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

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Abstract

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. The discontinuity arose because federal law raised capital requirements on banks operating in towns whose populations exceeded certain thresholds. These thresholds enable me to estimate the impact of capital requirements on the choices and outcomes of similar banks operating in similar towns under different regulatory regimes. I find that banks subject to higher capital requirements did hold more capital, but also increased their lending proportionately, so that their leverage and risk of failure remained roughly unchanged. Ultimately, capital requirements did not result in lower suspension rates or enhance financial stability.

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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 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

[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)

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 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 regulations from having their intended effect.[3] In addition, this study helps to explain the

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[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).

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

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[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).

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 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

[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).

debate about the optimal level of capital banks should hold and whether banks were holding enough capital during the national bank era.

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 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 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 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

[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.

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:

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

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:

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

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

[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

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 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 20th 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].

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[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

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 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.

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 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

[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

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 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 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, 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 5 displays a graph constructed using a subset of data to construct figure 4: banks with capital in the bottom 20th percentile of the capital distribution above and below the population threshold of 3,000. This

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

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.

Figure 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 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 7 suggests capital requirements affect banks in the lower 20th percentile of the capital distribution. In addition, figure 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 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

[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

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 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 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% 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 10A and 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.

[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.

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

Table 5 provides results on bank leverage and suspension rates for the full sample and for a subsample of banks below and above the 20^{th} percentile of the capital distribution. Not surprisingly, I do not find significant coefficients on leverage. For banks above the 20^{th} percentile, capital requirements do not have an impact on their leverage since they are not affected by the regulation. For banks below the 20^{th} 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 11A and 11B show that these results are robust to bandwidths between ±500 and ±1500. There is no evidence of capital requirements reducing bank leverage.

Although banks do not experience a change in their leverage, holding more capital could decrease a bank’s suspension rate. Larger banks, in terms of capital, have a larger buffer for economic shocks and may experience lower suspension rates. 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 and lowering suspension rates. Figure 11C and 11D illustrate that these results are robust to various bandwidths.

The results reported in table 6 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 7 reports that banks operating close to 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 20th century. The United States financial system consists of thousands of small and geographically isolated banks during this time period.

[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.

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 20th century did not prevent banks from engaging in excessive risk-taking and or enhance financial stability.

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Table 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 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 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 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 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:	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 6: 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 7: Estimated effect of capital requirements on bank capital, assets, leverage, and suspension rates, 6,000 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

Figure 1: Bank capital across town populations, 1905

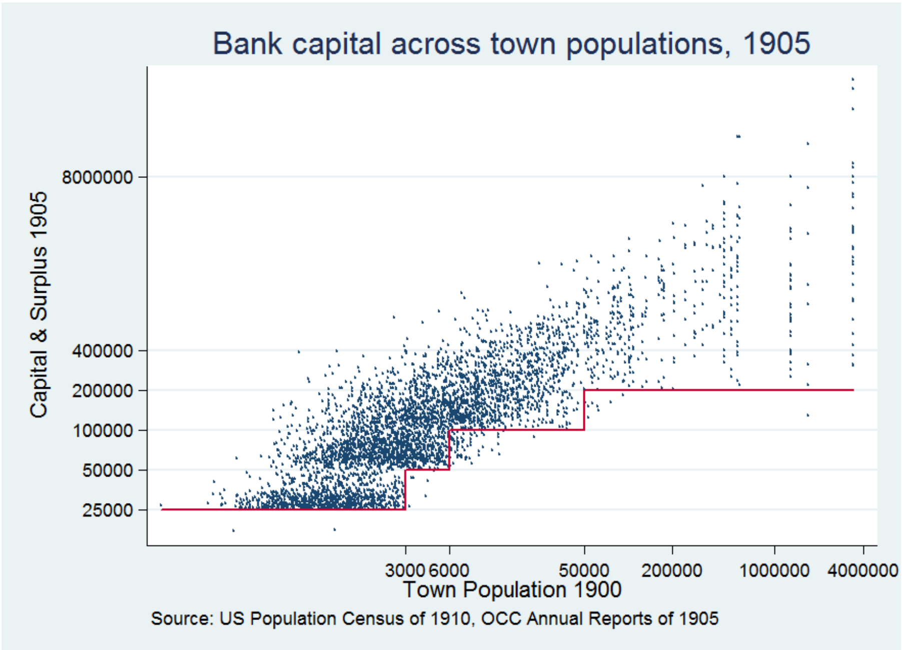

Figure 2: Empirical density of national banks operating in towns, sorted by town population, 1905

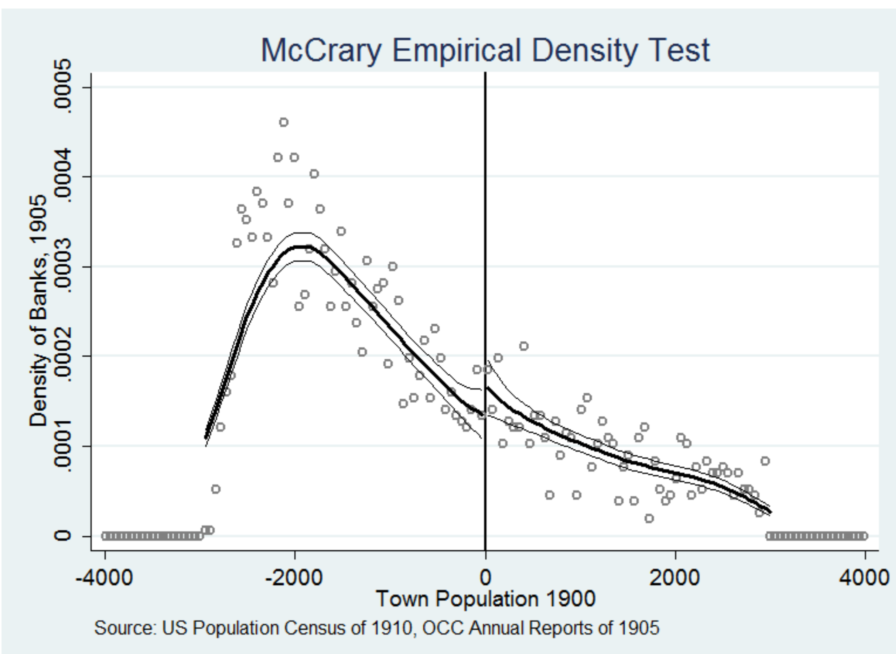

Figure 3: Binned local averages of county and bank characteristics, town population<6000, 1905

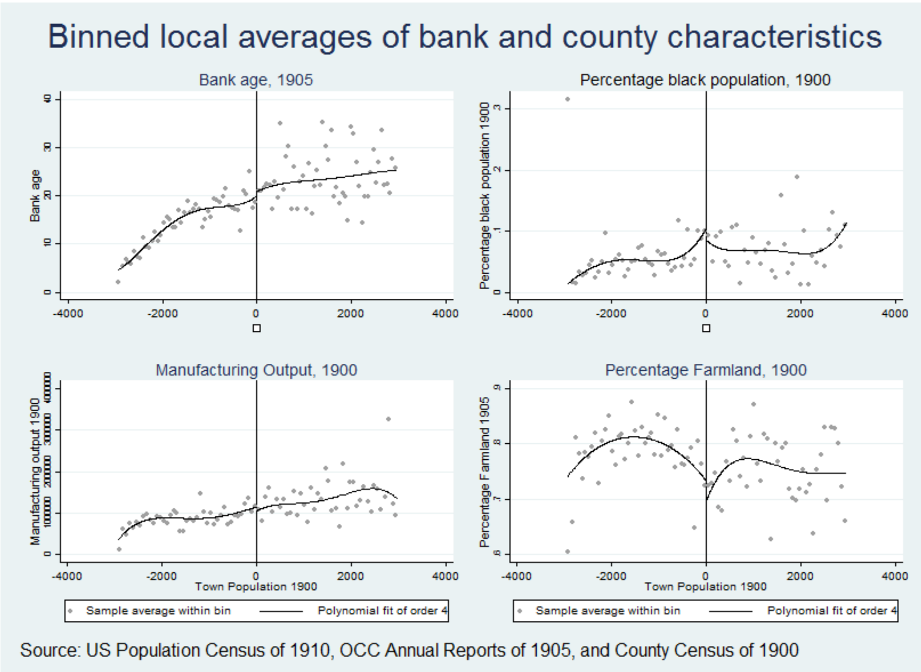

Figure 4: Bank capital across town populations, 1905, town population<6000

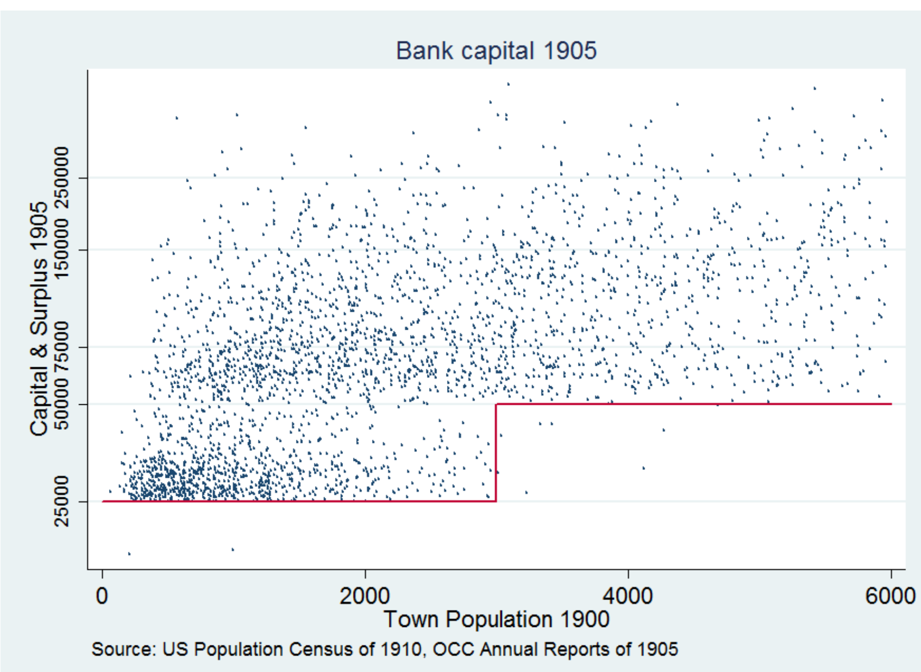

Figure 5: Binned, local averages of capital & surplus, 1905

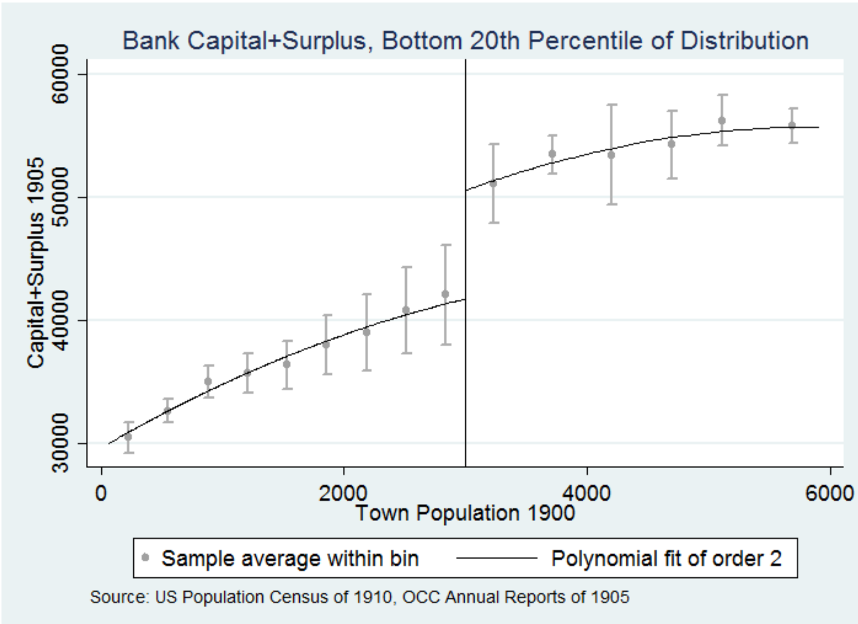

Figure 6: Binned, local averages of bank leverage, 1905

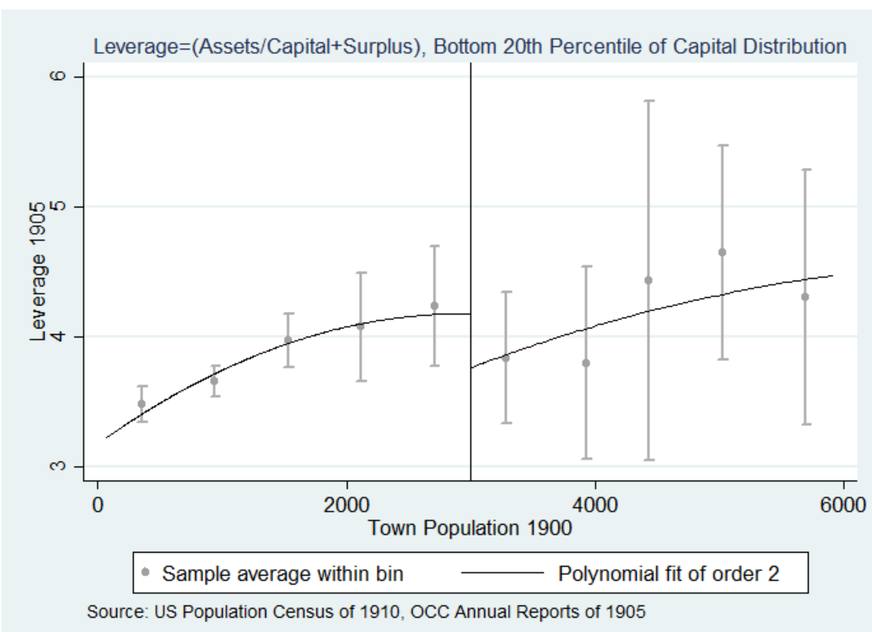

Figure 7: Cumulative Distribution of Capital & Surplus for banks below and population the population threshold of 3,000, 1905

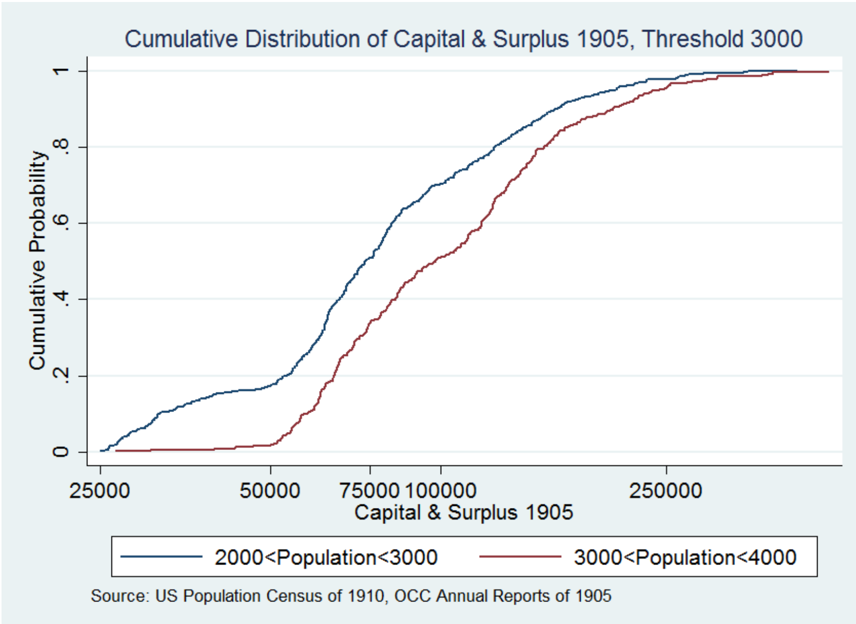

Figure 8: Predicted probabilities of banks meeting the $50,000 capital requirements at the population threshold of 3,000, 1905

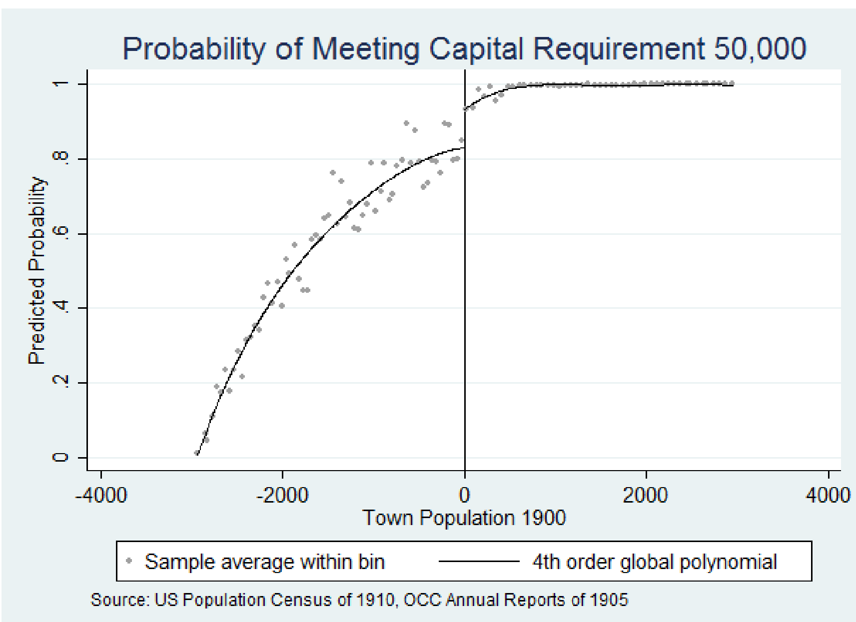

Figure 9: Estimated local quantile treatment effects of capital requirements on capital for a bandwidth of 1,000, 1905

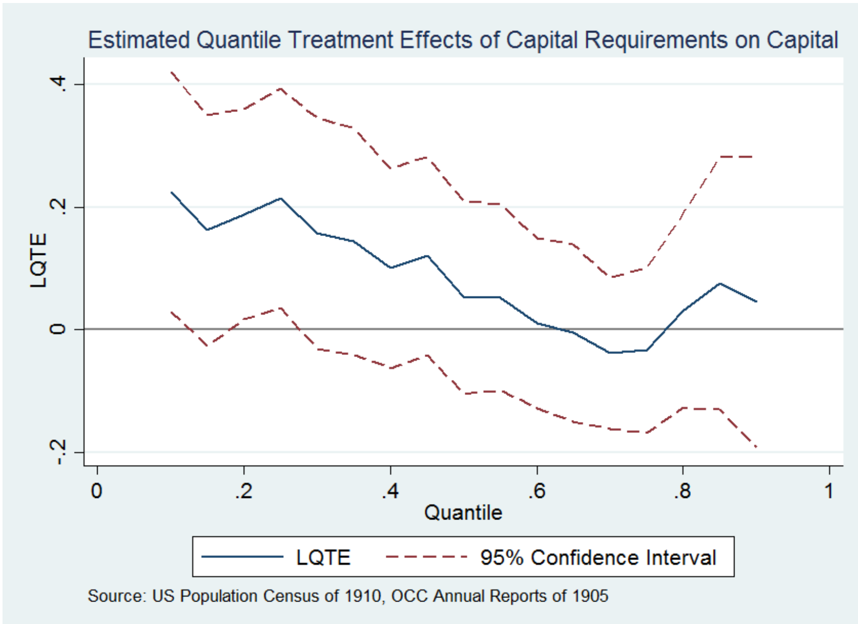

Figure 10: Estimated effect of capital requirements on capital and assets for bandwidths between ±500 and ±1500; full sample and subsample of banks with capital below 20th percentile of capital distribution

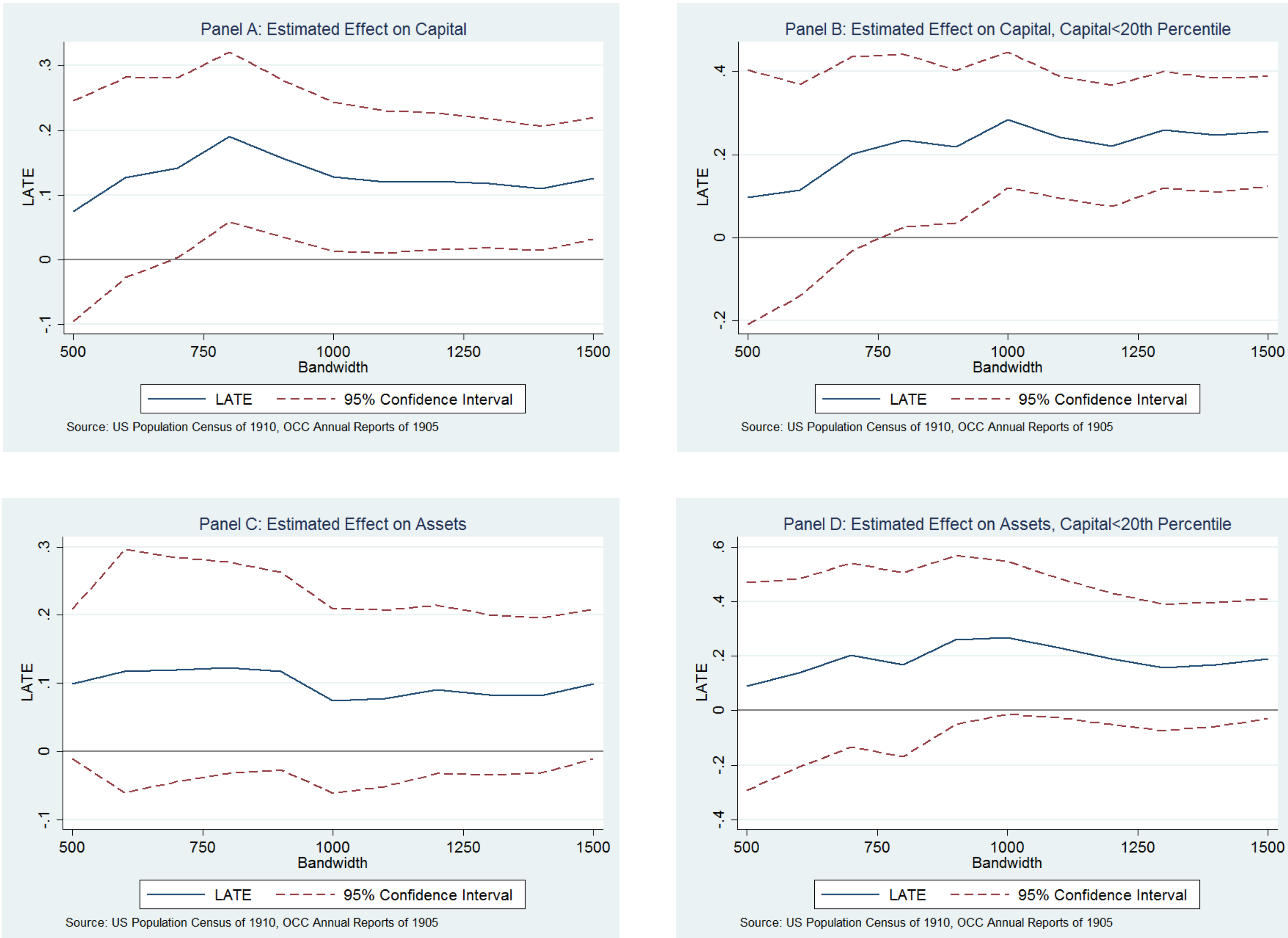

Figure 11: Estimated effect of capital requirements on leverage and suspension rates for bandwidths between ±500 and ±1500; full sample and subsample of banks with capital below 20th percentile of capital distribution