www.fdic.gov/resources/community-banking/report/2020/2020-cbi-study-full.pdf

[2] "https://www.cnbc.com/2022/02/17/natural-disasters-such-as-fires-hurricanes-hit-1-in-10-us-homes-in-2021.html"

taking and lending. I examine three ex-ante uncertain questions. The first question asks whether natural disasters impact banks' deposit-taking and lending, in terms of volumes and interest rates. Second, I investigate whether local banks are affected differently.[3] Third, the chapter highlights a plausible channel in driving the heterogeneous impacts of natural disasters on local banks.

Natural disasters increase depositors' demand of liquidity, for example the urgent need of property maintenance and medical expenses (Gallagher and Hartley, 2017; Billings et al., 2022). Therefore, depositors may withdraw their deposits in meeting the liquidity need. As a result, one would expect volumes of bank deposits decrease and deposit interest rates to increase. However, the provision of government natural disaster relief plays a role in mitigating the adverse impact of natural disasters (Strömberg, 2007; Deryugina, 2017), which may mitigate the deposit withdrawal. Thus the overall effect of natural disasters on bank deposits is ex-ante uncertain.

Disaster-exposed areas require lending to recover the damages of natural disaster, such as drawing on lines of credit to address their immediate liquidity and mortgages for property repairs. Moreover, government may motivates banks to lend after natural disasters to speed up the recovery process (Cortés, 2014). Therefore, natural disasters may result an increase in lending volumes and lending rates. However, banks may strategically reallocate their lending to unexposed or less disaster-prone areas (Ouazad and Kahn, 2022; Rehbein and Ongena, 2022), thus lowering loan supply in local area. Also deposit-loan synergies of banks could be disrupted by the deposit outflows during natural disasters (Kashyap et al., 2002; Gatev et al., 2009; Yang, 2022).

Local banks differ from national banks from several perspectives, including size, geographical distribution and product diversification. Local banks are smaller in terms of asset size and concentrate their businesses in local communities. Their business model is comparatively simple that they take deposits and lend within a local market. Most of the local banks have less than $1 billion in assets. Because of the geographical specification, community banks accumulates more local knowledge and soft information. Also, geographic specification of local banks may mitigate agency problems (Goetz et al., 2013). However, the lack of diversification could also cause banks to suffer from idiosyncratic risk due to the lack of product and geographical diversification (Diamond, 1984). National banks also benefit from economies of scales and more efficient internal capital marker (Berger et al., 1999; Houston et al., 1997). Apart from the response of banks, depositor-bank relationships and networks could also play a role. Closer bank-depositor relationship could plausibly mitigate depositors' withdrawal incentive during uncertainty (Iyer and Puri, 2012; Brown et al., 2020). Therefore, natural disasters may mitigate deposit outflows

[3]This chapter follows Homanen (2022) in defining local banks as banks classified as savings banks, and savings and loans in the Summary of Deposits.

or even create deposit inflows to local banks which have a stronger social connection to local depositors.

Employing several sources of data in the US over 2018-2019, I find that, on average, natural disasters reduce the volumes of annual branch deposits by 3.36%. However, the effect is not homogeneous to local banks and national banks. Local banks do not experience deposit outflows following natural disaster, on the contrary, volumes of branch deposits increase by 1.84%. The chapter also documents the dynamic effect of natural disasters on deposits.The impacts are short-lived and only last for 2 quarters. In terms of the pricing of deposits, natural disasters, on average, lead to 0.03% increase in 12-month certificate deposit rates, implying a reduction of deposit supply. However, the same finding could not be applied on local banks. Deposit rates of local banks reduce 0.06% after natural disasters. Contrary to national banks, the results imply that the additional deposit inflows are caused by an increase in supply of deposits for local banks after natural disasters, rather than an increase in deposit rates.

This chapter also attempts to identify the channel in driving the deposit inflows to local banks after natural disasters. I find no evidence that bank soundness, market power and government assistance can explain the deposit inflows, but I find novel evidence that the additional deposit inflows to local banks are particularly strong in counties with higher social connectedness, highlighting the additional deposit inflows are driven by the better social connection between local banks and the communities.

In terms of lending, banks with more branches exposed to natural disasters experience stronger increase in lending, indicating the role of banks in smoothing the adverse impact of shocks on local economy. A percentage increase in proportion of branches exposed natural disaster leads to 1.51% increase in bank total lending. With the deposit inflows, local banks increase lending particularly more after natural disasters, reflecting the deposit-lending synergies and the unique role of local banks in providing liquidity to local community. For the pricing of loan, there is no evidence that natural disasters affect the interest rates of loans of national banks. Yet, the results suggest that local banks reduce interest rates of personal unsecured loans following natural disasters.

The chapter contributes to three strands of literature. A growing strand of literature examines the impact of natural disaster risk on banks. Natural disaster potentially threat both the asset and liability side of banks (Klomp, 2014). On asset side, the most common collateral of banks, real estates, are vulnerable to extreme weather events. Therefore, natural disasters could significantly devalue the underlying assets of bank loans (Bernstein et al., 2019; Beltrán et al., 2018). Emerging evidence suggests that banks do not adequately price the climate risk into mortgages (Garbarino and Guin, 2021). Another source of less-discussed risk is the liquidity risk on the liability side. Natural disaster creates a shock to households liquidity needs, thus increases the withdrawal of bank deposits to weather the shock (Cortés and Strahan, 2017). It could therefore pose potential liquidity risk to banks. Different from the most of the existing papers which examine the 2 questions in isolation. This chapter contributes to the literature by documenting the comprehensive and heterogeneous impact of natural disaster on the volumes and price of bank deposits and lending.

The chapter also contributes to the literature highlighting the unique role of local banks. The key differences of community banks lie in the soft information accumulated through the banking relationship and local knowledge, which allows banks to have utilize this information in lending (DeYoung et al., 2004; Stein, 2002; Hakenes et al., 2015; Jagtiani et al., 2016; Wang et al., 2021). In the context of natural disaster, Koetter et al. (2020) find that local banks provide corporate recovery lending to firms affected by adverse regional macro-shocks. Allen et al. (2022) find that local banks increase lending to natural disaster-exposed areas, despite Allen et al. (2022) do not include non-local banks as a control group in the sample. I highlight the local knowledge and information is valuable to local community during natural disasters.

This chapter also speaks to the literature on the role of social networks in economic decisions(Hong et al., 2005; Rantala, 2019; Persson et al., 2021). In the banking sector, Iyer and Puri (2012) document that the social network of a depositor affects their likelihood to withdraw during bank runs. Flynn and Wang (2022) finds that banks in areas that are more socially connected to areas recently exposed to natural disasters record an increase in bank deposits. This chapter departs from the existing literature by showing how the social connectedness affect the effectiveness of local banks in weathering local economy from natural disasters.

The outline of the chapter is as follows. Section 2.2 describes the data sources and sample. Section 2.3 and 2.4 details the identification strategies and the empirical results of the impact on bank deposits and lending respectively. Section 2.5 discuss the potential channels in driving the findings, and Section 2.6 concludes.

2.2 Sample and data

To ensure the findings to be timely, the chapter focuses on natural disasters in 2018-2019. The study excludes observations in 2020 and 2021 because majority of the areas in the US are classified as disaster-exposed areas due to the COVID-19.

Records of natural disasters are extracted from the Spatial Hazards Events Database for the US (Sheldus). The Sheldus identifies the date and location of all presidentially declared natural disasters in the US. The chapter does not examine the impact of other minor disasters, i.e., non-presidentially declared natural disasters, because the disasters in the Sheldus are more severe and represent more significant shocks to banks. The detailed record of geographical information allows me to identify banks' exposure to natural disasters. The database also details the type of the disasters. The common types of natural disasters include hurricane, severe storm and flood. Natural disasters normally last for less than a month. Figure 2.1 details the geographical distribution of natural disasters in 2018-2019.

To implement a throughout analysis of the impact of natural disaster on bank deposits and lending, this chapter employs three data sources related to bank financial information, including the Call Report, the Federal Deposit Insurance Corporation (FDIC) Summary of Deposits, and RateWatch. The sample period covers 2018-2019.

I use the FDIC Summary of Deposits data to obtain branch-level deposits for FDIC-insured institutions, including US branches of FDIC-insured foreign banks, as of June 30th of each year. For each branch, I observe the total deposits held, the location of the branch, and the parent bank.

There are two key limitations of the SoD. The first one is the low frequency of data. It makes ruling out confounding events and identifying the dynamic effects of natural disaster difficult. Second, the SoD only contains deposit data which limits the analysis to deposits. To overcome this limitation, I turn to the Quarterly Reports on Condition and Income (Call Report) which document the quarterly bank-level data for US banks.

Finally, I employ RateWatch database to obtain information of branch-level deposit and loan interest rates. For deposits, this chapter focuses on 12-month fixed rate certificate of deposits (CDs), because 12-month CDs is largely standardized, which allows the comparison across branches. Also, it is the mostly reported deposit product by branches, hence minimizing the possible sample selection problem. For loans, the RateWatch database provides a less comprehensive coverage. I focus on loan products that are the most standardized and with most comprehensive coverage, including 60-month new automobile loans and personal unsecured loans.

To combine geographical information into the RateWatch data, I merge the observations on branches in the SoD with RateWatch using the branch identifier. Then, I collapse the weekly RateWatch data into branch-quarter level data following Manuszak and Wozniak (2017) by averaging each branches' observations in a given quarter. This approach smooths the variation on data and avoids the missing reporting of branches.

Panel A of Table 2.1 shows the summary statistics of the branch-level variables and panel B reports the the bank-level variables.

2.3 Impact of natural disasters on bank deposits

2.3.1 Effect of natural disasters on branch deposits

To investigate the impact of natural disasters on branch deposits, I estimate the following regression with branch-level deposits data from the SoD and bank-level control variables from the Call reports:

$$Deposit(ln)_{i,b,s,c,t} = \beta_0 + \beta_1 Natural\ disaster_{s,c,t} + \gamma X_{b,t-1} + \delta_{s,t} + \varepsilon_{i,b,s,c,t} \tag{2.1}$$

where outcome variables $Deposit(ln)_{i,b,s,c,t}$ is the logarithm of deposits of branch i of bank b located at state s and county c in year t. The variable of interest is $Natural\ disaster_{s,c,t}$, a dummy variable equals to 1 if there is any natural disaster in the county of branch i at year t. $X_{b,t-1}$ is a vector of a year-lagged bank-level control variables capturing the logarithm of assets value, interest-to-deposits ratio, tier 1 capital ratio, mortgage-to-loans ratio, net income-to-assets ratio and loan commitments-to-assets ratio[4]. The definitions of all variables are detailed in Table A2.1 in the Appendix. To capture time varying state effects, such as local economic condition and business cycle, the model includes state × year fixed effects which are represented by $\delta_{s,t}$. Standard errors are clustered at county level.

Column 1-2 in Table 2.2 show the estimation results of equation 2.1. Column 1 presents the preliminary results of equation 2.1 without the inclusion of control variables. The coefficient of interest, β_1 in equation 2.1, suggests that branches exposed to natural disasters in the year experience 5.4% decrease of deposits. The estimated β_1 in column 1 is statistically significant at 1% level. The estimation results are robust to the inclusion of control variables, shown in column 2. After including a vector of control variables, the results show that natural disaster reduce branch deposits by 3.0%.

After establishing the negative impact of natural disaster on branch deposits, the next exercise verifies the conjecture that natural disasters affect branch deposits of local banks differently. To do so, I modify equation 2.1 by including an interaction term, $Natural\ disaster \times Local\ bank_{s,c,t}$,

[4] The selection of control variables follows Gilje et al. (2016)

between the indicator variables of $Naturaldisasters$ and $Localbank$ in equation 2.2. The estimation model is shown as following:

$$\begin{aligned}(2.2)\quad Deposit(ln)_{i,b,s,c,t} = \beta_0 + \beta_1 Natural\ disaster_{s,c,t} + \beta_2 Local\ bank_{i,t} + \\ \beta_3 Natural\ disaster_{s,c,t} \times Local\ bank_{s,c,t} + \gamma X_{b,t-1} + \delta_{s,t} + \varepsilon_{i,b,s,c,t}\end{aligned}$$

where $Local\ bank_{i,t}$ is a dummy variable that equals to one if the bank is a local bank and 0, otherwise. The definitions of other variables follow equation 2.1. The coefficient of interest is β_3, a positive (negative) β suggests that local banks mitigate (aggravate) the adverse effect of natural disasters on branch deposits.

Column 3 of Table 2.2 presents the estimation results of equation 2.2. The coefficient of natural disaster is consistent to the results shown in column 2. The estimated coefficient of interest, β_3, is 0.053 (t-statistics 2.03), indicating that local banks completely mitigate the adverse impact of natural disasters on deposits. Additionally, natural disasters cause 5.4% increase in deposits of local banks. The results support a redistribution of deposits among banks after natural disasters.

2.3.2 Dynamic effect of natural disasters on bank deposits

The annual reporting frequency of the SoD poses the challenge in identifying the short-lived dynamic impact of natural disasters on bank deposits (Cortés and Strahan, 2017). To address this issue, I use quarterly Call reports data and estimate the following model:

$$\begin{aligned}(2.3)\quad Deposits(ln)_{b,t} = \beta_0 + \beta_1 Proportion\ of\ branches\ exposed\ to\ NDs_{b,t} \\ + \beta_2 Proportion\ of\ branches\ exposed\ to\ NDs_{b,t-1} \\ \beta_3 Proportion\ of\ branches\ exposed\ to\ NDs_{b,t-2} \\ + \gamma X_{b,t-1} + \delta_{s,t} + \varepsilon_{b,s,t}\end{aligned}$$

where the dependent variable $Deposits(ln)_{b,t}$ is the natural logarithm of bank deposits of bank b at year-quarter t. This set of regressions adopt a different measurement of banks' exposure to natural disasters. Considering they are bank-level regressions, the risk measurement, $Proportion\ of\ branches\ exposed\ to\ NDs$, is based on the proportion of branch of the bank b exposed to natural disasters. There are three coefficients of interest in this model, namely β_1, β_2 and β_3. β_1 captures the effect in the quarter of natural disasters taking place, while $\beta_{2(3)}$ captures the effect in one (two) quarter(s) after natural disasters taking place. This set of regressions is analysed by using Call reports year-quarter observations. The key advantage of the Call reports is the higher frequency of observations, allowing me to examine the dynamic effect of natural disasters on bank deposits and lending. The vector of bank control variables follow equation 2.1. $\delta_{s,t}$ captures headquarter state × year fixed effects and standard errors are clustered at state level.

Figure 2.2 reports the estimation results of equation 2.3. In the figure, the dot in 0 (1) (2) quarter after natural disasters shows the estimated β_1 (β_2) (β_3). The respective dash line indicates the 95% confidence interval of the estimated coefficient. The figure indicates that a percentage increased in proportion of branches exposed to the natural disasters experience 1.8% decrease in bank deposits in the quarter of natural disaster taking place and the impact lasts for another quarter following natural disasters. Consistent with previous finding on the short-lived effect of natural disasters, the impact does not last in the second quarter after natural disasters.

To shed light on the heterogeneous impact of natural disasters on local banks, I split the sample into local banks and non-local banks, then replicate the estimation above. The sub-figure on the left (right) of Figure 2.3 shows the estimation results for non-local banks (local banks). Consistent with the results in the previous section, the results suggest that only non-local banks' deposits are adversely affected by natural disasters and the effects last for 2 quarters after natural disasters. For local banks, natural disasters do not reduce deposits, irrespective of the periods after natural disasters.

2.3.3 Effect of natural disasters on branch deposits interest rates

To get a full picture of the impact of natural disasters on banks, it is important to understand the impacts on the pricing of deposits. Combined with the quantity results presented in the two previous sections, the pricing results could imply the relative changes in demand and supply of deposits after natural disasters.

To estimate the impact of natural disasters on deposit rates, I use the RateWatch data and estimate the following equation.

$$12 - month\ CD\ rate_{i,b,s,c,t} = \beta_0 + \beta_1 Natural\ disaster_{s,c,t} + \gamma X_{b,t-1} + \delta_{s,t} + \varepsilon_{i,b,t} \tag{2.4}$$

where the dependent variable $12 - month\ certificate\ of\ deposits\ rate_{i,b,s,c,t}$ is the interest rates of 12 months certificate of deposits of branch i of bank b located at state s and county c in year-quarter t. The definitions of all variables follow equation 2.1, except all variables included in this equation are in quarter frequency, and $\delta_{s,t}$ captures state x year x quarter fixed effects. Standard errors are clustered at county level. [5]

Column 1 of Table 2.3 reports the estimation result of the coefficient of interest, β_1, in equation 2.4. The results suggest that on average, banks increase 12-month CD rates by 0.025% in the quarter of natural disasters. Deposit interest rates increase while the quantity of deposits decreases after natural disasters. Hence the results imply that on average, there is a relative decrease in the supply of deposits following natural disasters.

The next column in the Table 2.3 presents the estimation results of equation 2.4 by adding the interaction term, $Natural\ disaster \times Local\ bank$, and the dummy variable $Local\ bank$. The results indicate a heterogeneous impact of natural disasters on deposit interest rates. The results show that while non-local banks increase 12-month CD rates by 0.028%, there are no statistically significant results showing local banks increase their 12-month CD rates after natural disasters. On the contrary, natural disasters reduce local banks' CD rates by 0.055%, indicating that there is an increase in supply of deposits for local banks after natural disasters. The results hint at a reallocation of deposits between local and non-local banks after natural disasters.

2.4 Effect of natural disasters on bank lending

2.4.1 Effect of natural disasters on bank lending volumes

This section examines the impact of natural disasters on bank lending volumes. To implement the estimation, I study the following regression with the Call reports data:

$$\begin{aligned} Lending(ln)_{b,t} = \beta_0 + \beta_1 Proportion\ of\ branches\ exposed\ to\ NDs_{b,t} \\ + \gamma X_{b,t-1} + \delta_{s,t} + \varepsilon_{b,s,t} \end{aligned} \tag{2.5}$$

where dependent variable is the natural logarithm of bank lending volumes of bank b at year-quarter t and the definition of all variables follows equation 2.3.

[5] Equation 2.4 is also employed to estimate the effects of natural disaster on loan rates, the results are discussed in section 2.4.2.

Table 2.4 presents the estimation results of equation 2.5. Column 1 shows that a percentage increase in branch exposure to natural disasters is associated with 2.1% of increase in banks' total lending, indicating that on average, banks exposed to the natural disasters increase lending to meet borrowers' need of liquidity.

Column 2 of Table 2.4 informs whether additional deposit inflows of local banks create additional liquidity after natural disasters. The estimated coefficient of interaction term $Naturaldisaster \times Localbank$ in column 2 suggests that local banks increase an additional 5.2% in total lending during the quarter following natural disasters. The results imply that local banks could better weather the local community through natural disasters by the additional credit supply.

2.4.2 Effect of natural disasters on bank loan rates

While banks on average increase lending after natural disasters, it is uncertain whether banks increase lending rates to compensate the increased credit risk. If it is the case, more deprived households may still subject to credit rationing after natural disasters.

To investigate the impact of natural disasters on bank loan rates, I employ RateWatch data of auto loans and unsecured personal loans. There are two reasons of focusing on these two categories of loan. First, RateWatch does not have comprehensive coverage of branches on different categories of loan. Auto loans and unsecured personal loans provide relatively extensive coverage, thus mitigating sample selection concern. Second, this chapter avoids examining mortgages which underlying assets are directly exposed to natural disasters. Otherwise, the findings could be driven by the differences in physical damages and the risk perception of the underlying properties of mortgages.

Column 1-2 of Table 2.5 present the estimation results for auto loans while column 3-4 of the table present the results for personal unsecured loans. The structure of the estimation model follows equation 2.4, apart from the dependent variable. The dependent variable in column 1-2 is interest rates of auto loans, and the dependent variable in column 4-5 is the interest rates of personal unsecured loans. Column 1 shows no statistic evidence that natural disasters affect the interest rates of auto loans. Column 2 examines the potential heterogeneous effect on local banks and the results indicate that local banks do not adjust interest rates of auto loans differently after exposed to the natural disasters. For personal unsecured loan, the estimated coefficient in column 3 shows that natural disasters, on average, do not affect the loan rates. However, the estimation results in column 6 suggest that local banks reduce interest rates by 6.2% of personal unsecured loan after the exposure of the natural disaster.

2.5 Discussion-Potential channels

This chapter finds that natural disasters affect banks' deposits heterogeneously: local banks receive additional supply of deposits after exposing to the natural disasters, resulting in a lower cost of deposits. Local banks also translate the additional deposit inflows and lower cost of deposits into higher credit supply. This section aims to examine four different possible channels.

2.5.1 Social connection

The first channel is the social connection channel which expects that depositors support local banks more due to the connection of local banks with their community.

I evaluate the social connection channel by examining whether the deposit inflows to local banks are particularly strong in counties with stronger social connection. If the additional deposit inflows are indeed caused by depositors' connection with the local banks, the additional deposit inflows of local banks should be stronger after the exposure to the natural disasters.

In validating this conjecture, I employs three measurements of social connectedness. The first one is the county-level social capital index developed by Rupasingha et al. (2006). The index takes into the consideration of numerous factors, such as voter turnovers, census response rate etc. The second measurement is the number of non-profit organization per capita. The third one is the religious adherence, capturing the proportion of population sharing the same religion.

I replicate the regression in column 3 of Table 2.2 (representing the bank-level deposit volumes) with the split samples by using different measurements of social connectedness. The estimation results are presented in Table 2.6. Column 1 (3) (5) shows the estimation results with counties which have equal to or below the national median of social capital index (no. of non-profit organization) (religion adherence), while Column 2 (4) (6) shows the estimation results with counties which are above the national median of social capital index (no. of non-profit organization) (religion adherence). The results are consistent across all three measurements of social connectedness. The results consistently suggest that the additional deposit inflows of local banks are particularly strong in counties with higher social connectedness. Thus, the findings are consistent to the conjecture that social connectedness is the key driver of the deposit inflows from local banks following natural disasters.

2.5.2 Bank soundness

An alternative explanation is the bank soundness channel which expects the additional deposit inflows are caused by the expectation that local banks are more likely to survive after natural disasters. If the inflows to local banks were simply caused by bank soundness, one would observe that banks with higher soundness, regardless of being a local or national banks, should receive higher deposit inflows.

To verify this channel, I employ two measurements of bank soundness, including the tier 1 capital ratio and net income to asset ratio, to split the sample. I then replicate the estimation of equation 2.1 based on each sub-samples. Column 1 (2) of Table 2.7 reports the estimation based on banks with lower than or equal to (higher than) the median value of tier 1 capital ratio, and Column 3 (4) of Table 2.7 reports the estimation based on banks with lower than or equal to (higher than) the median value of net income to asset ratio. Regardless of the measurements, the results consistently show no evidence that banks with higher soundness experience deposit inflows after natural disasters. Hence, the deposit inflows to local banks are unlikely to be driven by the bank soundness channel.

2.5.3 Government assistance

The deposit inflows to local banks could be the mechanical results of government disaster assistance if local banks systematically reside in areas with higher government disaster assistance. To verify this conjecture, I control for the total annual approved volume of U.S Small Business Administration (SBA) disaster loan on county level in the estimation of equation 2.2, as a proxy of government assistance after disasters.[6] The estimation results are presented in column 1 of Table 2.8. The results suggest that 1% increase in the SBA disaster loans indeed increase 0.4% of branch deposits. However, the inclusion of the control variable does not affect the economic magnitude and statistical significance of the variable of interest, *Disaster x Local Bank*, implying that the deposit inflows of local banks after natural disasters cannot be explained by government disaster assistance.

2.5.4 Local banks' market power

Presuming that natural disasters systemically happen in market with lower shares of local banks, it may explain the absence of negative effects on local banks' deposits, rather than social connectedness. If this conjecture is true, one should observe that the deposit inflows to local banks should be stronger in counties with lower market share of local banks.

To verify if that is the case, I employ two measures to proxy the market share of local banks on county level. The first one is the Herfindahl–Hirschman index (HHI) of local banks which

[6]SBA disaster loans aim to assists businesses and households that experience natural disasters. Banks play limited role in originating the SBA loans, the SBA evaluates and approves loan applications, and guarantees approved loans.

captures the squared deposit market share of local banks across counties. The second one is the three-firm concentration index which captures the market share of the largest three local banks in counties. I then create two dummy variables, *Low HHI* and *Low CR3*, to indicate counties with the respective measure below the 25^{th} percentile of the population. I then separately introduce the two variables into our baseline equation 2.2. The variables of interest are the triple interaction terms, *Disaster x Local Bank x Low HHI* and *Disaster x Local Bank x Low CR*. Positive and statistically significant coefficients of the variables support the alternative explanation.

The results are shown in column 2-3 of Table 2.8. The inclusion of the triple interaction terms in the regression model do not affect the baseline results. More importantly, the coefficients of both triple interaction variables are statistically insignificant at 10% level, suggesting that there is no evidence that the deposit inflows are particularly stronger in market with low local bank market share, thus market share of local bank does not seem to explain the findings.

2.6 Conclusion

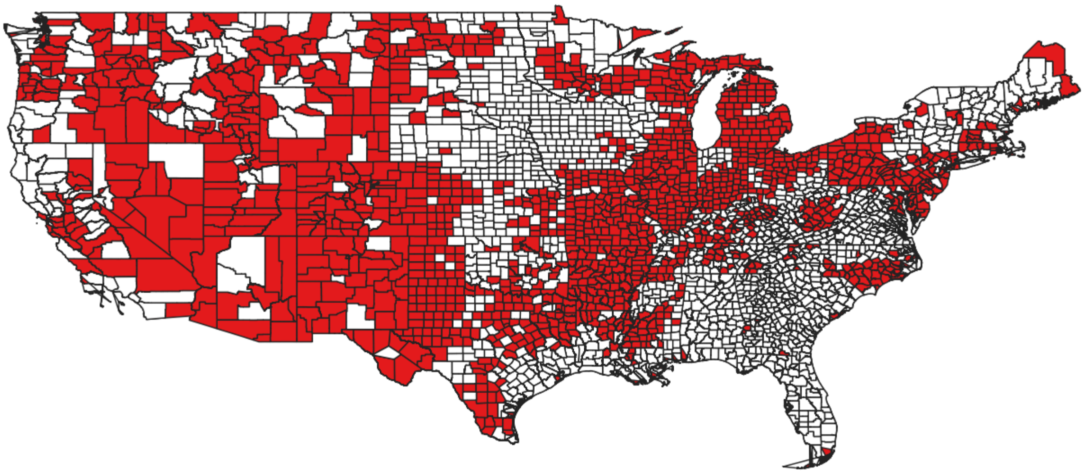
I conclude by answering the three questions raised in the introduction of the chapter. First, natural disasters, on average, reduce the supply of deposits, leading to a reduction of deposit volumes and an increase in deposit interest rates. Banks increase lending after natural disasters without adjusting interest rates of loans. Second, local banks do not experience deposit outflows after natural disasters. On the contrary, local banks experience deposit inflows, leading to an increase in deposit volumes and reduction in deposit interest rates. Following the deposit inflows, local banks increase lending. Finally, I find that the deposit inflows to local banks following natural disasters are particularly strong in counties with higher social connectedness.

The chapter offers timely implications in accessing the responses of banks to natural disasters. My findings reveal that natural disasters generally do not undermine banks supply of credit, despite of the deposit outflows following natural disasters. The results highlight that natural disasters do not cause severe liquidity issue to disaster-exposed banks. However, the increasing frequency and severity of natural disasters in the coming future may change this finding.

The chapter also offers an insight in evaluating the unique role of local banks in weathering local shocks. With the specialization of local market, local banks build up the relationship with the local communities and accumulate the soft information of their clients. During adverse shocks to local economies, local banks utilize these advantages to attract deposits at lower cost to increase credit supply.

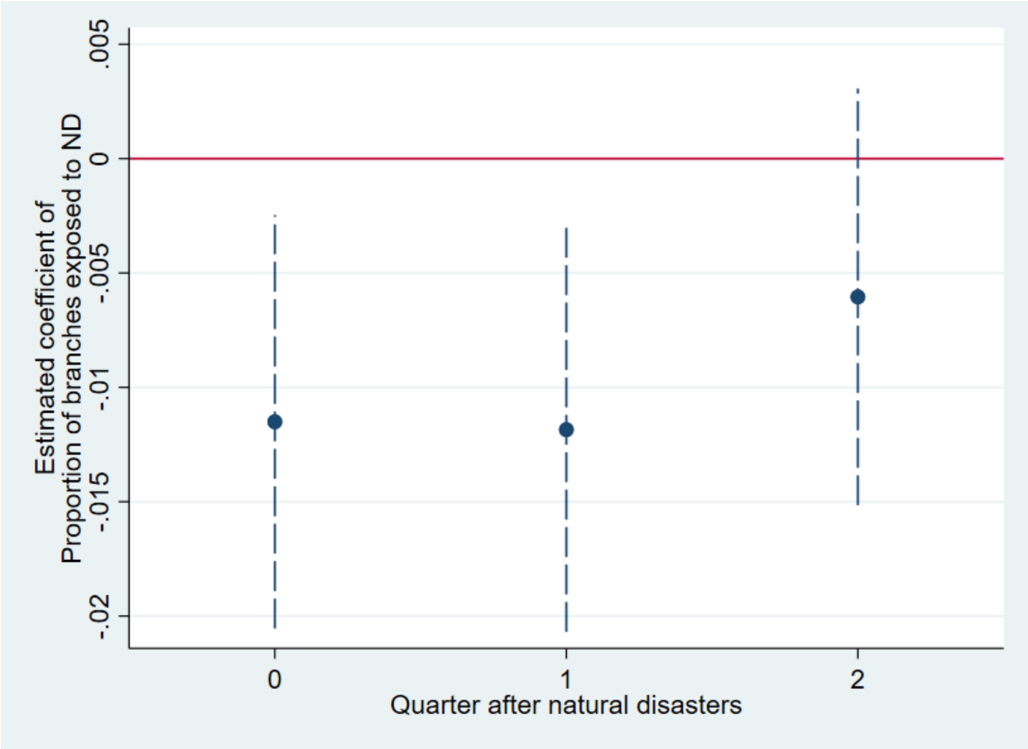
2.7 Tables and figures

Figure 2.1: Local authorities exposed to natural disasters in 2018-19



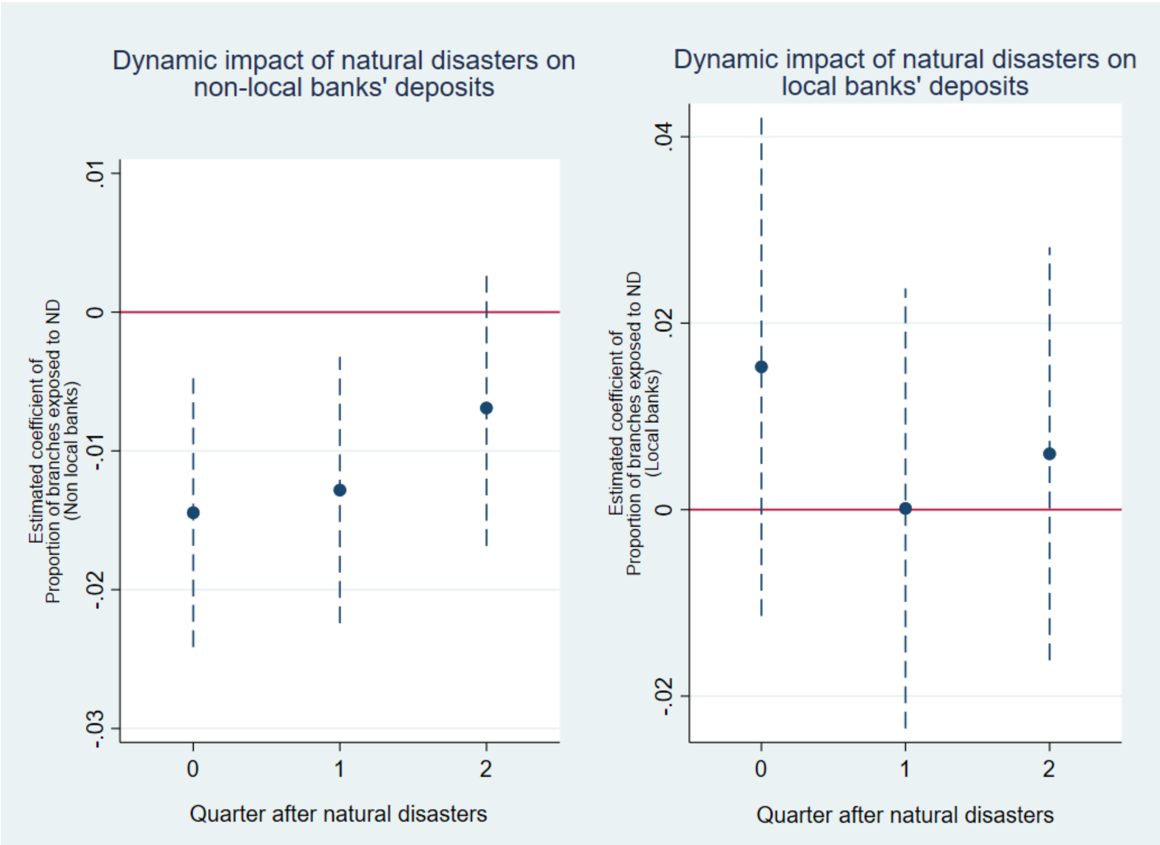
Notes: The red (white) areas of the figure indicate local authorities in the US (without) experiencing natural disasters in 2018-2019.

Figure 2.2: Dynamic impact of natural disasters on bank deposits



Notes: The the figure illustrates the dynamic impact of natural disasters on branch deposits, based on the equation 2.3. The dot at the 0 (1) (2) quarter after natural disasters represents the estimated coefficient of β_1 (β_2) (β_3) in equation 2.3. The dash line at the 0 (1) (2) quarter after natural disasters represents the 95% confidence interval of β_1 (β_2) (β_3) in equation 2.3.

Figure 2.3: Dynamic impact of natural disasters on bank deposits (local vs non-local bank)



Notes: The the figure illustrates the dynamic impact of natural disasters on branch deposits for non-local banks and local banks, based on the equation 2.3. The dot at the 0 (1) (2) quarter after natural disasters represents the estimated coefficient of β_1 (β_2) (β_3) in equation 2.3. The dash line at the 0 (1) (2) quarter after natural disasters represents the 95% confidence interval of β_1 (β_2) (β_3) in equation 2.3.

Table 2.1: Summary statistics

	N	Mean	SD	P5	p95
Branch-level					
Disaster	165,869	0.286	0.452	0.000	1.000
Local bank	165,869	0.066	0.247	0.000	1.000
Disaster x Local bank	165,869	0.017	0.128	0.000	0.000
Deposit volumes (ln)	168,935	10.829	0.945	8.867	12.481
12-month CD rates (%)	78,532	0.766	0.549	0.100	1.860
Auto loan rates (%)	16,725	4.949	1.131	3.290	7.000
Personal unsecured loan rates (%)	13,052	37.283	15.603	12.000	60.000
Bank-level					
Deposits (ln)	41,949	12.277	1.210	10.370	14.892
Total loans (ln)	41,949	12.019	1.310	9.840	14.771
Assets (ln)	41,949	12.502	1.456	10.547	15.160
Cost of deposits (%)	41,949	0.174	0.103	0.042	0.368
Tier 1 capital ratio (%)	41,949	11.630	4.274	8.125	18.289
Mortgage to assets ratio (%)	41,949	20.025	15.263	1.666	51.318
Net income to assets ratio (%)	41,949	0.283	1.549	-0.022	0.548
Letters of credits to assets ratio (%)	41,949	0.316	0.633	0.000	1.181

Notes: This table provides descriptive statistics for the variables used in the chapter. Panel A presents branch-level variables. Panel B shows bank-level variables.

Table 2.2: Effect of natural disasters on branch deposits

	1	2	3
Dependent variable	Deposit volumes- branch(ln)		
Disaster	-0.053***	-0.030**	-0.033**
	(-2.76)	(-2.09)	(-2.19)
Local Bank			0.096***
			(4.20)
Disaster x Local Bank			0.053**
			(2.03)
L.Assets (ln)		0.071***	0.071***
		(27.38)	(27.96)
L.Cost of deposits		1.758***	1.716***
		(20.02)	(19.38)
L.Tier 1 capital ratio		-0.005***	-0.006***
		(-2.72)	(-3.35)
L.Mortgage to assets ratio		-0.002***	-0.003***
		(-4.24)	(-6.33)
L.Net income to assets ratio		-0.022***	-0.021***
		(-20.66)	(-20.04)
L.Letters of credits to assets ratio		0.048***	0.048***
		(15.62)	(15.69)
Observations	165,869	165,869	165,869
R-squared	0.099	0.202	0.203
State x Year FE	Yes	Yes	Yes

Notes: The dependent variable of the this table is natural logarithm of branch-level deposits. Column 1-2 of this table presents estimation results of equation 2.1. Column 3 of this table presents estimation results of equation 2.2. Definitions of variables are detailed in Table A2.1 in the appendix. Standard errors are clustered at county level and the corresponding *t*-statistics are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 2.3: Effect of natural disasters on deposit interest rates

	1	2
Dependent variable	Interest rates of 12-month CDs (%)	
Disaster	0.025***	0.028***
	(2.68)	(2.91)
Local Bank		0.146***
		(2.93)
Disaster x Local Bank		-0.083*
		(-1.92)
Observations	78,532	78,532
R-squared	0.438	0.440
State x Year x Quarter FE	Yes	Yes
Bank controls	Yes	Yes

Notes: The dependent variable of the this table is interest rates of 12-month certificate of deposits (%). Column 1-2 of this table presents estimation results of equation 2.4. Definitions of variables are detailed in Table A2.1 in the appendix. Standard errors are clustered at county level and the corresponding *t*-statistics are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 2.4: Effect of natural disasters on bank lending

	1	2
Dependent variable	Total lending (ln)	
Disaster	0.021***	0.015**
	(2.91)	(1.96)
Local Bank		-0.077***
		(-3.23)
Disaster x Local Bank		0.051**
		(2.14)
Observations	41,949	41,949
R-squared	0.891	0.891
Year x Quarter FE	Yes	Yes
Bank controls	Yes	Yes

The dependent variable of the this table is natural logarithm of bank total lending. Column 1-2 of this table presents estimation results of equation 2.5. Definitions of variables are detailed in Table A2.1 in the appendix. Standard errors are clustered at state level and the corresponding *t*-statistics are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 2.5: Effect of natural disasters on loan rates

	1	2	3	4	5	6
Dependent variable	Interest rates (%)					
Sample	Auto New- 60 Mo Term			Personal Unsecured Loan - Max Term		
Disaster	-0.065	-0.071	-0.061	-0.345	-0.469	0.023
	(-1.33)	(-1.35)	(-1.20)	(-0.34)	(-0.42)	(0.02)
L1.Disaster		-0.105*			-0.959	
		(-1.90)			(-0.70)	
L2.Disaster		-0.012			-0.658	
		(-0.22)			(-0.55)	
Local Bank			-0.037			1.248
			(-0.26)			(0.27)
Disaster x Local Bank			-0.089			-6.203*
			(-0.50)			(-1.69)
Observations	16,725	16,725	16,725	13,052	13,052	13,052
R-squared	0.244	0.244	0.244	0.218	0.218	0.218
State x Year x Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: In column 1-3, the dependent variable of the this table is interest rates of new automobile loans (%). In column 4-6, the dependent variable of the this table is interest rates of personal unsecured loans (%). Definitions of variables are detailed in Table A2.1 in the appendix. Standard errors are clustered at county level and the corresponding *t*-statistics are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 2.6: Role of social connectedness

	1	2	3	4	5	6
Dependent variable	Bank-level deposit volumes(ln)					
Sample split	Social capital index		No. of non-profit organizations		Religion adherence	
	$\leq p50$	> p50	$\leq p50$	> p50	$\leq p50$	> p50
Disaster x Local Bank	0.015	0.071**	0.005	0.069*	0.006	0.091**
	(0.37)	(2.28)	(0.12)	(1.75)	(0.14)	(2.53)
Disaster	-0.029	-0.044***	-0.028**	-0.017	-0.063**	-0.010
	(-1.25)	(-2.88)	(-2.56)	(-0.52)	(-2.45)	(-0.79)
Local Bank	0.104**	0.083***	0.073***	0.069*	0.099***	0.073***
	(2.42)	(3.63)	(3.11)	(1.94)	(3.07)	(2.63)
Observations	83,078	82,088	81,879	83,287	83,081	82,788
R-squared	0.219	0.181	0.118	0.166	0.210	0.201
State x Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable of the this table is natural logarithm of branch-level deposits. This table presents estimation results of equation 2.2 based on different sub-samples. Definitions of variables are detailed in Table A2.1 in the appendix. Standard errors are clustered at county level and the corresponding *t*-statistics are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 2.7: Alternative explanation: bank soundness

	1	2	3	4
Dependent variable	Branch-level deposit volumes(ln)			
Sample split	Tier 1 capital ratio (%)		Net income to assets ratio (%)	
	$\leq p50$	> p50	$\leq p50$	> p50
Disaster	-0.032	-0.017	-0.019	-0.047***
	(-1.61)	(-1.17)	(-1.01)	(-3.09)
Observations	83,590	82,273	83,028	82,839
R-squared	0.226	0.148	0.255	0.167
State x Year FE	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes

Notes: The dependent variable of the this table is natural logarithm of branch-level deposits. This table presents estimation results of equation 2.1 based on different sub-samples. Definitions of variables are detailed in Table A2.1 in the appendix. Standard errors are clustered at county level and the corresponding t-statistics are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 2.8: Alternative explanation: SBA loans and market share

	1	2	3
Dependent variable	Deposit volumes- branch(ln)		
Disaster x Local Bank	0.053**	0.080**	0.061*
	(2.03)	(2.14)	(1.74)
Disaster	-0.034**	-0.052*	-0.022
	(-2.26)	(-1.70)	(-0.83)
Local bank	0.094***	0.129***	0.129***
	(4.16)	(5.13)	(5.13)
SBA loans (ln)	0.004***		
	(3.58)		
Disaster x Local Bank x Low HHI		-0.115	
		(-1.23)	
Disaster x Low HHI		0.028	
		(0.85)	
Local Bank x Low HHI		-0.201***	
		(-3.33)	
Low HHI		0.129***	
		(5.13)	
Disaster x Local Bank x Low CR3			-0.110
			(-1.09)
Disaster x Low CR3			-0.019
			(-0.65)
Local Bank x Low CR3			-0.236***
			(-3.30)
Low CR3			0.129***
			(5.13)
Observations	165,869	165,869	165,869
R-squared	0.203	0.203	0.203
State x Year FE	Yes	Yes	Yes

Notes: The dependent variable of the this table is natural logarithm of branch-level deposits. Column 1 of this table presents estimation results of equation 2.2 controlling total approved SBA disaster loans. Column 2-3 of this table presents estimation results of equation 2.2 with the respective triple interaction term. Definitions of variables are detailed in Table A2.1 in the appendix. Standard errors are clustered at county level and the corresponding *t*-statistics are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

2.8 Appendix

Table A2.1: Variables definition

Branch-level variables	Definiton	Data source
Deposit volumes (ln)	Natural logarithm of branch-level deposits	SoD
12-month CD rates (%)	Interest rates of 12-month Certificate of Deposits	RateWatch
Auto loan rates (%)	Interest rates of new automobile loans	RateWatch
Personal unsecured loan rates (%)	Interest rates of personal unsecured loans	RateWatch
Bank-level variables		
Deposits (ln)	Natural logarithm of bank-level deposits	Call Report
Total loan (ln)	Natural logarithm of bank-level total loan	Call Report
Total assets (ln)	Natural logarithm of total assets	Call Report
Average cost of deposits	Interest expenses on deposits/total deposits	Call Report
Tier 1 capital ratio	Tier 1 capital/ total assets	Call Report
Mortgages to assets ratio (%)	Mortgage loans/ total assets	Call Report
Net income to assets ratio (%)	Net Income/total assets	Call Report
Letters of credits to assets ratio (%)	Letter of credits/total assets	Call Report
County-level variables		
Social capital index	Social capital index	Rupasingha et al. (2006)
No. of non-profit organizations per capita	No. of non-profit organizations in per capita	Rupasingha et al. (2006)
Religious adherence	Population proportion sharing the same religion	Grammich et al. (2018)
SBA loans	Total approved SBA disaster loans	U.S. Small Business Admin
HHI	Local banks' Herfindahl-Hirschman index of deposits	SoD & Author's calculation
CR3	3-firm concentration ratio of local banks	SoD & Author's calculation

CHAPTER 3

Bank equity capital and lending

3.1 Introduction

Bank capital is at the core of bank regulation and has been one of the main focus of the regulatory reform after the 2007-2008 financial crisis. Although it is well understood that banks with higher level of capital have a number of advantages such as reducing the subsidy provided by deposit insurance and reducing the risk of contagion, the impact of bank capital on banks' lending behavior has been a source of debate for a long time. The theoretical literature offers explanations leading to contradictory predictions. On one hand, the financial fragility-crowding out hypothesis predicts that a fragile capital structure could motivate banks to expand credit (Diamond and Rajan, 2000, 2001). On the other hand, the cost-absorbing hypothesis expects that higher capital ratios could increase bank lending by expanding banks' risk-bearing ability (Bhattacharya and Thakor, 1993; Repullo, 2004; Coval and Thakor, 2005).

Empirical studies provide mixed evidence in verifying the two conflicting hypotheses, e.g, Rice and Rose (2016); Gambacorta and Shin (2018). There are two plausible reasons. First, most of the studies in the literature consider these two hypotheses mutually exclusive, in other words, they neglect the plausible non-linear relationship between capital and bank lending. Second, most of the empirical literature on this topic evaluates the impact of capital on lending at the aggregate level, which makes it difficult to disentangle the supply and demand effects, e.g., (Jiménez et al., 2012). Thus, this chapter proposes to reconcile the two conflicting hypotheses by evaluating the non-linear relationship between capital and lending with loan-level data, allowing the study to disentangle the supply and demand effects.

I employ syndicated loan data from the DealScan database to examine the impact of equity capital on aggregate facility volume and four loan contract terms: amount, spread, number of covenant and collateral. I define high-capitalized banks as any lead banks with one-year-lagged equity over assets ratio equal or are above the 75^{th} percentile of all lender banks in the origination year. The low-capitalized banks are defined as any lead banks with one-year-lagged equity over assets ratio are in the 25^{th} percentile of equity over assets ratio in the origination year. The granularity of the data allows to rule out potential confounding factors by including industry-year fixed effects and a rich set of firm control variables to control for the demand-side factors.

The main results are as follows. After controlling for bank specific characteristics and year fixed effect, I find high-capitalized banks originate greater number of facility(38%) each year than the control group, this result is in line with Chu et al. (2019), which finds that banks' allocation shares are positively associated with the banks' capital ratios. I also find that both high-capitalized and low-capitalized bank have higher aggregate facility volume compared to the control groups. This finding suggests that the effect of equity capital ratio on bank aggregate lending volume is nonlinear. For each year in the sample, high-capitalized banks lend 62% more and low-capitalized bank lend 38% more in terms of the aggregate facility volume than the control group.

Next, I determine the effect of bank equity capital on loan amount at facility-level and whether they vary depending on the lead banks' equity capital level. I start with testing the facility-level loan amount. I find that both high-and low-capitalized banks originate facilities with higher amount, 20% and 12% higher than the control group, respectively. This finding is consistent with the aggregate-level regression and it suggests that the relationship between bank equity capital and the amount of the facility is not linear. The results are robust to different approaches in classifying high and low-capitalized banks.

Consistent with Schwert (2018), I find that the increase in lending by both groups of banks is driven by borrowers with different credit qualities, in terms of leverage and profitability. While low-capitalized banks are more likely to lend to riskier firms, high-capitalized banks increase lending to safer firms. Such matching explains why different groups of bank behave differently and impose different loan terms. Low-capitalized banks originate facilities with higher spread (2%) and more collateral requirement(4%) with respect to the control group. However, high-capitalized banks originate facilities with lower spread (9%) than the control group.

The remainder of the chapter proceeds as follows. Section 3.2 reviews the literature. Section 3.3 presents the hypotheses. Section 3.4 and 3.5 describe the data and methodology respectively. Section 3.6 presents the results and robustness checks. Section 3.10 concludes.

3.2 Literature Review

Banking literature provides contradicting predictions regarding the relationship between bank capital and banks' lending. On the one side, theoretical works argue that higher capital ratios tend to impede bank lending by making the bank's capital structure less fragile (financial fragility-crowding out hypothesis) (Diamond and Rajan, 2000, 2001). This argument has been supported by empirical papers. For instance, Jackson et al. (1999) conclude that banks respond to tightened capital regulations by reducing lending in response to external and negative shocks to capital. Bridges et al. (2014) find that banks cut loan growth as a response to an increase in capital requirement. De Jonghe et al. (2020) document that higher capital requirements correspond to lower credit supply to corporations. Aiyar et al. (2014) find UK banks reduce the cross-border bank loan supply after the increase in bank-specific capital requirements. Noss and Toffano (2016) find an inverse relationship between the changes in banks' capital requirements and lending of UK banking system, suggesting an increase in the aggregate bank capital requirement is associated with a reduction of lending during an economic boom. Focusing on banks' capital ratio, Kim and Sohn (2017) suggest that the effect of an increase in capital ratio on credit growth is significantly negative for banks with low liquidity ratios. Dursun-de Neef and Schandlbauer (2021) find well-capitalized European banks decrease their loans significantly during COVID-19 outbreak.

On the other hand, there is a bulk of theory suggesting that capital absorbs risk and allows banks to spread their lending capacity (e.g.,Bhattacharya and Thakor, 1993; Repullo, 2004; Von Thadden et al., 2004; Coval and Thakor, 2005; Admati et al., 2013). There is also a vast empirical literature supporting this view. For instance, some papers highlight the positive relationship between capital requirements and bank lending (Gambacorta and Mistrulli, 2004; Berrospide and Edge, 2010; Francis and Osborne, 2012). Similarly, a large stream of work find a positive relationship between banks' capital and lending (Peek and Rosengren, 2000; Cornett et al., 2011; Gambacorta and Marques-Ibanez, 2011; Mora and Logan, 2012; Carlson et al., 2013; Rice and Rose, 2016; Gambacorta and Shin, 2018) [1]. Using loan-level data, Albertazzi and Marchetti (2010) , Jiménez et al. (2017) and Chu et al. (2019) also find well-capitalized banks are associated with higher credit supply.

This chapter contributes to the literature by offering evidence that reconciles these two opposite views. The empirical design in this chapter allows me to capture the non-linearity in the bank capital and lending relationship. My results indicate that both high- and low-capitalized banks lend more than the others.

[1] Peek and Rosengren (2000), Mora and Logan (2012) and Rice and Rose (2016) use natural experiments as negative shock to distinguish the demand and supply effects. Cornett et al. (2011), Carlson et al. (2013) and Gambacorta and Marques-Ibanez (2011), address the relationship between capital ratio and lending during financial crisis.

This chapter also contributes to the literature on the determinants of different terms of the syndicated loan. For instance, Qian and Strahan (2007), Ivashina (2009), Ivashina and Sun (2011), Lim et al. (2014), Gurara et al. (2020) and Gong et al. (2022) analyse different factors affecting the loan spread. None of these papers, however, analyzes how the capital level of the lenders affect the loan spread.

Degryse et al. (2018) and Mayordomo et al. (2021) find a positive relationship between regulatory capital requirements and requirements on loans' collateral by investigating Portuguese and Spanish loan data, respectively. Other papers focus on the relationship between collateral and banks' monitoring activity, e.g., Ono and Uesugi (2009) and Cerqueiro et al. (2016). This chapter contributes to the literature by using syndicated loan data to test whether bank with different capital level issue loans with different collateral requirements.

Regarding covenants, Demerjian et al. (2021) provide evidence that lenders with lower regulatory capital issue loans with lower financial covenant strictness. This chapter contributes to the existing literature by studying the relationship between bank capital level and the number of covenants in the loan contracts. I find no significant differential effect on the number of covenants issued by the high-capitalized banks and low-capitalized banks.[2]

3.3 Hypotheses

First I develop predictions for the how bank capital affects the amount of credit granted by banks. Next, I discuss how different types of loan term are affected by the capital of the lenders.

3.3.1 Effects on credit amount

There are two contradicting theories about the the relationship between bank capital and the amount of credit granted by banks. The financial fragility-crowding out hypothesis predicts that higher capital ratios tend to impede bank lending by making the bank's capital structure less fragile (Diamond and Rajan, 2000, 2001). On the other hand, the cost-absorbing hypothesis suggests that banks with higher capital ratios tend to lend more because they can absorb more losses before becoming insolvent. This allows them to take on riskier loans, which in turn can generate higher profits (Bhattacharya and Thakor, 1993; Repullo, 2004; Coval and Thakor, 2005). I propose to reconcile these two predictions. I argue that banks in both tails of the capital

[2] Other papers analysing the determinants of covenants are Wang and Xia (2014), Becker and Ivashina (2016), Billett et al. (2016), Prilmeier (2017), Demiroglu and James (2010).

distribution lend more and form the following Hypothesis 1 in null form.

Hypothesis 1: Both low- and high-capitalized banks do not lend more than medium-capitalized banks.

However, their loans convey different risks. Given that bank capital is a device to curb excessive risk-taking, low-capitalized banks will generate more risky loans by lending to riskier borrowers. High-capitalized banks get cheaper debt due to their lower solvency risk, and they provide more secure source of funding. Therefore I expect high (low)-capitalized banks generate less (more) risky loans.

3.3.2 Effects on loan terms: collateral, spread and covenants

A large body of the theoretical literature points out that higher capital levels provide bankers with more incentives to diligently manage their loan portfolio, i.e. the more skin in the game, the more incentives to monitor the borrower (e.g. Holmstrom and Tirole, 1997). Concurrently, another branch of the literature argues that banks use collateral as a substitute for monitoring (e.g. Manove et al., 2001). Considering these theoretical predictions together, I argue that high-capitalized banks will monitor more actively the borrower. This will increase the probability of loan success and therefore, there will be less need for a collateral. The following presents Hypothesis 2 in null form:

Hypothesis 2: Bank capital is not negatively correlated to the collateral requirement.

If high-capitalized banks have more incentives to monitor the borrower, and this is translated in a lower failure rate, this should have an impact on the loan spread. Everything equals, loans granted by high- capitalized banks have a lower delinquency rate and therefore, one would expect these loans have a lower spread. The following is Hypothesis 3 in null form:

Hypothesis 3: Bank capital is not negatively correlated to the loan spread.

Same as collateral, covenants are used as the contractual devices that increase a lender's monitoring incentives(e.g. Rajan and Winton, 1995, Park, 2000 and Garleanu and Zwiebel, 2009). This leads to the following Hypothesis 4 in null form:

Hypothesis 4: Bank capital is not negatively correlated to the number of covenants.

3.4 Data

This chapter employs three sets of data, including loan-level data, bank-level and firm-level data. The following outlines the sources of the three data sets.

I obtain loan-level data from DealScan database provided by the Loan Pricing Corporation (LPC). The database provides detailed terms and conditions of syndicated loans issued to the large public companies across the globe at both deal-level and facility-level, for example, each bank's share or contribution in the syndicate(allocation). In particular, the database records facility amount, loan spread, number of covenant and collateral requirements of each originated loan, allowing me to examine the effect of lenders' equity level on these key contract terms. The data set also provides lender and borrower identifiers in each syndicated loans, enabling me to merge the loan-level data to the following two data sets.

To identify banks with different equity level , I employ annual bank-level data from BankScope database provided by Bureau van Dijk. The database records information on balance sheet and income statements data of over 10,000 global banks. In particular interest of this chapter, it records the equity-to-assets ratio of banks which allows me to identify the equity capital level of banks (details of the identification are shown in the next section). I also employ total assets of banks,income diversity, activity diversity, net charge offs, RoA from BankScope to control for bank characteristics in affecting bank lending.

I then employ annual borrower-level data from the merged CRSP/Compustat database to test the lender-borrower matching.

3.4.1 Sample construction

Sample construction starts with merging the above three sources of data by the link table of DealScan lender names with bank identifiers in Bankscope, provided by Schwert (2018).I then use the DealScan–Compustat link file provided by Chava and Roberts (2008) to identify the borrowing firms from the US.

I study all the syndicated loans to borrowers which are issued in the US during 1996-2015. Due to the lack of firm-level data for non-US borrower firms, I exclude non-US firms and only keep the US borrowers. I begin my sample in 1996 because the DealScan coverage has become comprehensive since then and I end my sample in 2015 because the Bankscope data are no longer available from 2016. I further exclude facilities issued to the financial services companies (Standard Industry Classification(SIC) codes from 6000 to 6999).The main regressions of this chapter end up with a sample of 10,669 facilities, 231 banks and 2,536 firms.

3.4.2 Identify lead banks

For each syndicated loan, there are usually more than one bank provides funding to a borrower. The lead bank is responsible for establishing a relationship, arranging and negotiating the contract terms with the firm(Ivashina and Sun (2011)). In general, lead bank holds the largest share of a loan deal, compared to other participant banks. I follow Sufi (2007) and Bharath et al. (2011) , to define whether a bank is a lead lender in a loan facility.[3] After identifying the lead bank, I exclude the participant banks and focus on studying the lead bank(s) of a particular loan facility in the main results. Studying the effect of lead banks' equity capital level on syndicated loan contract term is more appropriate and it avoids including participant banks that have limited contribution in a specific facility. So, I keep the facility that at least has one lead bank in my main regression sample for facility-level analysis.

3.4.3 Variables

3.4.3.1 Define lead bank equity capital level

In order to test how do lead banks with different equity capital levels affect credit supply and syndicated loan contract term differently, I define two groups of lead banks with different equity capital level: the $High\,Equity\text{-}to\text{-}Asset\,Ratio_{z,t-1}$ and $Low\,Equity\text{-}to\text{-}Asset\,Ratio_{z,t-1}$.

The main independent variables are: $High\,Equity\text{-}to\text{-}Asset\,Ratio_{z,t-1}$, a dummy variable indicating whether the one-year-lagged equity over assets ratio of any one of the lead banks in the facility is equal or above the 75^{th} percentile of equity over assets of all lender banks in the origination year and $Low\,Equity\text{-}to\text{-}Asset\,Ratio_{z,t-1}$, a dummy variable indicating whether the one-year-lagged equity over assets ratio of any one of the lead banks in the facility is equal or below the 25^{th} percentile of equity over assets ratio of all lender banks in the origination year.

3.4.3.2 Bank allocation and aggregate loan volume terms

In order to study the effects of bank capital level on bank lending. I first look at the relationship at aggregate facility-bank level. In equation 3.1, I follow Biswas and Zhai (2021), to construct two aggregate level dependent variables. For each bank at each year, I measure $Volume(ln)_{z,t}$(in

[3]Lender is a lead bank if one of the following conditions is met: 1) LeadArrangerCredit equals "Yes" in the Lendershares tables of DealScan, 2) LeadRole equals "Arranger", "Co-arranger", "Lead arranger", "administrative agent", "agent", "co-agent", "Signing agent", "Senior arranger" or "Issuing bank" in the Lendershares tables of DealScan, and 3) the lender is the sole lender.

dollar amount) and $Number(ln)_{z,t}$(the number of facilities). $Volume(ln)_{z,t}$ is the log of total amount that bank z lends to all the US firm at time t. To create this variable, I sum up a bank's share to all its facilities during each year. $Number(ln)_{z,t}$ is the log of the total number of facilities originated by bank z, to all firms in the US at time t.

DealScan contains information on facility allocation/bank share only for about 25% of all facilities. Following Biswas and Zhai (2021), I impute the missing data by the following steps: First, for each facility issued during my sample period with the loan allocation information available, I calculate the lead banks' share and participants' share within the facility, respectively. Then, I take the average values of the lead and participant shares in these facilities, which gives us the average lead banks' share as 53% and the average participants' share as 47%. Finally, in the facilities in which loan allocation information is missing, I divide 53% equally among the lead banks, and 47% equally among the participants.

3.4.3.3 Loan contract terms

The facility-level variables are as following: $Facility\,amount(ln)_{i,z,b,d,t}$ is the logarithm of facility amount. $Loan\,spread(ln)_{i,z,b,d,t}$ is the logarithm of loan price calculated from the reported spread and fees (Lim et al., 2014; Berg et al., 2016). $Number\,of\,covenant_{i,z,b,d,t}$ is the logarithm of the number of the covenant(s) included in the facility . $Collateral_{i,z,b,d,t}$ is a dummy variable indicating whether the facility has any collateral secured.

3.4.3.4 Control variables

I include different level of controls commonly used in the literature. The bank-level control variables are as following: the lenders' size, which is the average asset of all the lenders in the same facility; the income diversity and activity diversity following Laeven and Levine (2007) and Goetz et al. (2013); the bank return on assets and net charge off. The loan-level controls are the loan terms of the facility(loan spread, loan amount, number of covenants and collateral), apart from the loan term captured by the outcome variable in the specification, to account for the jointness of different loan terms (Brick and Palia, 2007). The firm-level controls include total asset, capital expenditure, coverage, leverage and RoA.

All variables have been winsorized at the 1% level to minimize the effect of outliers. The definition of all the variables are presented in A3.1 in the appendix.

3.4.4 Summary statistics

Summary statistics of the key variables are presented in Table 3.1. Panel A reports the facility-bank level descriptive statistics. The range of the lead bank contribution in the total facility amount is from 4.4% at the 5^{th} percentile of the distribution to 53% at the 95^{th} percentile. Panel B reports the bank-year aggregate level descriptive statistics. On average, a lead bank originates in total 16.6 facilities and $0.50 billion as each year during sample period.

Panel C presents descriptive statistics for loan contract terms at the facility-level. On average, the facility amount in the sample is $0.21 billion with 44 months of maturity. The average spread is 608 basis points and the average number of covenants are 2.05. Over 50% of the facilities are secured by collateral. Panel D presents the firm-level characteristics. The range of firm sizes is from $0.18 billion in total assets at the 5^{th} percentile of the distribution to $22.65 billion in total assets at the 95^{th} percentile. On average, RoA is 4.4%. Panel E presents the bank-level characteristics. On average, the size of the lenders is $523.87 billion.

3.5 Research design

This chapter employs different sets of specification to examine the following two research questions: How does different level of bank equity capital affect the credit supply at aggregate level? Does different level of bank equity capital affect syndicated loan terms?

I start with a regression examining whether a non-linear relationship exist between equity capital ratio and banks' contribution to the syndicated loan. The specification of this test is at facility-bank level. The dependent variable captures the contribution of a bank to the facility. The independent variables of interest are two dummy variables indicating equity capital level of the lending banks. The key advantage of the model is that it allows the model to control for the characteristics of facility, borrowers and banks. Despite of the advantage, the model cannot be applied in examining loan contract terms, such as interest rate and number of covenants, because these loan contract terms are the same within the group of lending banks in the same facility. The following is the model specification:

$$Y_{z,t} = \beta_0 + \beta_1 High\,Equity\text{-}to\text{-}Asset\,Ratio_{z,t-1} + \beta_2 Low\,Equity\text{-}to\text{-}Asset\,Ratio_{z,t-1} + \psi_Z + \omega_t + \varepsilon_{x,t} \tag{3.1}$$

where $Y_{z,t}$ is the outcome variable of banks z in year t. There are two outcome variables measuring aggregate level bank lending, including (1) $Numberoffacility_{z,t}$ which measures the log of the total number of loans made by bank t, to all US firms at year t (2) $Aggregatefacilityamount(ln)_{x,t}$ which captures the log of the total amount that bank z lends to all firms in the US at year t. ψ_Z captures the bank fixed effects and ω_t captures the year fixed effect. $High\,Equity\text{-}to\text{-}Asset\,Ratio$ and $Low\,Equity\text{-}to\text{-}Asset\,Ratio$ represent banks with different equity capital levels. β_1 (β_2) therefore indicates the impact of high (low) equity-to-assets ratio on bank allocation, comparing with banks which have neither high nor low equity over assets ratio.

In terms of examining the impact of equity ratio on loan terms of facility, including facility amount, interest rate, number of covenants and collateral requirement. Due to these loan terms do not vary within facility, I employ the following model specification based on facility-level data.

$$\begin{aligned} Y_{i,x,b,d,t} = \beta_0 + \beta_1 High\,Equity\text{-}to\text{-}Asset\,Ratio_{x,t-1} + \beta_2 Low\,Equity\text{-}to\text{-}Asset\,Ratio_{x,t-1} \\ + \gamma X_{i,t} + \tau W_{x,t} + \upsilon Q_{b,t-1} + \delta_{d,t} + \varepsilon_{i,x,b,d,t} \end{aligned} \tag{3.2}$$

where $Y_{i,x,b,d,t}$ is the outcome variable of facility i issued by the group of lead banks x to firm b in industry d in year t. There are five outcome variables, including (1) $Facility\,amount(ln)_{i,x,b,d,t}$ or (2) $Loan\,spread(ln)_{i,x,b,d,t}$ or (3) $Number\,of\,covenant_{i,x,b,d,t}$ or (4) $Collateral_{i,x,b,d,t}$.

$High\,Equity\text{-}to\text{-}Asset\,Ratio_{x,t-1}$ and $Low\,Equity\text{-}to\text{-}Asset\,Ratio_{x,t-1}$ represent if the facility is originated by at least one bank with high or low capital level. β_1 (β_2) therefore indicates the impact of equity-to-assets ratio on the contract terms of loans, comparing with banks which have neither high nor low equity over assets ratio. Particularly, I would like to highlight that the measurement of the two variable of interest in this equation 3.2 is different from equation 3.1. While $High(Low)Equity\text{-}to\text{-}Asset\,Ratio_{z,t-1}$ in equation 3.1 capture whether the bank is a high or low-capitalized bank. $High(Low)Equity\text{-}to\text{-}Asset\,Ratio_{x,t-1}$ in equation 3.2 capture if there is any at least one bank in the facility is a high or low-capitalized banks.

$X_{i,t}$ is a vector of loan-level control variables, $W_{x,t}$ is a vector of bank-level control variables and $Q_{b,t-1}$ is a vector of firm-level control variables. Bank-level control variable includes the average asset value of all lead banks in facility i; firm-level control variables include total asset, capital expenditure, coverage, leverage and RoA; loan-level control variables control for the loan terms of the facility, apart from the loan term captured by the outcome variable in the specification. $\delta_{d,t}$ captures the interaction of year and industry fixed effect, allowing the model to control for time-varying factors affecting the industry, such as the demand shock of the industry.

Standard errors are clustered on firm level.

3.6 Results-Impact on aggregate loan level

This section shows the impact of equity capital on credit supply at aggregate level. In Table 3.2, I present the results that show the relationship between bank equity capital and the aggregate level lending (equation 3.1). Bank allocation regression is estimated at facility-bank level. Facility aggregate amount and the number of facility regression are estimated at bank-year level.

In column 1 of Table 3.2, I find a positive relationship between high-capitalized banks and the number of facility that they granted each year. The estimated coefficient is statistically significant at 10% level. It shows that on average, high-capitalized banks generate more loans in terms of the number of facility than the other groups each year. High-capitalized lenders increase the numbers of facility by 38%. The estimated coefficient on low-capitalized bank is positive but statistically insignificant at the conventional levels. This finding is supporting the cost absorbing hypothesis that bank with higher capital level can increase credit supply. In the aggregate loan volume regression(column 2), rejecting Hypothesis 1, I find a non-linear result that both high-capitalized bank and low-capitalized bank generate more loans than the control group in terms of aggregate facility amount. The estimated coefficients for both well-capitalized banks and low-capitalized bank are statistically significant at the 5% and 10%, respectively.

Based on the analysis that the both group of banks increase their lending at aggregate level. I expand the analysis further to find out whether the lending behaviors of high-capitalized banks and low-capitalized banks are different at facility-level.

3.7 Results-Impact on facility amount

This section presents the regression results of equation 3.2, which shows the impact of capital level of banks on facility amount. In column 1 of Table 3.3, I find the positive and statistically significant coefficients on both high-capitalized banks and low-capitalized banks. The estimated coefficients are statistically significant at 1% level. Higher and lower level of bank equity capital are associated with an increased facility-level lending volume. In terms of economic significance, high-and low-capitalized banks originate facilities 20.0% and 12.1% higher than the control group respectively. These findings reject Hypothesis 1, that the banks with high equity capital level and with low equity capital level do not lend more in terms of facility amount compared to the control group. They are consist with the aggregate level regression in column 3 of Table 3.2, suggesting the non-linear relationship between bank equity capital level and lending amount.

3.7.1 Robustness tests-Impact on facility amount

Table 3.3 also provides a set of tests to verify whether the baseline results on facility amount are robust to different definitions of low-capitalized and high-capitalized banks. The first exercise narrows down the definition of high and low-capitalized. In the baseline estimations, I define high (low)-capitalized banks as banks with equity-assets ratio equal or above the 75 $(25)^{\text{th}}$ percentile of all lender banks. I replicate the estimation with stricter definitions that high (low)-capitalized banks as banks with equity-assets ratio equal or above the 90 $(10)^{\text{th}}$ percentile of all lender banks. The results are shown in column 1 of Table 3.3, suggesting that the results are robust to the stricter definition of high and low-capitalized banks.

The baseline model employs equity-to-asset ratio in defining high and low-capitalized banks, the next exercise examine if the results are robust to different capital ratios. I replicate the estimation of equation 3.2 using tier 1 capital ratio in classifying high and low-capitalized banks. The replication results are shown in column 3 of Table 3.3. The results are consistent to the baseline results.

3.8 Borrower-lender matching

Schwert (2018) finds that well-capitalized banks specialize in bank-dependent firms which do not have public debt rating. Therefore, it is plausible that the increase in lending of low-capitalized banks is driven by lower-quality borrowers, while high-capitalized banks increase loan amount to higher-quality borrowers. This borrower-lender matching also carries implications on the loan terms imposed by the two groups of banks, which will be discussed in the next section.

To investigate if such borrower-lender matching exists. I replicate the baseline equation 3.2 with the dependent variables, leverage and return on assets (RoA), to examine if lower capitalized banks systemically lend to firms with higher *ex-ante* higher credit risk, in terms of firms' leverage and return on assets. The results are presented in Table 3.4. In column 1, I find that borrowers of low-capitalized banks have higher leverage, while column 2 shows that profitability of lower-capitalized banks is lower. The results suggests that borrowers of lower-capitalized banks have higher *ex-ante* higher credit risk, which could lead to the stringent loan terms imposed by low-capitalized banks.

3.9 Results-impact on other loan terms

This section presents the impact on other loan terms at facility level, including collateral requirement, spread and number of covenants in Table 3.5.

3.9.1 Impact on collateral

In column 1 of Table 3.5, I present the regression results of estimating whether banks with different level of equity-to-asset ratio have different requirements on collateral.

The dependent variable is *Collateral*, with control variables and industry x year fixed effect included. The estimated coefficient on *High Equity-to-Asset Ratio* is positive and statistically insignificant. In contrast, the estimated coefficient on *Low Equity-to-Asset Ratio* is positive but statistically significant at the 1% level. The results imply that low-capitalized banks require stringent collateral requirement (more collateral) than the others. This finding reject H2 that bank equity capital is not negatively correlated to the collateral requirement since the low-capitalized banks use collateral as a substitute for monitoring.

3.9.2 Impact on loan spread

In column 2 of Table 3.5, I test the Hypothesis 3 and present regression that tests whether the level of equity capital of banks will affect the loan spread in the loan contract.

The banks with higher equity capital level issue loan with lower loan spread of 9%, on the contrary, the banks with lower equity capital level issue loan with higher loan spread of 2% . These findings suggest that compared with the control group, banks with a year-lagged equity over asset level higher than 75^{th} before the loan origination decrease their loan spread in the contract. In contrast, the banks with a year-lagged equity over asset level lower than 25^{th} behave differently by increasing the loan spread. The results highlight the one of the key differences in lending behaviours between these two groups of banks, in terms of interest rate. High (low) -capitalized banks decrease (increase) interest rate, while both groups increase lending. These findings reject H3, that bank equity capital is not negatively associated with loan spread because high-capitalized banks have lower delinquency rate on the issued loans, thus they can have lower interest rate.

3.9.3 Impact on loan covenant

Lastly, I test the changes on number of covenants in loan contracts when they are issued by banks with different equity capital level.In column 3 of Table 3.5, the dependent variable is the number of covenants in the contract, with control variables and industry x year fixed effect included. The coefficients of interest are negative and statistically insignificant for banks with different equity over assets ratio which implies that the number of covenants are not statistically significant changed in the loan contract either originated by banks with higher equity capital or lower equity capital.

3.10 Conclusion

This chapter reconciles the two conflicting theoretical hypotheses, cost absorbing hypothesis and financial fragility-crowding out hypothesis, in predicting the relationship between bank capital and lending. The chapter shows that the two hypotheses are not mutually exclusive. Both high-capitalized and low-capitalized banks increase lending, comparing with other banks. However, there is a distinction between the borrowers of both groups of banks. I find that high-capitalized are matched to higher quality borrowers, while low-capitalized banks specialize in lower quality borrowers. The borrower-lender matching carries implications on other loan terms imposed by both groups of banks. The chapter finds that loan terms of low (high)-capitalized banks tend to be more (less) stringent. Low-capitalized banks are more likely to require for collateral and charge higher loan spreads.

3.11 Tables and figures

Table 3.1: Summary statistics

Variable	N	Mean	SD	p5	p95
Panel A: Facility-bank					
Bank allocation(%)	23,210	19.356	16.361	4.440	53.000
Panel B: Aggregate bank-year					
Numbers of facility (ln)	627	2.808	1.445	1.386	5.460
Aggregate facility volume (ln)	627	20.036	2.053	17.483	23.410
Panel C: Loan terms					
Facility amount (ln)	10,669	19.164	1.253	17.034	21.129
Loan spread (ln)	10,669	1.805	1.175	0.350	4.000
No of covenant (ln)	10,669	0.719	0.450	0.000	1.386
Collateral	10,669	0.569	0.495	0.000	1.000
Panel D: Borrower characteristics					
Firm size(ln)	10,669	7.495	1.439	5.180	10.029
Capex	10,669	0.075	0.090	0.009	0.251
Coverage	10,669	14.031	25.460	1.133	56.590
Leverage	10,669	0.313	0.195	0.012	0.666
ROA	10,669	0.043	0.083	-0.100	0.169
Panel E: Bank characteristics					
Lenders size (ln)	10,669	13.169	1.084	11.163	14.560
Income Diversity	10,669	0.671	0.164	0.434	0.935
Charge off(ln)	10,669	7.500	1.788	4.025	9.784
Activity Diversity	10,669	0.911	0.367	0.342	1.638
ROA(%)	10,669	0.009	0.004	0.002	0.015

Notes: This table provides descriptive statistics for the variables used in the empirical analysis. The dependent variable Bank allocation in Panel A is at the bank-facility level.The dependent variable Number of facilities and Aggregate facility volume in Panel B are at the bank-year level. The dependent variables in Panel C are at the facility level. The borrower characteristics in Panel D are at the firm-year level.The bank characteristics in Panel E are at the bank-year level.

Table 3.2: Bank equity capital and aggregate-level lending

	1	2
Dependent Variables	Numbers of facility(ln))	Aggregate facility volume(ln)
High Equity-to-Asset Ratio	0.322*	0.481**
	(1.80)	(2.12)
Low Equity-to-Asset Ratio	0.096	0.323*
	(0.66)	(1.67)
Observations	627	627
R-squared	0.809	0.826
Industry*Year FE	No	No
Bank FE	Yes	Yes
Year FE	Yes	Yes
Firm controls	No	No
Bank controls	Yes	Yes
SE cluster	Bank	Bank

Notes: The dependent variable in column 1 is Bank allocation. The dependent variable in column 1 is Number of facility. It is a bank-year level regression. It presents estimation results of equation 3.1. Standard errors are clustered at bank level and the corresponding t-statistics are reported in parentheses. The dependent variable in column 3 is Aggregate facility volume. It is a bank-year level regression. It presents estimation results of equation3.1. Standard errors are clustered at bank level and the corresponding t-statistics are reported in parentheses. Definitions of variables are detailed in Table A3.1 in the Appendix. Variables are winsorized at the 1% level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively

Table 3.3: Bank equity capital and facility amount

	1	2	3
Dependent Variables	Facility amount(ln)		
High Equity-to-Asset Ratio	0.185***		
	(4.28)		
Low Equity-to-Asset Ratio	0.115***		
	(3.07)		
High equity-asset ratio P90		0.133**	
		(2.55)	
Low equity-asset ratio P10		0.086**	
		(2.09)	
High tier 1 capital ratio			0.093**
			(2.43)
Low tier 1 capital ratio			0.149***
			(4.19)
Observations	10,669	10,669	10,669
R-squared	0.620	0.625	0.615
Firm Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Industry*Year FE	No	No	No
No. of banks	231	231	231
No. of facilities	10669	10669	10669
No. of firms	2536	2536	2536

Notes:This table shows the facility-level regression results. The dependent variable is Facility amount. It presents estimation results of equation 3.2. Standard errors are clustered at firm level and the corresponding t-statistics are reported in parentheses. Definitions of variables are detailed in Table A3.1 in the Appendix. Variables are winsorized at the 1% level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively

Table 3.4: Bank equity capital and loan contract terms-borrower characteristics

	1	2
Dependent Variables	Leverage	RoA
Low equity-asset ratio	0.057***	-0.014***
	(11.69)	(-6.72)
High equity-asset ratio	-0.004	0.000
	(-0.89)	(0.11)
Observations	10,669	10,669
R-squared	0.017	0.005
Firm Industry FE	Yes	Yes
Year FE	Yes	Yes
Industry*Year FE	No	No

Notes:This table shows the facility-level regression results of equation 3.2. The dependent variable in column 1 is firm leverage. The dependent variable in column 2 is RoA. Standard errors are clustered at firm level and the corresponding *t*-statistics are reported in parentheses. Definitions of variables are detailed in Table A3.1 in the Appendix. Variables are winsorized at the 1% level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively

Table 3.5: Bank equity capital and other loan contract terms

	1	2	3
Dependent Variables	Collateral	Spread(ln)	Covenants(ln)
High Equity-to-Asset Ratio	0.019	-0.086**	0.012
	(1.23)	(-2.52)	(0.76)
Low Equity-to-Asset Ratio	0.041**	0.022**	-0.037
	(2.43)	(0.59)	(-1.24)
Observations	10,669	10,669	10,669
R-squared	0.488	0.585	0.424
Industry*Year FE	Yes	Yes	Yes
Other loan terms controls	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes
SE cluster	Firm	Firm	Firm

Notes:This table shows the facility-level regression results, presenting estimation results of equation 3.2. The dependent variable in column 1 is Collateral. The dependent variable in column 2 is Spread. The dependent variable in column 3 is Covenants. Standard errors are clustered at firm level and the corresponding *t*-statistics are reported in parentheses. Definitions of variables are detailed in Table A3.1 in the Appendix. Variables are winsorized at the 1% level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively

3.12 Appendix

Table A3.1: Variable definitions

Variable	Definition	Source
Bank allocation (%)	Percentage contribution of the bank in terms of loan volume of the facility	DealScan
Number of facility (ln)	Natural logarithm of the number of facility issued by the bank	DealScan
Aggregate facility volume (ln)	Natural logarithm of the aggregate volume of facilities issued by the bank	DealScan
Facility amount (ln)	Natural logarithm of the facility size	DealScan
Loan spread (ln)	Natural logarithm of the basis point spread over LIBOR plus the annual fee and the up-front fee spread	DealScan
No of covenant	Number of the covenant of the facility	DealScan
Collateral	A dummy variable that equals to one if the loan has collateral, and zero otherwise	DealScan
Firm size(ln)	Natural logarithm of total assets of the borrower firms	Compustat
Capex	Capital expenditure of the borrower firms	Compustat
Coverage	Interest coverage ratio of the borrower firms	Compustat
Leverage	Ratio of long-term debt over total assets	Compustat
ROA	Return over assets of the borrower firms	Compustat
Lenders size	Average amount of total assets of the lead leaders	BankScope
Income Diversity	Average fraction of income in interest relative to non-interest of the lead leaders	BankScope
Charge off(ln)	Natural logarithm of charge off of the lead leaders	BankScope
Activity Diversity	Average fraction of earning assets in loans relative to non-loans of the lead leaders	BankScope
ROA(%)	Average return over assets of the lead leaders	BankScope
High equity-to-asset ratio	An indicator variable that takes a value of one if the one-year-lagged equity-to-assets ratio of any one of the lead banks equal to or is above the 75^{th} percentile of equity-to-assets ratio of all lender banks in the originate year	BankScope and Author's calculation
Low equity-to-assets ratio	An indicator variable that takes a value of one if the one-year-lagged equity-to-assets ratio of any one of the lead banks equal to or is below the 25^{th} percentile of equity-to-assets ratio of all lender banks in the originate year	BankScope and Author's calculation
High tier 1 capital ratio	An indicator variable that takes a value of one if the one-year-lagged tier 1 capital ratio of any one of the lead banks equal to or is above the 75^{th} percentile of tier 1 capital ratio of all lender banks in the originate year	BankScope and Author's calculation
Low tier 1 capital ratio	An indicator variable that takes a value of one if the one-year-lagged tier 1 capital ratio of any one of the lead banks equal to or is below the 25^{th} percentile of tier 1 capital ratio of all lender banks in the originate year	BankScope and Author's calculation
High regulatory capital ratio	An indicator variable that takes a value of one if the one-year-lagged regulatory capital ratio of any one of the lead banks equal to or is above the 75^{th} percentile of regulatory capital ratio of all lender banks in the originate year	BankScope and Author's calculation
Low regulatory capital ratio	An indicator variable that takes a value of one if the one-year-lagged regulatory capital ratio of any one of the lead banks equal to or is below the 25^{th} percentile of regulatory capital ratio of all lender banks in the originate year	BankScope and Author's calculation
Crisis	A dummy variable=1 if the observations are in 2007-2010, 0 otherwise	Author's calculation

Chapter 4

Concluding remarks

I conclude the thesis by summarizing the key findings in the three previous chapters. Chapter 1 examines the effect of a form of under-explored financial deregulation, removal of usury ceiling, on banks. The chapter finds that the deregulation in Arkansas motivates risk-taking of Arkansas-chartered banks. While affected banks do not increase total lending, the banks reallocate lending to riskier categories of loans. Consistent with the loan reallocation, the deregulation increases credit risk of Arkansas-chartered banks, highlighting the potential cost of interest rate deregulation. The chapter also sheds light on the effectiveness of the deregulation in enhancing bank competition. I find that the deregulation has no effect on bank competition because Arkansas-chartered banks are not immediately able to compete with others after the deregulation, evidenced by the increase in their cost after the deregulation.

Chapter 2 examines whether specialized local knowledge and network of local banks allow them to weather communities against adverse local shocks. Employing natural disasters as regional shocks, I find that natural disasters affect local banks and national banks banks heterogeneously in terms of deposit-taking and lending. Contrary to national banks, natural disasters increase deposits supply of local banks, leading to an increase in deposit volume and lower deposit rate. The deposit allocation is particularly pronounced in counties with higher social connectedness. With the additional deposit supply, local banks increase more loan supply after natural disasters, shedding light on the role of local banks in assisting the recoveries of communities after natural disasters.

Chapter 3 studies the roles of equity capital in affecting bank lending. Rather than evaluating the linear relationship between equity capital and loan volume, this chapter leverages loan-level syndicated loan data to highlight the non-linear relationship between equity capital and various loan terms. In terms of loan volume, the chapter finds that both higher-capitalized and lower capitalized banks lend more than other banks in the sample. However, lower (higher)-capitalized banks are more (less) cautious in terms of imposing more (less) stringent loan terms, including higher (lower) spread and more (less) collateral with respect to the medium-capitalized group. The differences in loan terms reflect the inferior credit quality of lower-capitalized banks.

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