Title
Commercial Banks and Capital Regulation in the Early 20th Century US

Author
Gou, Michael

Publication Date
2017

UNIVERSITY OF CALIFORNIA,
IRVINE

Commercial Banks and Capital Regulation in the Early 20th Century United States

DISSERTATION

submitted in partial satisfaction of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

in Economics

by

Michael Gou

Dissertation Committee:
Professor Gary Richardson, Chair
Associate Professor Daniel Bogart
Associate Professor Yingying Dong

2017

DEDICATION

To Anna and Paul

TABLE OF CONTENTS

	Page
LIST OF FIGURES	iv
LIST OF TABLES	v
ACKNOWLEDGMENTS	vii
CURRICULUM VITAE	viii
ABSTRACT OF THE DISSERTATION	xi
CHAPTER 1: Did Capital Requirements Promote Financial Stability: Lessons from the National Banking Era	1
CHAPTER 2: Capital Requirements and Financial Markets During the Early 20th Century	37
CHAPTER 3: The Impact of Bank Suspensions on Wholesale Activity During the Great Depression: A County-Level Study	52
REFERENCES	72
APPENDIX CHAPTER 3	77

LIST OF FIGURES

		Page
Figure 1.1	Bank capital across town populations, 1905	23
Figure 1.2	Empirical density of national banks operating in towns, sorted by town population, 1905	23
Figure 1.3	Binned local averages of county and bank characteristics, town population<6000, 1905	24
Figure 1.4	Bank capital across town populations, 1905, town population<6000	24
Figure 1.5	Binned, local averages of capital, 1905	25
Figure 1.6	Binned, local averages of bank leverage, 1905	25
Figure 1.7	Cumulative Distribution of Capital & Surplus for banks below and the population threshold of 3,000, 1905	26
Figure 1.8	Predicted probabilities of banks meeting the $50,000 capital requirement at the population threshold of 3,000, 1905	26
Figure 1.9	Estimated local quantile treatment effects of capital requirements on capital for a bandwidth of 1,000, 1905	27
Figure 1.10	Estimated effect of capital requirements on capital and assets for bandwidths between ±500 and ±1500	28
Figure 1.11	Estimated effect of capital requirements on leverage and suspension rates for bandwidths between ±500 and ±1500	29
Figure 1.12	Aggregate differences in suspension rates from 1906 to 1929 for banks in operation during the year 1905	30
Figure 2.1	Bank capital across town populations, 1910	49
Figure 2.2	Bank market characteristics across town populations, 1910, town population<6,000	49
Figure 3.1	Histograms illustrating the common support across counties	66

LIST OF TABLES

		Page
Table 1.1	Capital requirements for National Banks, 1900-1933	31
Table 1.2	Bank balance sheet variables collected from OCC annual reports, 1905	31
Table 1.3	Estimated local quantile treatments of capital requirements on capital, 3,000 population threshold, 1905	31
Table 1.4	Estimated effects of capital requirements on capital and assets, 3,000 population threshold, 1905	32
Table 1.5	Estimated effect of capital requirements on bank leverage and suspension rates, 3,000 population threshold,1905	33
Table 1.6	Estimated effect of capital requirements on suspension rates, 3,000 population threshold,1905	34
Table 1.7	Estimated effect of capital requirements on bank capital, assets, leverage, and suspension rates, 6,000 population threshold, 1905	35
Table 1.8	Estimated effect of capital requirements on bank capital, assets, leverage, and suspension rates, 3,000 population threshold, 1915	36
Table 2.1	National and State bank minimum capital requirements, 1909	50
Table 2.2	Mean level of Capital & Surplus, by bank category and town population, 1910	50
Table 2.3	Fraction of banks in operation, by bank category and town population, 1910	50
Table 2.4	Impact of higher minimum capital requirements, bandwidth choice based on CCT	51
Table 3.1	Percentage of Bank Failures due to various, primary reasons for failure	67
Table 3.2	Weeks with thirty or more bank failures	67
Table 3.3	Comparing the difference of means between Treated and Control groups	67

Table 3.4	OLS Estimates, Regressing percentage change in Wholesale Sales on Bank run indicator variable and county characteristics	68
Table 3.5	Regressing the probability of a Bank run occurring between 1930 and 1933 on 1930 county characteristics using a probit model	69
Table 3.6	Propensity Score Matching Estimates	69
Table 3.7	OLS Estimates, Regressing percentage change in wholesale sales on declines in deposits from 1929 to 1933 due to various reasons for failure	70
Table 3.8	OLS Estimates, Regressing percentage change in Wholesale Sales on decline in deposits for open banks, banks failing during panic periods, and banks failing during non-panic periods	71

ACKNOWLEDGMENTS

I am grateful to my committee members, Professors Daniel Bogart, Yingying Dong, and Gary Richardson. Gary Richardson has helped me grow intellectually and inspired me to pursue graduate studies. I have learned much from his courses and working on numerous projects. Daniel Bogart has also shaped my research throughout the years. I have learned much about the world in his classes and enjoyed our many conversations and your insights. Yingying Dong provided invaluable feedback on the main chapter of my dissertation and taught me the empirical methods needed to analyze data. My committee has seen my research grow and with their encouragement, support, and patience I am the scholar that I am today. Most importantly, they have always kept research fun, enjoyable, and exciting. I cannot thank them enough for their dedication to my intellectual growth.

I am also grateful to my family Anna, Debby, Paul, and Ronnie who have stood by me throughout my entire time in school. With their encouragement and support I have achieved more education than I could have ever imagined.

I am grateful to Charina Lampa for keeping me grounded during the most stressful times in my graduate studies.

Finally, I am grateful to my classmates and friends whom I have spent countless hours working with and their insights into my research. I have enjoyed our time together in graduate school.

This work was financially supported by the Department of Economics and School of Social Sciences, ALL-UC Group in Economic History, and the Mercatus Center through the Adam Smith Fellowship.

CURRICULUM VITAE

Michael Gou

Education

Ph.D. Economics, University of California, Irvine, 2017

M.A. Economics, University of California, Irvine, 2013

B.A. Economics, University of California, Irvine, 2011

Research Interests

Economic History, Banking and Finance, Applied Econometrics

Publications

Journal Articles, Peer-Reviewed

Capital Requirements and Financial Markets in California During the 20th Century, Journal of Business and Management, August 2016, Vol 22, No. 2, pp.83-93

Chapters in Books, Encyclopedias, Conference Proceedings, and other volumes

Banking Act of 1935 with Alejandro Komai, Daniel Park and Gary Richardson, Federal Reserve History website http://www.federalreservehistory.org/2015

Gold Reserve Act of 1934 with Alejandro Komai, Daniel Park, and Gary Richardson, Federal Reserve History website http://www.federalreservehistory.org/2015

Roosevelt's Gold Program with Alejandro Komai, Daniel Park, and Gary Richardson, Federal Reserve History website http://www.federalreservehistory.org/2015

Stock Market Crash of 1929 with Alejandro Komai, Daniel Park and Gary Richardson, Federal Reserve History website http://www.federalreservehistory.org/2015

McFadden Act of 1927 with Alejandro Komai, Daniel Park and Gary Richardson, Federal Reserve History website http://www.federalreservehistory.org/2015

Teaching Experience

UC Irvine, School of Social Sciences, 2011-2017
Basic Macroeconomics
Basic Microeconomics
Global Economy
Intermediate Microeconomics

Intermediate Macroeconomics
Money and Banking
Corporate Finance
Econometrics 122A
International Trade
UC Irvine, School of Social Sciences
Research Supervisor, 2013-present
Independent Research
UC Irvine, Learning and Academic Resource Center
Calculus Tutor, September 2009-April 2010

Research Experience

Graduate Research Assistant, UC Irvine
Summer 2013, Spring-Summer 2014, Winter 2017

Undergraduate Research Assistant, UC Irvine
Fall-Summer 2009-2011

Undergraduate Research Opportunities Program (UROP) Fellowship, UC Irvine
Undergraduate Fellow Fall 2009; Spring, and Summer 2011
Undergraduate Research Opportunities Program(UROP) Symposium, 2010-2011

Presentations
UC Irvine Economics Department Poster Session, UC Irvine 2014- 2016
Economic History Mini Conference, UC Irvine June 2015
Economic History Association Annual Meeting Poster Session, Nashville September 2015
Applied Microeconomic Seminar Series, UC Irvine November 2015
Associated Graduate Students Symposium, UC Irvine May 2016
Annual Cliometric Society Conference, University of Pittsburgh May 2016
Annual Economic and Business History Society Conference, Montreal May 2016
2016 Community Banking Research and Policy, St. Louis September 2016
All-UC Economic History Graduate Student Workshop, UC Berkeley October 2016
Graduate Student Job Market Seminar Series, UC Irvine November 2016

Awards
Summer Fellowship Award, UC Irvine 2014-2016
Art DeVany Award for Best Poster Presentation, UC Irvine November 2015
Associate Graduate Students Travel Grant, UC Irvine, 2016
ALL-UC Economic History Graduate Student Fellowship, University of California 2016
Adam Smith Ph.D. Fellowship, Liberty Fund & Mercatus Center, 2016-2017

Other
Computer skills: Stata, Eviews, Excel, Matlab
Languages: English (Native), Mandarin Chinese (Conversational)
Citizenship: United States

Profession Affiliations

American Economic Association
Economic History Association
Cliometric Society

ABSTRACT OF THE DISSERTATION

Commercial Banks and Capital Regulation in the early 20th Century United States

By

Michael Gou

Doctor of Philosophy in Economics

University of California, Irvine, 2017

Professor Gary Richardson, Chair

My dissertation investigates the effect of capital requirements on commercial banks and the impact of commercial bank suspensions on the United States economy during the early 20th century.

The first chapter examines the effect of capital requirements on bank stability. The early 20th century United States provides an opportunity to determine whether imposing capital requirements on commercial banks promotes banking stability in the long run. The structure of the national banking system facilitates inference using a regression discontinuity design. I find that banks subject to higher capital requirements did hold more capital, but also increased lending proportionately so that their leverage and risk of failure remained roughly unchanged. Ultimately, capital requirements did not result in lower suspension rates.

The second chapter investigates the role of national bank capital requirements as a barrier to entry as a case study for California. Previous studies focusing on national banks find that rural bankers operated as price discriminating monopolist. However, by 1900 over half of the banks in the US were state banks. Bank and town level data is gathered for California to explore the impact of capital requirements on banking markets one year after state regulators began implementing capital requirements. The data suggest capital requirements do not alter the composition of capital in local banking markets during this time period. The majority of state banks still held capital levels similar to national banks even when they were subject to lower capital requirements.

The third chapter analyzes the impact of bank failures on wholesale activity at the county-level during the Great Depression. A propensity score model is used to mitigate the endogeneity issue between bank suspensions and wholesale activity. I find that counties experiencing bank suspensions during panic periods experience an eight to ten percent decline in wholesale sales relative to similar counties that did not experience suspensions during panic periods. In addition, data is gathered from bank examiners' reports to observe which types of bank failures have an adverse impact on wholesale activity. I find Banks failing due to asset and withdrawal reasons have a large negative impact on wholesale activity.

CHAPTER 1

Did Capital Requirements Promote Bank Stability: Lessons from the National Banking Era

1. Introduction

To protect the interests of depositors and prevent banking instability, which may have broad economic consequences, policymakers regulate commercial banks. Regulatory regimes typically impose capital requirements, which mandate that the owners of a bank must invest in their institution a certain minimum amount or a certain share of their banks' assets. These required investments help to align the incentives of banks' owners and managers with depositors and the general public; ensure that banks hold sufficient buffers against unexpected losses; and enhance regulators' ability to effectively supervise institutions. While capital requirements form a foundation for financial regulation, scholars debate their impact on financial institutions. Some argue that capital requirements reduce bank suspension rates. Others find little or no evidence of enhanced financial stability, and find some evidence of unintended consequences.[1]

The debate continues for an array of reasons. First, changes in capital requirements are often responses to ongoing economic events, particularly financial crises. This endogeneity generates correlations between higher capital requirements and financial instability which complicate efforts to ascertain cause and effect. Second, modern regulatory regimes often impose the same capital requirements on all banks. This uniformity makes it difficult to estimate how different capital requirements influence outcomes of interest. Third, unobserved attributes of banks (and

[1] Previous work finds that higher capital requirements did not decrease bank risk (Ashcraft 2001; Ashcraft, 2008; Rime, 2001). Other scholars find that banks respond by decreasing their assets to meet capital ratio requirements (Aiyar et al. 2014; Gropp et al., working paper). Mitchener and Wheelock find that higher minimum capital requirements led to lower banks per capita and lower suspension rates at the county-level (Wheelock, 1992; Mitchener 2005)

the environments in which they operate) may be correlated with banks' behavior, economic outcomes, and capital requirements. An example is regulatory forbearance, which might vary across time and from bank to bank, particularly those deemed too big to fail. These features of modern banks and their regulators impede efforts to accurately ascertain capital requirement's impact on commercial banks in the short and long run.

In this paper, I examine the impact of capital requirements on commercial banks in the United States in an era, 1900 to 1930, when the structure of the national banking system facilitates accurate inference. In the early 20th century, federal law required nationally chartered commercial banks to hold a minimum amount of capital determined by the population of the town which the bank operated. The minimum required capital doubled at specific population thresholds. For example, banks were required to have at least $25,000 worth of capital if they operated in a town with population less than 3,000 and $50,000 worth of capital if they operated in a town whose population exceeded 3,000. These abrupt jumps in required capital requirements allow me to accurately estimate the effects of capital requirements using a regression discontinuity approach. I verify the veracity of this method, by demonstrating that the environment that I analyze conforms to the methods' identifying assumption, such as that towns close to the population thresholds resembled each other in terms of business activity and observable characteristics. Then, I use the regression discontinuity to estimate the impact of capital requirements on bankers' choices (such as how much capital to hold, how much leverage to employ, and how many loans to make) and banks' outcomes (including suspension rates). These methods, which yield an average treatment, resemble those standard in the regression discontinuity literature (Hahn, Todd, and van der Klaauw, 2001; Lee and Lemieux, 2010).

I employ more novel methods to estimate local average treatment effects. This is necessary because the majority of banks voluntarily held capital in excess of that required by law. Capital regulations were devised to increase capital at banks which policymakers and regulators believed held insufficient amounts. Capital regulations were not intended to effect choices of banks holding capital which regulators deemed adequate or higher. I demonstrate the differential impact of capital requirements by estimating the quantile treatment effects across the entire capital distribution. My method resembles that of Frandsen et al. I find that capital requirements typically affected banks below the 20th percentile of the capital distribution. Capital requirements compelled these banks on average to increase the book value of equity by 28% at the 3,000 population threshold and by 45% at the 6,000 population threshold. Capital requirements typically had no impact on banks above the 20th percentile of the capital distribution.

While capital requirements did force banks with low levels of capital to hold more capital, the treated banks appear to be responding in ways which prevented the regulations from having their intended effect. Treated banks acquired more deposits, extended more loans, and held more assets than their untreated counterparts. The leverage of treated banks, which is a measure of bank risk defined as their asset over equity ratio, was the same as their untreated counterparts.[2] The same is true for their suspension rates (measured from 1905 through 1929 or 1905 through 1933) and longevity. In other words, I find no evidence that capital requirements reduced bank risk or enhanced bank stability, which was their fundamental intent.

This study contributes to the literature in several ways. It enhances our understanding of how banks respond to capital requirements, and it shows that bankers' responses may prevent these

[2] Bank leverage is measure of the amount of risk a bank is engaging in. Higher leverage is associated with lower survival rates during financial crises (Berger and Bouwman, 2013). However, banks have an incentive to hold more leverage since they are more profitable and experience more return on their capital (Sylla, 1969).

regulations from having their intended effect.[3] In addition, this study helps to explain the high failure rates of commercial banks in the United States in the early 20th century. This system consisted of thousands of small and geographically isolated unit banks. This structure left banks prone to failure and suffered repeated banking panics (Calomiris and Haber, 2014). The United States experienced 29 banking panics from 1865 to 1933.[4] Capital requirements were a principal tool used to prevent these problems.[5] But, I find that this tool did not work. Capital requirements neither deterred banks from taking risks nor increased the stability of the banking system. The failure of this principal policy tool helps to explain why, in the words of Calomiris and Haber (2014), the American banking system was "fragile by design."

The rest of this essay presents the details of my argument. Section 2 briefly reviews the literature review on capital requirements. It discusses theoretical works explaining why banks hold capital and why regulate bank equity capital. It also reviews empirical studies of the impact of capital requirements. Section 3 provides the historical background underlying this study. It describes the structure of the national banking system in the early twentieth century, focusing on details required to justify my regression discontinuity estimation method. Section 4 describes the data collected for this study. Section 5 presents my regression discontinuity design methods. Section

[3] Previous work finds that higher capital requirements did not decrease bank risk (Ashcraft 2001; Ashcraft, 2008; Rime, 2001). Other scholars find that banks respond by decreasing their assets to meet capital ratio requirements (Aiyar et al. 2014; Gropp et al., working paper). Mitchener and Wheelock find that higher minimum capital requirements led to lower banks per capital and lower suspension rates at the county-level (Wheelock, 1992; Mitchener 2005)

[4] Jalil documents eleven banking panics that occurred from 1873 to 1908, including three major banking panics in 1873, 1893, and 1907 (Jalil, 2013). Davison and Ramirez document fourteen local banking panics that occurred from 1920 to 1929 (Davison and Ramirez, 2014). Lastly, there were four major panics that occurred during the 1930s resulting in the collapse of the US banking system that deepened the Great Depression (Friedman and Schwartz, 1971; Wicker, 2000).

[5] Following the major banking panic of 1907, the National Monetary Commission found that "the prevention of panics such as those occurred in 1893 and 1907" and "the minimizing of losses through bank failures" were two key problems in the US banking system that needed to be addressed (Barnett, 1911). They argue that minimum capital requirements are one of the primary commercial bank regulations designed to help prevent these problems. Barnett states that "the requirement that each bank shall have a specified minimum capital is fundamental in the systems of regulation laid down in the national-bank act and state banking laws" since "the capital of the bank is regarded as a buffer interposed between the bank's creditors and losses which the bank may suffer" (Barnett, 1911).

6 reports the empirical results. Section 7 discusses this essay's principal findings and the implications of my analysis.

2. Bank Capital in Theory and Practice

In the absence of capital requirements, banks hold positive amounts of capital due to market incentives. On the liability side, holding more capital enhances a bank's ability to acquire more deposits (Calomiris and Powell, 2001; Calomiris and Mason, 2003). On the asset side, holding more capital increases a bank's incentives to make efficient portfolio choices and strengthen incentives to monitor borrowers. Banks with more capital are in a better position to lend (Hohlmstrom and Tirole, 1997; Allen et al., 2009; Thakor, 2014). On the other hand, scholars have suggested that higher capital may directly reduce banks' liquidity…or lead to less efficient contracting resolutions and higher agency costs, thereby leading to lower liquidity creation by banks" (Diamond and Rajan, 2001). Whether positive amounts of capital lead to more assets is still an open question. However, there is a consensus among scholars that holding more capital increases the buffer against economic shocks and reduces the probability of bank distress (Hohlmstrom and Tirole, 1997; Diamond and Rajan, 2001).

Banks choose to hold positive amounts of capital as a buffer against economic shocks, but the amount of capital chosen may not be enough to ensure bank stability. Governments implement capital requirements as a way to promote bank stability. Requiring banks to hold sufficient capital reduces bank moral hazard by discouraging banks from taking on excessively risky loan portfolios and reduces bank distress (Mishkin, 2007; Morrison and White 2005; Allen Et al., 2009). Also, the socially-optimal level of capital may exceed the privately-optimal level. A handful of bank suspensions can raise issues of financial stability in other banks resulting in a wide-spread banking crisis and banks do not internalize the social cost of large-scale bank failures induced by contagion effects (Thakor, 2014). Lastly, capital requirements are motivated by the need to protect small depositors. Monitoring costs are expensive and inefficient for small depositors suggesting a need for a public representative (Tirole, 1995).

A vast amount of empirical research has been devoted to studying the impact of recent capital regulation in the form of ratio requirements. I briefly go over a few existing studies. Ashcraft finds that increasing bank capital to asset ratio requirements from 6% to 7% did not significantly increase their ratios and suggests that there are market based incentives to holding more capital above the regulatory minimum (Ashcraft, 2001). Rime finds that regulatory pressure induces banks to increase their capital, but does not affect their level of risk. Regulatory pressure increases capital to asset ratios, but does not increase their capital to risk-weighted asset ratios. This suggests that banks are reallocating their portfolios to maintain their return on capital (Rime, 2001). Aiyar, Calomiris, and Wieladek utilize time-varying, bank-specific capital requirements to study the impact of capital requirements on bank behavior. They find that regulated banks reduce lending in response to higher requirements, while unregulated banks increase lending (Aiyar, Calomiris, and Wieladek, 2014). Gropp et al. find that banks respond to higher capital requirements by reducing their credit supply instead of increasing their equity capital. In short run, this leads to a reduction in firm, investment, and sales growth (Gropp et al., 2016).

Several studies analyze the impact of historical capital requirements in the form of minimum capital requirements. Wheelock finds that lower minimum capital requirements are positively associated with banks per capita during the 1920s (Wheelock, 1992). Mitchener finds that higher minimum capital requirements lowered county-level suspension rates in the 1930s (Mitchener, 2005). State-level variation in capital requirements is exploited to study the impact of capital requirements on county-level suspension rates and banks per capita. Fulford finds that increasing bank capital increases agricultural production per capita at the county level. Prior to 1900, minimum capital requirements were $50,000 for banks operating in towns below a population of 6,000. The optimal level of capital is imputed for each county and the excess amount of capital is estimated to determine the impact on agricultural output per capita (Fulford, 2011).

3. Historical Background

The National Currency Act of 1863 and National Bank Act of 1864 created the national banking system. These acts created the Office of the Comptroller of the Currency (OCC) and authorized the OCC to charter and regulate national banks. The OCC's primary tools for promoting financial stability were capital requirements graded according to town population. Table 1.1 documents these capital requirements from 1900 to 1933. There were three population thresholds. In towns with a population under 3,000, banks were required to hold a minimum capital of at least $25,000. In towns with a population between 3,000 and 6,000 banks were required to hold at least $50,000. In towns with a population between 6,000 and 50,000, banks were required to hold at least $100,000. In towns above a population of 50,000, banks required were to hold at least $200,000.[6] Capital requirements provided "a minimum level of security for the holders of a bank's liabilities" (White, 1983, 2011). They enhance stability by preventing stockholders and directors from engaging in excessive risk taking (White, 2011). There is some debate about the optimal level of capital banks should hold and whether banks were holding enough capital during the national bank era.

[6] A lowering in capital requirements occurred in the year 1900 when the Gold Standard Act of 1900 halved the minimum capital required for banks operating in towns with a population less than 3,000 from $50,000 to $25,000. The lowering of capital requirements was a response to state bank regulation setting their capital requirements lower than national bank capital requirements (White, 2009). In 1933, the Banking Act of 1933 raised the minimum capital required for banks operating in towns with a population less than 3,000 back to $50,000. The raising of capital requirement was a response to the banking runs of the 1930s (White, 2009).

Banking panics occurred regularly in the nineteenth and early twentieth centuries. All scholars agree on that fact, but they disagree on the exact number and timing of these events. Nonetheless, there is a consensus that this was a period of financial instability. Jalil documents eleven banking panics that occurred from 1873 to 1908 while Davison and Ramirez document fourteen local banking panics occurring from 1920 to 1929 (Jalil, 2013; Davison and Ramirez, 2014). Four major panics occurred during the 1930s resulting in the collapse of the US banking system that deepened the Great Depression (Friedman and Schwartz, 1971; Wicker, 2000 Michener and Richardson, 2016).

It is not surprising the system suffered from frequent banking panics. During this time period, branch banking was prohibited. Most banks were unit banks, which means they were a corporation with a single balance sheet operating from a single building. Unit banks were managed by local citizens and made most of their loans in their local economic area. If a local economic shock were to occur, banks' portfolios may not have been diversified to withstand this shock. In addition, bank liquidations were long and expensive. Depositors had an incentive to withdraw funds rapidly if they believed their bank might be insolvent or if their fellow depositors might withdraw their funds. Nationally chartered banks did not have deposit insurance, and also had never received government bailouts.

4. Data Sources

Data for this study comes from three principle sources: the annual reports of the OCC, Rand McNally's Bankers Directory, and the United States population census. The OCC's annual report indicates the financial status of each nationally chartered bank in operation as well as details about the date, cause, and consequence of each national bank failure. The balance sheets report detailed information about each bank's assets and liabilities. On the asset side, information includes include loans, discounts, investments in securities and bonds, holdings of real estate, cash on hand, deposits in other banks, and overdrafts. On the liability side, information includes capital, surplus and undivided profits, circulation, and deposits. Table 1.2 lists these balance sheet variables. Bank leverage, defined as a bank's asset to capital ratio variable is constructed by summing a bank's total amount of assets and dividing it by its capital and surplus. This variable represents the amount of assets being issued for each dollar of capital a bank holds and is a measure of bank risk. I gather data on all nationally chartered banks operating in the United States in 1905. The dataset includes over 5600 banks operating in 3,743 towns.

The OCC also preserved data on bank suspensions from 1865 to 1929. The suspension data includes information on the date of suspension, location and name of bank suspended, reason for suspension, and bank balance sheet characteristics at the time of suspension. These data on bank suspensions are collected and merged with balance sheet data.

The OCC's annual report also indicates the town, county, and state in which the banks operated. I use this information to determine the population of the town in which each bank in my data set operated in 1890, 1900, and 1910 as indicated by the United States Population Census. I find exact populations for the year 1900 for a total of 3,217 towns and 5602 banks in operation in 1905. Checks with earlier and later censuses indicate that the towns for which I do not find populations were small, around a few hundred residents, and were typically unincorporated places. Since the banks towns operated far from the population-capital-requirement thresholds, the lack of this information does not affect my analysis. Over 80% of the towns for which I have populations had a population of less than 6,000. About 860 banks operated in towns with populations between 2,000 and 4,000. There are 62 banks established after 1890 operated in towns with populations between 5,000 and 7,000[7]. There are 9 banks operated in towns with populations between 49,000 and 51,000. The large number of banks in towns near the 3,000 and 6,000 population thresholds enables me to conduct regression discontinuity analysis at those points. These small numbers of banks near the 50,000 threshold means that regression discontinuity analysis will not produce precise estimates near that point.

5. Research Design:

Capital requirements should have a direct impact on bank capital. Figure 1.1 provides a visual representation of the impact of capital requirements on bank capital. Each dot indicates a bank's capital in dollars and the population of the town in which the bank operates. The red line in figure 1.1 traces out the capital requirements for banks operating in different town populations. Discrete jumps in capital requirements at specific population thresholds coincide with large increases in capital. These abrupt changes in capital requirements provide an appropriate setting for a sharp regression discontinuity design to study the effect of capital requirements on bank behavior, risk, and suspension rates.

The first outcome variable of interest is bank capital. Bank capital is a measure of bank size and is positively correlated with town population, which can be taken as a measure of the volume of business activity being conducted in a town. In absence of capital requirements, a positive continuous relationship should be observed between a bank's capital and town population. However, given there are capital requirements that force banks to hold a minimum amount of a capital, abrupt increases in capital should be observed at town population thresholds where the capital requirement doubles. Town population is the forcing variable that determines the minimum amount of capital required for a bank. The forcing variable is described below:

[7] There are 340 banks operating between town population of 5,000 and 7,000. The sample size is restricted to banks established after 1890 since I cannot identify the exact population a bank's capital requirement is subject to.

$$Min.\,Capital\ Requirement = \begin{cases} \$25{,}000, if\ Pop_{bis} < 3{,}000 \\ \$50{,}000, if\ Pop_{bis} \geq 3{,}000 \end{cases}$$

The minimum capital requirement doubles from $25,000 to $50,000 if a town's population crosses the threshold of 3,000. In particular, an abrupt increase in bank capital should be observed for banks operating in towns to the right of the population threshold of 3,000 compared to banks operating in towns to the left of this threshold.

The second outcome variable of interest is asset to capital ratios, a measure of risk defined as bank leverage. Bank leverage is linked to bank survival rates. Berger and Bouwman find that small banks with lower leverage prior to a financial crises experience higher rates of survival during crises (Berger and Bouwman, 2013). Banks with higher capital requirements may have lower leverage which would imply that they have higher survival rates.

Lastly, the third outcome variable of interest is bank suspension rates. This variable represents a measure of bank stability. Capital requirements are implemented to achieve this goal by preventing bank suspensions. Comparing differences in suspensions rates will determine whether capital requirements were effective in promoting bank stability.

A sharp regression discontinuity design is used to the study the impact of capital requirements on bank capital, leverage, and suspensions using bank-level data. I study population thresholds of 3,000 and 6,000 and focus on the range of banks operating in towns between the smallest town population size of 65 and 50,000 leaving out banks operating in the larger towns in the US. An identifying assumption is that towns should be similar just below and above the town population thresholds. In addition, a limitation of examining these town population thresholds is that inference can only be made on banks operating in towns with populations close to 3,000 and 6,000 in the US. These towns represent "rural areas of the country" where "low population density required, numerous widely, dispersed banking offices" (White, 1983). A significant portion of the US, especially in the Midwest and South, during this time period was characterized as rural farming regions with low population density.

I estimate the impact of capital requirements on bank capital, leverage, and suspension rates using a local-linear estimator for a given bandwidth. The bandwidth proposed is based on Calonico, Cattaneo, and Titiuniks' (CCT, 2014) methodology where "data-driven confidence interval estimators are constructed that exhibit close-to-correct empirical coverage and good empirical interval length on average…improving upon the alternatives available in the literature" (Calonico et al., 2014). In addition, several specifications are conducted using other bandwidth selection criteria proposed in the literature to observe the robustness of my results to different bandwidth choices[8]. Specifically, I regress a bank outcome variable on town population, an indicator for crossing the population threshold, and an interaction term between town population and crossing the threshold. This specification estimates the direct effect of minimum capital requirements. The model is described below:

$$BankOutcome_{bis} = \beta_0 + \beta_1 P_{bis} + \beta_2 1(P_{bis} \geq T)_{bis} + \beta_3 P_{bis} 1(P_{bis} \geq T)_{bis} * P_{bis} + \varepsilon_{bis} \quad (1)$$

$$P_{bis} \in \{T - k, T + k]$$

where "b" represents a bank located in town "i" and state "s" for the year 1905 and bandwidth "k" represents the bandwidth chosen for the specification. The variable "*Bank Outcome*" represents a bank outcome variable in the year 1905. The population variable "*P*" represents the town population in 1900. The indicator variable $1(P_{bis}>T)_{bis}$ represents if a bank is operating in a town just above a town population threshold where minimum capital requirements doubles in dollar amount. This is the variable of interest that identifies the average treatment effect of capital requirements on bank outcomes. A positive coefficient should be expected for bank

[8] In addition to the CCT bandwidth selection criteria, bandwidths proposed by Imbens and Kalyanaramans' based on MSE-optimal bandwidth selection criteria and Ludwig and Millers' cross-validation criterion are implemented. The results are robust to various bandwidths

capital. If the outcome variable is bank leverage or suspension rate, then a negative sign should be expected if higher capital requirements are having an effect on lowering leverage and suspension rates, which is the intended goal of minimum capital requirements.

The average treatment effect may not accurately capture the effects of capital requirements on bank outcomes. The reason is that most banks hold capital well above the regulatory minimum. A small fraction of banks hold capital close to the constraint. Policymakers intend for capital requirements to raise capital levels of banks holding insufficient amounts. The policies are not designed to alter the behavior highly-capitalized banks operating far from the regulatory minimum. To determine whether capital requirements influence capital choices of the target group, but not highly capitalized banks, I estimate quantile treatment effects in a regression discontinuity design. The quantile treatment estimates reveal the impact of capital requirements for banks across the entire capital distribution. The model is described below:

$$RDQTE = q^{+}(\tau) - q^{-}(\tau), where$$

$$q^{+}(\tau) = \inf\left\{Cap_{bis}: F\left(Cap_{bis} \middle| Pop_{bis} \epsilon [T+k)\right) \geq \tau\right\}$$

$$q^{-}(\tau) = \inf\{Cap_{bis}: F(Cap_{bis} | Pop_{bis} \epsilon (T-k)) \geq \tau\}$$

Where τ represents the quantile, q(τ) represents the value of capital at the τth quantile, and F represents the capital distribution conditional on population size. Differences in the value of capital at each quantile allow me to estimate the distributional change in the capital distribution. In addition, specifications where the full sample is split between banks below and above the 20^{th} percentile of the capital distribution are conducted to illustrate the impact of capital requirements on banks operating close to the regulatory minimum.

There are several concerns about the validity of the research design. First, banks choose where they want to establish and operate. They may choose to operate in towns slightly below the population thresholds in order to take advantage of lower capital requirements[9]. Second, since the OCC lowered capital requirements in the year 1900 for towns below a population of 3,000 from $50,000 to $25,000 one might expect newer banks to be established slightly below the threshold. Third, local economic conditions may be different for towns slightly below and above the population threshold.

Concerns about the validity of the research design are tested in two ways. First, a McCrary empirical density test is conducted to test the possibility of banks sorting into towns slightly below the population cut-off of 3,000. Second, I check the smoothness of bank and county characteristics around the population threshold. County data are merged with towns and the smoothness of several county covariates is inspected around the population thresholds[10]. Specifically, I estimate equation 1 for several county characteristics and test for significance on β_2.

6. Results

First, evidence is provided that the research design is valid. Figure 1.2 illustrates a McCrary density test of the running variable; town population. A vertical line is drawn at the town population of 3000 to illustrate the smoothness of the density both to the left and right of the population cut-off. There is little evidence of banks sorting into towns just below the town population cut-off of 3,000. The estimated increase in density is .224 with a standard error of .151 providing little evidence of banks establishing in towns slightly below the population threshold.

[9] One could also think that towns are manipulating their population to be slightly below the population threshold of 3,000 in order to attract more banks. I also conduct a McCrary density test to observe to possibility of towns manipulating their populations and find no evidence of towns sorting below the population threshold.

[10] Besides town population, there is not much information on town characteristics for towns of all sizes in the United States. I use the county census to look at other differences in other characteristics besides population. County characteristics are gathered and merged to each bank. These data is a gathered from Historical Demographic, Economic, and Social Data: The United States, 1790-1970, ICPSR 2896

Next, the smoothness of bank age and county characteristics for banks operating in towns close to the population threshold of 3,000 is inspected. The county covariates I observe are percentage black population, and percentage farmland, and manufacturing output for the year 1900[11]. Figure 1.3 provides scatterplots of binned, local averages of these bank and county covariates. A 4th order local polynomial is superimposed on both sides of the threshold to illustrate any differences in bank and county characteristics below and above the population threshold to illustrate any differences in county characteristics to the left and right of the population cut-off. There does not appear to be any significant differences in bank or county characteristics around the population threshold. Furthermore, estimates of β_2 are statistically insignificant suggesting that these bank and county characteristics are smooth around the threshold[12]. There is little evidence of newer banks choosing to establish in towns slightly below the population threshold and the composition of towns appear to be similar. Next, I discuss how I analyze the impact of capital requirements on capital, leverage, and suspension rates.

A scatter plot illustrating the relationship between bank capital and town population is provided in figure 1.4. Each observation represents a bank's capital and the population of the town that bank is operating in. The red line drawn on the figure represents the national policy of minimum capital requirements. Banks are required to hold at least $25,000 worth of capital below a town population of 3,000 and the requirement doubles to $50,000 for towns above a population of 3,000. There are a few observations one can make from figure 1.4. First, there is a positive relationship between town population and bank capital. Since bank capital is a measure of bank-size, it is reasonable to find a positive relationship given larger towns have larger banks. Second,

[11] A county's population density is constructed by dividing total population by square miles. Percentage of black population constructed as the number of black individuals divided by total population. Percentage farmland is constructed by dividing total farm acres by total square acres

[12] For bank age the estimate of β_2 is 1.98 with a standard error of 2.14. The estimates of β_2 for percentage black population, manufacturing output, and percentage farmland are -.0157, -.022, -1.3e^{06}, with standard errors of .024, .039, and 2.5e^{06}, respectively.

the density of banks is higher at towns with smaller populations. A visual examination suggests that these banks tend to have capital very close to the minimum required amount of $25,000. Third, many of these banks hold capital amounts well above the regulatory minimum operating in towns with a population below 3,000. Minimum capital requirements were lowered in the year 1900 from $50,000 to $25,000. Many of these banks were established prior to the year 1900 and kept the same amount of capital when capital requirements were lowered.

A scatter plot of binned, local averages of bank capital provides a clearer graphical representation of the relationship between capital and town population[13]. Figure 1.5 displays a graph constructed using a subset of data to construct figure 1.4: banks with capital in the bottom 20th percentile of the capital distribution above and below the population threshold of 3,000. This allows me to observe the impact of capital requirements for banks close to the regulatory minimum. Each observation is an evenly space binned local average of capital for a town population interval of 326 below the threshold and 485 above the threshold. The bin size was determined based on CCT's method to trace the underlying regression function of the data. The intervals surrounding each population bin represent 95% confidence intervals. A vertical line is drawn at the town population of 3000 to illustrate the impact of the law on a bank's average capital operating in a town of a certain bin size. The average capital increases as town population size increases. A vertical line is drawn at the town population threshold of 3,000. The average capital of a bank is approximately $42,059 operating in a town with a population slightly less than 3,000. The average capital of a bank is approximately $51,103 operating in towns slightly above the threshold. There appears to be a jump in capital of about $9,044, a 22% increase in capital, slightly above the population threshold of 3,000, but not $25,000 which is the increase in capital requirements described in table 1.1.

[13] These local, binned averages are constructed using methods described in CCT, 2014 (Calonico et al., 2014)

Figure 1.6 displays binned, local averages of bank leverage defined as the assets to capital ratio. The bin size of 587 below the threshold and 582 above the threshold was determined based on CCT's method to trace the underlying regression function of the data. The average leverage of a bank operating in a town slightly below the population threshold is approximately 4.2 while the average leverage of a bank operating in towns slightly above the threshold is 3.8. This suggests a 10% decrease in leverage. However, the confidence intervals capture the mean leverage for banks above the population threshold. There is not much evidence of higher capital requirements decreasing bank leverage. Banks may be responding to holding more capital by raising their assets.

Minimum capital requirements are intended to insure banks have an adequate amount of capital to prevent them from engaging in excessive risk-taking. These policies should have the largest impact on banks operating close to the regulatory minimum. Figure 1.7 plots the cumulative probability function of capital for banks below and above the population threshold of 3,000 for a bandwidth of ±1000. The blue line represents banks below the population threshold and the red line represent banks above the threshold that are subject to the higher capital requirement of 50,000. Banks operating below the threshold have capital less than $50,000 below the 20th percentile. Banks operating above the threshold have capital of at least $50,000 and at the 20th percentile these banks are holding capital less than $68,000. Figure 1.7 suggests capital requirements affect banks in the lower 20th percentile of the capital distribution. In addition, figure 1.8 reports binned, local averages of predicted probabilities of meeting the capital requirement of $50,000. At the population threshold of 3,000 the predicted probability of meeting the $50,000 capital requirement is 80%. Above the population threshold, the predicted probabilities jumps to 100% suggesting that 20% of banks would be affected by the higher capital requirement.

Local quantile treatment effects of capital requirements on capital are estimated using equation 2 with a bandwidth of ±1000 proposed through CCT's bandwidth selection criteria[14]. State fixed effects and bank age are included in each of these specifications. Table 1.3 reports results for percentiles between .10 to .90 and the average treatment effect for the full sample of banks. The average treatment effect (ATE) is .126 and statistically significant at the 5 percent level. However, the ATE is driven by banks operating in the lower end of the capital distribution. Rows 3 to 6 report statistically significant coefficients ranging from .16 to .23 for banks in the lower 25th percentile of the capital distribution. However, banks operating at higher percentiles of the distribution do not experience a statistically significant increase in capital. Figure 1.9 traces out the local quantile treatment effects and 95% confidence interval for each percentile from .10 to .90. Banks with capital below the 25th percentile are driving the ATE result, while banks above the 25th percentile are not affected by capital requirements. Capital requirements significant raise the lower end of the distribution of capital.

Table 1.4 reports the estimated effect of capital requirements on capital for the full sample and for a subsample of banks below and above the 20th percentile of the capital distribution. The bandwidth determined for these specifications is ±1000 obtained through CCT's bandwidth selection criteria[15]. The ATE of capital requirements on capital for the full sample is .126 and statistically significant at the 5% level. The ATE for the subsample of banks in the lower 20th percentile of the capital distribution is .284. These results are statistically significant at the 5%

[14] The precise bandwidth proposed by CCT is ±1054. Depending on the outcome variable chosen, the bandwidth varies however CCT's bandwidth selection criteria typically proposes a bandwidth of approximately ±1000
[15] The exact bandwidth is ±992, but a bandwidth of ±1000 is used since the bandwidth determine for other bank outcome variables is approximately ±1000.

level. Banks operating close to the regulatory minimum are affected by capital requirements. However, an insignificant coefficient of .072 is reported for banks above the 20th percentile of the capital distribution. Figures 1.10A and 1.10B illustrate the effect of capital requirements on capital for the full sample and subsample of banks below the 20th percentile of capital distribution for bandwidths between ±500 and ±1500. These results are robust to various bandwidth choices besides CCT's bandwidth choice of ±1000.The dotted lines represent 95% confidence intervals and the solid line represents the local ATE. The standard errors of the coefficient are larger as the bandwidth shrinks, but the size of the coefficient does not drastically decrease. Capital requirements increase a bank's capital for banks operating close to the regulatory minimum, but do not affect banks holding capital far from the minimum.

The estimated effect of capital requirements on assets for the full sample and a subsample of banks below and above the 20th percentile of the capital distribution are provided in table 1.4. I find an insignificant ATE of.074 with a standard error of .069 with the full sample of banks. Focusing on the subsample of banks in the lower 20th percentile of the capital distribution I find a positive coefficient of .267 significant at the 10% level. For banks above the 20th percentile I find coefficients that are insignificant and close to zero. Figures 1.10C and 1.10D display the effect of capital requirements on assets for the full sample and subsample of banks below the 20th percentile of capital distribution for bandwidths between ±500 and ±1500. These results are robust to various bandwidths. Although the lower bound of the 95% confidence interval hovers near zero, the coefficient stays close to .20 for banks in the lower 20th percentile of the capital distribution. Banks in the lower 20th percentile respond to higher capital requirements by holding more assets.

Table 1.5 provides results on bank leverage and loans to assets ratio for the full sample and for a subsample of banks below and above the 20th percentile of the capital distribution. Not surprisingly, I do not find significant coefficients on leverage. For banks above the 20th percentile, capital requirements do not have an impact on their leverage since they are not affected by the regulation. For banks below the 20th percentile, I find that banks increase their assets when they are required to hold more capital suggesting that leverage stays the same. The results in table 5 reflect the results found in table 3 and 4. Figure 1.11A and 1.11B show that these results are robust to bandwidths between ±500 and ±1500. There is no evidence of capital requirements reducing bank leverage.

Although I find no evidence of banks lowering their leverage, it's possible they could still be more risky in terms of their portfolio allocation. For example, banks could be shifting their portfolio towards riskier loans or they could be shifting towards less risky assets such as US bonds. It is not clear how banks would be increasing their asset size. To analyze how banks are adjusting their portfolio I estimate the difference in their loans to assets ratio. I do not find any evidence of banks subject to higher requirement shifting towards riskier portfolios. Banks respond to holding larger amounts of capital by holding more assets. However, they increase their asset size proportionally and do not obtain more loans relative to their other assets.

Banks do not experience a change in their leverage or adjust their portfolios towards riskier assets. However, holding more capital may decrease a bank's suspension rate in the long-run. Larger banks, in terms of capital, have a larger buffer against economic shocks and may experience lower suspension rates. Figure 1.12 illustrates aggregate suspension rates from 1906 to 1929 for banks in operation during 1905. The vertical axis represents suspension rates and the horizontal axis represents time. The solid blue line illustrates suspension rates for all banks from

1906 to 1929. The red dotted line represents suspension rates for banks slightly below the population threshold of 3,000 and the green dotted line represent suspension rates for banks slightly above the threshold. At first glance, it appears that banks subject to higher capital requirements experienced lower suspension rates at the aggregate level.

I estimate the effect of capital requirements on long-run suspension rates by calculating the difference in suspension rates for banks operating slightly below and above the 3,000 population threshold. Specifically, I determine if banks required to hold more capital in 1905 experienced lower suspension rates from 1906 to 1929. These estimates are reported in table 1.6 and provide an interpretation of the long-run effect of capital requirements on financial stability. I do not find statistical evidence of banks subject to higher capital requirements experiencing lower suspension rates. Although banks have larger amounts of capital, there is no evidence of minimum capital requirements reducing bank leverage or lowering suspension rates. Figures 1.11C and 1.11D illustrate that these results are robust to various bandwidths.

The results reported in table 1.7 for the 6,000 population threshold tell the same story. The ATE of capital requirements on capital is a 49% and statistically significant at the 5% level[16]. In addition, the estimated effect on assets is a 59% increase resulting in no decrease in leverage and suspension rates. Capital requirements raised equity for banks operating in small towns across the nation. However, banks responded by increasing their assets and were not less risky than banks subject to lower requirements. These results are also consistent when I analyze data for banks in operation during the year 1915. Table 1.8 reports that banks operating close to

[16] Results exclude banks established before 1890. Banks established between 1890 to1900 were subject to their town population in 1890. Banks established between 1900 to1905 were subject to their town population in 1900. I was not able to assign appropriate town populations for banks established before 1890 since they could have been assigned their 1880 town population which I do not have or they could have re-chartered between 1900 and 1905 and been subject to their 1900 town population.

the regulatory minimum do increase their capital, but are not less risky. The data suggests that capital requirements were not effective in lowering suspension rates.

7. Conclusion

Capital requirements are a fundamental regulation designed to promote financial stability. This study contributes to our understanding of how capital requirements work in practice and their unintended consequences. My findings also help explain the high suspension rates of commercial banks in the United States in the early 20^{th} century. The United States financial system consists of thousands of small and geographically isolated banks during this time period. These banks were prone to failure and banking panics (Calomiris and Haber, 2014). Policymakers implemented capital requirements as a principal tool designed to prevent these problems. I find that banks subject to higher capital requirements substantially increased their capital. However, these banks responded by increasing their assets proportionately and did not experience lower leverage or suspension rates. Capital requirements in the early 20^{th} century did not prevent banks from engaging in excessive risk-taking and or enhance financial stability.

Figure 1.1: Bank capital across town populations, 1905

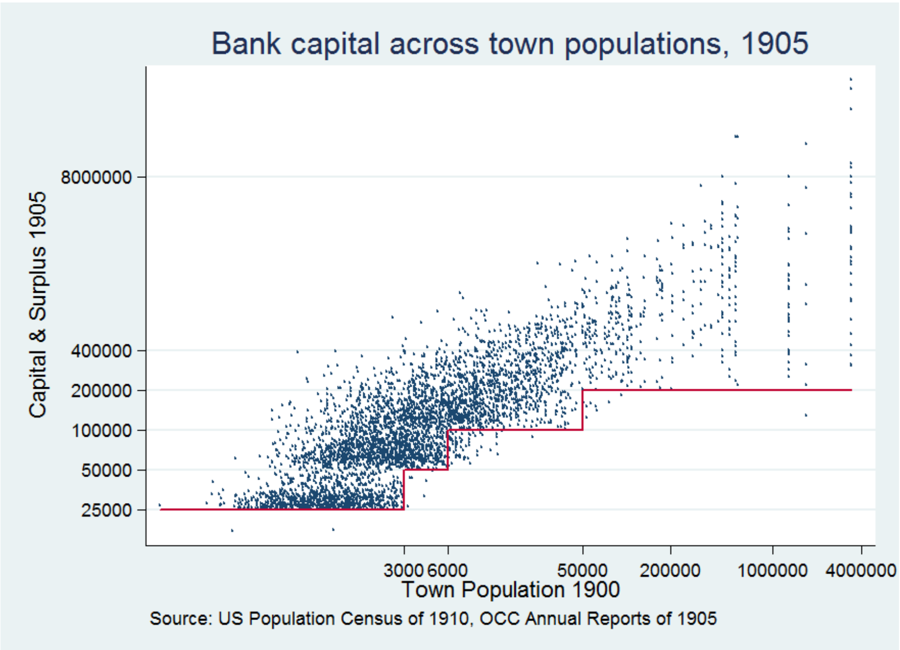

Figure 1.2: Empirical density of national banks operating in towns, sorted by town population, 1905

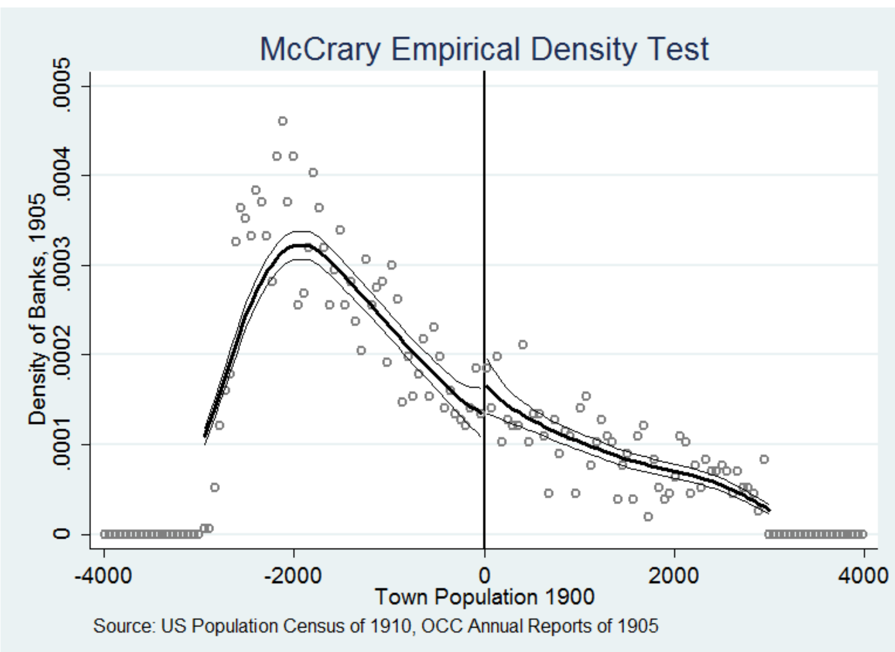

Figure 1.3: Binned local averages of county and bank characteristics, town population<6000, 1905

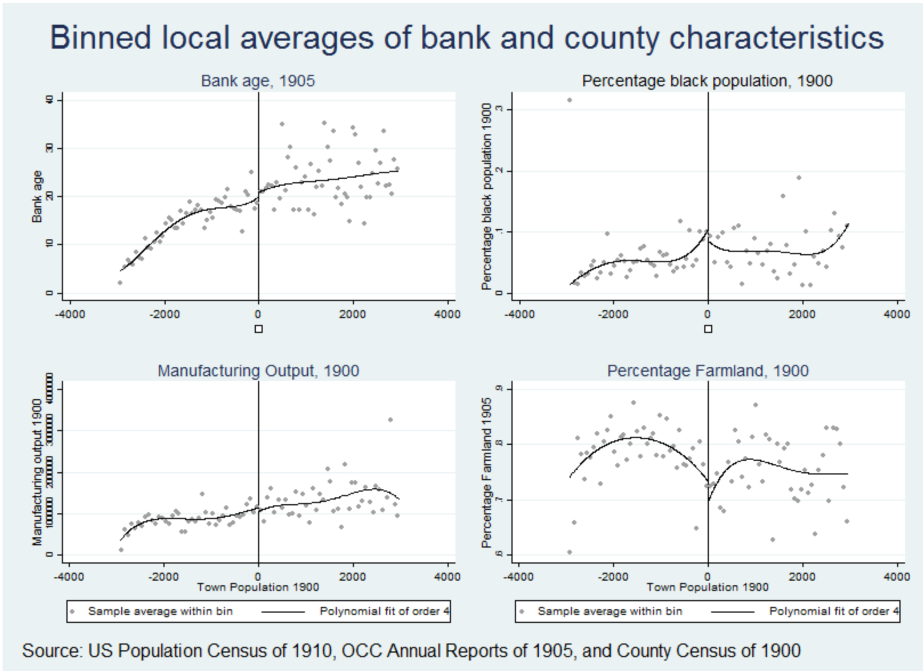

Figure 1.4: Bank capital across town populations, 1905, town population<6000

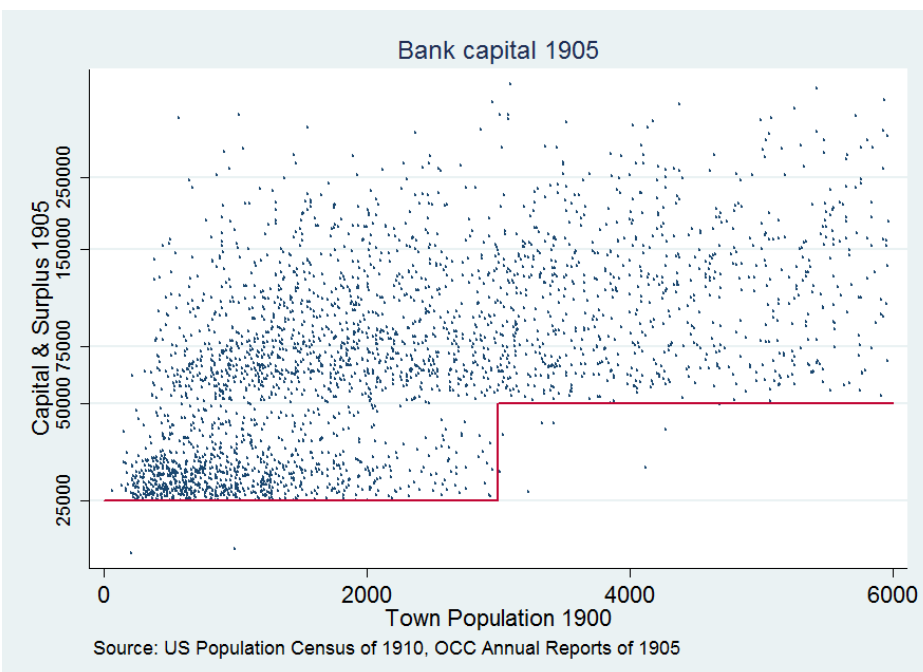

Figure 1.5: Binned, local averages of capital & surplus, 1905

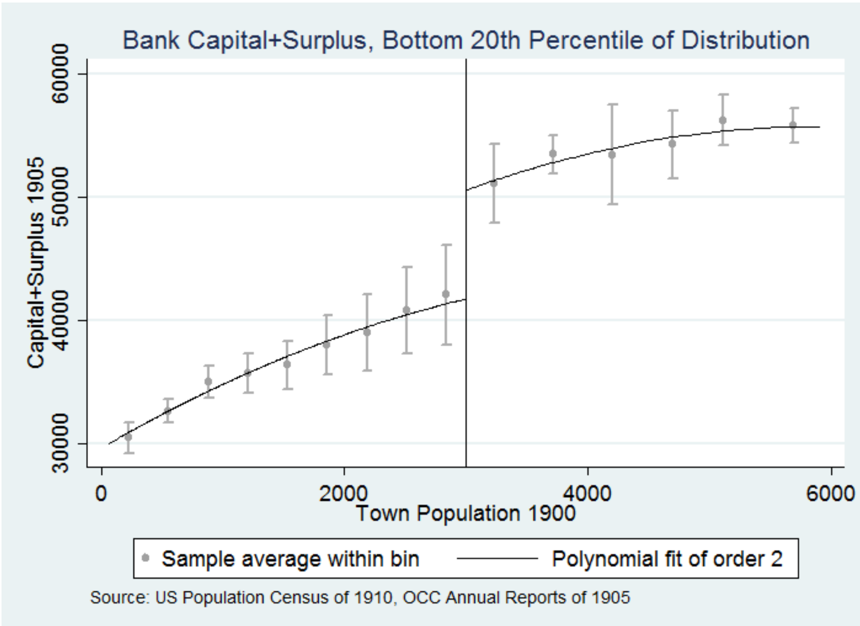

Figure 1.6: Binned, local averages of bank leverage, 1905

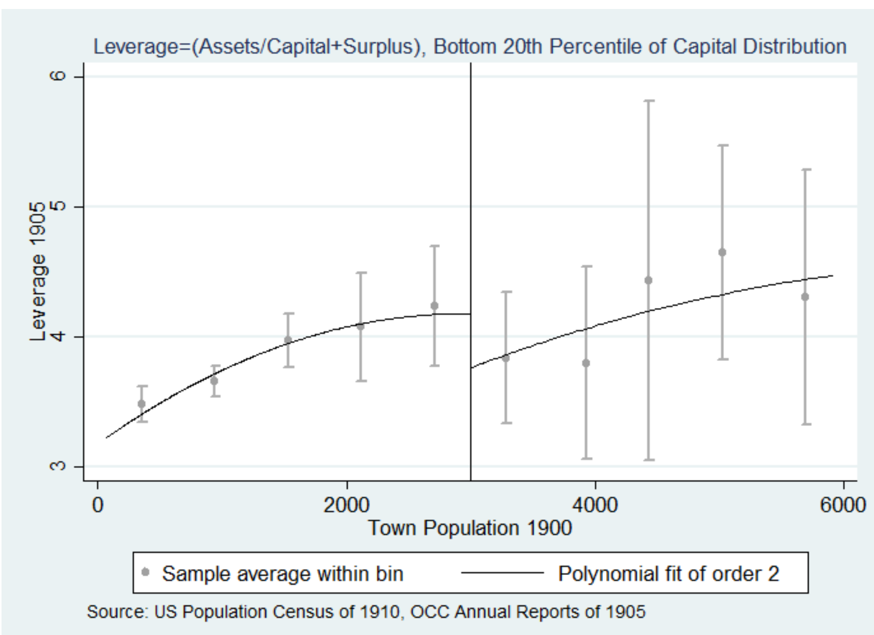

Figure 1.7: Cumulative Distribution of Capital & Surplus for banks below and population the population threshold of 3,000, 1905

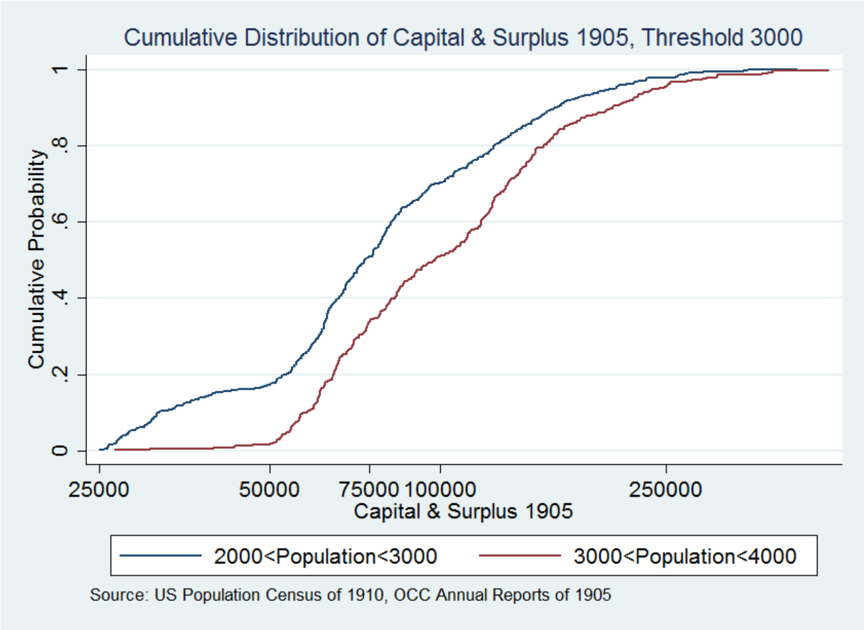

Figure 1.8: Predicted probabilities of banks meeting the $50,000 capital requirements at the population threshold of 3,000, 1905

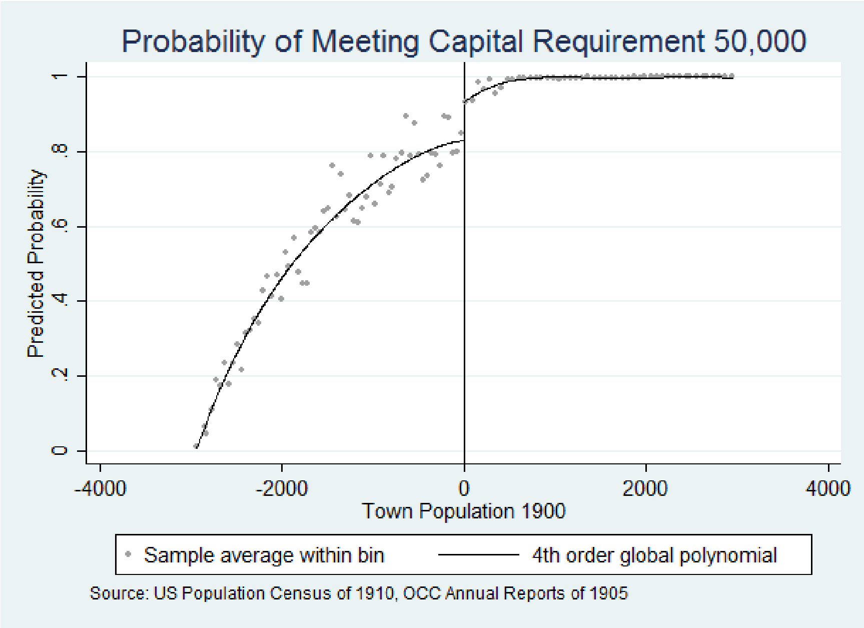

Figure 1.9: Estimated local quantile treatment effects of capital requirements on capital for a bandwidth of 1,000, 1905

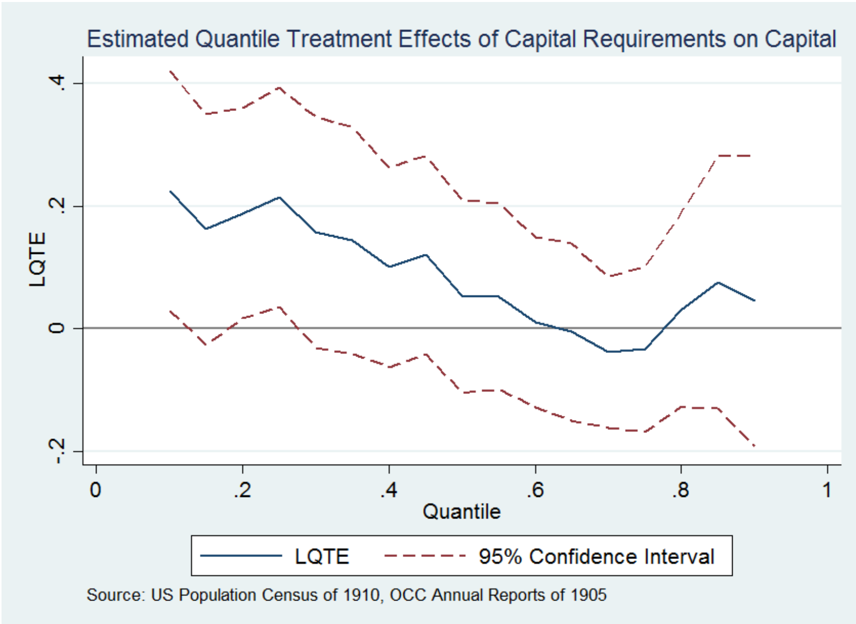

Figure 1.10: Estimated effect of capital requirements on capital and assets for bandwidths between ±500 and ±1500

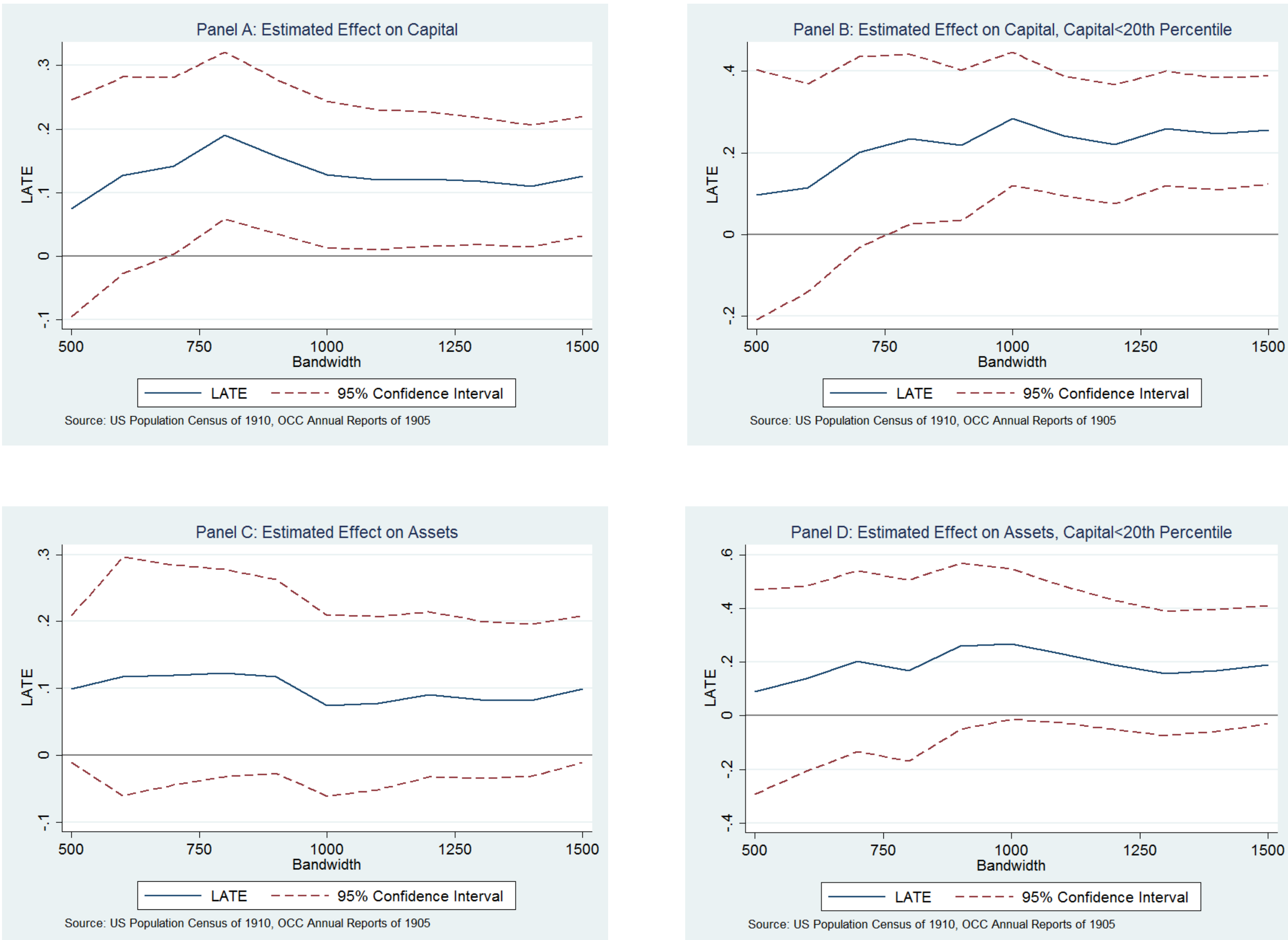

Figure 1.11: Estimated effect of capital requirements on leverage and suspension rates for bandwidths between ±500 and ±1500

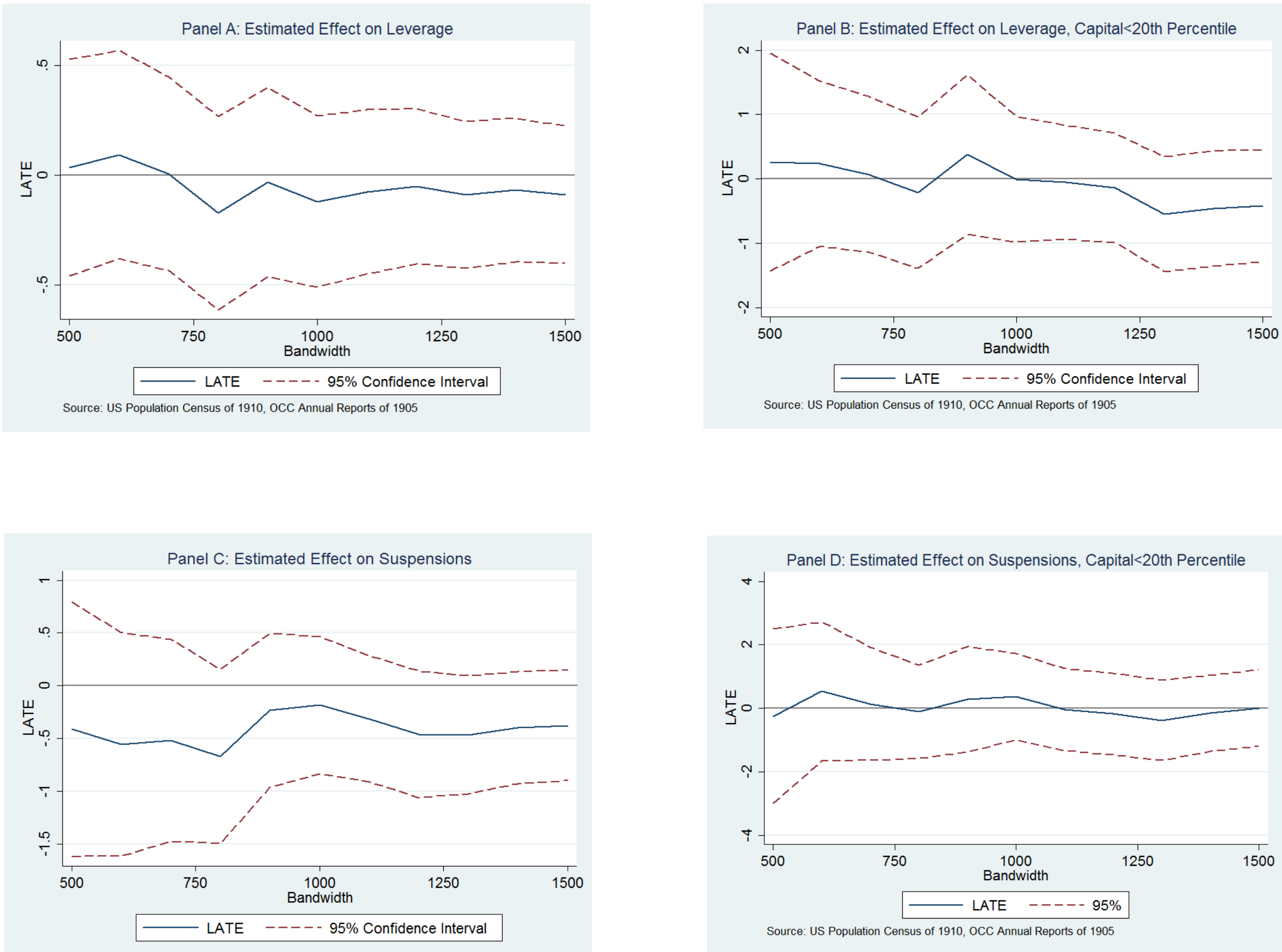

Figure 1.12: Aggregate differences in suspension rates from 1906 to 1929 for banks in operation during the year 1905

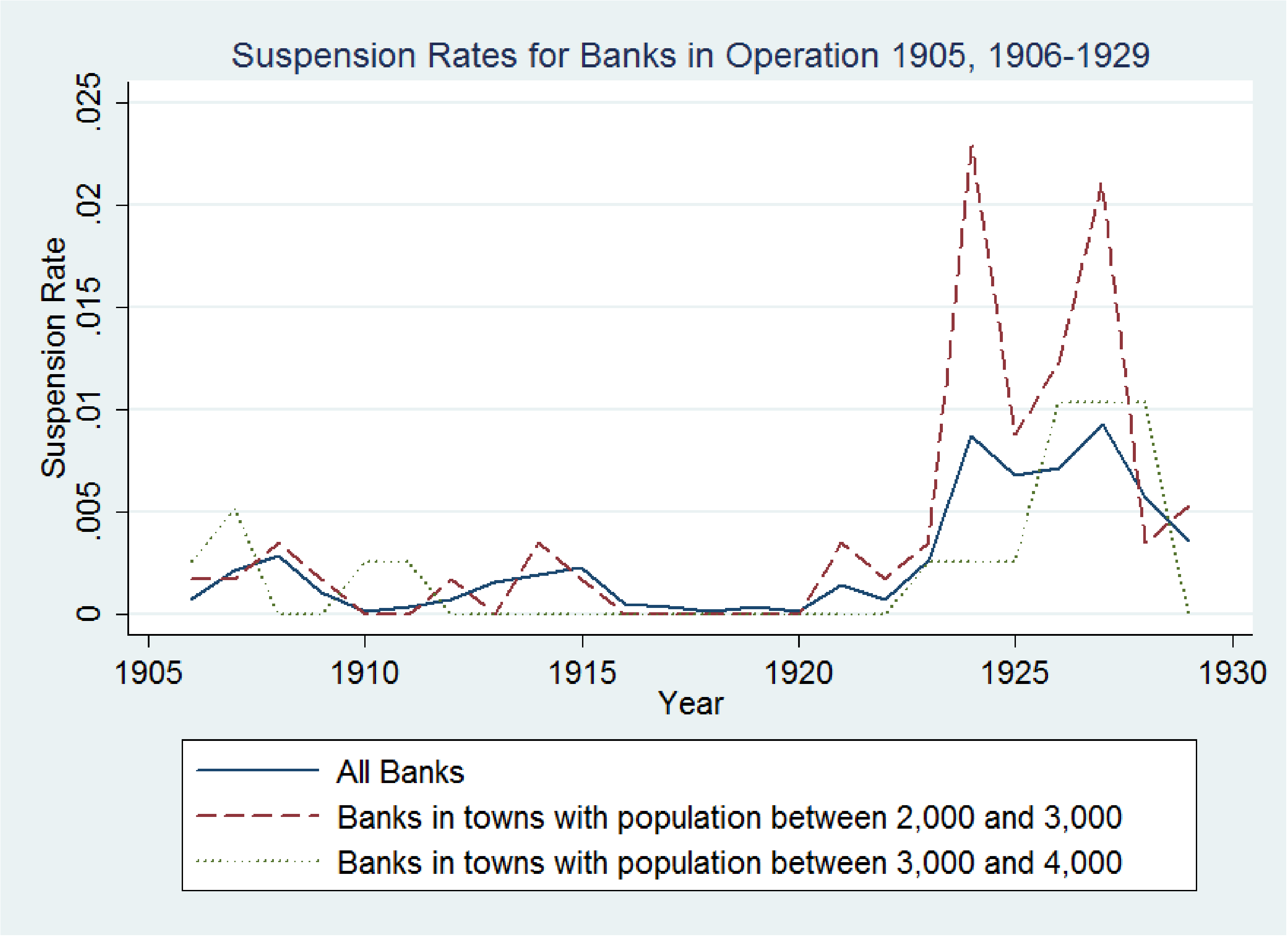

Table 1.1: Capital requirements for National Banks, 1864-1933

Minimum capital required to establish a bank, by federal laws				
	Town Population			
	Population<3,000	3,000≤Population<6,000	6,000≤Population<50,000	50,000≤Population
1900-1933	$25,000	$50,000	$100,000	$200,000

*Source: OCC Annual Reports, 1900 and 1910; White, 1983; Banking Act of 1933

Table 1.2: Bank balance sheet variables collected from OCC annual reports, 1905

Bank Characteristics, OCC Annual Report of 1905	
Assets:	**Liabilities:**
Loans, discounts, and overdrafts	Capital
United States Bonds	Surplus, undivided profits
Other bonds, investments, and real estate	Circulation
Lawful money	Deposits
	Bank leverage= total assets/capital & surplus

Source: OCC Annual Reports, 1905

Table 1.3: Estimated local quantile treatments of capital requirements on capital, 3,000 population threshold, 1905

Dependent Variable: Log(Capital & Surplus)

Quantile	LQTE	S.E.
0.10	0.23	(0.0998)**
0.15	0.16	(0.0959)*
0.20	0.19	(0.0876)**
0.25	0.21	(0.0912)**
0.30	0.157	(0.0959)
0.35	0.144	(0.0941)
0.40	0.100	(0.083)
0.45	0.120	(0.0824)
0.50	0.053	(0.0804)
0.55	0.053	(0.0775)
0.60	0.011	(0.0708)
0.65	-0.005	(0.0735)
0.70	-0.039	(0.0627)
0.75	-0.034	(0.0687)
0.80	0.031	(0.0808)
0.85	0.076	(0.105)
0.90	0.045	(0.121)
	ATE	S.E.
Full Sample	0.129	(.0598)**

Notes: Robust town clustered standard errors, LQTE conditional on state effects and bank age. *** p<0.01, ** p<0.05, * p<0.1. Results presented for a bandwidth of +1000

Table 1.4: Estimated effects of capital requirements on capital and assets, 3,000 population threshold, 1905

Dependent Variable:	Log(Capital & Surplus)		
	Full Sample	Subsample	
		Below 20th	Above 20th
(Pop-3000)	0.000112	5.89e-05	4.36e-05
	(7.04e-05)	(8.54e-05)	(6.40e-05)
1(Pop>3000)	0.129**	0.284***	0.0720
	(0.0598)	(0.0833)	(0.0558)
(Pop-3000)*1(Pop>3000)	-2.95e-05	-7.24e-05	-5.40e-06
	(0.000107)	(0.000167)	(0.000103)
Bank Age	0.0181***	0.00571***	0.0131***
	(0.00114)	(0.00176)	(0.00106)
Constant	11.04***	10.10***	11.13***
	(0.320)	(0.130)	(0.0590)
State Effects	Yes	Yes	Yes
Bandwidth	±1000	±1000	±1000
Observations	860	171	689
R-squared	0.457	0.440	0.361

Dependent Variable:	Log(Assets)		
	Full Sample	Subsample	
		Below 20th	Above 20th
(Pop-3000)	0.000183**	6.30e-06	0.000122
	(8.16e-05)	(0.000144)	(8.00e-05)
1(Pop>3000)	0.0745	0.267*	0.0119
	(0.0694)	(0.143)	(0.0683)
(Pop-3000)*1(Pop>3000)	-4.96e-06	5.99e-05	4.29e-05
	(0.000119)	(0.000299)	(0.000117)
Bank Age	0.0168***	0.0159***	0.0100***
	(0.00129)	(0.00366)	(0.00129)
Constant	12.32***	10.70***	11.89***
	(0.377)	(0.253)	(0.0739)
State Effects	Yes	Yes	Yes
Bandwidth	±1000	±1000	±1000
Observations	860	171	689
R-squared	0.457	0.384	0.308

Notes: Robust standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1. Subsample refers to banks with capital below or above the 20th percentile of the capital distribution. The 20th percentile refers to capital amounts of $58,601

Table 1.5: Estimated effect of capital requirements on bank leverage and suspension rates, 3,000 population threshold, 1905

Dependent Variable:	Leverage=Assets/Capital & Surplus		
	Full Sample	Subsample	
		Below 20th	Above 20th
(Pop-3000)	0.000130	-0.000637	0.000274
	(0.000224)	(0.000539)	(0.000218)
1(Pop>3000)	-0.121	-0.00851	-0.141
	(0.199)	(0.497)	(0.215)
(Pop-3000)*1(Pop>3000)	0.000221	0.000893	0.000145
	(0.000367)	(0.00101)	(0.000367)
Bank Age	-0.00597*	0.0430***	-0.0113***
	(0.00356)	(0.0145)	(0.00363)
Constant	3.615***	0.440	3.958***
	(0.293)	(0.949)	(0.162)
State Effects	Yes	Yes	Yes
Bandwidth	±1000	±1000	±1000
Observations	860	171	689
R-squared	0.185	0.350	0.236

Dependent Variable:	Loans/Assets		
	Full Sample	Subsample	
		Below 20th	Above 20th
(Pop-3000)	0.000	-0.0001	0.0000
	(0.000)	(0.000)	(0.0000)
1(Pop>3000)	-0.268	0.055	-0.423*
	(0.215)	(0.047)	(0.025)
(Pop-3000)*1(Pop>3000)	0.0000	0.000	7.14e-06
	(0.0000)	(0.0001)	(0.000)
Bank Age	-0.002***	-0.0001	-0.0024***
	(0.0004)	(0.001)	(0.0005)
Constant	0.733***	0.598**	0.894***
	(0.052)	(0.076)	(0.024)
State Effects	Yes	Yes	Yes
Bandwidth	±1000	±1000	±1000
Observations	860	171	689
R-squared	0.31	0.39	0.33

Notes: Robust standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1. Subsample refers to banks with capital below or above a percentile on the capital distributions. The 20th and 40th percentile refers to a capital level of $58,601 and $71,175.

Table 1.6 Estimated effects of capital requirements on suspension rates from 1906 to 1929, 3,000 population threshold, 1905

Dependent Variable:	Suspension=1 if suspended		
	Full Sample	Subsample	
		Below 20th	Above 20th
(Pop-3000)	-0.000730**	-0.000697	-0.000840**
	(0.000339)	(0.000599)	(0.000421)
1(Pop>3000)	-0.183	0.368	-0.203
	(0.331)	(0.697)	(0.378)
(Pop-3000)*1(Pop>3000)	0.000980*	-0.000196	0.00115*
	(0.000529)	(0.00132)	(0.000611)
Bank Age	-0.00284	0.0121	-0.00494
	(0.00539)	(0.0188)	(0.00640)
Constant	-1.780***	-1.653**	-1.996***
	(0.569)	(0.728)	(0.444)
State Effects	Yes	Yes	Yes
Bandwidth	±1000	±1000	±1000
Observations	601	77	418
R-squared	0.194	0.073	0.226

Notes: Robust standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1. Subsample refers to banks with capital below or above a percentile on the capital distributions. The 20th and 40th percentile refers to a capital level of $58,601 and $71,175. A probit model is used to estimate suspension rates

Table 1.7: Estimated effect of capital requirements on bank capital, assets, leverage, and suspension rates, 6,000 population threshold, 1905

Dependent Variable:	Log(Capital + Surplus)	Log(Assets)
	Full Sample	
(Pop-6000)	-0.0002	-0.001***
	(.0002)	0.0002
1(Pop>6000)	0.492***	0.592***
	(0.170)	(0.180)
(Pop-6000)*1(Pop>6000)	0.0003	0.001***
	(0.0003)	(0.0003)
Bank Age	0.464***	0.045***
	(0.009)	(0.010)
Constant	10.90***	12.03***
	(0.145)	(0.157)
State Effects	No	No
Bandwidth	±1000	±1000
Observations	62	62
R-squared	0.49	0.44

Dependent Variable:	Leverage	Suspension=1 if suspended
	Full Sample	
(Pop-6000)	-0.002***	0.004*
	(0.001)	(0.002)
1(Pop>6000)	0.441	-0.025
	(0.521)	(1.387)
(Pop-6000)*1(Pop>6000)	0.002**	-0.010**
	(0.001)	(0.004)
Bank Age	-0.009	-1.904
	(0.027)	(0.670)
Constant	3.16	4.25**
	(0.424)	(2.053)
State Effects	No	No
Bandwidth	±1000	±1000
Observations	62	62
R-squared	0.114	0.60

Notes: Robust standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1. Controlling for bank age. Excluding banks established before 1890. Probit model used to estimate suspension rates. Suspension rates for banks suspended between 1906 to 1929

Table 1.8: Estimated effect of capital requirements on bank capital, assets, leverage, and suspension rates, 3,000 population threshold, 1915

Dependent Variable:	Log(Capital + Surplus)	Log(Assets)
	Subsample: Capital<$100,000	
(Pop-3000)	-0.0001	0.0001
	(0.0001)	(0.0001)
1(Pop>3000)	.163*	0.067
	(0.083)	(0.125)
(Pop-3000)*1(Pop>3000)	0.0001	0.0003
	(0.0002)	(0.0002)
Bank Age	0.039***	0.052***
	(0.009)	(0.011)
Constant	10.98***	13.22***
	(0.036)	(0.047)
State Effects	Yes	Yes
Bandwidth	±1000	±1000
Observations	261	261
R-squared	0.31	0.40

Dependent Variable:	Leverage	Suspension=1 if suspended
	Subsample: Capital<$100,000	
(Pop-3000)	0.001	-.0003
	(0.001)	(0.001)
1(Pop>3000)	-0.630	0.107
	(0.724)	(0.605)
(Pop-3000)*1(Pop>3000)	0.001	-0.0003
	(0.001)	(0.001)
Bank Age	0.065	0.153***
	(0.063)	(0.402
Constant	9.48***	-1.89***
	(0.279)	0.389
State Effects	Yes	Yes
Bandwidth	±1000	±1000
Observations	261	276
R-squared	0.38	0.10

Notes: Robust standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1. Controlling for bank age. Excluding banks established before 1900. Probit model used to estimate suspension rates. Suspension rates for banks suspended between 1906 to 1929

CHAPTER 2

Capital requirements and Financial Markets in California During the Early 20th century

1. Introduction

A key theme in Lynne Doti's work was the study of financial history to gain a better understanding of how financial institutions operate and the role they have in economic development. In *Banking in an Unregulated Environment California 1878-1905*, Doti gathers historical data on financial institutions and markets, in particular commercial banking data, to study issues in late 19th century banking theory and development. Prior studies focused on analyzing national bank data during this time period. However, by 1900 more than half of the banks in the United States (US) were established as state banks rather than national. The inclusion of state and private banks in California improve the accuracy of previous results on financial institutions and development.

For example, Doti shows that state banks would have been able to meet the minimum capital requirements required to establish as national banks[17]. Scholars argue that national bank capital requirements were a barrier to entry which resulted in country banks with monopoly power in rural areas of the United States (US) (Sylla, 1963). However, Doti shows that California state banks held similar levels of capital and these national capital requirements may not have been a barrier to entry in rural areas. In addition, interest rates in urban and rural areas are not statistically different. National banks operating in rural areas may not have had monopoly

[17] From this point on minimum capital requirements will be stated as capital requirements which require banks to hold a minimum amount of capital in order to organize.

power in California since state banks operate alongside national banks with similar levels of capital (Doti, 1978, 1995).

Following Doti's example, this study explores the impact of capital requirements on banking markets after the California Board of Bank Commissioners began implementing capital requirements on state banks in 1909[18]. In the early 20th century, national banks were subject to minimum capital requirements. Banks are required to hold a minimum amount of capital determined by the population of the town a bank was operating in. The intuition is that a town's population represents a measure for a town's business activity and the larger a town's business activity the more capital a bank should hold as a buffer for negative economic shocks (White, 1983). However, the minimum amount of capital required doubles at specific population thresholds. For example, national banks are required to hold at least $25,000 worth of capital if they are operating in a town with population less than 3,000 and the requirement doubles to $50,000 for banks operating in towns with a population greater than 3,000[19].

The California Board of Bank Commissioners also implemented capital requirements on state banks that doubled at specific population thresholds. However, state capital requirements were lower than national capital requirements. For example, state banks operating in towns with populations between 3,000 and 6,000 were subject to half the capital required of national banks. However, state and national banks operating in towns with population below 3,000 were subject

---

[18] For this study, State and savings bank are grouped together. In 1895 California required all state-chartered banks to hold capital of at least 25,000. In 1895, California required all state banks to hold a minimum capital of $25,000 although most banks had at least this amount of capital. In 1905, the state instituted capital requirements based on town population, but this provision was declared unconstitutional in 1907. In 1909, the law was rewritten and enacted stricter capital requirements that were still graded according to town population (Doti, 1994, 1995; Barnett, 1910, 1911; White, 1983).

[19] Prior to 1900, capital requirements were $50,000 for national banks operating in town populations below 6,000. The Gold Standard Act of 1900 halved the minimum capital required for banks operating in towns with a population less than 3,000 from $50,000 to $25,000 as a response to state bank regulation setting their capital requirements consistently lower than national capital requirements (White, 2009)

to the same capital requirement of $25,000. These differences in state and national capital requirements at specific population thresholds allow me to estimate the effect of capital requirements on banking markets at the town-level. The main identifying assumption is that towns very close to these population thresholds should be similar in business activity and other town characteristics. The only difference is that towns with a population slightly above and below a population threshold are subject to different state and national capital requirements. Comparing differences in banking market outcomes allows me to estimate the impact of capital requirements. Specifically, I gather detailed bank and town level data and exploit these abrupt changes in capital requirements using a sharp regression discontinuity design to estimate the effect of higher capital requirements on bank capital, number of banks, bank size, and state to total bank capital ratios at the town level (Hahn, Todd, and van der Klaauw, 2001; Lee and Lemieux, 2010).

To summarize, I find that towns with higher national relative to state capital requirements do not have significant differences in the amount of capital available, number of banks, or the average size of their banks. Higher capital requirements did not restrict entry or result in towns with larger banks in terms of capital. In addition, the composition of state and national banks is similar in towns slightly above and below a population thresholds. These results suggest state banks held enough capital to meet the national requirements during the early 20th in rural areas of California.

This study contributes to the understanding of capital requirements as a barrier to entry in financial markets during the early 20th century. Previous studies show that national banks in rural areas of the US did have monopoly power relative to banks operating in urban areas due to high capital requirements (Sylla, 1963). Doti shows that by 1889 over 55% of states banks held could have met the $50,000 minimum capital required of state banks. I further extend this literature by testing whether this finding still holds when California began implementing state capital requirements in 1909 (Doti, 1995). I find that state banks still hold levels of capital similar to national banks in 1909 after California Bank regulators began implementing capital requirements.

The rest of this essay analyzes the impact of capital requirements on banking markets during the early 20th century in California. Section 2 provides a brief literature review on capital requirements as a barrier to entry. Section 3 describes a detailed description of these capital requirements, both state and national, which fits a regression discontinuity framework. Section 4 describes the data collected for this study. Section 5 describes the regression discontinuity design utilized in this study to estimate the impact of capital requirements on financial market outcomes at the town level. Section 6 reports the empirical results and section 7 concludes.

2. Literature Review:

A vast amount of quantitative work has been devoted to studying the effect of capital requirements in the late 19th century US. Sylla argues that capital requirements were an effective barrier to entry and supports his claim by providing evidence of a rapid increase in the establishment of national banks when these capital requirements are lowered in 1900. Prior to 1900, capital requirements allow rural bankers to operate as price discriminating monopolists, charging higher interest rates in rural areas, during the late 19th century (Sylla, 1963). Other scholars find results that do not support Sylla's findings. James argues that while the number of national banks did increase after 1900 the number of state banks also increases and some national banks were converted state banks. James finds that interest rates are more correlated with a states' capital requirement and that including a states' capital requirement may complicate Sylla's analysis (James, 1976).

Sylla's work is extended by using information on all financial institutions operating within the state of Wisconsin including national banks, state banks, and private banks. Keehn uses Sylla's technique to determine whether capital requirements are an effective barrier to entry for the state of Wisconsin. He finds that most counties had a high level of bank density. In addition, Keehn finds that the counties with low bank density attributed the reason due to low demand not capital requirements restricting entry (Keehn, 1974). Doti gathers information on all financial institutions for the state of California and uses Sylla's techniques to determine whether national bank capital requirements are effective barriers to entry in rural area. Doti finds that most state banks could have met the national capital requirements and interest rates charged by banks are not significantly higher in rural areas (Doti, 1978, 1995).

This study contributes to the literature by utilizing the structure of the California and national banking system to analyze the impact of capital requirements banking markets; specifically capital, banks per town, bank size and bank composition at the town level. Detailed information on towns and state and national banks allows me to observe how different state and national capital requirements influence a town's banking market structure. The next section provides a background of these capital requirements.

3. Background of Minimum Capital Requirements

Capital requirements are a fundamental regulation designed to promote financial stability. They were intended to provide a minimum level of security for depositors in case of a negative economic shock (White, 1983). These laws required banks to hold a minimum amount of capital according to the size of their town's population. Town population is a crude measure of the volume of business activity in a town. The larger the volume of business activity the greater the minimum amount of capital was required to offset the losses that could occur from borrowers defaulting on their loans. However, the minimum amount of capital required for banks to hold was not graded continuously by town population. Instead, the minimum amount of capital required by banks to operate doubles at each specific population thresholds.

Table 2.1 describes these national and state capital requirements for the year 1909. Row 1 illustrates the national capital requirements. At specific population thresholds these capital requirements double in amount. For example, banks operating in towns above the population threshold of 3,000 are required to hold at least $50,000 worth of capital. However, banks operating in towns below the threshold of 3,000 are required to hold $25,000, half the amount.

California state banks are subject to capital requirements that are lower than national requirements. Row 2 illustrates the state capital requirements in California. For example, state banks are required to hold $25,000 worth of capital operating in towns with a population below 6,000. State banks do not have to increase their capital to $50,000 once their town population is above the 3,000 threshold. Instead, they are required to increase their capital to $50,000 for towns above population threshold of 6,000. Figure 2.1, provides a visual representation of these differences in capital requirements between state and national banks for towns with a population less than 6,000. The solid blue line represents national requirements while the dashed red line represents state requirements. There is a discrete jump in capital required of national banks at the population threshold 3,000. However, for state banks there is no discrete jump at the population threshold of 3,000. These differences in capital requirements allow me to compare differences in banking markets for towns slightly below and above these population thresholds.

4. Data Sources

Data on commercial banks comes from *Rand McNally Banker's Directory* published biannually in January and July. These data contain information on bank characteristics including name of the bank, location of establishment, and year of establishment, bank status, correspondent relationships, and bank balance sheet information such as paid-up capital, surplus, and loans. I gather data on all national and state banks from the July 1910 issue of *Rand McNally Banker's Directory* for the state of California and provide a total of 676 banks operating in 212 towns

The precise location of each bank allows a bank's corresponding town to be merged with another source that contains data on town population. This data source is the United States Population Census of 1910. The population census is published by the Federal government each decade and contains information on population characteristics at the national, state, county, and town level. Each town's population for the years 1910, 1900, and 1890 are provided in the population census of 1910. These town population data is gathered for every bank in the dataset. In addition, I also include in the analysis towns that do not have any banks. There are a total of 212 towns matched with town populations in our dataset with over 86% of towns with a population of less than 6,000. Since most of the towns in California have a population of less than 6,000 the focus of the analysis is on the lowest population threshold of 3,000.

5. Research Design:

Capital requirements, if binding, should have an impact on a town's banking market in several ways. First, they can increase the total amount of capital in a town. Bank capital is positively correlated with town population, which is a proxy for business activity. In absence of capital requirements a positive continuous relationship may be observed between the level of capital in a town and population. However, these capital requirements may create rigid increases in capital levels for towns with populations slightly above a threshold. Town population is the key variable that determines the minimum amount of capital required for a bank. A description of national and state capital requirements are provided below:

$$National\ Capital\ Requirement = \begin{cases} \$25{,}000, if\ Pop_i < 3{,}000 \\ \$50{,}000, if\ Pop_i \geq 3{,}000 \end{cases}$$

$$State\ Capital\ Requirement = \begin{cases} \$25{,}000, if\ Pop_{bis} < 6{,}000 \\ \$25{,}000, if\ Pop_{bis} \geq 6{,}000 \end{cases}$$

The capital requirement doubles from \$25,000 to \$50,000 for national banks if a town's population crosses the threshold of 3,000 while the requirement remains at \$25,000 for state banks. An abrupt increase in capital, being driven by an increase in national requirements, may be observed for towns slightly above the population threshold of 3,000 compared to towns slightly below the threshold. Specifically, I estimate a local-linear regression where I regress capital on town population, an indicator for crossing the population threshold, and an interaction term between town population and the indicator crossing the threshold for a given bandwidth. The bandwidth proposed is based on Calonico, Cattaneo, and Titiuniks' methodology where "data-driven confidence interval estimators are constructed that exhibit close-to-correct empirical coverage and good empirical interval length on average…improving upon the alternatives available in the literature" (Calonico et al., 2014). The model is described below:

$$Capital_i = \beta_0 + \beta_1 Pop_i + \beta_2 1(Pop_i \geq 3000)_i + \beta_3 Pop_i 1(Pop_{bis} \geq 3000)_i * Pop_i + \varepsilon_i \ (1)$$

$$Pop_i \in (3000 - k, 3000 + k)$$

where "i" represents a town in the year 1910 and the bandwidth "k" represent the bandwidth chosen for the specification. The variable "*Capital*" represents the total amount of bank capital in a town for the year 1910. The population variable "*Pop*" represents the town population in 1910. The indicator variable $1(Pop_i>3000)_i$ represents if a bank is operating in a town just above the town population cut-off of 3,000 where national capital requirements increase from $25,000 to $50,000, but state requirements remain at $25,000.

It is possible that capital requirements do not have an impact on the total amount of capital available in a town, but instead alter the composition of a town's banking market. These higher national capital requirements could result in towns with fewer, but larger banks in terms of capital. The second and third outcome variables estimated using equation 1 are number of banks and mean bank size[20]. Comparing differences in the number of banks allows me to observe if there are fewer banks in a town above a population threshold due to national capital requirements. In addition, observing bank size allows me to observe if there are fewer, but larger banks due to these requirements.

The fourth outcome variable estimated using equation 1 is state to total capital ratio in a town. State and national capital requirements are the same for banks operating in towns below the population threshold of 3,000. National capital requirements are twice the amount of state requirements for towns above the threshold of 3,000. Differences in state to national bank capital ratios may arise if lower state requirements provided an incentive to organize as a state bank.

6. Results

[20] Bank size is measured as average amount of capital for a bank in a given town.

First, I provide descriptive statistics that illustrate state banks hold capital amounts similar to national banks above and below the population threshold of 3,000. Table 2.2 reports the fraction of state and national banks operating with various capital levels above and below the population threshold of 3,000. The fraction of state banks holding capital between $25,000 and $50,000 is similar to that of national bank in towns with a population below 3,000. This is not surprising since banks are subject to the same capital requirements below the threshold. However, the composition of capital is also similar for national and state banks operating in towns above the threshold. One might expect more states banks to hold capital below $50,000 since the state capital requirement is $25,000. This is not the case. 83% of state banks hold capital amounts above $50,000 and 88% of national banks hold capital above $50,000[21]. In addition, table 3 illustrates the fraction of state and national banks operating in towns above and below the threshold of 3,000. The composition of state and national banks are relatively similar above and below the threshold. 67% of banks possess state charters below the threshold while 70% of banks possess state charters above the threshold. At first glance, state and national capital requirements do not alter on the composition of town's banking market.

Figure 2.2 provides a visual representation of the relationship between town population and financial market characteristics at the town level. Each observation represents a town's population and its associated outcome variable. The vertical line illustrates where the town population is 3,000; the population threshold where the national requirement doubles to from $25,000 to $50,000. There are a few inferences to be made from these plots. First, there are many small towns with low populations. On the contrary, there are not many banks with a population greater than the threshold of 3,000. This means that the local-linear results may be unprecise due

[21] There are 4 out of 32 national banks that have capital below the capital requirement who appear to be not treated by the capital requirement.

to a lack of observations. Second, there is a positive relationship between capital and town population, but there does not appear to be a significant jump in capital at the population threshold. In addition, there is not an obvious relationship between the number of banks and town population or bank size and town population. Lastly, many of these towns have 1 or 2 banks which results in the majority of state to total capital ratios equal to unity.

Table 2.4, reports estimation results of higher national capital requirements on capital, number of banks, bank size, and state to total capital ratio derived from equation 1 for the bandwidth choice of ±1,000[22]. There is no evidence of a significant increase in capital. However, there could be larger and fewer banks due to higher capital requirements. I do not find a significant difference in the number of banks or bank size suggesting that this is not the case. Lastly, it is not surprising to find that state to total capital ratios are no difference. This last result suggests that there were not significantly more state banks relative to national banks. Tables 2.1 and 2.2 provide evidence that state banks hold capital levels similar to national banks above and below the population threshold and the regression estimates support this finding. The findings in table 2.4 suggest that state banks may not have been impacted by national capital requirements even when California began to implement capital requirements in 1909. These results support Doti's findings that "most of the state banks would have been able to meet the capital requirements of the national banking system" (Doti, 1978).

7. Conclusion:

Capital requirements are a barrier to entry for national banks in many areas for the US prior to 1900. These higher capital requirements led to country banks behaving as price

[22] The bandwidth choice of ±1,000 is used since it was the most common bandwidth selected for each outcome variable using Calonico, Cattaneo, and Titiuniks' method.

discriminating monopolists in rural areas of the US. However, many of these results focus on analyzing national banks. By 1900, many states have a significant fraction of state banks in operation. California is no exception. In 1909, California began to implement capital requirements graded according to town population that were more lenient relative to national requirements. I find that higher national relative to state capital requirements did not result in more capital in towns. Most state banks were holding enough capital to meet the national requirements. Thus, higher national requirements also did not alter the composition of state and national banks for towns with higher national relative to state capital requirements. These findings reveal that the addition of state banks improves the accuracy of studies on banking markets in California and in this case how banks respond to capital requirements.

Figure 2.1: Bank capital across town populations, 1910

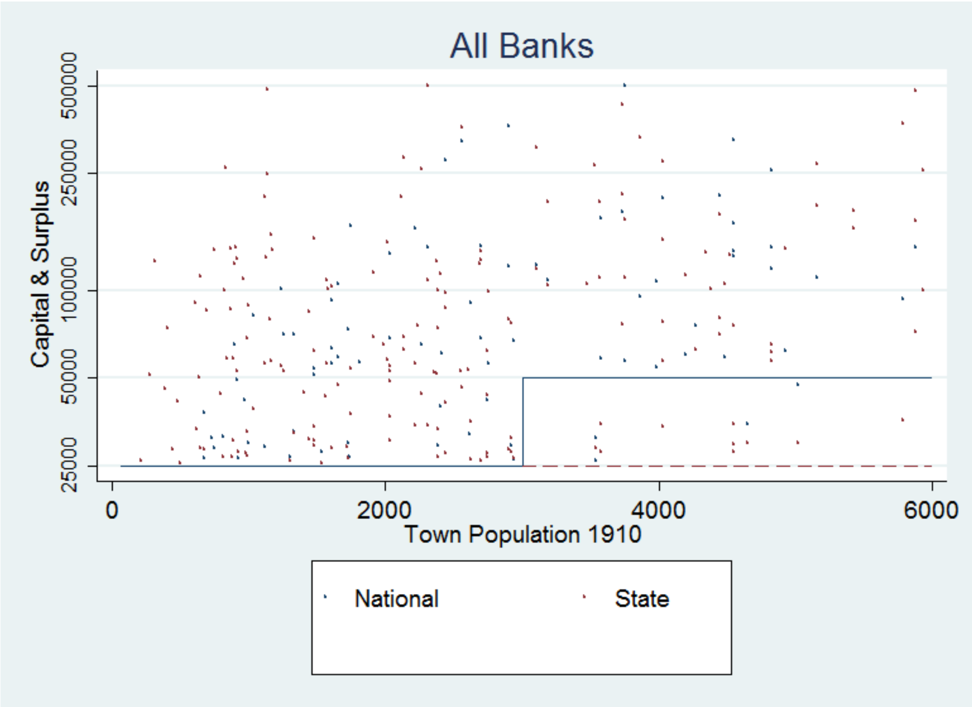

Figure 2.2: Bank market characteristics across town populations, 1910, town population<6,000

Table 2.1: National and State bank minimum capital requirements, 1909

Minimum capital required to establish a bank				
	Town Population			
	Population<3,000	3,000≤Population<6,000	6,000≤Population<25,000	25,000≤Population
National	$50,000	$50,000	$100,000	$100,000
State	$25,000	$25,000	$50,000	$100,000

*Source: OCC Annual Reports, 1900 and 1910; White, 1983; Doti, 1973

Notes: Minimum capital required to established a State or a National bank doubles from $100,000 to $200,000 for towns with a population greater than 50,000

Table 2.2: Mean level of Capital & Surplus, by bank category and town population, 1910

Percentage of Banks in each Category in the year 1910			
	Population<3,000	3,000<Population<6,000	All Towns
State & National Banks			
Capital<25,000	0	0	0
25,000<Capital<50,000	38	16	22
50,000<Capital	62	84	78
State Banks			
Capital<25,000	0	0	0
25,000<Capital<50,000	38	17	23
50,000<Capital	62	83	77
National Banks			
Capital<25,000	0	0	0
25,000<Capital<50,000	34	13	18
50,000<Capital	66	88	82

Source: US Population Census of 1910, Rand McNally Bankers Directory 1910

Table 2.3: Fraction of banks in operation, by bank category and town population, 1910

Percentage of Banks by each Category in the year 1910			
	Population<3,000	3,000<Population<6,000	All Towns
State	30	33	30
National	70	67	70
Total	100	100	100

Source: US Population Census of 1910, Rand McNally Bankers Directory 1910

Table 2.4: Impact of higher minimum capital requirements, bandwidth choices based on CCT

Dependent Variable:	Capital & Surplus	Number of Banks	Bank Size	State to Total Capital
(Pop-3000)	-0.0002	0.000900	-0.000586	-0.0003
	(0.0006)	(0.000658)	(0.000422)	(0.0002)
1(Pop>3000)	0.890	0.460	0.668	0.407
	(0.854)	(0.989)	(0.634)	(0.296)
(Pop-3000)*1(Pop>3000)	0.0002	-0.00109	0.000713	-0.0002
	(0.001)	(0.00153)	(0.000983)	(0.0006)
Constant	11.83***	2.855***	10.85***	0.513***
	(0.345)	(0.399)	(0.256)	(0.119)
Bandwidth	±1000	±1000	±1000	±1000
Observations	43	43	43	43
R-squared	0.148	0.156	0.120	0.104

Notes: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1, Town Clustered SE's, excluding 1 Town holding capital and surplus greater than 600,000. Optimal data-driven bandwidth is chosen based on Calonico, Cattaneo, Titiunik, 2014.

CHAPTER 3

The Impact of Bank Failures on Wholesale Activity during the Great Depression: A County-Level Study

1. Introduction

Scholars have long debated the role banks play in the economy. Friedman and Schwartz have argued that the bank failures during the 1930s decreased the money supply due to a loss of deposits which led to a decline in aggregate demand (Friedman and Schwartz, 1971). Bernanke argues that the important role of banks as financial intermediaries is significant and bank failures have a real negative impact on economic activity. When a bank fails, its creditor-debtor relationships are lost with the bank, and debtors (i.e. firms seeking credit) might incur a cost to finding a new bank to obtain credit from (Bernanke, 83). For some firms, their primary channel of obtaining credit is obstructed when banks fail. Bank-dependent firms fail when banks fail.

More recently, Cole and Ohanian argue that bank failures merely reflect the poor state of the economy. Specifically, bad/risky assets deliver no returns during poor economic times and banks fail due to falls in asset values. Cole and Ohanian suggest that the bank failures during the 1930s did not contribute heavily to the Great Depression since the “decline in deposits during the 1929-1933 decline was small relative to the decline in output” (Cole and Ohanian, 2000). The debate on whether bank failures have a negative impact on real economic activity is still being resolved.

I study the impact of bank failures on wholesale activity during the 1930s for the United States. Wholesalers historically have been known to be bank dependent in the early 20th century. Thus, bank failures during the 1930s should have a negative impact on wholesale activity.

Richardson and Troost have found that "wholesale activity contracted after banks failed during the banking panic in the fall of 1930…for the region which straddled the border of the 6th and 8th Federal Reserve Districts in Mississippi" (Richardson and Troost, 2009). This study has two primary contributions. First, I provide evidence supporting the claim that there is a negative relationship between bank failures and wholesale activity. I provide estimates of the impact of bank failures on wholesalers for the United States during the Great Depression employing a propensity score matching model that mitigates the endogeneity issue between bank failures and wholesale activity.

Counties experiencing bank failures during panic periods are matched with comparable counties that were not experiencing bank failures during panic periods. I find that counties experiencing bank distress are associated with a decline in wholesale sales ranging from eight to ten percent compared to similar counties that did not experience bank distress[23]. The second contribution of this study involves using bank examiners' reports to uncover the mechanism through which bank failures have an impact on wholesalers.

Using extensive, detailed information on individual bank failures compiled from bank examiners' reports, I observe what types of bank failures have the largest impact on wholesale activity. Failed deposits are aggregated due to different reasons for failure and I observe their impact on wholesale sales at the county-level. Banks failing due to asset reasons represent unhealthy bank failures. These types of bank failures reflect bad/risky assets generated during poor economic times. However, banks failing due to withdrawal reasons represent healthy bank failures (solvent, but illiquid). These types of bank failures should have a real negative impact on wholesalers.

[23] Counties that did not experience bank distress still experience a decline in wholesale sale of about thirty percent while counties that experience bank distress experience a decline in wholesales of about forty percent.

I find that banks failing due to both asset and withdrawal reasons are important for explaining declines in wholesale firm sales during the early 1930s. In addition, I aggregate suspended deposits due to bank failures occurring during panic periods to determine if the banks failing during panic periods have a large impact on wholesale activity. I find that bank failures during panic periods and non-panic periods are both associated with a decline in wholesale activity. Bank failures do have a negative impact on wholesalers and this study provide some evidence about the mechanism through which they have an impact.

Section two provides a review of relevant studies that have been conducted. Section three describes the data used in this study. Section four explains the methods used to identify which bank failures have the largest impact on wholesale activity. Section five reports and discusses the results. Section six concludes this study.

2. Literature Review

Bernanke argues that bank failures increase the cost of obtaining credit for bank-dependent firms. This increased cost of obtaining credit may have adverse effects on real economic activity. He gathers monthly national data from 1929 to 1933 and finds that deposits of failed banks have a negative impact on industrial output growth (Bernanke, 1983).

Recent studies analyze the impact of bank failures on manufacturing activity by exploiting exogenous differences in monetary policy regimes across different Federal Reserve districts and their impact on bank failures. Ziebarth utilizes a quasi-experimental setup exploiting the differences in monetary policy between two different district regions of Mississippi, St. Louis Fed district and Atlanta Fed district, to study the impact of additional bank failures occurring within the St. Louis Fed district on manufacturing activity. Plant-level data from the Census of manufactures is gathered for the years 1929, 1931, 1933, and 1935 and a differences-in-differences framework is used to the study the impact of being in the St. Louis Fed district compared to being in the Atlanta Fed district. He finds that the additional bank failures which occurred in the St. Louis Fed region of the state "had a large negative differential effect on revenue at both the plant and county-level" (Ziebarth, 2012). This study addresses the endogeneity issue between bank failures and manufacturing activity, but a limitation to this study is that it applies only to counties that are located near the district borders in the state of Mississippi. This study may not be appropriate for making inference on bank failures and their impact on manufacturers (or wholesalers) for the rest of the nation.

Another study has examined the impact of FDIC-induced failures of healthy banks on real economic activity. Ashcraft studies "two incidents when healthy subsidiaries of a multi-bank holding company failed following the failure of unhealthy lead banks" (Ashcraft, 2005). He argues that subsidiary banks failed independently of local economic activity and that these bank failures are exogenous. However, the location of these banks may not have been randomly assigned. Using yearly county-level data for the state of Texas, Ashcraft analyzes the impact of an increase in the ratio of bank deposits to income on real county income. He finds evidence suggesting that healthy bank failures "have significant and apparently permanent effects on real economic activity" (Ashcraft, 2005).

Current work being conducted by Mldjan argues that bank failures do have a negative impact on manufacturing industries and the impact is greater for more financially dependent manufacturing industries. Mladjan constructs a state-level biannual panel dataset consisting of twenty one industries from 1921 to 1937. He measures the impact of bank failures, financial dependence, and their interaction on the growth rate of manufacturing output. Mladjan addresses the endogeneity issue by instrumenting bank failures with "predetermined vulnerabilities of the banking system in each state" (Mladjan, 2011). The two instruments he uses are the "percentage of branch offices in the year 1920 and the increase in the value of farmland over the 1910s" (Mladjan, 2011). He finds that an increase in suspended deposits leads to a reduction in output growth that varies by how financially dependent an industry is.

This study is different from the previous studies in the sense that it seeks to make inference about the impact of bank failures on wholesale activity at the county level for the entire Nation during a time of financial distress. Also, instead of measuring manufacturing activity, the impact of bank failures on wholesale activity is measured since wholesalers are directly influenced by bank failures.

3. Data

Data is gathered from four sources. The first source is the Wholesale Census of the United States. The Wholesale Census contains information on the number of wholesale establishments and wholesale sales at the county-level for the years 1929 and 1933[24]. It should be noted that approximately three hundred counties have missing establishment and sales data and imputations were made for these counties. The crucial information collected from these data is wholesale sales. This information is used to construct a measure for wholesale activity in a county. The second source is the Federal Deposit Insurance Corporation (FDIC) bank deposit dataset. This dataset contains an extensive amount of deposit data at the county-level for the years 1920 to 1936. For this study, I use data on total deposits for the years 1929 and 1933. These data allows me to construct a measure for the amount of deposits available in a county.

[24] The Wholesale census contains wholesale data for the years 1929, 1933, 1935, and 1939, but for the purpose of this study information is only used for the years 1929 and 1933.

The third source is individual bank failure data that comes from the Archives of the Board of Governors (Richardson, 2007). This dataset contains vast, detailed information for each bank that failed between 1929 and 1933[25]. It includes information on the location of each bank, the date of failure, the date of reopening (if any), and their reason for failure. This information is gathered from bank examiners' reports during the 1930's (Richardson, 2007). In addition, the dataset includes bank balance sheet information, including deposit data, for the year 1929. This detailed information on the location of each individual bank failure and their reason for failure allows me to aggregate suspended deposit data due to many different categories of failure to the county-level.

County-level suspended deposits due to eight different categories for failure. The first category represents failures solely due to asset reasons[26]. The second category represents failures due to asset reasons as a primary cause and withdrawals as a secondary cause. The third category represents failures due to asset and withdrawal reasons as both primary causes. The fourth category represents failures due to asset reasons as a contributing cause and withdrawals as a primary cause. The fifth category represents failures solely due to withdrawal reasons. The sixth category represents failures solely due the closer of a bank's correspondent. The seventh category represents failures solely due to defalcation and mismanagement. The eighth category represents failures due to other and multiple causes. These data is used to identify which types of bank failures have the largest impact on wholesale activity. Table 3.1 provides the percentage of all banks failing due to their primary, but not limited to, reason for failure. Banks failing due to asset reasons range between 36 to 42 percent of all banks failing while banks failing due to

[25] This dataset actually contains information on each individual bank failure from 1929 to 1935, but since my empirical analysis is only analyzing data from 1929 to 1933 I exclude bank failures that occurred after 1933.
[26] Failing due to asset reasons actually refers to failing due to slow, doubtful or worthless paper. They represent assets that either had "little or no value…, were unlikely to yield book value…, or whose repayment lagged" (Richardson, 2007).

withdrawals range between 21 to 48 percent. In 1932, over 48 percent of banks failed due to withdrawals as a primary reason for failure. Also, a large amount of banks failed due to other and multiple causes ranging between 18 to 28 percent. Overall, the data suggests that the majority or banks either failed due to asset (insolvency) reasons, heavy withdrawals (liquidity), or other and multiple causes.

In addition, the date of bank failure is used to construct county-level suspended deposits during panic periods. Time periods where more than thirty banks were failing each week are considered panic periods. These data allows me to identify whether bank failures during panic periods have a larger impact on wholesale activity than bank failures during non-panic periods. Table 3.2 reports the weeks that are indicated as panic periods. The time periods being captured are somewhat reassuring since they are similar to Wicker's panic periods (Wicker, 2000).

The fourth source is the Historical Demographic, Economic, and Social Data: The United States, 1790-1970. These data contains information on county-level characteristics such as number of acres devoted to farming, agricultural production, urban population, black population, unemployment, and etcetera for the year 1930. These county-level characteristics allow me to control for a variety of factors that may influence wholesale activity other than bank distress. Calomiris and Mason's specifications provide some insight about what county characteristics to include in this study (Calomiris and Mason, 2003).

4. Methodology

A propensity score matching model is used to match counties that experienced bank failures during panic periods with comparable counties that did not experience bank failures during panic periods. The comparable control groups are constructed and the difference in percentage change in wholesale sales from 1929 to 1933 between treated counties and comparable counties is estimated. A variable called "bankrun" is created that represents if a county experienced bank failures during panic periods from 1930 to 1933[27]. A county is defined as experiencing banking run if this variable is a one and zero otherwise. A probit regression is used to estimate the probability that a county experienced failed deposits during panic periods given a county's economic, demographic, business, and banking characteristics prior to the year 1930. Specifically, the probability of experiencing a banking run is regressed on unemployment rate, percent black population, percent urban population, percent farmland, reserve bank or branch city indicator variable, State fixed effects, and Federal Reserve District fixed effects. The model is described below:

$$\Pr(BankRun = 1) = UrbanPop_c + FarmLand_c + BlackPop_c + UnempRate_c + \log(DepositsperWholesaler)_c + \gamma_d + \lambda_s \quad (1)$$

Propensity scores are obtained from this regression for each county. Counties that experienced bank failures during panic periods are matched with counties that did not experience bank failures during panic periods with similar propensity scores using a matching method.

Radius matching is the primary matching method used to estimate the impact of bank failures during panic periods on wholesale activity. Treated counties are matched that have propensity scores less than or equal to 1 percent of each other[28]. Multiple matches are allowed to

[27] There were not any panic periods for the year 1929, this is crucial for the matching process since the 1930 Census Characteristics can be used to match prior trends.

[28] There is no well-defined method specifying what caliper is reasonable. Smith and Todd have suggested using ".1" as a caliper, but ".01" and later on ".001" are used in this study as threshold values for reasonable matches (Smith, Todd, 2005).

be made within the threshold of 1 percent. It is possible that a comparable county could be matched with many treated counties. Previous studies suggest that allowing multiple matches "improves the estimate of the treatment effect without raising the variance of the estimate" (Dehejia and Wahba, 1999). The propensity score model alleviates the difficult process of matching counties solely by their county characteristics. However, an issue with this matching process is that there are some counties with a higher intensity of bank failures during panic periods. In this model I assume the counties that experience bank failures during panic periods are impacted the same way. Also, the propensity score model solely matches on observable characteristics. Assuming that the treated counties only differ in observable characteristics and the probit model used is the right specification, the propensity score estimates provide accurate and consistent results. However, it is possible that counties experiencing banking runs could differ greatly in unobservable characteristics. If this is the case then the propensity score matching estimates will be biased.

This study also seeks to understand which types of bank failures have a negative impact on wholesalers during the early 1930s. The outcome variable observed is the percentage change in wholesale sales from 1929 to 1933. I decompose the percentage change in deposits from 1929 to 1933 between surviving bank deposits and failed bank deposits due to various reasons. The percentage change in surviving bank deposits represents the percentage change in bank deposits from 1929 to 1933 net failed bank deposits for the year 1929. I also construct variables representing the percentage of failed deposits due to various reasons for failures for the year 1929. A description of how these variables are constructed is described in Appendix A. The model is described below:

$$Pct\_Change\_Sales_c$$

$$= Pct\_Change\_Deposits\_NetSusp_c + Ratio\_Assets\_P_c$$

$$+ Ratio\_Assets\_P\_Withdrawal\_C_c + Ratio\_Assets\_P\_Withdrawal\_P_c$$

$$+ Ratio\_Assets\_C\_Withdrawal\_P_c + Ratio\_Withdrawal\_P_c + Ratio\_Corr\_P_c$$

$$+ Ratio\_DefalcMismanage\_P_c + Ratio\_Other\_Multiple\_P_c + \beta X_c + \gamma_d + \lambda_s$$

$$+ \varepsilon_c \ \ (2)$$

where the ratio variables represent the fraction of total deposits that belong to banks that failed from January 1929 to February 1933 due to their corresponding reason for failure. For example, the variable "Ratio_Assets_P_c" represents the fraction of failed deposits due primarily and solely to asset reasons for the year 1929 divided by the number of total deposits for the year 1929. The subscript "P" and "C" represent the primary reason for failure and the contributing reason for failure, respectively. X_c represents a vector of county characteristics, including percentage urban population, percentage farmland, and percentage black population.

I also estimate the impact of bank failures during panic periods on wholesale activity. These bank failures may be perceived as failures due to liquidity reasons (i.e. depositors losing confidence in their banks and withdrawing their deposits). Failed deposits are aggregated for banks that failed during weeks where more than thirty banks failed. In addition, I also estimate the impact of bank failures that occurred during non-panic periods. This specification estimates the impact of deposit declines at open banks, deposit declines at banks that failed during panic periods, and deposits declines at bank that failed during non-panic periods on wholesale activity. The model is described below:

$$Pct\_Change\_Sales_c = Pct\_Change\_Deposits\_NetSusp_c + Ratio\_Deposits\_Panic_c + Ratio_{Deposits_{NonPanic}} + \beta X_c + \gamma_d + \lambda_s + \varepsilon_c \quad (3)$$

where X_c represents a vector of county characteristics, including percentage urban population, percentage farmland, and percentage black population. The next section discusses and reports the results.

5. Results and Discussion

The propensity score estimates are presented first. The data suggests that counties experiencing bank failures during panic periods are different from counties that did not experience bank failures, prior to the banking runs. Table 3.3 illustrates that counties experiencing bank failures tend to have more farmland, higher urban population, slightly higher unemployment rates (prior to the panic periods), more deposits available per wholesaler, and etcetera. Furthermore, counties experiencing bank runs experience a forty-three percent decline in wholesale sales from 1929 to 1933, while counties not experiencing bank runs experience a thirty-three percent decline. This evidence suggests an approximately ten percent difference in the decline in wholesale sales between counties experiencing bank runs nationwide. Controlling for county characteristics, State, and Federal Reserve district fixed effects lowers this estimate to an eight percent difference shown in table 3.4.

Table 3.5 provides estimates of the probit model used to generate the propensity scores. Figure 3.1 illustrates that there is much common support between the two samples. The y-axis corresponds to the density of counties that experience a bank run and the x-axis represents the probability of having a bank run for a county ranging from 0 to 1. Depending on the matching algorithm used, many matches are able to be constructed. The mean propensity score for counties experiencing bank failures during panic periods is approximately 65 percent while for counties that did not experience bank failures during panic periods is approximately 45 percent. Table 3.6 provides estimates for various matching algorithms. They range between -8.3 to -9.7 percent. These estimates are not much different from the OLS estimates provided in table four of which are –10 percent without controls and -8 percent with controls. The data suggest that counties experiencing bank failures during panic periods experience a significant decline in wholesale activity compared to similar counties supporting the claim that there is a relationship between bank failures and wholesalers. Next, the estimates from model two are presented in table 3.7. This specification helps uncover the mechanism through which bank failures have an impact on wholesalers

I find that a one percent decline in deposits for banks still in operation is associated with a 17.3 percent decline in wholesale activity. As the availability of credit decreases wholesale sales also decrease. Also, the data suggest that failed deposits primarily due to both asset and withdrawal reasons have a large negative impact on wholesale activity. A one percent decline in deposits of banks failing primarily due to asset and withdrawal reasons is associated with a 46.2 percent decline in wholesale activity. In addition, failed deposits primarily due to asset reasons and withdrawals as a secondary reason also have a large negative impact on wholesale activity. A one percent decline in deposits of banks failing primarily due to asset reasons and withdrawals as a contributing reason is associated with a 28.8 percent decline in wholesale activity. These findings suggest that banks failing due to both asset and withdrawal reasons matter. The data suggest that some bank failures (i.e. banks failing due to asset reasons) reflect the poor state of the economy and these bank failures do not have a negative impact on wholesalers. On the contrary, I cannot rule out the fact that some bank failures (i.e. banks failing due to heavy withdrawals) have a real negative impact on wholesalers. It is difficult to disentangle what types of bank failures have the larger negative impact on wholesale activity and the data suggests that both types of failures matter.

In addition, failed deposits due to other and multiple reasons have a large, negative impact on wholesale activity and are associated with a 27.5 percent decline in wholesale activity. It is difficult to determine whether the majority of these failures were random or endogenous. Richardson provides as an example “a poorly managed bank which failed to enforce collections on its slow farm loans and which experienced runs after local newspapers revealed that its president embezzled funds from savings accounts” (Richardson, 2006). Further reading of bank examiners’ reports must be done to determine how these banks failed. Nonetheless, the hypothesis that these other bank failures have an impact on wholesalers cannot be rejected.

In table 3.8, I present the estimates from the third specification. I find that a one percent decline in deposits for banks still in operation is associated with a 16.6 percent decline in wholesale activity. In addition, both bank failures that occurred during the panic periods and non-panic periods have a negative impact on wholesale activity. However, the data suggest that the bank failures during panic periods have a slightly larger impact on wholesale activity than bank failures during non-panic periods. A one percent decline in deposits due to banks failing during panic-periods is associated with a 19 percent decrease in wholesale activity while a one percent decline in deposits due to banks failing during non-panic panic periods is associated with a 14 percent decline in wholesale activity. The data suggests that banks failing during both panic and non-panic periods matter.

6. Conclusion

This study provides evidence bolstering the claim that there is a relationship between bank failures and wholesale activity. Using a propensity score model, I find that counties experiencing bank failures during panic periods experience a significant decline in wholesale sales ranging between eight to ten percent. I also shed light on the mechanisms through how bank failures negatively impact wholesalers.

Utilizing detailed information on individual bank failures gathered from bank examiners' reports I am able uncover what types of failures have a negative impact on wholesalers. I find that banks failing due to solvency reasons (i.e. asset reasons) reflecting the poor state of the economy make up a significant share of failed deposits negatively correlated with wholesale activity. But, I also cannot reject the claim that banks failing due to illiquidity (i.e. withdrawal reasons) have a real economic impact on wholesalers since they also make up a significant share of failed deposits negatively correlated with wholesale activity.

In addition, I also utilize information on the date of each bank failure and the frequency of failures to establish failures during panic periods and non-panic periods. I find that both banks failing during panic periods and non-panic periods have a negative impact on wholesalers. However, banks failing during panic periods have a slightly larger impact. The results of this study provide evidence that bank failures do have an adverse impact on wholesale activity for the United States during the early 1930s. Future work should focus on finding a better way to address the endogeneity issue associated with this study and uncovering the precise mechanism through which bank failures affect wholesalers.

Figure 3.1: Histograms illustrating the common support across counties

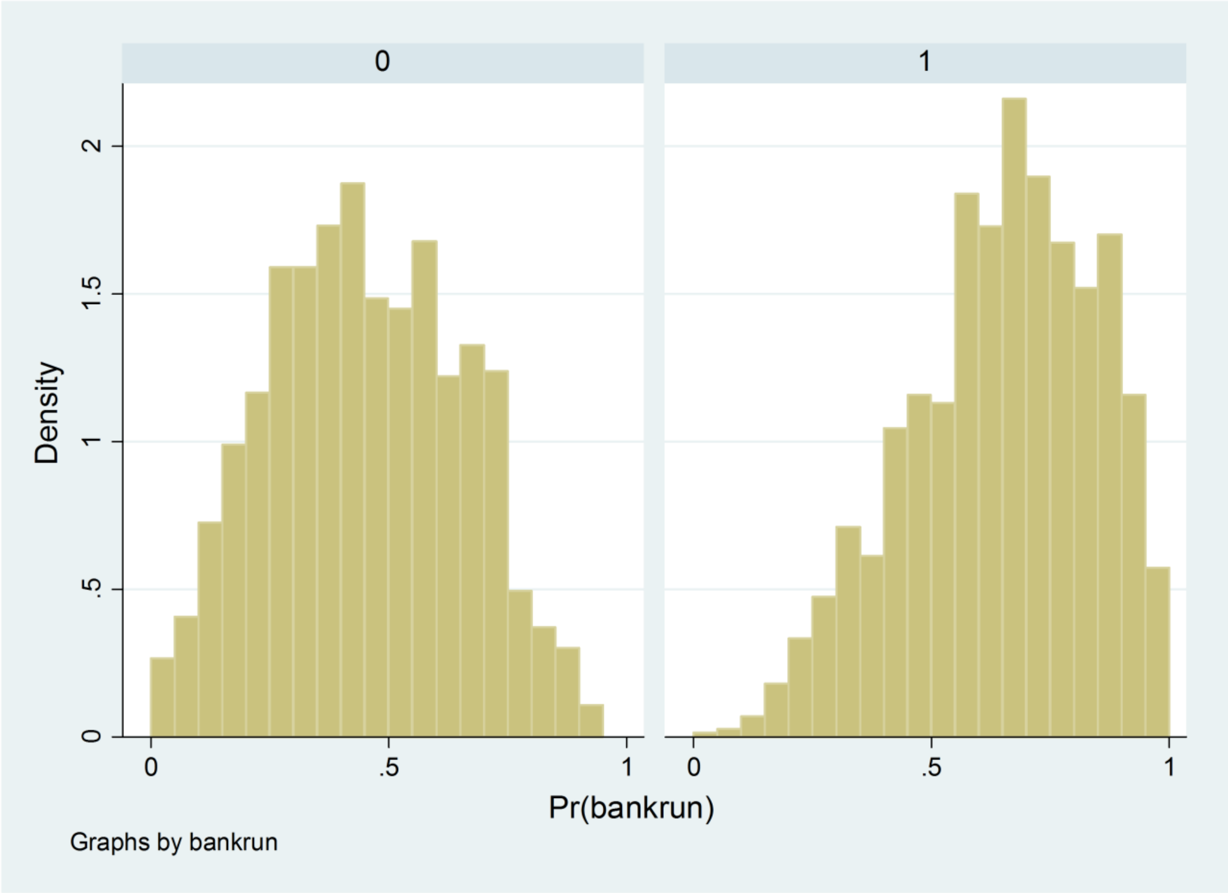

Table 3.1: Percentage of Bank Failures due to various, primary reasons for failure

Causes of Failure:	**1929**	**1930**	**1931**	**1932**	**1933 (until March)**
Assets	.38047	.3817	.3717	.417	.3637
Withdrawals	.21043	.264	.4816	.2992	.2412
Correspondent	.04377	.0837	.027	.0333	.0204
Defalcation and Mismanagement	.069	.0511	.02347	.01636	.0048
Other or Multiple Cause	.27946	.1815	.1999	.1875	.2232
Number of Bank Failures	594	1564	2685	1711	833

Table 3.2: Weeks with thirty or more bank failures

Year	**Weeks with thirty or more bank failures**
1929	
1930	1, 5, 6, 13, 16, 46-52
1931	1-6, 10, 23-26, 30-52
1932	1-7, 17, 25-29, 44, 48, 50-52
1933(until March)	1-8

Table 3.3: Comparing the difference of means between Treated and Control groups

Variable:	**BankRun=1**	**BankRun=0**	**Difference**
Pct. Change. Sales in Wholesale	-.428	-.327	-.101**
Sales 1929-1933	(.01)	(.02)	(.022)
Pct. Urban Pop.	.275	.186	.088**
	(.006)	(.006)	(.009)
Pct. Farmland	.708	.605	.102**
	(.006)	(.008)	(.01)
Pct. Blackpop	.093	.112	.019**
	(.004)	(.005)	(.007)
Pct. Unemp.	.0113	.0102	.0011**
	(.0002)	(.0002)	(.0003)
Deposits per Wholesaler	203.1	183.7	19.39**
	(5.02)	(5.7)	(7.6)
Log(Deposits per Wholesaler)	4.98	4.72	.264**
	(.019)	(.034)	(.039)

*denotes significant at the ten percent level, ** denotes significant at five percent level.

Table 3.4: OLS Estimates, Regressing percentage change in Wholesale Sales on Bankrun indicator variable and county characteristics

Dependent Variable: Pct. change in Wholesale sales 1929-1933		
Constant	-.327**	-.677**
	(.0167)	(.22)
Bankrun	-.1018**	-.079**
	(.0167)	(.0237)
Pct. urban population		-.319**
		(.06)
Pct. farm land		-.3488**
		(.0606)
Pct. black population		-.0199
		(.105)
Pct. Unemp		-2.58
		(1.9)
Log(Deposits per Wholesaler)		.124**
		(.014)
State Fixed Effects		Yes
Fed District Fixed Effects		Yes
Observations	2585	2583

**represents significant at the five percent level

Table 3.5: Regressing the probability of a Bank run occurring between 1930 and 1933 on 1930 County characteristics using a Probit model

Dependent Variable: Pr(Bank run=1)	
Pct. urban population	.967**
	(.155)
Pct. farm land	.82**
	(.151)
Pct. black population	.326
	(.257)
Pct. Unemp	9.56**
	(4.89)
Log(Deposits per Wholesaler)	.098*
	(.037)
State Fixed Effects	Yes
Fed District Fixed Effects	Yes
Observations	2567

**denotes significant at 5% level

Table 3.6: Propensity Score Matching Estimates

Propensity Score Estimates	**Mean Diff**	**1 Nearest neighbor with common support**	**Radius Matching (threshold=.001)**	**Radius Matching (threshold=.0001)**	**Kernel Estimation(Bandwidth=.2)**
Pct. Change in Wholesale Sales 1929-1933	-.101** (.022)	-.097** (.046)	-.095** (.032)	-.091* (.05)	-.083** (.025)
# of Matches		1405	1140	300	1405

*denotes significant at the ten percent level, ** denotes significant at 5% level

Table 3.7: OLS Estimates, Regressing percentage change in wholesale sales on declines in deposits from 1929 to 1933 due to various reasons for failure

Dependent Variable: Pct. change in Wholesale sales 1929-1933					
Constant	-.299**	-.295**	.054	.0705	.0321
	(.021)	(.02)	(.039)	(.186)	(.19)
Pct. change in deposits in Open Banks net failed deposits	.149**	.1556**	.1737**	.183**	.183**
	(.037)	(.037)	(.036)	(.037)	(.037)
Pct. decline in deposits due to Assets, primary	-.0715	-.066	.014	-.044	-.031
	(.106)	(.103)	(.10)	(.106)	(.106)
Pct. decline in deposits due to Assets, primary, Withdrawals, contributing	-.256**	-.254**	-.288**	-.301**	-.311**
	(.105)	(.101)	(.099)	(.102)	(.101)
Pct. decline in deposits due to Assets, contributing, Withdrawals, primary	-.1309	-.1268	-.177	-.116	-.111
	(.1302)	(.1265)	(.123)	(.125)	(.125)
Pct. decline in deposits due to Assets, primary, Withdrawals, primary	-.5766**	-.5712**	-.4615**	-.346*	-.347*
	(.194)	(.188)	(.1819)	(.181)	(.182)
Pct. decline in deposits due to Withdrawals, primary	-.166	-.155	-.057	-.181	-.173
	(.177)	(.172)	(.166)	(.166)	(.167)
Pct. decline in deposits due to Correspondent bank failing		-.0973	-.249*	-.379**	-.377**
		(.147)	(.143)	(.151)	(.151)
Pct. decline in deposits due to Defalcation		-.5412	-.547	-.466	-.462
		(.615)	(.5948)	(.58)	(.581)
Pct. decline in deposits due to Other		-.318*	-.2758**	-.255**	-.256**
		(.106)	(.103)	(.103)	(.104)
Pct. urban population			-.14**	-.269**	-.268**
			(.043)	(.045)	(.0455)
Pct. farm land			-.4387**	-.341**	-.315**
			(.0409)	(.05)	(.057)
Pct. black population			-.2716**	-.072	-.047
			(.0627)	(.10)	(.101)
State Fixed Effects				Yes	Yes
Fed District Fixed Effects					Yes
Observations	2623	2622	2558	2558	2558

*denotes significant at the ten percent level, ** denotes significant at the five percent level

Table 3.8: OLS Estimates, Regressing percentage change in Wholesale Sales on decline in deposits for open banks, banks failing during panic periods, and banks failing during non-panic periods

Dependent Variable: Pct. change in Wholesale sales 1929-1933					
Constant	-.313** (.0211)	-.313** (.0211)	.059 (.0412)	.0735 (.193)	.037 (.206)
Pct. change in Deposits in Open Banks net failed deposits	.1303** (.0384)	.137** (.0388)	0.166** (.0384)	0.172** (.039)	.172** (.039)
Pct. decline in deposits from 1929 to 1933 due to panic period	-.20** (.055)	-.206** (.055)	-.190** (.054)	-0.245** (.056)	-.243** (.06)
Pct. decline in deposits from 1929 to 1933 due to non-panic period	-.108 (.074)	- .1204** (.074)	-.139** (.073)	-.128* (.073)	-.13* (.07)
Pct. urban population		-.0562	-.139** (.044)	-.261** (.0469)	-.26** (.047)
Pct. farm land			-.449** (.041)	-.361** (.057)	-.338** (.059)
Pct. black population			-.277** (.0648)	-.101 (.103)	-.079 (.105)
State Fixed Effects	No	No	No	Yes	Yes
Fed District Fixed Effects					Yes
Observations	2559	2559	2559		2559

*denotes significant at the ten percent level, **Significant at the five percent level

References

Aiyar, Shekhar, Calomiris, Charles W., and Wieladek, Tomasz (2014). Does Macro-Prudential Regulation Leak? Evidence from a UK Policy Experiment. *Journal of Money, Credit, and Banking*, 46(1),181-214.

Allen, Franklin, Carletti, Elena, and Marquez, Robert (2009). Credit Market Competition and Capital Regulation. *The Review of Financial Studies*, 24(4), 983-1018.

Ashcraft, Adam (2005). Are banks really special? New evidence from the FDIC-induced failure of healthy banks. *American Economic Review*, 95(5), 1712-1730.

Barnett, George (1910). *State Banks and Trust Companies since the Passage of the National-Bank Act*. Washington, D.C.: U.S. Government Printing Office.

Barnett, George (1911). Recent Tendencies in the State Banking Regulation. *Proceedings of the Academy of Political Science in the City of New York*, 1(2), 270-284.

Berger, Allen and Bouwman, Christa (2013). How does capital affect bank performance during financial crises. *Journal of Financial Economics,* 109(1), 146-176.

Bernanke, Ben (1983).Nonmonetary effects of the financial crisis in the propagation of the Great Depression. *American Economic Review*, 73(3), 257-276.

Calomiris, Charles W. and Haber, Stephen (2014). *Fragile By Design.* Princeton, New Jersey: Princeton University Press.

Calomiris, Charles W., and Mason, Joseph R. (2003). Consequences of Bank Distress During the Great Depression. *American Economic Review*, 93(3), 937-947.

Calomiris, Charles W., and Mason Joseph R. (2003). Fundamentals, panics, and bank distress during the Depression. *American Economic Review*, 93(5), 1615-1647.

Calomiris, Charles W., and Powell, Andrew (2001). Can emerging market bank regulators establish creditor discipline? The case of Argentine 1992-1999. Prudent Supervision: what works and what doesn't. In F. S. Mishkin (Ed.), *Prudential Supervision: What Works and What Doesn't* (pp. 147-196). Chicago, IL: University of Chicago Press.

Calonico, Sebastion, Cattaneo, Matias D., and Titiunik, Rocio (2014). Robust Nonparametric Confidence Intervals for Regression-Discontiniuty Designs. *Econometrica*, 82(6), 2295-2326.

Census Office (1910). *Thirteenth Census of the United States Taken in the Year 1910, vol. 2 and 3*. Washington, D.C.: US Government Printing Office.

Chung, Ching-Yi and Gary Richardson (2007). Deposit Insurance Altered the Composition of Bank Suspensions during the 1920s: Evidence from the Archives of the Board of Governors. *The B.E. Journal of Economic Analysis & Policy*, 5(1).

Cole, H. and L. Ohanian (1999). The Great Depression in the United States from a Neoclassical Perspective. *Federal Reserve Bank of Minneapolis Quarterly Review*, 23, 1-24.

Comptroller of the Currency (2016). Various issues. *Annual Report*. Washington, D.C.: United States Government Printing Office.

Dehejia, Rajeev and Wahba, Sadeck (1999). Causal Effects in Nonexperimental Studies: Reevaluating the Evaluation of Training Programs. *Journal of the American Statistical Association*, 94(448), 1053-1062.

Dewatripont, Mathias, Tirole, Jean (1994). *The Prudential Regulation of Banks*, Cambridge, MA: MIT Press.

Diamond, Doug W., and Raghuram, Rajan G (2000). A Theory of Bank Capital. *The Journal of Finance*, 55(6), 2431-2465.

Diamond, Doug W., and Raghuram, Rajan G (2001). Liquidity Risk, Liquidity Creation, and Financial Fragility: A Theory of Banking. *Journal of Political Economy*, 109(2), 287-327.

Federal Deposit Insurance Corportation and Intra-university Consortium for Political and Social Research (1984). *Federal Deposit Insurance Corporation Data on Banks in the United States, 1920-1936*. Intra-university Consortium for Political and Social Research Study #00007. Ann Arbor, MI: University of Michigan and Intra-university Consortium for Political and Social Research [distributor], 2016-5-25. Available at: https://doi.org/10.3886/ICPSR00007.v1

Frandsen, Brigham, Froelich, Markus, and Melly, Blaise (2012). Quantile Treatment Effects in the Regression Discontinuity Design, *Journal of Econometrics*, 168(2), 382-395.

Friedman, Milton and Schwartz, Anna J (1963). *A monetary history of the United States, 1867–1960*. Princeton, NJ: Princeton University Press.

Fulford, Scott (2015). How important are banks for development? National banks in the United States 1870-1900?. *Review of Economics and Statistics*, 97(5), 921-938.

Gropp, Rein, Mosk, Thomas, Ongena, Steven, and Wix, Carlo (2016). Bank Response to Higher Capital Requirements: Evidence from a Natural Experiment. Working Paper available at: http://dx.doi.org/10.2139/ssrn.2877771

Hahn, Jinyong, Todd Petra, and Van der Klaauw, Todd (2001). Identification and Estimation of Treatment Effects with a Regression-Discontinuity Design *Econometrica*, 69(1), 201-209.

Haines, Michael R., and Intra-university Consortium for Political and Social Research (1984). *Historical, Demographic, Economic, and Social Data: The United States, 1790-1970. Intra-university Consortium for Political and Social Research Study #00003*. Ann Arbor, MI: University of Michigan and Intra-university Consortium for Political and Social Research [distributor], 2016-05-25. Available at: http://doi.org/10.3886/ICPSR02896.v3

Hohlmstrom, Bengt, and Tirole, Jean(1997). Financial Intermediation, Loanable Funds, and the Real Sector. *The Quarterly Journal of Economics*, 112(3), 663-691.

James, John A. (1976). Banking Market Structure, Risk, and the Pattern of Local Interest Rates in the United States, 1893-1911. *The Review of Economics and Statistics*, 58(4), 453–462.

Keehn, Richard H (1974). "Federal Bank Policy, Bank market Structure and Bank Performance: Wisconsin, 1863-1914." *Business History Review*, 48(1), 1-27.

——— (1972). "Market Structure and Bank Performance: Wisconsin 1870-1900." Phd. Dissertation, University of Wisconsin.

Lee, Davison, and Ramirez, Carlos (2014). Local Banking Panics of the 1920s: Identification and Determinants. *Journal of Monetary Economics*, 66, 164-177.

Lee, David S., and Lemieux, Thomas (2010). "Regression Discontinuity Designs in Economics." *Journal of Economic Literature* 48(2), 281-355.

McCrary, Justin (2008). Manipulation of the Running Variable in the Regression Discontinuity Design: A Density Test. *Journal of Econometrics*, 142(2), 698-714.

Mishkin, Frederic S. (1997). The Causes and Propagation of Financial Instability: Lessons for Policymakers. Kansas City Federal Reserve Symposium: Maintaining Financial Stability in a Global Economy, 55-96.

Mitchener, Kris James (2005). "Bank Supervision, Regulation, and Instability during the Great Depression." *The Journal of Economic History*. 65(1), 152-185.

Mldjan, Mrjdan (2016). "Accelerating into the abyss: Financial dependence and the Great Depression." Unpublished, 2016 Available at: http://dx.doi.org/10.2139/ssrn.2366291

Morrison, Alan D., and White, Lucy (2005). Crises and Capital Requirements in Banking. *The American Economic Review*, 95(5), 1548-1572.

Pierson Doti, Lynne (1978). *Banking in California: Some Evidence on Structure 1878-1905* (Doctoral dissertation). Dissertation Abstracts International 39. Riverside, CA: University of California.

——— (1995). "*Banking in an unregulated Environment California, 1878-1905* New York & London: Garland Publishing.

Pierson Doti, Lynne, and Schweikart, Larry (1991). *Banking in the American West: From the Gold Rush to Deregulation*. Norman, OK and London: University of Oklahoma Press.

Reinhart, Carmen M. and Rogoff, Kenneth, S (2009). "The Aftermath of Financial Crises" *American Economic Review*, 99(2), 466-72.

Richardson, Gary (2008). Quarterly Data on the Categories and Causes of Bank Distress during the Great Depression. *Research in Economic History*, 25, 37-115.

———(2007).Categories and Causes of Bank Distress during the Great Depression, 1929-1933: The Illiquidity-Insolvency Debate Revisited. *Explorations in Economic History*, 44(4), 586-607.

———(2007).The Check is in the Mail: Correspondent Clearing and the Banking Panics of the Great Depression. *Journal of Economic History*, 67(3), 643-671.

———(2006). The Records of the Federal Reserve Board of Governors in the National Archives of the United States. *Financial History Review*, 13(1), 123-134.

Richardson, Gary and Troost, William (2009). Monetary Intervention Mitigated Banking Panics During the Great Depression: Quasi-Experimental Evidence from the Federal Reserve District Border in Mississippi, 1929 to 1933. *Journal of Political Economy*, 117(6), 1031-1073.

Rime, Bertrand (2004). Capital requirements and bank behavior: Empirical evidence for Switzerland. *Journal of Banking & Finance*, 25(4), 789-805.

Rochet, Jean-Charles (1992). "Capital requirements and the behavior of commercial banks" *European Economic Review*, 36(5), 1137-1178.

Smith, Jeffrey A. and Todd, Petra E. (2005). Does matching overcome Lalonde's critique of nonexperimental estimators? *Journal of Econometrics*, 125(1-2), 305-353.

Aldrich, Nelson W. (1910). *Suggested Changes in the Administrative Features of the National Banking Laws, National Monetary Commission*, Washington, D.C.: United States Government Printing Office.

Sylla, Richard (1969). "Federal Policy, Banking Market Structure, and Capital Mobilization in the United States, 1863-1913."*The Journal of Economic History*, 29, 657-686.

Thakor, Anjan V. (2014). “Bank Capital and Financial Stability: An Economic Trade-Off or a Faustian Bargain?” *Annual Review of Financial Economics*, 6, 185-223.

United States, Department of Commerce, Bureau of the Census (1935). *Census of American Business: 1933. Wholesale Distribution, Volume 1, Summary for the United States*. Washington, D.C.: Government Printing Office.

Welldone, Samuel A. (1909). *Digest of Banking Statutes*. Washington, D.C.:U.S. Government Printing Office.

Wheelock, David C. (1993). Government Policy and Banking Market Structure in the 1920s. *The Journal of Economic History*, 53(4), 857-879.

Wicker, Elmus (2000). *Banking Panics of the Gilded Age*. Princeton, New Jersey: Princeton University Press.

White, Eugene N. (1983). *The Regulation and Reform of the American Banking System, 1900-1929*. Princeton, NJ: Princeton University Press.

White, Eugene N. (2011). "To Establish a More Effective Supervision of Banking": How the Birth of the Fed Altered Bank Supervision. NBER Working Paper w16825 Available at: http://www.nber.org/papers/w16825

Ziebarth, Nicolas L. (2013). Identifying the effects of bank failures from a natural experiment in Mississippi during the Great Depression. *American Economic Journal: Macroeconomics* 5(1), 81-101.

Appendix Chapter 3

Illustration of Decomposition of Suspended Deposits:

$$PctChangeDeposits_{1933-1929} = \frac{Deposits_{1933} - Deposits_{1929}}{Deposits_{1929}} \quad (1)$$

$$= \frac{Deposits_{1933} - Deposits_{1929} - (FailedDepositsAssets_{1929} - FailedDepositsWithdrawals_{1929})}{Deposits_{1929}}$$

$$+ \frac{FailedDepositsAssets_{1929}}{Deposits_{1929}} + \frac{FailedDepositsWithdrawals_{1929}}{Deposits_{1929}} \quad (2)$$

Equation 1 illustrates a formula showing how the percentage change in deposits from 1929 to 1933 is calculated. In this study, I decompose the percentage change in deposits into different components. Equation 2 illustrates an example of a basic decomposition of the percentage change in deposits from 1929 to 1933. The first term is the percentage change in deposits net of failed deposits and represents the percentage change of deposits for banks still in operation in the year 1933. The second term represents the percentage of failed deposits due to asset reasons. The third term represents the percentage of failed deposits due to withdrawal reasons.