THE EFFECTS OF POST-FINANCIAL CRISIS BANKING REGULATIONS ON BANK LENDING AND REGIONAL ECONOMIC GROWTH

by

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ABSTRACT

RACHEL M. SCHORNO. The effects of post-financial crisis banking regulations on bank lending and regional economic growth (Under the direction of DR. ISABELLE NILSSON AND DR. ARTHUR ZILLANTE)

Following the financial crisis, regulations were implemented by the Board of Governors of the Federal Reserve System to monitor banks and reduce the probability of future banking crises. This dissertation uses bank and macroeconomic data to analyze the effectiveness of these regulations on bank lending and household leverage. It also provides an analysis of related regional economic growth, and the potential public policy implications. The spatial effects of the crisis and recession are analyzed at the metropolitan statistical area level, as areas of the country were affected differently regarding employment and firm growth following the recession. The main goal of this dissertation is to conclude whether the regulations implemented post-crisis have had a positive effect on bank lending and on firm and employment growth, and whether there have been differences in economic outcomes across the regions of the United States.

The second chapter examines the impact of capital ratios on bank lending. The results suggest that increased capital ratios are only beneficial in times of economic distress. The third chapter looks at consumer bank deposits in relation to household leverage in the periods surrounding the crisis. The results indicate that household leverage decreased prior to the implementation of regulations, suggesting that the

regulations were less beneficial than expected in decreasing household leverage. The fourth chapter analyzes employment and firm growth relative to commercial real estate loan growth. The results suggest that both employment growth and firm growth were stronger post-regulation, and that different types of regions experienced different levels of growth. Overall, results show that post-crisis banking regulations are less effective than intended.

DEDICATION

This dissertation is dedicated to my parents, Hollis and Edmond, and my brother, Patrick, who have always been there for me.

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CHAPTER 1: INTRODUCTION

Economists and policymakers were not fully prepared for the Financial Crisis of 2007-08,[1] and the result was an extended recession that required government intervention and a change in the way banks were monitored by the government (Bernanke, 2018). New federal regulations were necessary to mandate stricter bank monitoring and lower the probability of future crises. The goals of the financial regulations were to stabilize the financial system and the economy, and to increase the transparency of bank activities (Kroszner & Strahan, 2011).

After the financial crisis, several regulations were put into place to monitor the bank holding companies (BHCs) in the United States, to be supervised by the Board of Governors of the Federal Reserve System (the Federal Reserve hereafter). One such regulation is the Dodd-Frank Wall Street Reform and Consumer Protection Act (to be referred to as Dodd-Frank or the Dodd-Frank Act hereafter), which was enacted in 2010 (U.S. Congress, 2010). Dodd-Frank was intended to ensure that the banks maintained an adequate level of capital to withstand another crisis-level adverse economic event. This was perceived by some as beneficial to consumers, as its implementation meant there was a lower risk of bank failures and lower risk of another recession of the magnitude of the Great Recession.

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[1] The Financial Crisis period is widely considered to extend from 2007-2008, with the Great Recession officially ending in 2009 (Bullard et al., 2009).

However, the question remains as to whether the regulations benefit individual consumers, the United States, and the world economy. This dissertation examines several aspects of banking that were affected by the Dodd-Frank Act and analyzes the impact of the regulations on bank lending and household leverage, as well as related regional economic growth in the United States, adding to the literature on the financial crisis, banking regulations, and economic consequences associated with both. The current literature on the financial crisis focuses on the causes of the crisis, and much of the literature uses pre-crisis and crisis period data. This research study adds to the literature by investigating the crisis from a different perspective, by including financial policy implications, and using data inclusive of the post-Dodd-Frank era in bank regulation, which has been largely overlooked by previous studies.

The Dodd-Frank Act is composed of multiple pieces of regulation, and the Federal Reserve is responsible for monitoring several aspects of the regulation (Board of Governors of the Federal Reserve System, 2010). The specific parts of the regulation that are of interest for this dissertation are the capital ratio requirements, bank stress tests and the changing atmosphere around the stress test requirements, and finally the impacts of these two pieces of regulation on bank lending and regional economic growth. The Federal Reserve mandates that banks maintain capital sufficient to withstand an adverse economic event.[2] This regulation is of interest, as it is expected that when banks are required to maintain a higher level of capital than they otherwise would hold, they would

[2] Specifically, a minimum of 4% Tier 1 capital ratio and 8% Total capital ratio (Moody's, 2011).

reduce lending as they would have less money available to lend. However, prior research indicates that this is not the case (Berrospide & Edge, 2010; Carlson et al., 2013). This analysis extends the literature by including post-regulation data and examining the impacts the regulations had on bank capital and on lending growth in and beyond the recovery period of the Great Recession.

Moreover, the requirement for certain banks to comply with annual stress testing is of interest, as this aspect of the bank regulation impacts the level of assets that banks can hold before they are subject to the stress tests. It is suspected that this affects economic growth in regions where many smaller banks are located, particularly if these banks are at or near the asset threshold. The Dodd-Frank Act currently requires banks with over $100 billion[3] in total consolidated assets to undergo annual stress tests including the Dodd Frank Act Stress Test (DFAST) and the Comprehensive Capital Analysis and Review (CCAR) (Board of Governors of the Federal Reserve System, 2019). Although a stress test failure does not equate to a bank failure, it does mean that the bank must raise capital or attempt to get aid from the government (Hill, 2010). Stress test failure may result in other negative consequences for banks: Citigroup fired their CEO after failing the 2012 stress test, and Citigroup stockholders lost 6% in stock value and received limited dividend payouts after a second failure in 2013 (Cornett et al., 2018). Thus, banks that can avoid participating in the stress tests may alter their behaviors to stay below the asset threshold.

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[3] This was changed from the requirement that banks with over $50 billion in assets be subject to the stress tests from 2011 through 2018 (Board of Governors of the Federal Reserve System, 2019).

The stress tests and capital ratio requirements are designed to verify that banks have sufficient capital to withstand potential adverse economic situations, hence a stress test failure or insufficient capital ratio indicates to the public that the bank might not have the ability to withstand a potential crisis event (U.S. Congress, 2010). However, these regulations have been a source of contention between individuals and private entities; monitoring bank capital via regulations has the power to increase bank efficiency, but regulations could be used to promote private interests, including certain banks using political pressure for their own interests (Barth et al., 2013).

Further, after Dodd-Frank was implemented, some researchers argued that the final version of the Act was not effective in preventing the existence of "too-big-to-fail" banks or systemically important institutions (Gao et al., 2018). It has also been shown that the Dodd-Frank asset threshold for participating in the stress tests has prompted some banks below, but near, the threshold to alter their loan and asset growth behavior; this behavior is likely altered to avoid incurring the costs imposed by exceeding the threshold and being subject to Federal Reserve stress testing (Bouwman et al., 2018). Since the implementation of Dodd-Frank, it is unclear whether the regulations have worked overall to reduce risky bank ventures, promote transparency, and prevent adverse economic conditions.

The requirements for banks to follow regulations and participate in the stress tests have changed since the implementation of Dodd-Frank in 2010. Prior to 2018, banks maintaining assets greater than $50 billion were under regulation (Board of Governors of

the Federal Reserve System, 2009).[4] As of 2018, the Federal Reserve raised the asset threshold level at which a bank is required to participate in the stress tests to $100 billion in total consolidated assets. However, only banks with over $250 billion in total assets are subject to Federal Reserve CCAR stress tests for 2019 (Rappeport, 2018).[5] In 2019, the Federal Reserve determined that banks would no longer receive a grade of pass or fail on a portion of the exams that measure the lending ability of a bank in the event of a potential crisis or economic downturn. The Federal Reserve will still pass or fail banks on their ability to maintain enough capital to keep functioning during a financial crisis situation (Rappeport & Flitter, 2019). There were also several non-bank financial institutions once considered systemically important that the Federal Reserve would have considered "too-big-to-fail." Under the updated regulations, those institutions can no longer be labeled under that classification, e.g., MetLife and American International Group (AIG) (Rappeport & Flitter, 2019). This changing environment may increase risk-taking and lower the capital ratios of the banks that are now under a different level of scrutiny from the Federal Reserve, leading to potential serious problems, particularly if an adverse economic situation occurs in the future.

Banks with between $50 and $250 billion in assets may benefit from the raised asset threshold of the federal regulations by no longer being required to participate in Federal Reserve CCAR stress tests. However, there may still be a negative impact on the

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[4] Lowered from $100 billion after the first stress test, the Supervisory Capital Assessment Program in 2009 (see Board of Governors of the Federal Reserve System (2009)).

[5] Future years are not yet decided; potentially, banks with between $100 and $250 billion in assets will be put on an extended cycle for stress testing (Patel, 2019).

economy. The systemic risks taken by the banks not under stress testing regulations are, on average, greater than the risks taken by the banks that are stress tested (Acharya et al., 2018). The risk-taking of small banks affected their ability to withstand the crisis as well, indicating that the riskier the investments, the more likely they were to fail (DeYoung & Torna, 2013). While most bank failures no longer cause a loss of consumer deposits due to backing by the Federal Deposit Insurance Corporation (FDIC), 489 FDIC insured banks failed during the crisis; this cost nearly $73 billion to the Deposit Insurance fund (Federal Deposit Insurance Corporation (FDIC), 2017). However, not all banks in the United States are FDIC insured. A bank failure of an uninsured bank would mean the loss of most, if not all, of the consumer deposits held by the bank. Still, uninsured banks have lower failure rates as a result of the moral hazard of government insurance (Wheelock & Wilson, 1995), so this may have been less of a concern for consumers during the crisis.

Additionally, there is concern regarding the effect of the regulations on economic growth in different regions of the United States as a result of the change in lending growth post-crisis. A strong financial system can stimulate economic growth (King & Levine, 1993), whereas the banking regulations could lead to a more constrained financial system that brings about slower economic growth and negatively affects employment (Beck et al., 2010). Existing literature examining the crisis and recession has found that higher capital in banks is associated with stronger bank lending growth, but that relationship is predicated on the banks being better capitalized to begin with, so the growth is likely to be unevenly distributed throughout banks and regions (Gambacorta & Shin, 2018). Studies have found that the growth in household leverage (i.e., household

debt relative to income) was a strong predictor of the severity of the recession (Mian & Sufi, 2010), and that the losses in the recession were distributed unequally throughout the United States (Mian et al., 2013). Research investigating bank lending finds that lending growth declined during the crisis, particularly new loans to corporations (Ivashina & Scharfstein, 2010), and that a decline in lending led to decreased local economic activity (Huber, 2018).

While the regulations may benefit individuals and the economy overall, related questions are whether and how the regulations affect regional economic growth. As seen in the existing literature, there are clear relationships between lending growth and economic growth. However, the existing literature focuses more on the crisis and recession, mostly analyzing data from that period. In this dissertation, the post-crisis period is examined, analyzing the effects of the Dodd-Frank Act in changing the behavior of banks and their lending growth as a result. The impact that banking regulations have had on the economic environment in the United States is also examined, along with the way the impact varies regionally. In light of the existing research and with the intention to add to the financial crisis literature, this dissertation will aim to address the following research questions:

1. What is the impact of bank capital ratios on overall bank lending growth post-crisis?
2. What is the relationship between bank deposits and household leverage during the crisis period and post-regulatory period?

3. What are the impacts of post-crisis banking regulations on regional economic growth?

To address these research questions, this dissertation uses three related analyses, divided into separate chapters. Following the introduction, Chapter 2 focuses on the requirement for banks to maintain a certain level of capital, as determined by capital ratios and monitored by the Federal Reserve. To estimate the impact of bank capital ratios on bank lending, regressions on the capital ratio effect on bank lending growth are performed using data from bank Call Reports and economic data from the Federal Reserve. The results suggest that an increase in bank capital ratios leads to an increase in bank loan growth in the crisis and post-regulatory period. The years pre-crisis had no statistically significant change in loan growth. Further analysis uses propensity score matching and a regression discontinuity model to answer whether the changes in loan growth were consistent for banks on either side of the Dodd-Frank Act asset threshold for stress tests. Results indicate that banks under Federal Reserve monitoring via CCAR stress tests had lower loan growth than those not required to undergo stress testing, which suggests that Dodd-Frank was restraining bank loan growth further than the regulators may have intended post-crisis.

In Chapter 3, the effect of the Dodd-Frank Act on household leverage is examined using regression analysis with bank-level MSA fixed effects to assess the impact of changing bank deposits on the change in household leverage (using the debt-to-income ratio as proxy), using bank Call Reports and FDIC Summary of Deposits data. The results suggest that an increase in deposits statistically significantly impacted household leverage

positively in the years prior to the crisis and negatively impacted household leverage in the years during and after the crisis. This indicates that the change in bank deposits over time are useful as a potential indicator for economic distress. Further analysis looks deeper into the change in the level of deposits, the effects based on population growth in different MSAs, and a multilevel model looks at the effects within banks and within MSAs over time. Results suggest that Dodd-Frank had little to no impact on the changing household leverage post-crisis.

Chapter 4 looks at the effect of bank regulations on the regional growth of firms and employment over time. This study is performed using regression analysis, with loan commitments as an instrumental variable, to estimate the effect of commercial real estate (CRE) loans from banks on employment and firm growth at the metropolitan level in the periods related to the crisis and regulations, using bank Call Report data and employment data from the Bureau of Labor Statistics (BLS). Results suggest that growth in CRE loans year-over-year leads to a statistically significant increase in both firm and employment growth, with positive firm and employment growth seen after the implementation of Dodd-Frank Act regulations. Further analysis looks at regions using cluster analysis to determine more clearly where and how loan growth is impacting employment growth and firm creation. Results suggest that types of regions were impacted differently, with stable regions maintaining the greatest firm growth overall and in the post-regulation period.

The three core chapters of this dissertation are interrelated in that they all focus on the impact of the financial crisis and banking regulations passed as a result of the crisis, and their lasting effect on economic growth within the United States. The results from

these analyses add to the existing knowledge on the financial crisis and the impact of the Dodd-Frank Act regulations on banking behavior and regional economic growth.

CHAPTER 2: CAPITAL RATIOS AND BANK LENDING: EFFECTS OF POST-CRISIS BANKING REGULATIONS

2.1 Introduction

The financial crisis of 2007-08 led to questions regarding the safety and reliability of the financial system. One of the largest concerns of the public during the crisis was whether banks could withstand the crisis, and how the survival or failure of large banks would affect the economy. The public associates a higher level of capital at banks with increased bank lending (Hoenig & Bair, 2018), so banks with lower levels of capital predict poorer economic performance. For smaller banks this means capital is related to survival, and for larger banks, increased capital enhances their performance, particularly during times of crisis (Berger & Bouwman, 2013).

Following the financial crisis, the Board of Governors of the Federal Reserve System (hereafter, the Federal Reserve) instituted requirements for all bank holding companies (BHCs), and certain nonbank financial institutions considered systemically important, to have minimum risk-based capital ratios. For an institution to be considered well capitalized, the Federal Reserve requires them to maintain a 6% Tier 1 capital ratio,[1]

[1] The Tier 1 capital ratio uses Tier 1 capital, i.e., common equity capital, including common stock and surplus net of treasury stock, retained earnings, accumulated other comprehensive income, regulatory adjustments or deductions, and common equity Tier 1 minority interests if they qualify. The Tier 1 capital ratio is calculated by dividing Tier 1 capital by total risk-weighted assets. Risk-weighted assets include risk-weighted assets for credit and operational risk, minus the eligible credit reserves (The Federal Reserve Board, 2006).

and 10% total capital ratio,[2] whereas to be considered adequately capitalized, required ratios are 4% for the Tier 1 capital ratio and 8% for the total capital ratio (Moody's, 2011).

Higher capital ratios are generally associated with lower systemic risk for larger banks, indicating that tighter capital requirements may be advantageous in reducing systemic risk, particularly for larger banks (Laeven et al., 2016). Further, regulatory interventions reduce the risk-taking of banks in aggregate, and better capitalization as required by regulations leads to greater resilience in crisis scenarios (Berger et al., 2016; Demirguc-Kunt et al., 2013). However, the effect of the amount of bank capital on lending is relatively small (Berrospide & Edge, 2010). This analysis uses the Dodd-Frank Act (hereafter, Dodd-Frank) as a Federal Reserve regulation that should, in theory, lower systemic risk, but may have less of an effect on loan growth than intended.

This paper analyzes the impact of capital ratios on the lending growth of banks subsequent to the implementation of Dodd-Frank in 2010. Regional disparities in loan growth are examined within the United States, and then banks that are above or below the Dodd-Frank asset threshold for stress tests are compared.[3] This paper extends the empirical analysis of Carlson et al. (2013) in two ways. First, this analysis uses BHC data

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[2] The total capital ratio is a measure of capital adequacy. It is calculated by dividing total capital (Tier 1 and Tier 2) by risk-weighted assets. Tier 1 capital is described in footnote 1; Tier 2 capital uses qualifying preferred stock, subordinated debt, qualifying Tier 2 minority interests, and the allowance for loan and lease losses for up to 1.25 percent of the risk-weighted assets (Federal Deposit Insurance Corporation (FDIC), 2015).

[3] The Dodd-Frank Act currently requires banks with over $100 billion ($50 billion from 2011-2018) in total consolidated assets to undergo annual stress tests including the Dodd Frank Act Stress Test (DFAST) and the Comprehensive Capital Analysis and Review (CCAR) (Board of Governors of the Federal Reserve System, 2019; Flannery et al., 2017).

covering the years following the implementation of Dodd-Frank to examine the impact of bank capital ratios on loan growth after the regulations were enacted. Second, it uses propensity score matching and a regression discontinuity model to determine whether banks on either side of the Dodd-Frank asset threshold for stress tests had significantly different lending growth following the regulations.

This paper first uses OLS regression with metropolitan statistical area (MSA) and year fixed effects.[4] The results indicate that an increase in bank capital ratios leads to an increase in bank loan growth overall. In the years before the crisis, banks have no statistically significant change in loan growth, while in the years during the crisis and post-regulation, banks have a statistically significant increase in loan growth in the following year. However, the post-regulation years may also have been impacted by economic factors outside of the regulations, as the regulations were implemented at the end of the crisis. Next, a regression discontinuity model shows that banks with total assets greater than the Federal Reserve asset threshold for participating in stress tests have significantly lower loan growth than banks with total assets below the threshold. Further analysis in this paper attempts to disentangle the effects of the regulations from the effects of the change in economic conditions.

Capital ratios for the BHCs in the sample have increased overall since the crisis and, on average, are higher than they were before the crisis.

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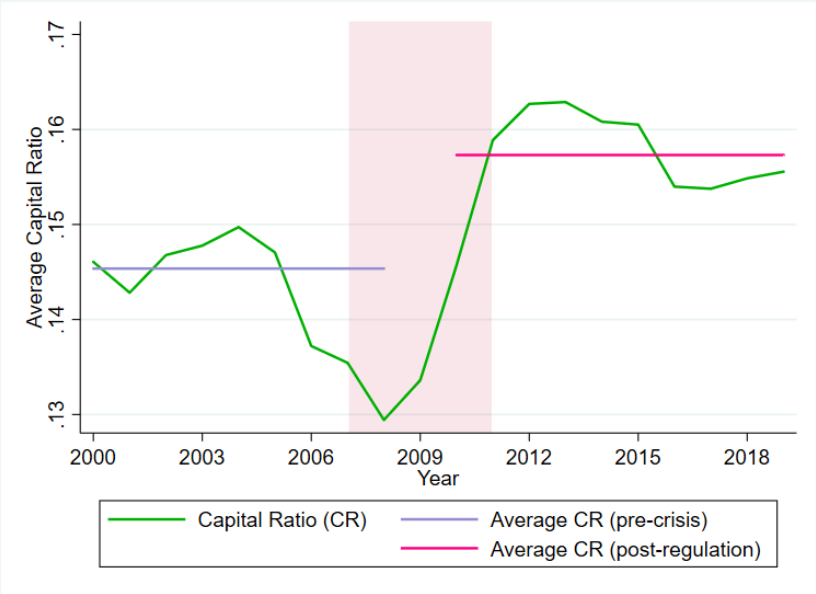
[4] Other fixed effects were tested, including state fixed effects, which had qualitatively similar results to using MSA fixed effects. MSA fixed effects were chosen since the method and results better match the paper by Carlson et al. (2013).

Figure 2.1: Capital Ratio and Loan Growth over Time

2.1a Average Capital Ratio by Quarter, 2000 to 2019



2.1b Average BHC Loans and Loan Growth over Time

These figures show the capital ratios and loan growth over time. Figure 2.1*a* shows BHC total capital ratios aggregated by quarter, from the first quarter of 2000 to the second quarter of 2019, and show the progression in capital ratios for 8,707 BHCs. Figure 2.1*b* shows the loans and loan growth. Lines are added to show the average capital ratios for the pre-crisis period and post-regulation period. Pink shaded area shows the crisis and recession period, from 2007 to 2011.

However, while mean total capital ratios of the BHCs are currently above the minimum required to be considered well capitalized, and certainly far above the capital ratios during the crisis, the mean capital ratio and overall loans for BHCs started to decrease after 2013. The capital ratios also appear to remain low through the second quarter of 2019 when the sample period ends. Figure 2.1*a* shows the average capital ratios over time, and Figure 2.1*b* shows the BHC loans and loan growth over time, with the crisis and recession period shaded in pink for both figures.

The rest of this paper is organized as follows. Section 2.2 discusses the related literature. Section 2.3 presents the data and methodology. Section 2.4 discusses the results. Finally, Section 2.5 discusses potential policy implications and concludes this paper.

2.2 Related Literature

There are a number of studies that examine the effect of federal regulations on bank behavior using data from prior bank regulations and crises. For example, Barth et al. (2004) find that for banks, there are negative implications of regulations that involve oversight by the government, and that accurate information disclosure, among other things, is more important for bank performance and stability than direct government supervision. Beck et al. (2010) look at prior bank deregulation, finding that banking regulations within the U.S. had negative impacts on income equality, and led to restricted competition between banks.

In general, much of the literature examining the direct effects of the crisis uses data from the crisis period exclusively, with less research aimed at the years prior to or after the crisis. In terms of post-crisis research, articles examining the effects of various regulations look at the impacts of the Federal Reserve stress tests (Acharya et al., 2018; Cornett et al., 2018; Flannery et al., 2017) and the effects of capital on bank liquidity creation post-crisis (Berger & Bouwman, 2013).

Previous literature on the effect of capital requirements on lending growth focuses on data that cover just the financial crisis, or the crisis and recession period inclusively. Carlson et al. (2013) use bank capital ratios to determine the impact of higher ratios mandated by the capital requirements of the Dodd-Frank Act on bank lending. Using data through 2011, they find that banks with higher capital ratios had stronger lending growth during and just after the crisis, from 2008 to 2010, with significant increases in lending growth of 0.05 to 0.2 percentage points per one percentage point increase in the capital

ratio. Gambacorta and Marques-Ibanez (2011) use data from a sample of 15 countries from 1999 to 2009 to find that bank capital had a greater effect on loan growth during the crisis period than during non-crisis periods, similar to the results of Carlson, et al. (2013).

Related studies evaluating capital ratios and bank lending examine the effects of liquidity, monetary policy, and individual bank performance. Cornett et al. (2011) look at the effect of asset liquidity on bank lending during the crisis. They find that banks with more liquid assets were more likely to underwrite loans during the crisis compared to other banks, and that banks that held a greater quantity of loans prior to the crisis decreased lending during the crisis. Gambacorta and Marques-Ibanez (2011) examine the impact of monetary policy during the crisis, and how financial innovation and bank business model changes impacted the lending of the banks. The main implication from their findings that is relevant to this study is that deregulation made banks more vulnerable to financial crises via financial instability, implying a close link between stability and monetary policy. Finally, Berger and Bouwman (2013) study the effect of different levels of capital on bank performance during the crisis; they find primarily that an increase in capital during the crisis was critical to the survival of smaller banks, but also enhanced the performance of larger banks during the crisis.

All three papers use data ending in 2009 or 2010, suggesting that there might be new conclusions to be drawn by using data after 2010 to examine the post-crisis state of bank lending growth. Thus, based on the literature, while it is expected lower pre-crisis capital ratios lead to increased lending growth during the crisis and early recession period, lending growth is not expected to change after the regulations as a result of the

required higher capital ratios. As seen in Figure 2.1, capital ratios began increasing prior to the implementation of Dodd-Frank, but overall loan value did not start increasing again until nearly 2014, while annual loan growth started increasing in 2010.

There is also a wealth of literature on the banking industry in relation to regulation, with particular focus on capital regulations. Kapan and Minoiu (2018) look at banks from 48 countries and find that banks with stronger balance sheets maintained their credit supply better than those with weaker financial health. One study using bank data for analysis looks at capital requirements to find that banks with a stronger capital position were more likely to maintain a better stock market performance (Demirguc-Kunt et al., 2013). Another study finds that there is a statistically significant impact of a higher capital ratio on the lending rates BHCs charge, resulting in a higher cost of loans during a crisis or economic downturn (Lambertini & Mukherjee, 2016). These studies indicate that higher capital is associated with better financial position for the banks.

The literature incorporating geographical approaches and spatial analysis is more focused on the similarities and differences between countries, and how the crisis affected the economies in each of the countries. Capello et al.(2015) look at 27 different countries over the years 1990 through 2011 and find that the resilience of regions was often affected by the presence of large cities, in that whole regions were better able to recover from the crisis if there was a large city within the region. Similarly, Degl'Innocenti et al. (2017) look at the relationship between the performance of banks and their proximity to a large city – particularly to New York and London. They find that increasing the distance of a bank's headquarters from these specific financial centers inversely affects their

technical efficiency; thus, the further a bank is from a large city, the less efficient it will be at utilizing its inputs (labor and capital). However, Degl'Innocenti et al. (2017) use data from 2004 to 2010, which could mean that their results were heavily impacted by the crisis period.

These concepts regarding distance to large agglomerations and the effects on bank performance indicate that the lending effects are likely to vary regionally in the United States. Additionally, bank mortgage lending during the collapse of the housing market had spillover effects wherein the local shocks to the market were transmitted to other regions (Berrospide et al., 2016). These articles suggest that the level of capital held by banks did have an impact on the growth of their lending and that location matters for lending growth.

In terms of geographic theory, there are many positive effects of agglomeration economies: the geographic areas with concentrated knowledge bases that allow firms located close to each other to benefit from each other via technological and economic growth and specialized labor pools (Feldman, 1999). In general, agglomeration increases economic growth in an area, builds up market size, and utilizes knowledge spillovers between nearby firms (Bosker, 2007); lending institutions and firms in agglomeration economies may also be more likely to take larger risks because of the concentrations of knowledge and know-how regarding certain industries. Because of these advantages, certain regions were better able to weather the crisis than others, particularly those with agglomeration economies (Martin, 2011). Based on the literature, banks in agglomerations are hypothesized to have been able to return to normal investing and

lending behavior sooner than those banks in other areas, within the confines of the new regulations. It is therefore expected that regions in which these banks are headquartered will have stronger loan growth post-crisis than other regions.

However, as with bank behavior in general, it is expected that banks in agglomeration economies will continue to operate with more risk-taking in their lending behaviors, leading to greater risk of firm loss and unemployment. It is expected that these banks will be more willing to take risks even after the crisis and will have stronger lending growth accordingly. Thus, this paper considers the size of the cities in which banks are headquartered. The analysis allows for MSAs within the United States to define large city areas, as they are the areas in the country with the greatest concentration of people and businesses (as opposed to micropolitan and more rural areas). Further, the analysis looks at whether lending growth is stronger after the crisis and if there is any effect of the implementation of Dodd-Frank.

Prior to the financial crisis, studies examined the effect of geographical location of bank branches on lending (Garrett et al., 2005; Richards et al., 2008) and location of agglomerations on economic growth (Bosker, 2007). The implications of these studies are that location matters in examining regulations and the spread of economic growth. Bosker (2007) finds that economic growth in a particular region is associated with higher economic growth in nearby regions. Similarly, Garrett et al. (2005) find that state regulatory choices are impacted by the decisions that neighboring states make for their own regulations.

Although research shows that lending growth exists post-crisis and post-implementation of regulations (Gambacorta & Shin, 2018), this growth may be due to higher risk lending (Foos et al., 2010). It is expected that years prior to the regulations have significantly different results in terms of lending growth as compared to years after the implementation of Dodd-Frank. Since the Federal Reserve requires a total capital ratio of 8% (Moody's, 2011), there is less flexibility to use that capital for other investment opportunities.

At the same time, larger BHCs tend to maintain higher overall capital ratio averages than required, as seen in the data; there may be less of a problem maintaining loan growth for larger banks than for smaller banks that may have more trouble with liquidity due to the higher capital ratios required (Berger & Bouwman, 2009).

The capital requirements may initially reduce risk taking (Hellmann et al., 2000), but it is unclear for how long after the adverse event (in this case, the financial crisis) the risky behavior is abated. The theory of moral hazard suggests that those who are not responsible for the risks (e.g., banks with government assurances) will take greater risks (Holmstrom, 1979); therefore, it is expected that as time passes and the negative effects of the crisis are forgotten, increased risks will be taken.

While household debt increased less dramatically in the years following the crisis, subprime auto loans increased steadily to reach an all-time high of $584 billion in new auto loans and leases in 2018 (Haughwout et al., 2019), signifying that lenders have never stopped making risky loans despite the regulations and Federal Reserve oversight.

2.3 Data and Methodology

2.3.1 Data

As this paper looks at the effects of the change in capital ratios on the loan growth of banks in the United States, data at the BHC level is used to assess the effects on a higher level than branch-level data can provide. This allows examination of the banks at the MSA level of the headquarters as opposed to the branches, which gives a broader economic overview of the impacts of the regulations on banks.

BHC data for the analyses are extracted from publicly available Federal Financial Institutions Examination Council (FFIEC) Call Reports, which contain both income and balance sheet data, including summary information on the loans held by each bank, and the level of delinquent loans. Wharton Research Data Services (WRDS) compiles this information for bank holding companies from 1986 through the end of 2017, and the Federal Reserve Bank of Chicago provides the data through the first quarter of 2019.

Bank-level data are obtained from the Call Reports from BHCs in the United States that underwrite loans throughout the pre- and post-crisis periods. Years included in the sample extend from 2000 to the first quarter of 2019. This allows comparison of results from before, during, and after the crisis. It also enables examination of whether a new pattern has emerged since the end of the recession and following the implementation of Dodd Frank and the Federal Reserve monitored CCAR exams. The Call Report data are merged with data from the US Census Bureau via bank zip codes, to add MSA coding to the data. Finally, MSA level data on employment, income levels, and population levels are merged with the FDIC branch location data to assess the spatial effects of the crisis;

these data are acquired from the Bureau of Labor Statistics (BLS) and the Bureau of Economic Analysis (BEA) as aggregate measures.

In examining the capital ratios and bank lending, annual loan growth is the dependent variable. This variable is measured from the second quarter of each year to the second quarter of the next year and includes the total loans and leases for each BHC, net of unearned income.[5]

The key explanatory variable is the capital adequacy ratio for each bank in each year, calculated as risk-based capital divided by risk-weighted assets; capital ratios are grouped together into pre-crisis, crisis, and post-crisis periods. In order to examine the annual loan growth, the balance sheet variables and loan growth are computed for each year from the end of the second quarter in one year to the end of the second quarter in the next year. This time period is chosen for variable measurement due to the FDIC Summary of Deposits being released at the end of the second quarter each year.

Other variables of interest expected to affect loan growth include balance sheet items such as different types of loans held and liabilities, and income and expense variables such as domestic deposits for the BHCs. Bank deposits are of interest, as it is expected that banks with greater levels of capital during the crisis had better liquidity and were more likely to have greater loan growth as shown by Cornett et al. (2011). Further, it is expected that banks that held certain types of loans, and banks with greater loan

[5] Variable BHCK2122, "for the FR Y-9C Schedule HC-I--Risk-Based Capital report, includes loans and lease financing receivables" (Federal Reserve, 2019).

delinquencies, were less likely to experience loan growth during the crisis due to the housing bubble and crash.

Table 2.1: Summary Statistics

This table presents descriptive statistics for the variables of interest from the sample of banks within the data. The dependent variable, loan growth, is computed as percent change year over year, as is the control variable for unemployment rate. The explanatory variable, capital ratio, is measured as the capital adequacy ratio for each bank in each year. Observations with capital ratios over 1 (N = 21) and under 0 (N = 96) were dropped from analysis as outliers; this did not affect overall results. Indicator variables pre, during, and post are computed as 0 or 1 multiplied by the capital ratio in each of the periods of time. Observations where BHC domestic deposits were $0 in a year were dropped (N = 18); dropping these observations did not affect overall results. Observations = 9,707

Variable	Mean	Median	Std. Dev.
Loan Growth (percent change)	9.67	7.15	21.72
Capital Ratio	14.82	13.6	5.7
Pre-Crisis	14.61	13.12	5.71
Crisis	13.28	12.43	4.53
Post-Regulation	15.73	14.56	5.92
Delinquent Loans (year over year change)	0.0001	<0.000	0.011
Unemployment Rate (percent change)	2.8	-4.2	23.3
GDP Change (percent)	3.85	3.9	3.81
Federal Funds Rate	1.87	1.25	1.95
Total Assets (millions)	12,500	700.15	107,000
Deposits (millions)	6,983.7	542.5	56,600
Non-Performing Loans (percent)	1.62	0.86	2.47
Charge-off Rate (percent of total loans)	0.25	0.10	0.64
Fraction of Total Loans			
Residential Real Estate Loans	0.275	0.2543	0.1645
Consumer Loans	0.0726	0.0414	0.0983
Commercial Real Estate Loans	0.3858	0.3885	0.1995
Commercial and Industrial Loans	0.1594	0.1405	0.1046

Control variables include delinquent loans as a percentage of total assets, year-over-year for each bank holding company, as a measure of the credit quality of bank portfolios. Additionally, the local GDP (measured for each MSA), and unemployment rate (using percentage change in unemployment rate year-over-year, per MSA) are used

to control for the local and national economic environment. The federal funds rate is taken from the Federal Reserve Bank of St. Louis Economic Data (FRED) as a countrywide measure, while the local unemployment rate is measured for each MSA.

Summary statistics are reported in Table 2.1. The main variable of interest is the capital ratio in three periods: pre-crisis (2000 – 2006), during the crisis (2007 – 2009), and post-regulation (2010 – 2019). The mean capital ratio overall is 14.8%, far above the 8% minimum required by the Federal Reserve. However, when the capital ratios are separated by period, and the capital ratios pre-crisis and during the crisis periods are above the 8% minimum, the post-regulation capital ratios are the highest, with an average of 15.7%. The dependent variable, loan growth, shows an average 9.7% change per year, with delinquent loans showing a change of less than 1% of total assets per year.

2.3.2 Empirical Specification

To examine the relationship between the change in bank capital ratios and lending growth, this paper estimates an OLS regression with MSA and year fixed effects. The regression analysis specification uses the form:[6]

$$\left(\left(\frac{loans_{i,t+1}}{loans_{i,t}}\right) - 1\right) = \beta_0 + \beta_1\left(PRE * \ CR_{i,t}\right) + \beta_2\left(DURING * \ CR_{i,t}\right) + \beta_3\left(POST * \ CR_{i,t}\right) + \delta MSA_i + \boldsymbol{\gamma Z}_{i,t} + u_{i,t}, \quad (1)$$

[6] Dependent Variable: Loan growth uses the year over year percentage change in loan growth in each bank *i* from the second quarter of one year to the second quarter of the next year.

where $CR_{i,t}$ is the capital ratio for bank *i* at year *t*, interaction effects $PRE, DURING,$ and $POST$ are used to examine the capital ratios pre-crisis, during the crisis, and post-regulation, respectively. Thus, $\beta_1,\ \beta_2,$ and β_3 are the main parameters of interest. $\boldsymbol{Z}_{i,t}$ represents a vector of control variables that may impact bank loan growth, including loan delinquencies and charge-offs to control for loan quality. MSA_i is a vector of regional dummy variables, to control for regional fixed effects.[7] For the regressions using equation (1), MSA fixed effects are used and standard errors are clustered by state to control for correlation between banks within each state. It is expected that there may be unobserved correlation due to banks having branches in multiple states.

To further investigate regional differences, the model in Equation (1) is estimated separately for different types of MSAs, which are grouped based on population growth throughout the pre- and post-crisis periods. This allows comparison of results across regions with differing population growth rates. Thus, the analysis compares loan growth for banks in different types of cities based on their growth rate during the analysis period.

2.3.3 Methodology for Matching and Regression Discontinuity Model

To determine whether loan growth is divergent for banks above and below the Dodd-Frank threshold, this analysis uses propensity score matching (PSM), as developed by Rosenbaum and Rubin (1983). The goal is to find banks that have similar observable characteristics, specifically the composition of bank portfolios. The matching is done

[7] Using the latest MSA delineation as defined by the Office of Management and Budget as of April 10, 2018, as MSA boundaries change over time (Office of Management and Budget, 2018).

based on the proportion of deposits to assets, the charge-off rate, non-performing loans, and the fraction of loans to different types of industries, as it is expected banks with similar portfolios should have similar levels of loan growth, holding everything else constant. Additionally, matching is done with the loan portfolios and by region to determine if any differences in loan growth could be attributed to regional properties rather than the regulations.

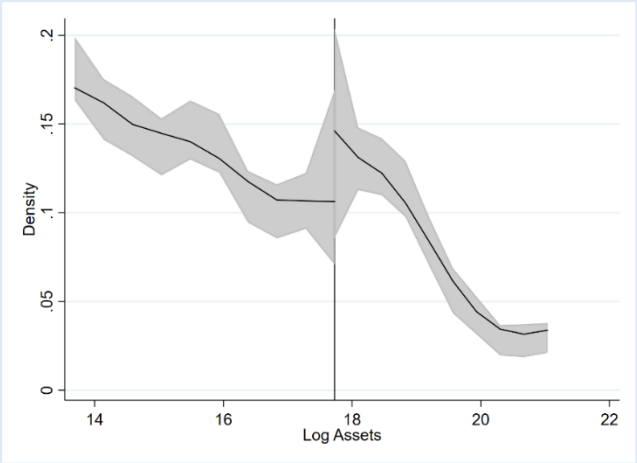
Based on this goal, nearest neighbor matching, with up to five neighbors, is used to match each treatment bank to the banks with the closest propensity score. In this case, a treated bank is one in which total assets are greater than $50 billion (banks above the Dodd-Frank threshold, and subject to stress tests), and an untreated bank is one with total assets lower than $50 billion. This method allows comparison between banks that were affected the most by Dodd-Frank and banks that should not otherwise be significantly affected by the regulations.

An alternative approach is to use a regression discontinuity (RD) model to examine whether the banks that were impacted by Dodd-Frank have significantly different loan growth than those that were not subject to the federal regulations and stress tests. The assignment variable in this model is the total asset value of each BHC. The regression discontinuity design allows BHCs to receive the treatment if they are above the cutoff point for Dodd-Frank; treatment in this case is defined as being subject to regulations. The cutoff value is the $50 billion Dodd-Frank asset threshold of 2011 to

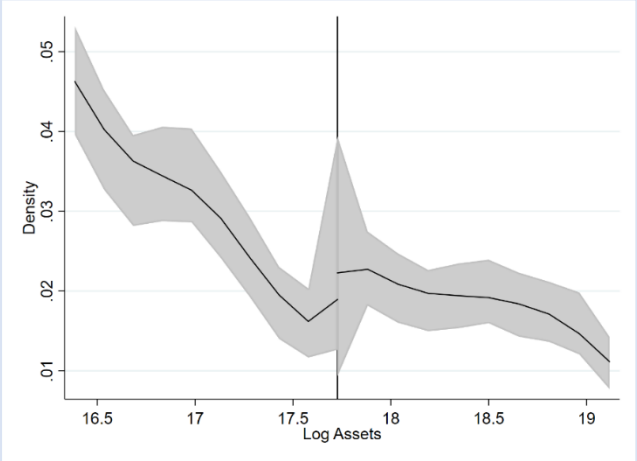
2018, since it is expected the banks just above or below this threshold would not otherwise be different outside of the effects of the regulations.[8]

Figure 2.2: RD Manipulation Test

2.2a. Banks Matched by Loan Portfolios



2.2b. Banks Matched by Loan Portfolios and Region



These figures show the matched banks log total assets around the cut-point of the RD model to test for any manipulation. Signs of manipulation on the graph would be more observations below the asset threshold in order to avoid the Federal Reserve stress tests. Figure 2.2*a* presents the density test for banks matched based on their loan portfolios, while Figure 2.2*b* presents the density test for banks matched based on region as well. With these graphs and the non-significant p-value in Table 2.7, Panel B, there appears to be no asset manipulation by the banks.

[8] Matching was done three separate times, using asset levels in three individual years, all of which had the same results when merged back into the bank data.

While banks can manipulate their assets to remain below the threshold (Bouwman et al., 2018), a density test shows no significant results around the threshold (Table 2.7, Panel B and Figures 2.2a and 2.2b). The goal of the test is to determine whether manipulation is occurring in bank assets. Test results indicate that there is no visible manipulation of bank assets at the Dodd-Frank threshold, so any change in loan growth within this RD framework can be attributed to the regulations.

To examine the loan growth of banks around the threshold, a regression discontinuity model is run on the matched banks using the pre-crisis, during, and post-regulation framework with banks above and below the asset threshold. The goal of the RD model then is to confirm the effect on lending of those banks above and below the regulation threshold.

The RD model is specified as follows:

$$loan\ growth_{i,t} = \beta_0 + \tau T_i + \beta_1 f(X_i - X_c) + u_i, \quad (2)$$

where $loan\ growth_{i,t}$ is the outcome variable, loan growth at bank i at time t; τ represents the estimate of treatment effect – in this case the regulations – and T_i is the treatment binary variable with values of 0 or 1, with 1 indicating that the bank is over the threshold and is mandated to conduct stress tests. The RD estimator τ is the outcome from assignment; f represents a 4th order global polynomial, X_i is the assignment variable, and X_c is the cutoff. The regression discontinuity estimator tells the difference in bank lending growth between those banks above the threshold and those below the threshold.

2.4 Results

2.4.1 Fixed-effects models

The fixed-effects model examines the changes that bank capital ratios have on loan growth in the following year. Table 2.2 presents the results for the MSA fixed-effects model in equation (1). Increased capital ratios lead to an increase in loan growth during the crisis and post-regulation periods, with the pre-crisis period negative but not statistically significant. The coefficient on *crisis* in column 1 is 0.3281 (significant at the 1% level), and in column 1, the coefficient on *post-regulation* is 0.2724 (significant at the 5% level). Including one lag of loan growth provides the same results for the three periods, with the lagged loan growth positive and significant in all periods.

Running the OLS model without fixed effects provides different results; the pre-crisis period has significant and positive loan growth and the post-regulation period has a significant and negative coefficient. In column 3, the coefficient on *pre-crisis* is 0.2285, significant at the 1% level, and the coefficient on *post-regulation* in column 3 is -0.1534, significant at the 5% level. These divergent results suggest that the changes in loan growth were not the same throughout MSAs in the country and justify using the MSA fixed-effects model.

The results from the fixed-effects models are also in line with Carlson, et al. (2013) for the pre-crisis period (i.e., no significant change in loan growth pre-crisis) and the crisis period (i.e., significant and positive loan growth during the crisis years).

Table 2.2: Results for MSA Fixed Effects and OLS Regression

This table presents the MSA fixed effects analysis results examining changes in capital ratio for banks within the sample and the impact on bank loan growth. Pre-crisis period includes 2001 to 2006, crisis period includes 2007 to 2009, and post-regulation period includes years after 2009. Column 2 includes one lag of deposits for the year preceding. Column 3 presents OLS regression with no MSA effects. ***, **, * represent 1, 5, and 10% significance, respectively. Standard errors clustered at state level are shown in parentheses below coefficient estimates. Obs. = 9,707.

VARIABLES	(1)	(2)	(3)
DV: Loan Growth	MSA Fixed Effects	MSA Fixed Effects w/Lagged DV	No MSA Fixed Effects
Capital Ratio			
Pre-Crisis	-0.1900	-0.1682	0.2285***
	(0.1160)	(0.1282)	(0.0762)
Crisis	0.3281***	0.3499***	-0.1234
	(0.1048)	(0.0972)	(0.0771)
Post-Regulation	0.2724**	0.2712**	-0.1534**
	(0.1242)	(0.1073)	(0.0735)
Lagged Loan Growth (t-1)			
Pre-Crisis	-	0.1406***	-
		(0.0333)	
Crisis	-	0.0894***	-
		(0.0259)	
Post-Regulation	-	0.2156***	-
		(0.0379)	
Delinquencies – Loans	-2.9424***	-2.8996***	-3.3494***
	(0.7013)	(0.6733)	(0.8624)
GDP Change	0.0026***	0.0023***	0.0039***
	(0.0006)	(0.0006)	(0.0013)
Unemployment Rate	-0.0087	-0.0092	-0.0827***
	(0.0181)	(0.0174)	(0.0128)
Deposits – Total Domestic	-0.0000**	-0.0000*	-0.0000*
	(0.0000)	(0.0000)	(0.0000)
Fraction of Total Loans			
Residential Real Estate	0.0184	0.0162	-0.0416
	(0.0276)	(0.0231)	(0.0336)
Consumer Loans	-0.0476	-0.0433	-0.0864**
	(0.0387)	(0.0345)	(0.0345)
Commercial Real Estate	0.0362	0.0302	-0.0153
	(0.0254)	(0.0219)	(0.0212)
Commercial and Industrial	0.1434***	0.1091**	0.0662**
	(0.0434)	(0.0430)	(0.0296)
Constant	0.0340	0.0266	0.0910***
	(0.0263)	(0.0236)	(0.0218)
MSA	Yes	Yes	No
Adjusted R^2	0.1510	0.1806	0.0591

Their results suggest that capital ratios only matter for loan growth during times of crisis, and that regulations may be unlikely to impact loan growth when banks are not under financial stress. As seen in the baseline model, the post-regulation period shows an increase in loan growth. However, this may be partially due to using different variables than the Carlson, et al. (2013) analysis, as well as grouping all years since 2009 together.

As a robustness check, the model is estimated separately using the same variables, and splitting out all individual years. Results for the robustness check are presented in Table 2.3. The results for the analyses are almost the same in sign and magnitude overall in comparison to the baseline results. In the pre-crisis years, only 2004 is significant at the 10% level, matching up with the baseline results of no significant change. The crisis years are positive, and almost all are statistically significant; the largest difference in magnitude is seen in 2009, where the coefficient is nearly three times as large as the baseline coefficient (0.91 in column 1 in 2009 as compared to 0.33 for the crisis period overall). The post-regulation years are positive and significant only in certain years, with similar magnitude overall as the baseline post-regulation period.

In this analysis, the coefficients for the capital ratio[9] in column 1 from 2008 through 2010 are statistically significant at the 1% level and positive, using the same control variables as Carlson, et al. (2013), and the coefficients for the capital ratio from 2007 through 2010 in column 2 are statistically significant at the 1% level and positive, also including control variables from the model in equation (1).

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[9] Where the capital ratio is interacted with the year in the regression.

Table 2.3: Results for Fixed Effects Models by Year

This table presents the results for the replication model continuing Carlson, et al. (2013). This model examines the changes in capital ratio for the banks within the sample and how that affects bank loan growth by year. Column 1 includes the control variables from the Carlson paper. Column 2 includes the control variables from the base analysis in this paper. ***, **, * represent 1, 5, and 10% significance levels, respectively. Fixed effects included are year and MSA. Controls for the regressions are not displayed in table. Standard errors clustered at the state level are shown in parentheses below coefficient estimates.

Pre-crisis	(1)	(2)
2001	-0.0730	0.0866
	(0.1257)	(0.2204)
2002	-0.0794	0.1964
	(0.0789)	(0.1388)
2003	-0.0140	0.1811
	(0.0848)	(0.1434)
2004	0.2477*	0.3879*
	(0.1383)	(0.1935)
2005	0.3480	0.5822
	(0.3374)	(0.4725)
2006	-0.0730	0.0866
	(0.1257)	(0.2204)
Crisis		
2007	0.1820	0.3107**
	(0.1119)	(0.1450)
2008	0.5609***	0.5955***
	(0.1568)	(0.1844)
2009	0.9073***	0.9135***
	(0.1692)	(0.1872)
Post-regulation		
2010	0.5687**	0.8475***
	(0.2564)	(0.2446)
2011	0.0826	0.1061
	(0.1096)	(0.1372)
2012	0.3290*	0.3032**
	(0.1853)	(0.1385)
2013	0.1379	0.1433
	(0.1368)	(0.2724)
2014	0.1910	0.3631***
	(0.1469)	(0.1163)
2015	0.2699*	0.3683*
	(0.1389)	(0.2118)
2016	0.1561	0.3153*
	(0.1262)	(0.1659)
2017	0.4901	0.1508
	(0.4307)	(0.1439)
Observations	14,319	8,647
Adjusted R^2:	0.2332	0.2475

The results after 2011 are interesting; including the same control variables as Carlson et al. (2013) provides significant results in 2012 and 2015 (only at the 10% significance level), while including the controls from equation (1) has significant results in 2012 and 2015, and also has significant results in 2014 and 2016 (with 2012 and 2014 significant at the 5% level and the 1% level, respectively).

These results may be related to the stress tests conducted by the Federal Reserve under Dodd-Frank. The first CCAR stress test results to be published occurred in 2012 (Flannery et al., 2017), and four banks failed the stress tests that year (Gongloff, 2012).[10] Although 2012 was after the crisis, if the failure of these tests was seen by other banks as financial stress, then the increased loan growth in the following year could be attributed similarly to the stress of the crisis period. Similarly, in 2014, five banks failed the Federal Reserve stress tests (Touryalai, 2014), and again, the loan growth increased in the following year.

Since Dodd-Frank requires banks of different asset sizes to undergo the Federal Reserve stress tests depending on the year, the next analysis looks at banks based on their total asset size, to determine if there are differences in loan growth for different size banks. The model in equation (1) is estimated separately for banks with different levels of assets: those with assets less than $100 billion, less than $50 billion, and less than $10 billion. Table 2.4 presents the results. For banks with less than $100 billion in total assets, the lending growth was positive in the crisis and post-regulation period and not

[10] Citigroup, Ally Financial, SunTrust and MetLife.

significantly different in the pre-crisis period, similar to the analysis on all banks (i.e., the coefficient on *crisis* in column 1 is 0.3461, and the coefficient on *post-regulation* in column 1 is 0.2932, significant at the 1% level and the 5% level respectively).

Table 2.4: Results for BHCs based on Asset Size

This table reports fixed effects regression for banks with different levels of total assets. ***, **, * represent 1, 5, and 10% significance levels, respectively. Standard errors clustered at the state level are shown in parentheses below coefficient estimates.

VARIABLES	(1)	(2)	(3)
DV: Loan Growth	MSA Fixed Effects <$100b Total Assets	MSA Fixed Effects <$50b Total Assets	MSA Fixed Effects <$10b Total Assets
Capital Ratio			
Pre-Crisis	-0.1706	-0.1199	-0.0305
	(0.1173)	(0.1080)	(0.0974)
Crisis	0.3461***	0.3445***	0.4100***
	(0.1080)	(0.1031)	(0.1059)
Post-Regulation	0.2932**	0.2974**	0.3307**
	(0.1228)	(0.1224)	(0.1288)
Delinquencies – Loans	-2.8939***	-2.8685***	-2.6332***
	(0.6786)	(0.6794)	(0.6505)
GDP Change	0.0025***	0.0024***	0.0025***
	(0.0006)	(0.0006)	(0.0006)
Unemployment Rate	-0.0119	-0.0178	-0.0144
	(0.0177)	(0.0172)	(0.0171)
Deposits – Total Domestic	-0.0000	-0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)
Fraction of Total Loans			
Residential Real Estate	0.0418	0.0148	-0.0053
	(0.0394)	(0.0319)	(0.0273)
Consumer Loans	-0.0369	-0.0718	-0.1166**
	(0.0484)	(0.0548)	(0.0502)
Commercial Real Estate	0.0559	0.0373	0.0330
	(0.0379)	(0.0338)	(0.0318)
Commercial and Industrial	0.1730***	0.1601***	0.1532***
	(0.0431)	(0.0426)	(0.0496)
Constant	0.0120	0.0286	0.0263
	(0.0348)	(0.0318)	(0.0319)
MSA	Yes	Yes	Yes
Observations	9,414	9,263	8,723
Adjusted R^2	0.1572	0.1730	0.1853

Increased capital ratios for banks with assets lower than $100 billion lead to an increase in loan growth, which is significant in the crisis and post-regulation period. Banks with under $50 billion in total assets have the same results as those under $100 billion.

Table 2.5: Effect of Capital Ratio by Changing Loan Growth

This table reports fixed effects regression for banks whose loans have contracted over each period (column 1) and banks whose loans have expanded over each period (column 2). ***, **, * represent 1, 5, and 10% significance levels, respectively. Standard errors clustered at the state level are shown in parentheses below coefficient estimates.

VARIABLES	(1)	(2)
DV: Loan Growth	Lending Contraction	Lending Expansion
Capital Ratio		
Pre-Crisis	0.0105	0.2632**
	(0.0643)	(0.1162)
Crisis	-0.0165	0.3425**
	(0.0903)	(0.1512)
Post-Regulation	-0.0223	0.4278***
	(0.1572)	(0.1235)
Delinquencies – Loans	-1.6499***	0.3464
	(0.3524)	(0.9810)
GDP Change	0.0004	0.0021***
	(0.0004)	(0.0005)
Unemployment Rate	0.0279**	-0.0082
	(0.0138)	(0.0194)
Deposits – Total Domestic	0.0000**	-0.0000***
	(0.0000)	(0.0000)
Fraction of Total Loans		
Residential Real Estate	0.0275	-0.0218
	(0.0397)	(0.0296)
Consumer Loans	-0.0399	-0.0832**
	(0.0535)	(0.0332)
Commercial Real Estate	-0.0128	0.0585*
	(0.0386)	(0.0311)
Commercial and Industrial	0.0299	0.1219**
	(0.0505)	(0.0580)
Constant	-0.0839**	0.0534
	(0.0385)	(0.0379)
MSA	Yes	Yes
Observations	2,209	7,239
Adjusted R^2	0.2051	0.1125

However, a greater increase in loan growth is seen for the smaller banks; for example, the coefficient on *crisis* is 0.41 for banks under 10 billion in total assets (significant at the 1% level).

Following Carlson et al. (2013), Table 2.5 shows that banks with decreased lending have different results from the whole sample, but the results are not statistically significant. Banks with increased lending have significant increases in loan growth associated with increased capital ratios in all periods: pre-crisis, crisis, and post-regulation periods (i.e., the coefficient for *pre-crisis* in column 2 is 0.2632, for *crisis* is 0.3425, significant at the 5% level, and the coefficient for *post-regulation* is 0.4278, significant at the 1% level). These coefficients are also larger than those in the baseline analysis.

This analysis gives insight to the argument regarding the way in which changing monetary policy and recessions affects loan growth in terms of supply and demand (Peek & Rosengren, 2010). Prior literature attempts to disentangle whether decreasing loan growth related to recessions is a result of supply side or demand side changes (Becker & Ivashina, 2014; Leary, 2009). Results from this analysis indicate that loan supply is stronger, as increased capital ratios are related with increased loan growth in all periods for banks that have greater loan growth overall (i.e., banks that are willing to supply loans). At the same time, banks with decreased loan growth overall (i.e., banks that are not willing to supply loans) do not have this increased loan growth during any period. These results combined suggest that firms demand loans during economic downturns, but

not all banks are willing to supply loans. The results are consistent with both Becker and Ivashina (2014) and Leary (2009).

2.4.2 Matching and Regression Discontinuity Model

Table 2.6 reports the differences in means in the two groups of banks before matching and running t-tests of the equality of means. Before matching, most of the variables are statistically significantly different, while after matching, the bias is reduced, and no variables are statistically significantly different between the two groups of banks.

Table 2.6: Matched Banks Sample – Differences in Mean Before and After Matching
***, **, * represent 1, 5, and 10% significance levels respectively

Variable	Below $50b (0)	Above $50b (1)	Difference
Panel A			
BEFORE MATCHING			
Deposits as percentage of Total Assets	0.7939	0.5729	0.2210***
Fraction of Total Loans			
Residential Real Estate Loans	0.2758	0.2494	0.0264***
Consumer Loans	0.0695	0.1736	-0.1041***
Commercial Real Estate Loans	0.3928	0.1555	0.2373***
Commercial and Industrial Loans	0.1576	0.2192	-0.0616***
Charge-off Rate	0.0024	0.0056	-0.0032***
Change in Capital	1.1037	0.2682	0.8355***
Non-Performing Loans	0.0161	0.0187	-0.0026***
Panel B			
AFTER MATCHING			
Deposits as percentage of Total Assets	0.55261	0.58121	0.0286
Fraction of Total Loans			
Residential Real Estate Loans	0.24316	0.24798	0.0048
Consumer Loans	0.18756	0.1562	-0.0314
Commercial Real Estate Loans	0.20071	0.21292	0.0122
Commercial and Industrial Loans	0.18826	0.21167	0.0234
Charge-off Rate	0.01410	0.01584	0.0017
Change in Capital	1.08150	1.1372	0.0557
Non-Performing Loans	0.04458	0.04228	-0.0023

Panel A of Table 2.7 presents the regression discontinuity models using the first matched set of banks (columns 2 and 3), the banks matched by region (column 4), and all banks in the sample (column 1).

Table 2.7: Regression Discontinuity Estimation

This table presents the regression discontinuity analysis. The treatment effects estimate the change in loan growth where the bank is part of the treatment group (i.e., banks with above $50 billion in total assets). The RD estimator is the difference between the treated and untreated banks. Panel A presents the regression results, and Panel B presents the results of the RD Manipulation test comparing the treated and untreated banks for manipulation at the cut point of $50 billion. ***, **, * represent 1, 5, and 10% significance levels, respectively.

Panel A: RD Results

	(1)	(2)	(3)	(4)
	Not Matched	Matched Banks by Loan Portfolios		Matched Banks by Region & Portfolio
RD Estimator	0.132	-0.107**	-0.109**	-0.092**
Robust *p*-value	0.442	0.011	0.016	0.04
Robust 95% CI	[-0.22, 0.5]	[-0.19 -0.03]	[-0.19; -0.03]	[-0.18; -0.004]
Kernel Type	Triangular	Uniform	Triangular	Triangular
Conventional std. error	0.18	0.038	0.041	0.042
Conventional *p*-value	0.263	0.005	0.008	0.03
Order Loc. Poly. (*p*)	4	4	4	4
Order bias (*q*)	5	5	5	5
BW Loc. Poly. (*h*)	[3.4; 2.3]	[2.3; 1.3]	[2.6; 1.6]	[3.8; 1]
BW Bias (*b*)	[4.2; 3.1]	[2.8; 1.9]	[3.1; 2]	[4.4; 1.6]
Observations	11,230	1,105	1,105	9,385

Panel B: RD Manipulation Test

T Value	-1.159	0.403	0.626	-0.149
Robust *p*-value	0.247	0.687	0.532	0.882

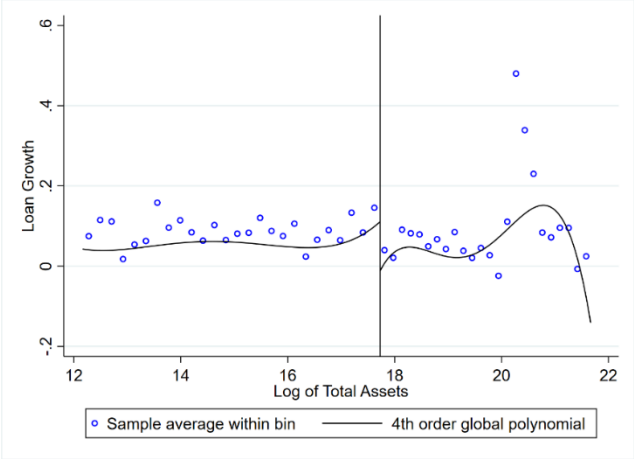
The RD estimator represents the difference between BHCs that are above the asset threshold of $50 billion and those that are below that threshold. The results show that for the matched banks, the change in the loan growth for the banks above the threshold is statistically significantly lower than the banks below the threshold; the coefficient in column 2 is -0.107 (significant at the 5% level). Using triangular kernel weights (Porter, 2003), loan growth for banks above the threshold is still lower than those below the threshold (the coefficient for the RD estimator in column 3 is -0.109 and significant at the 5% level).

When also matching based on region and loan portfolios, the same results hold for loan growth (the coefficient in column 4 is slightly lower at -0.092, significant at the 5% level). The unmatched banks have no significant change in loan growth on either side of the threshold. Thus, banks with similar loan portfolios have significantly lower loan growth when subject to stress tests, and this holds within different regions as well.

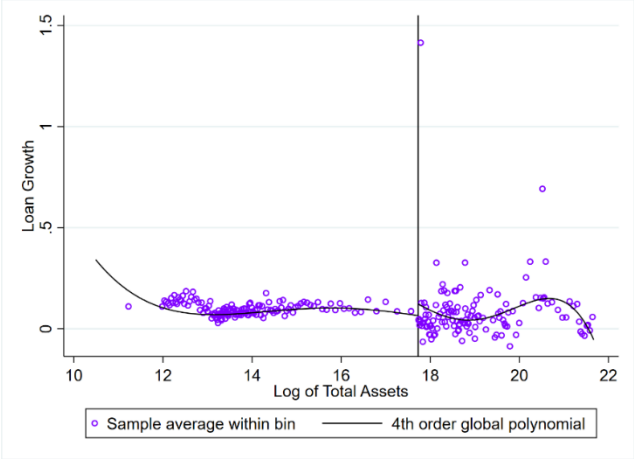
Figure 2.3 shows the regression discontinuity estimates for the total assets at the threshold required for participating in stress tests. The figures show a clear discontinuity at the threshold for assets for the matched sample of banks in Figure 2.3*a*. The figure shows the banks below the stress testing threshold have greater loan growth than those above the threshold. As seen in Table 2.7, the unmatched banks (Figure 2.3*b*) do not appear to have a discontinuity at the threshold.

Figure 2.3: RD Plot – Loan Growth and Log of Total Assets

2.3a. Matched Banks



2.3b. Unmatched Banks



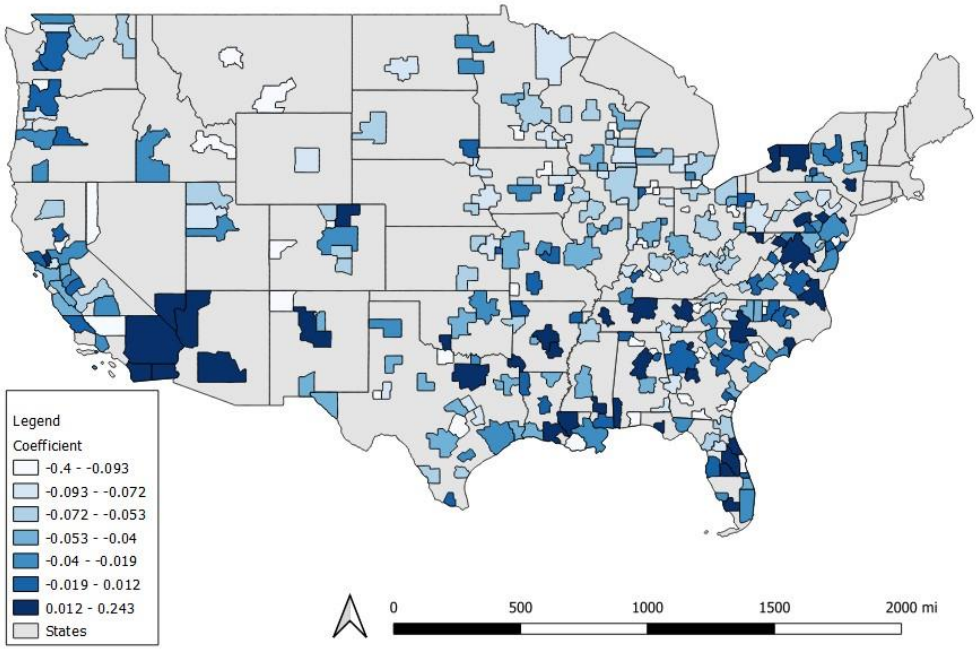
These figures show the regression discontinuity plots showing discontinuity estimates at the threshold for log of total assets. Figure 2.3a shows the RD plot for the matched set of banks, while Figure 2.3b shows the RD plot for all banks in the dataset.

2.4.3 Spatial Analysis

To determine the regional disparity of the change in capital ratios, a visualization of the results from the baseline model on a map is performed. Figure 2.4 shows the mapped coefficients for the MSA fixed effects analysis, with the New York City metro

area as the reference region. The Southwest region and parts of the Southeast of the US have, on average, the same or greater loan growth compared to the NYC metro area, while the rest of the country has lower loan growth. The Midwest region, on average, experiences relatively less loan growth compared to the NYC metro region.

Figure 2.4: MSA Regression Coefficients – Reference region- New York City MSA



This figure presents the coefficients for the MSAs from the base regression model. Lighter colors represent lower loan growth in comparison to the NYC MSA, while darker colors represent higher loan growth.

These findings correspond with the results from the model, as well as regional economic growth literature. The South and Northeast regions have had the strongest growth in income over time (Garrett et al., 2007), and there has been both growing production and population in the Southern regions, particularly the Southeast (Glaeser &

Tobio, 2008). Further, the Midwest region has experienced shrinking cities in terms of both economic growth and population (Shetty & Reid, 2013).

Based on the map in Figure 2.4 and the results of the baseline analysis using MSA fixed effects, banks within different MSAs were affected differently by the change in capital ratio requirements. To determine the differences in loan growth between the MSAs, regions are grouped based on the population growth within the MSAs. Regions with population growth in the 10^{th} percentile or less each year are classified as shrinking, while regions with population growth above the 90^{th} percentile are classified as growing. Finally, regions are between the 11^{th} and 89^{th} percentile of growth are considered stable regions. Cities included in the shrinking region include Pittsburgh and Detroit, while cities in the stable region include Chicago and New York, and cities included in the growing region include Dallas and Houston.

The model in equation (1) is next estimated using different groups of regions as specified above: shrinking, stable, and growing. The results for this analysis are presented in Table 2.8.

The impact of capital ratios on lending growth is not statistically significant in any period for shrinking or growing regions. In the stable regions, loan growth is positive in the crisis and post-regulation periods, and negative but not significant in the pre-crisis period (the coefficient on *crisis* in column 2 is 0.3827, and the coefficient on *post-regulation* in column 2 is 0.2937, significant at the 1% level and the 5% level, respectively). Thus, banks in shrinking and growing regions experienced no significant change in loan growth in any period, while stable regions experienced an increase in loan

growth during the crisis and post-regulation periods, of slightly greater magnitude than the country as a whole.

Table 2.8: MSA Analysis based on Population Growth, 10%
This table reports the fixed effects regression using population growth groupings of ≤ 10% (shrinking), 11-89% (stable) and ≥ 90% (growing). ***, **, * represent 1, 5, and 10% significance levels, respectively. Standard errors clustered at the state level are shown in parentheses below coefficient estimates.

VARIABLES	(1)	(2)	(3)
	Group 1	Group 2	Group 3
DV: Loan Growth	Shrinking	Stable	Growing
Capital Ratio			
Pre-Crisis	-0.4983	-0.1084	-0.1223
	(0.3858)	(0.1633)	(0.1742)
Crisis	-0.5862	0.3827***	0.2894
	(0.7239)	(0.1220)	(0.2447)
Post-Regulation	0.2291	0.2937**	0.0917
	(0.2027)	(0.1365)	(0.1403)
Delinquencies – Loans	-4.8700**	-2.7046***	-3.7711
	(2.1508)	(0.7886)	(2.3188)
GDP Change	0.0047	0.0013**	0.0043***
	(0.0032)	(0.0006)	(0.0013)
Unemployment Rate	0.0590	-0.0185	0.0228
	(0.0495)	(0.0142)	(0.0459)
Deposits – Total Domestic	-0.0000	-0.0000**	0.0000***
	(0.0000)	(0.0000)	(0.0000)
Fraction of Total Loans			
Residential Real Estate	0.2147***	0.0076	-0.0637
	(0.0694)	(0.0319)	(0.0827)
Consumer Loans	0.0927**	-0.0411	-0.1272
	(0.0396)	(0.0439)	(0.0887)
Commercial Real Estate	0.1354**	0.0092	0.2135**
	(0.0497)	(0.0264)	(0.0817)
Commercial and Industrial	0.2064*	0.1170***	0.2603
	(0.1151)	(0.0375)	(0.2385)
Constant	-0.0518	0.0429	0.0034
	(0.0413)	(0.0282)	(0.0984)
MSA	Yes	Yes	Yes
Observations	961	7,729	968
Adjusted R^2	0.1872	0.1551	0.2165

The grouped MSA analysis is also conducted using larger groups for population growth, with the shrinking regions composed of the 25th percentile or lower of population

growth, and growing regions comprising the 75th percentile or greater population growth.

Results for this analysis are presented in Table 2.9.

Table 2.9: MSA Analysis based on Population Growth, 25%
This table reports the fixed effects regression using population growth groupings of ≤ 25% (shrinking), 26-74% (stable) and ≥ 75% (growing). ***, **, * represent 1, 5, and 10% significance levels, respectively. Standard errors clustered at the state level are shown in parentheses below coefficient estimates.

VARIABLES	(1)	(2)	(3)
	Group 1	Group 2	Group 3
DV: Loan Growth	Shrinking	Stable	Growing
Capital Ratio			
Pre-Crisis	-0.3477	-0.0248	-0.2167*
	(0.2418)	(0.2272)	(0.1095)
Crisis	-0.1371	0.2749*	0.4038**
	(0.2288)	(0.1373)	(0.1788)
Post-Regulation	0.2084	0.1791*	0.3500
	(0.1236)	(0.0998)	(0.2559)
Delinquencies – Loans	-3.4578**	-3.5503***	-2.2356
	(1.5662)	(0.8643)	(1.4987)
GDP Change	0.0026	0.0014	0.0030***
	(0.0019)	(0.0009)	(0.0008)
Unemployment Rate	0.0406	-0.0066	-0.0222
	(0.0348)	(0.0192)	(0.0268)
Deposits – Total Domestic	-0.0000***	-0.0000***	-0.0000
	(0.0000)	(0.0000)	(0.0000)
Fraction of Total Loans			
Residential Real Estate	0.1194**	-0.0464*	0.0463
	(0.0567)	(0.0242)	(0.0627)
Consumer Loans	0.0122	-0.0280	-0.0538
	(0.0389)	(0.0483)	(0.0783)
Commercial Real Estate	0.0350	-0.0004	0.1362*
	(0.0589)	(0.0248)	(0.0715)
Commercial and Industrial	0.1222	0.0813*	0.3102***
	(0.0755)	(0.0409)	(0.1008)
Constant	0.0283	0.0622**	-0.0278
	(0.0407)	(0.0261)	(0.0671)
MSA	Yes	Yes	Yes
Observations	2,502	4,659	2,480
Adjusted R^2	0.1551	0.1646	0.1893

In this analysis, results are similar to the prior analysis for the stable regions (in this case, 26 to 74% population growth), but the growing regions have greater loan growth in the crisis period (the coefficient on *crisis* in this regression is 0.4038, significant at the 5% level, as compared to the positive, but statistically insignificant growth in the smaller grouped analysis). Taken together, these results suggest that banks in stable and growing regions had greater loan growth related to the increased capital ratios than shrinking regions, and the capital ratios had different impacts throughout the country. This confirms the expectation that stable and growing regions would have greater loan growth and reaffirms the mapped results in Figure 2.4.

2.5 Discussion

The results of this analysis suggest that prior research on capital ratios can be extended, and this paper adds to the existing literature by including post-regulatory years. In the years after the implementation of Dodd-Frank, lending growth appears to be increasing as a result of the increased capital ratios mandated by the Federal Reserve, but with less of an increase in loan growth than the crisis years. Regressing capital ratios on loan growth individually by year demonstrates that the years after 2010 maintain positive loan growth, but only loan growth in the years following 2012 and 2014 are significantly impacted by an increase in capital ratios. The results suggest that the increased capital ratios are associated with increased loan growth only in times of financial stress.

Further analysis in this paper includes the regression discontinuity model to look at banks just above and below the $50 billion asset threshold for stress tests. Using propensity score matching, the analysis finds that matched banks below the Federal Reserve asset threshold have significantly greater loan growth than those above the asset threshold. This indicates that the banks that are not required to undergo annual Federal Reserve stress tests are able to increase their loan growth in comparison to those that are subject to the regulations. Based on the analysis in Cornett et al. (2018), this suggests that those banks subject to the stress tests are managing their financial performance, which is leading them to loan less to meet the stress test requirements.

Additionally, the analyses in Carlson et al. (2013) are extended to include post-regulatory years. These analyses include looking at the difference between lending contraction and expansion and how these aspects of loan supply and demand are affected

by the capital ratios during the pre-crisis, crisis, and post-regulation periods. This further informs the results of the initial analysis as to whether there was a greater supply or demand impact on the lending growth. In this analysis, the banks that expanded their lending had significantly increased loan growth, while those that contracted lending did not have any significant change in loan growth. This indicates that the capital ratios are good at predicting loan growth only for banks that are already lending more.

Finally, the capital ratio impact on lending for banks within certain regions with greater population growth is examined as compared to banks in regions with shrinking populations, to see if there is a difference in their lending growth that is impacted by the crisis and regulations. This analysis suggests that the stable and growing cities are more likely to have increased loan growth during the crisis and post-regulations, while shrinking regions have no significant change in loan growth.

This paper adds to the financial crisis and regulation literature by extending the analysis done in Carlson et al. (2013) by using data through 2019 to examine the loan growth subsequent to Dodd-Frank implementation. Additionally, it adds to the literature by using a regression discontinuity model with propensity score matched banks to compare the loan growth of banks subject to the Federal Reserve stress tests as part of the regulations with those not undergoing stress tests.

2.5.1 Policy Implications

One part of the Dodd-Frank regulation that is of particular interest in relation to this paper is the mandated capital ratio. Federal Reserve research indicates that banks

maintaining increased capital ratios may lead to a decrease in economic output in the long run; however, if the capital ratios of the large U.S. banks had been at the Federal Reserve minimums, the banks may have been able to survive the crisis without government intervention (D'Erasmo, 2018). This implies that loan growth would likely decrease or remain stagnant over time, the latter of which is in line with the results for this paper. From the analyses in this paper, the increased capital ratios were only related to increasing loan growth during times of financial stress. Based on the prior financial crisis literature and the analyses in this paper, Dodd-Frank has not been successful in increasing loan growth except during times of financial stress. As the same results occurred during the crisis, when there was no capital ratio monitoring, this suggests that the mandated capital ratios are not an effective method of increasing or sustaining loan growth.

Additionally, there are policy implications of the 2018 legislation changing the Dodd-Frank Act asset thresholds for banks to participate in annual Federal Reserve stress tests. In 2013, Moody's predicted that the stress tests required by the Federal Reserve would discourage lending and would negatively impact bank balance sheets (Hughes, 2013). The analyses in this paper indicate banks under the Dodd-Frank asset thresholds maintain greater loan growth than those over the threshold (i.e. banks subject to the stress tests have lower loan growth). As the analysis shows no indication of overt manipulation at the threshold, this suggests that banks that are not undergoing stress tests are better able to maintain loan growth.

Future research needs to examine the changes in Dodd-Frank after the updates to the regulation, to determine whether banks no longer subject to stress tests (such as those

with assets under $250 billion in 2019) increase their loan growth in subsequent years. The results in this paper suggest that banks that are not subject to the stress tests have stronger loan growth; this would be confirmed if banks that were formerly subject to the stress tests increased their loan growth after the 2019 regulation change.

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CHAPTER 3: BANK BRANCH DEPOSITS, HOUSEHOLD LEVERAGE, AND THE U.S. FINANCIAL CRISIS

3.1 Introduction

The financial crisis of 2007-08 led to growth in the unemployment rate and millions of housing foreclosures throughout the world. When the financial crisis became a prominent economic event, and individuals started to miss mortgage payments, pay their bills late, and carry more debt, many people needed to withdraw money they had deposited in banks with the intention of saving for the future. This led to an increase in deposit withdrawals, particularly from banks that appeared to be in trouble (Anbil, 2018), further signaling increasing economic distress. At the same time, some people were using banks and increasing their deposits as a way to maintain liquidity to pay their current debts (Cunha et al., 2011). Additionally, unemployment rates, subprime mortgages, and foreclosures were not uniformly distributed during the crisis, with regions and countries affected differently by the crisis (Anacker, 2015; Martin, 2011). This uneven impact may have predicted the disparity in the severity of the recession on the regions within the United States.

There are numerous explanations for what precipitated the crisis, and there are many variables that contributed to the severity of the crisis and the extended length of the recovery. Household leverage was a large factor contributing to the recession and the time it took to recover from the crisis (Korinek & Simsek, 2016).[16] There were two

[16] Household leverage in this case is defined as "household debt relative to household income" (Board of Governors of the Federal Reserve System, 2018).

factors that led to increased household leverage prior to the crisis, namely the expanded credit supply and the increase in house prices combined with low interest rates (Mian & Sufi, 2010).

This paper examines the effect of the change in bank branch deposits each year on the household leverage of consumers in the United States using OLS regression analysis with metropolitan statistical area (MSA) fixed effects and cluster analyses based on population growth and income levels. The results show that a change in bank deposits in the years prior to the crisis statistically significantly impacted household leverage in terms of debt-to-income ratio. Prior to the crisis, an increase in deposits is associated with an increase in the debt-to-income ratio, indicating that people were overleveraged and more likely to default on their loans. During the crisis and after implementation of the Dodd-Frank regulations, an increase in deposits is associated with a statistically significant decrease in household leverage. These results suggest that the level of deposits at bank branches were a leading indicator of increased household leverage prior to the crisis and implementation of regulations.

The remaining sections of this paper are organized as follows. Section 3.2 discusses the related literature. Section 3.3 presents the data and methodology. Section 3.4 discusses the results. Finally, Section 3.5 discusses potential policy implications and concludes this paper.

3.2 Related Literature

The news surrounding the financial crisis was focused on the failure of two major U.S. banks, and on people losing their jobs and their homes.[17] Much of the research that followed examined what may have led to the crisis, and the potential indicators that something was wrong before the banks started failing. There are a multitude of studies focusing on the effects of the financial crisis on the outcomes of banks (Acharya & Mora, 2015; Berger & Bouwman, 2013; Covitz et al., 2013), and the effect of the regulations on the economy as a whole (Adrian et al., 2018; Baker et al., 2017; Jakovljević et al., 2015). Further, individual-level outcomes are examined as a consequence of post-crisis unemployment (Chodorow-Reich, 2014; Duygan-Bump et al., 2015), the housing market (Hurd & Rohwedder, 2010; Mian & Sufi, 2011), and the impact of the crisis on investors (Gennaioli et al., 2015; Hoffmann et al., 2013). However, to my knowledge, there is no prior research focusing on the changing level of deposits within bank branches as a potential leading indicator of the crisis.

One of the key relationships examined in the literature is the decrease in bank lending and its relationship to bank failures and the crisis. Ivashina and Scharfstein (2010) find that a decline in lending directly relates to the strength of the deposit base of the bank; those banks with lower deposits suffered the greatest reduction in lending. Focusing more on loan commitments than loan growth, Craioveanu and Mercado-Mendez (2014) look at the effect of both unused loan commitments and transaction

[17] The two major banks that went bankrupt during 2008 were Lehman Brothers and Washington Mutual.

deposits on banks' financial condition via capital ratios during the crisis, comparing those banks that failed with those that did not. Similar to Ivashina and Scharfstein (2010), they find that deposits impact bank financial conditions; in this case, the deposits significantly affect the capital ratios of those banks that did not fail during the crisis (Craioveanu & Mercado-Mendez, 2014). Comparing retail to wholesale deposits, Dagher and Kazimov (2015) find that the banks that had greater reliance on wholesale funding had more funding problems than those that were funded by retail deposits.

The research suggests that the level of deposits held in banks may be more influential in predicting the severity of the crisis and subsequent recession than previously thought. Another major concern for banks during the crisis was asset liquidity. Banks needed to maintain a reasonable level of liquid assets based on demand from borrowers and expanded their cash assets by selling off other assets with lower liquidity such as loans and new loan commitments (Cornett et al., 2011). The banks that held assets with higher market liquidity held onto them, and banks with greater core deposits[18] increased their lending levels during the crisis by using deposits instead of liquid assets to fund loans and commitments (Cornett et al., 2011). Prior to the crisis, there was concern regarding banks participating in relationship lending using core deposit funding;[19] this type of lending significantly impacts the loan supply of these banks when monetary policy is tightened, reducing the availability of funds to borrowers (Black et al., 2007).

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[18] Core deposits include transaction deposits and other insured deposits.
[19] Funding through core deposits allows banks to pass through the "sticky price on deposits" to borrowers, as banks using relationship loans both originate the loans and monitor them throughout, leaving borrowers in some cases "bank-dependent" (Black et al., 2007).

Additionally, illiquidity in the form of loans can be a problem within banks, as banks that held more loans and other illiquid assets reduced lending during the crisis (Cornett et al., 2011). Consumer demand for liquidity often arrives during a time that the banks are unable to disburse large amounts of cash to depositors if they hold too many illiquid assets. This is a common problem during financial crises; financial fragility becomes prominent due to this combination of illiquid loans and consumers demanding a return of liquid funds in poor economic conditions (Diamond & Rajan, 2001). During the crisis, banks maintained asset liquidity by cutting back on their lending, as exemplified by a study of German retail banking (Puri et al., 2011). Puri et al. (2011) also find that depositors with prior bank relationships are less likely to have a loan rejected at that bank during the crisis than new customers, thus somewhat lessening the effects on the supply side – an important policy implication. As a result of banks decreasing their lending due to illiquid loans, individual consumers and households were affected by the reduction in available credit supply (Jensen & Johannesen, 2017).

Several studies investigate whether the growth in household leverage could be used to predict the extent of the crisis. Mian and Sufi (2010) examine the crisis using household leverage as a predictor for the severity of the subsequent recession. They conclude that the growth of household leverage could have been used to predict the economic decline leading to the recession, as consumers cut back on durable consumption as part of an effort to pay their increasing debts. Consumers started purchasing fewer durable goods, such as cars, late in 2007; this occurred concurrently with increasing defaults on homes (Mian & Sufi, 2010). Andersen et al. (2016) use data

from Danish households and find that households with greater debt-to-income ratios spent a larger percentage of their income prior to the crisis, leading these highly leveraged households to potentially be unable to borrow post-crisis; thus, these households would reduce their spending at a higher rate than less leveraged households. Similarly, Glick and Lansing (2010) find that household consumption started declining as soon as the housing prices began to fall, and Ramcharan et al. (2016) indicate that the recession may have been caused in part by the reduction in availability of credit due to the price collapse in housing-backed financial securities. In a prior recession in the early 1990s, King (1994) found that increases in household leverage ratios before the recession led to increased severity of recession in 10 major countries, similar to the results of Mian and Sufi (2010) for the 2007-08 crisis. Household consumption levels have also been impacted by the geographically disparate levels of wealth, with the marginal propensity to consume varying by zip codes and, independently, by income level (Mian et al., 2013).

The research has shown a strong connection between household leverage and the severity of the crisis and recession. However, it is expected that household leverage was preceded by some other predictor of the crisis, particularly, a change in the level of bank deposits. The relationship between bank deposits and purchasing decisions is a mechanical one; the decision to save money in a bank often precludes the decision to spend money, and the decision to use money to purchase items means that money is not being saved. Thus, the question is what impact the change in deposits had on household leverage.

3.2.1 Theoretical Foundation

One concept that supports the notion that lending and deposits are related to the severity of the crisis is the theory proposed by Diamond and Dybvig (1983) to explain consumer desire for liquidity on demand, concurrently with a demand for illiquid assets like mortgages. They use the concept of bank runs to explain the damage to the economy brought on by this combination. Long before the crisis, they predicted that banks would have incentive to take risks on investments if they anticipated a bailout, though not entirely in the manner of the "too-big-to-fail" bank bailouts by the government.

However, there is a connection between this liquidity risk of the bank run model and the illiquidity of the major banks and bank holding companies during the crisis. Investors that would prefer to maintain liquidity in their assets will invest in a bank via deposits (Diamond, 2007), but the same liquidity that investors desire is what enables them to easily pull their deposits in adverse economic situations – the panic of the so-called run on the banks. Part of the theory put forth by Diamond and Dybvig (1983) involves an economic game theory model, in which a potential economic panic or impending crisis forces depositors to make decisions on whether to keep deposits within a bank, while risking the potential that when they need the money it will not be available to them as other depositors are making that same decision. Related to this theory, Chari and Jagannathan (1988) examine the bank run model of Diamond and Dybvig and conclude that the greatest risk of bank runs begins with banks that appear insolvent, regardless of whether consumers expect lower future returns.

Table 3.1: Deposits and Debt-to-Income Theory

This table presents the theory behind the analysis of the deposits. While the deposits, debt, and income are going in specific directions, it is unclear which direction the debt-to-income ratio is heading during the three periods this paper covers.

	No Crisis	**Pre-Crisis**	**Crisis**	**Post-Regulation**
Deposits	↑	↑	↓	↑
Debt	–	↑	↑	↑
Income	↑	↑	↓	↑
Debt-to-Income	↓	?	?	?

There are expectations for how the main variables behave during times of crisis based on the literature. Table 3.1 presents the theory behind the hypotheses that bank deposits and debt-to-income ratios are related in times of crisis. During good economic times, it is expected that bank branch deposits would be increasing overall, along with income. As a result, the debt-to-income ratio will be decreasing during these times.

Prior to the financial crisis, while deposits and income were still increasing, debt was also increasing at a rapid pace due to consumers purchasing houses and durable goods that they could not necessarily afford even with an increased income (Reinhart & Rogoff, 2008). It is unclear at this point what the relationship is between these factors and the debt-to-income ratio. Similarly, during the crisis, deposits and income decreased at a large rate while debt rapidly increased (Guttmann & Plihon, 2010), but the impact of this on debt-to-income and household leverage is still unclear. Post-regulation when the economy started improving conditions, the deposits and income started increasing again,

along with debt. Again, it is not yet clear how these factors impact debt-to-income. This paper further explores the relationship between deposits and the changing debt-to-income ratio, which will help answer the question of the impact that deposits have on household leverage.

3.3 Data and Methodology

3.3.1 Data

This paper examines the level of deposits at bank branches throughout the 392 MSAs of the United States, and the impact of branch-level deposits on MSA-level household leverage. An annual panel dataset is built, from the second quarter of 2000 through the second quarter of 2019 that includes all bank branches as described below. Hence, this dataset contains observations before, during, and after the financial crisis.

The Financial Crisis began in 2007, so the years from 2000 to the first quarter of 2007 represent the pre-crisis period and from the second quarter of 2007 to the second quarter of 2009 comprise the crisis period; both preceding periods are the pre-regulation years.[20] Finally, the third quarter of 2009 to the second quarter of 2019 include the post-regulation years, the period in which at least some form of bank regulations have been in effect (based on SCAP occurring in the second quarter of 2009).[21]

Data from the bank holding company Call Reports are obtained from Wharton Research Data Services (WRDS) for the years 2000 through 2018, and from the Federal Reserve Bank of Chicago from 2018 to the second quarter of 2019. These data are merged with the Summary of Deposits from the FDIC (Federal Deposit Insurance

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[20] The Financial Crisis and Great Recession period is considered to be from 2007Q1 to 2009Q2, but since the data for this paper is gathered as of the second quarter of each year, the second quarter is used for computations (Federal Reserve Bank of St. Louis, 2019).

[21] Prior to the implementation of the Dodd-Frank Act, the first of the Federal Reserve bank stress tests – the Supervisory Capital Assessment Program (SCAP) – was conducted in the second quarter of 2009 (Bookstaber, Cetina, Feldberg, Flood, & Glasserman, 2014). While this does not include Dodd-Frank, it is still considered the post-regulation period based on the first SCAP exam occurring, and the recession being ended at this point.

Corporation) in order to get the amount of deposits from each bank branch.[22] The Summary of Deposits is collected by the FDIC annually as of June 30, and all FDIC-insured institutions with branch offices are required to submit the survey to the FDIC each year (FDIC, 2019). Geographic identifiers of bank branches in the Summary of Deposits raw data include the MSA code, zip code, and street address of each branch, as well as latitude and longitude.

The dependent variable is the change in the growth of annual household leverage at the MSA level. The variable for household leverage measures household debt as a percentage of disposable income. Applying the variable concept from Mian and Sufi (2010), the change in the debt-to-income ratio is used. The change in annual median household debt-to-income ratio by MSA is used to measure the annual growth in household leverage.[23] The data for the household debt-to-income ratio at the MSA level is gathered from the Federal Reserve.

Bank deposits are aggregated at the branch-level and examined based on three periods of time as described above: pre-crisis, crisis, and post-crisis/post-regulation. The main explanatory variable of interest is the change in the level of deposits[24] at each bank branch. To analyze the impact on household leverage, deposits are separated into the

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[22] Deposits within branches are reported based on internal record-keeping practices – typically the deposits are assigned to the office nearest the address of the accountholder or where the account is most active (Federal Deposit Insurance Corporation (FDIC), 2019).

[23] The change in debt-to-income ratio is measured from the second quarter each year to the second quarter of the next year to match the Summary of Deposits data.

[24] Deposits are measured as the log of total deposits at each branch each year; change in deposits is the difference in the log of total deposits from the second quarter in one year to the second quarter in the following year, to match the Summary of Deposits data.

aforementioned three distinct time periods. This enables measurement of the change in deposit level in each period.

Table 3.2: Summary Statistics

This table presents descriptive statistics for the variables of interest from the sample of banks within the data. The dependent variable, debt-to-income ratio, is computed as percent change year over year, as are control variables: loan growth, GDP, and unemployment rate. The explanatory variable, deposits, is computed as a natural logarithm, and then subtracted year over year to get the annual change in deposits; pre, during, and post indicate the periods of time.

Variable	Mean	Median	Std. Dev.
MSA Level Variables			
Debt-to-Income Ratio (percent change)	1.37	0.00	9.55
Median Annual Income (in dollars)	61,343.6	59,478	12,045.3
Unemployment Rate (percent change)	2.35	-5.71	24.88
GDP Change (percent change)	3.74	3.8	3.66
Branch Level Variables			
Deposits (difference in ln deposits yearly)	0.0853	0.0429	0.4266
PRE * deposits	0.1139	0.0498	0.5242
DURING * deposits	0.0918	0.0296	0.4993
POST * deposits	0.0669	0.0429	0.3271
Loan Growth (percent change)	9.52	5.09	20.14
Delinquencies – Loans (difference yearly)	0.00003	-0.0001	0.0023
Total Assets (in millions)	$538,000	$111,000	$803,000
Total Domestic Deposits (in millions)	$311,000	$88,300	$432,000
National Level Variables			
Fed Funds Rate	1.47	0.95	1.67

N (branch-year) = 843,653

Control variables include the federal funds rate nationwide and GDP, median annual income, and unemployment levels by MSA to control for the national and local economies. Unemployment is measured in terms of the year over year percentage change, calculated by MSA. Additional bank branch-level control variables include loans outstanding and loan growth to control for loan-level delinquency and demand. Loan delinquencies are measured at the bank level as the annual change in delinquent loans as

a percentage of total assets; it is calculated as the difference from each year to the next. Data for the control variables come from several sources, including economic data from the Federal Reserve Bank of St. Louis (FRED) at the national level, and from the Bureau of Labor Statistics (BLS), and the Bureau of Economic Analysis (BEA), both at the MSA level.

Summary statistics are reported in Table 3.2. Log deposits during the crisis increased, on average by 0.085 (approximately $1.09 million per branch); less than the pre-crisis increase of 0.114 ($1.12 million), but greater than the post-regulation periods increase of 0.067 ($1.07 million), which is potentially related to the change in the debt-to-income ratio. The debt-to-income ratio has an average of 1.4% annual increase; in three MSAs,[25] the annual change in the ratio is as high as a 72% increase and one MSA[26] had as great as a 42% decrease, suggesting that there are at least several areas in the country that went through a much greater change in household leverage than others.

Figure 3.1 shows the debt-to-income ratio in the three periods (pre-crisis, crisis, and post-regulation) in the U.S. The figure clearly shows that during the crisis, the debt-to-income ratio was lowest overall. Further, the debt-to-income ratio in the post-regulation period is lower than the pre-crisis period in areas like the West Coast, but higher in certain regions, specifically in the Northeast.

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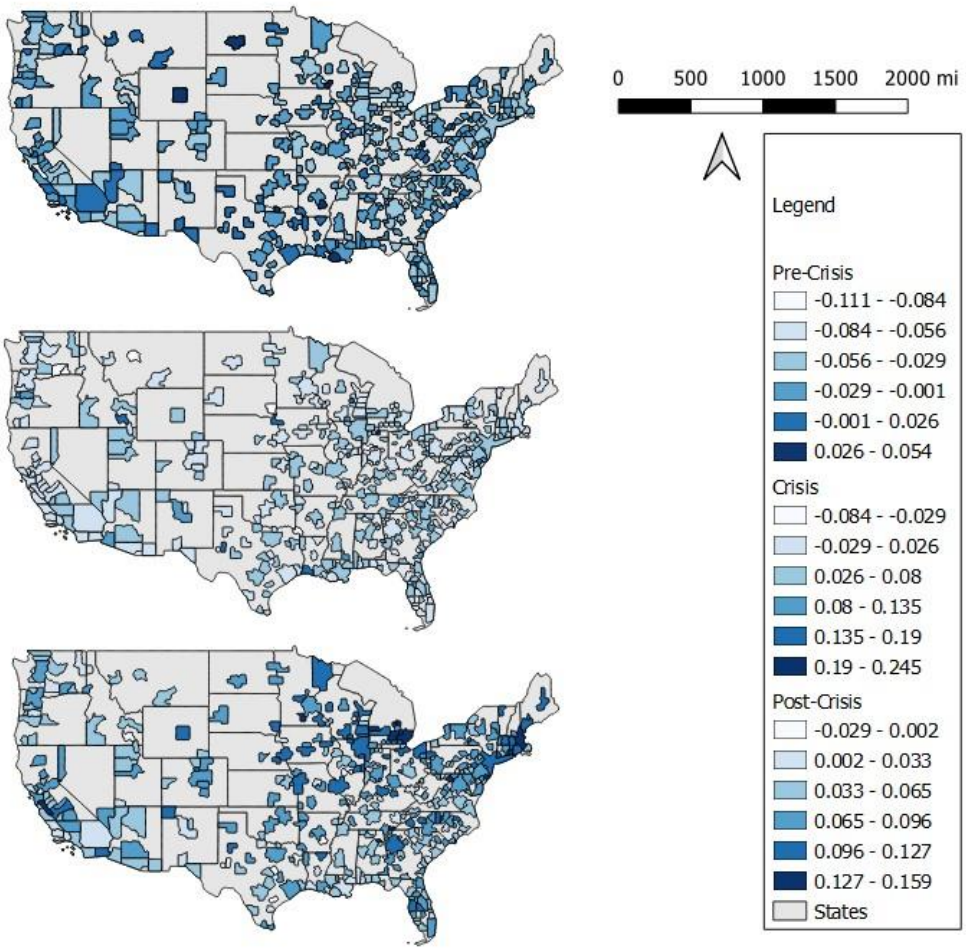
[25] Elkhart-Goshen, IN; Beckley, WV; Midland, MI; these MSAs comprise 116 observations in the dataset
[26] Grand Island, NE; this MSA comprises 42 observations in the dataset

Figure 3.1 Map of Debt-to-Income Ratio during Pre-Crisis, Crisis, and Post-Regulation Periods



This figure shows the debt-to-income ratio in the three periods – pre-crisis, crisis, and post-regulation. Lighter colors represent lower debt-to-income levels, while darker colors represent higher debt-to-income levels.

3.3.2 Empirical Specification

To analyze the effect that a change in deposits has on household leverage, this paper first estimates an OLS regression with MSA fixed effects, using the following equation:

$$\left(\frac{HL_{j,t}}{HL_{j,t-1}} - 1\right) =$$

$$\beta_0 + \beta_1(PRE * \Delta Log\ Deposits_i) + \beta_2(DURING * \Delta Log\ Deposits_i)$$
$$+\beta_3(POST * \Delta Log\ Deposits_i) + \beta_4 FedFundsRate +$$
$$\boldsymbol{\lambda} MSA_j + \boldsymbol{\gamma X}_{i,t} + \boldsymbol{\zeta Z}_{j,t} + u_{i,t} \quad (1)$$

where $HL_{j,t}$ is the household leverage measured for each MSA *j* in time *t*, and $\Delta Log\ Deposits_i$ represents the change in log of total deposits from branch *i* in time *t – 1* to time *t*; *PRE, DURING,* and *POST* represent indicator variables for the years before the crisis, during the crisis, and after Federal Reserve regulation implementation as specified earlier. Control variables as described above are contained in the vector $\boldsymbol{X}_{i,t}$ for branch-level variables and $\boldsymbol{Z}_{j,t}$ for MSA-level variables, as well as the Fed Funds rate, which is a national-level variable. MSA_j is a vector of MSA dummy variables, controlling for regional fixed effects.[27] Equation (1) tests how the change in branch-level deposits in each of the three periods impacts the growth in MSA-level household leverage.

In order to assess and control for differences across regions, this analysis uses data from the FDIC Summary of Deposits, which includes coding for MSA for each bank branch. The fixed effects regression uses dummy variables for each MSA within the United States to differentiate specific areas in the analysis.

To further probe into regional differences, the model in equation (1) is estimated separately after clustering the MSAs using a *K*-means algorithm, which separates the data

[27] The analysis uses the latest MSA delineation as defined by the Office of Management and Budget as of April 10, 2018, as MSA boundaries change over time (Office of Management and Budget, 2018).

based on the means of the variables used (Rokach and Maimon, 2005). In this analysis, clustering is done using the following variables: population growth, population levels, median income, unemployment, education levels, and percentage of employment in the manufacturing and construction industries. This forms clusters of growing, stable, or shrinking MSAs, and allows comparison across the different types of regions based on their socioeconomic conditions, to determine whether such conditions had an impact on the effect of the regulations.

Variables are standardized by MSA before clustering; standardization allows all variables an equal weight in the clusters as the variables are measured using different units through time (e.g., percentage, dollars) (Rokach & Maimon, 2005). Three clusters of MSAs are used, as verified by the Caliński–Harabasz pseudo-F value. The three-cluster solution has the largest stopping value (measured against four, five, and six clusters). This suggests that these three clusters of MSAs are the most distinct and well separated within the data (Caliński & Harabasz, 1974).

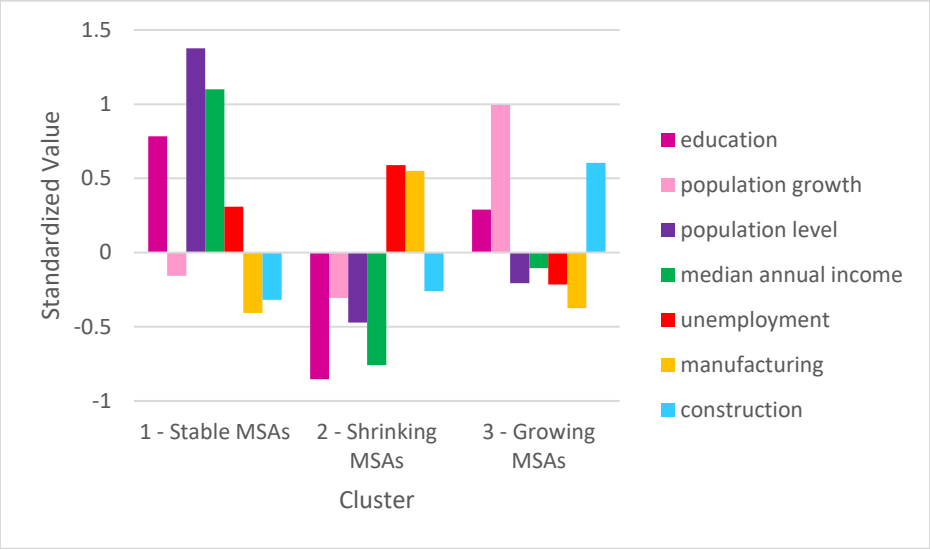
A region is defined as shrinking, stable, or growing based on the means of the variables specified above. Then, the results are compared across the region types. Figure 3.2 shows the standardized values of the variables used to cluster the different MSAs, and clusters are described as follows:

Cluster 1: Stable MSAs cluster. This cluster includes MSAs with less population growth, but higher population levels. MSAs in this cluster have higher levels of education and income, and lower percentages of manufacturing and construction jobs. Cities in stable MSAs include Chicago and NYC.

Cluster 2: Shrinking MSAs cluster. This cluster includes MSAs with decreasing population growth and population levels, lower education and income, and higher unemployment. Cities within shrinking MSAs include Detroit and Pittsburgh.

Cluster 3: Growing MSAs cluster. This cluster includes MSAs with increased population growth, but lower overall population levels and education than the stable MSAs. It also has the lowest unemployment levels, and increased percentage of construction jobs. Cities in growing MSAs include Charlotte and Dallas.

Figure 3.2: Description of Clusters



This figure shows the clusters based on the variables shown in the key. Cluster 1 is the shrinking MSA cluster, while Cluster 2 is the stable MSA cluster, and Cluster 3 is the growing MSA cluster.

3.3.3 Multilevel model

To determine whether the effect of deposits on household leverage is stronger over time or across MSAs, a multilevel repeated measures model is used. This model is used to examine deposits across MSAs and across banks, and the full three-level model includes banks nested within MSAs, with both nested within time.

At the first level of the multilevel model, household leverage is measured using variation over time:

$$\frac{HL_{t,j}}{HL_{t-1,j}} =$$

$$\pi_{0,i,j} + \pi_{1,i,j} time_{t,i,j} + \pi_{2,i,j} gmdeposits_{t,i} + \pi_{3,i,j} gm\boldsymbol{X}_{t,j} + \pi_{4,i,j} gm\boldsymbol{Z}_{t,i} + \varepsilon_{t,i,j} \quad (2)$$

where $HL_{t,j}$ is the household leverage for MSA *j* in time *t*. The time periods are separated, and the pre-crisis period is omitted as the reference group. This model uses group mean centering of the variables of interest (*gm*)[28] which allows comparison of the individual means to the means of the group (i.e., the means of each MSA or branch to the means of the whole country).

The level 2 model includes the cross-sectional variables that vary across MSAs. This model is measured as:

$$\pi_{0,i,j} = \beta_{0,0,j} + \beta_{0,1,j} \overline{deposits}_{m,i} + \beta_{0,2,j} \overline{\boldsymbol{X}}_{m,j} + r_{m,i,j}$$

$$\pi_{k,i,j} = \beta_{k,0,j} + r_{m,i,j}, \text{ where k = 1, 2 ,3} \quad (3)$$

This model accounts for the variation from one MSA to another, using the means of the independent and control variables.

Finally, the level 3 model allows for variation across banks:

$$\beta_{0,0,j} = \gamma_{0,0,0} + \gamma_{0,0,1} \overline{\boldsymbol{Z}}_{m,i} + \mu_{0,0,i}$$

$$\beta_{0,1,j} = \gamma_{1,0,0}$$

$$\beta_{0,2,j} = \gamma_{2,0,0} \quad (4)$$

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[28] The grand mean is estimated over all banks. This is done by subtracting the group mean from the individual score and makes the coefficient more interpretable.

Which leads to the full mixed model:

$$\frac{HL_{t,j}}{HL_{t-1,j}} =$$

$$\gamma_{0,0,0} + \gamma_{0,0,1}\overline{\boldsymbol{Z}}_{m,j} + \gamma_{1,0,0}\overline{deposits}_{m,i} + \gamma_{2,0,0}\overline{\boldsymbol{X}}_{m,i,j} +$$

$$\pi_{1,i,j}time_{t,i,j} + \pi_{2,i,j}gmdeposits_{t,i} + \pi_{3,i,j}gm\boldsymbol{X}_{t,i,j} +$$

$$\pi_{4,i,j}gm\boldsymbol{Z}_{t,i} + \varepsilon_{t,i,j} + r_{m,i,j} + \mu_{0,0,j} \quad (5)$$

In this case, deposits are grouped within the bank branches, and each year that deposits are reported is a repeated measure in the panel dataset.

3.4 Results

3.4.1 Baseline Results

Results for the MSA fixed effects regression model in equation (1) are shown in Table 3.3. Controlling for bank portfolio differences, as well as regional and national economic conditions, there is a significant decrease in the debt-to-income ratio (household leverage), but only in the crisis period and the period after the implementation of Dodd-Frank Act regulations. The pre-crisis period shows a significant increase in the debt-to-income ratio. The coefficient on *pre-crisis* in column 1 is 0.018, and coefficients on *crisis* and *post-regulation* are both approximately -0.01 (all are significant at the 1% level). Adding a one-year lagged growth rate of deposits provides similar results for each period.

Based on the results, with deposits increasing and debt increasing, this suggests that people are taking out loans and other household debt at a larger ratio to their income, while still maintaining deposit growth. While it is expected that deposits would decrease in accordance with the debt-to-income ratio going up, these results seem to indicate that people were not behaving in this manner prior to the crisis, i.e., that people would not be saving money when they were overleveraged in household debt. However, during the crisis and after the recession period, increasing deposits is associated with a decrease in the debt-to-income ratio, suggesting that people started acting as the literature would indicate; they would be expected to save money while only taking out loans they could afford. The results from the model with MSA fixed effects and the one without are qualitatively the same; this suggests there is less variation between MSAs than expected.

Table 3.3: Baseline Results

This table presents the MSA fixed effects analysis results in which the changes in levels of deposits are examined for the banks within the sample and how that affects the household leverage (using the debt-to-income ratio as proxy). Pre-crisis period includes years 2001 to 2006, crisis period includes years 2007 to 2009, and post-regulation period includes years after 2009. Column 2 includes one lag of deposits for the year preceding. Column 3 presents the OLS regression with no MSA effects. ***, **, * represent 1, 5, and 10% significance levels, respectively. Standard errors clustered at the MSA level are shown in parentheses below coefficient estimates.

VARIABLES	(1)	(2)	(3)
DV: Debt-to-Income Ratio	MSA Fixed Effects	MSA Fixed Effects and Lagged Deposits	Without MSA Fixed Effects
Deposits			
Pre-Crisis	0.0180***	0.0216***	0.0177***
	(0.0020)	(0.0023)	(0.0019)
Crisis	-0.0131***	-0.0133***	-0.0132***
	(0.0021)	(0.0021)	(0.0020)
Post-Regulation	-0.0103***	-0.0097***	-0.0105***
	(0.0014)	(0.0013)	(0.0014)
Deposits – lag (t-1)			
Pre-Crisis	-	0.0256***	-
		(0.0022)	
Crisis	-	-0.0121***	-
		(0.0015)	
Post-Regulation	-	-0.0111***	-
		(0.0012)	
Loan Growth	0.0079***	0.0075**	0.0096***
	(0.0030)	(0.0029)	(0.0029)
Delinquent Loans	-1.4592***	-1.3615***	-1.4481***
	(0.3166)	(0.3159)	(0.3146)
Fed Funds Rate	0.0125***	0.0121***	0.0125***
	(0.0007)	(0.0007)	(0.0007)
Unemployment Rate	0.1089***	0.1084***	0.1081***
	(0.0105)	(0.0105)	(0.0103)
Constant	-0.0078***	-0.0074***	-0.0080***
	(0.0011)	(0.0011)	(0.0018)
MSA Fixed Effects	Yes	Yes	No
Observations	843,653	843,653	843,653
Adjusted R^2	0.1351	0.1411	0.1236

Table 3.4: Effect by Year, One Lag of Deposits (t-1)

This table presents the MSA fixed effects stratified by year. Control variables not shown include loan growth, loan delinquencies, and unemployment, all by MSA, and the federal funds rate countrywide. ***, **, * represent 1, 5, and 10% significance levels, respectively. Standard errors clustered at the MSA level are shown in parentheses below coefficient estimates.

Pre-crisis	coefficient	coefficient (t-1)	CPI adjusted
2001	-0.0131***	-0.0006	-0.0091***
	(0.0027)	(0.0015)	(0.0019)
2002	0.0403***	0.0332***	0.0283***
	(0.0058)	(0.0044)	(0.0041)
2003	0.0421***	0.0326***	0.0302***
	(0.0047)	(0.0037)	(0.0034)
2004	0.0455***	0.0503***	0.0337***
	(0.0058)	(0.0059)	(0.0043)
2005	0.0101***	0.0070*	0.0077***
	(0.0038)	(0.0036)	(0.0029)
2006	-0.0073	-0.0046	-0.0058
	(0.0056)	(0.0044)	(0.0044)
Crisis			
2007	-0.0118***	-0.0252***	-0.0096***
	(0.0033)	(0.0040)	(0.0027)
2008	-0.0019	-0.0048*	-0.0016
	(0.0017)	(0.0026)	(0.0015)
2009	-0.0227***	-0.0142***	-0.0191***
	(0.0051)	(0.0030)	(0.0043)
Post-regulation			
2010	-0.0093**	-0.0185***	-0.0080**
	(0.0038)	(0.0037)	(0.0032)
2011	-0.0180***	-0.0128***	-0.0159***
	(0.0042)	(0.0030)	(0.0037)
2012	-0.0221***	-0.0214***	-0.0198***
	(0.0067)	(0.0071)	(0.0060)
2013	-0.0280***	-0.0243***	-0.0255***
	(0.0061)	(0.0043)	(0.0055)
2014	0.0110***	0.0125**	0.0102***
	(0.0041)	(0.0051)	(0.0038)
2015	-0.0149	-0.0099	-0.0139*
	(0.0091)	(0.0084)	(0.0084)
2016	0.0130	0.0193	0.0123
	(0.0088)	(0.0123)	(0.0083)
2017	0.0026	0.0049	0.0025
	(0.0072)	(0.0068)	(0.0069)
2018	-0.0159***	-0.0252***	-0.0157***
	(0.0046)	(0.0056)	(0.0045)
Observations	817,236	753,700	817,555
Adjusted R^2:	0.1449	0.1614	0.1449

Robustness checks on the analysis are done by adjusting the deposits for inflation using the Consumer Price Index (CPI) then running the analysis. The results of the robustness test are reported in Table 3.3; the coefficients remain the same in sign and significance, and are slightly lower due to the inflation adjustment, as expected. For example, in 2010, the coefficient on deposits in column 1 (unadjusted) is -0.009, while the coefficient in column 3 (CPI adjusted) is -0.008 (both significant at the 1% level).

The next step is to regress the debt-to-income ratio on deposits by year, which presents the same outcomes as the full model. Table 3.4 shows the results for the individual years. In the year just prior to the start of the crisis, 2006, the coefficient on the debt-to-income growth was negative; this trend continued into the crisis years and the coefficient did not become positive again until 2014 and 2016. The same trend appears with a one-year lag of deposits for each individual year. Interestingly, the coefficient turns negative in 2006, just before the financial crisis, and again in 2018, potentially signaling economic downturn in future years

Next, the differences are examined between household leverage growth for those banks that have a growing level of deposits each year and those that have a shrinking level of deposits. As shown in Table 3.5, the effects of shrinking or growing deposits on household leverage differ in sign: the shrinking deposits have the opposite effect of the growing deposits. Before the crisis, when deposits are decreasing, so too is the debt-to-income ratio; during and after the crisis, as deposits decline, the debt-to-income ratio is increasing. As deposits decrease and the debt-to-income ratio increases during and after the crisis, this indicates people were not saving money, but were taking out more loans.

In comparison, before the crisis, at the banks where deposits increased, so too did the debt-to-income ratio; people were saving money and taking out more debt. During and after the crisis, when deposits increased, the debt-to-income ratio decreased, which is what would normally be expected – people are saving money in the bank and taking out fewer loans or paying off those obligations outstanding.

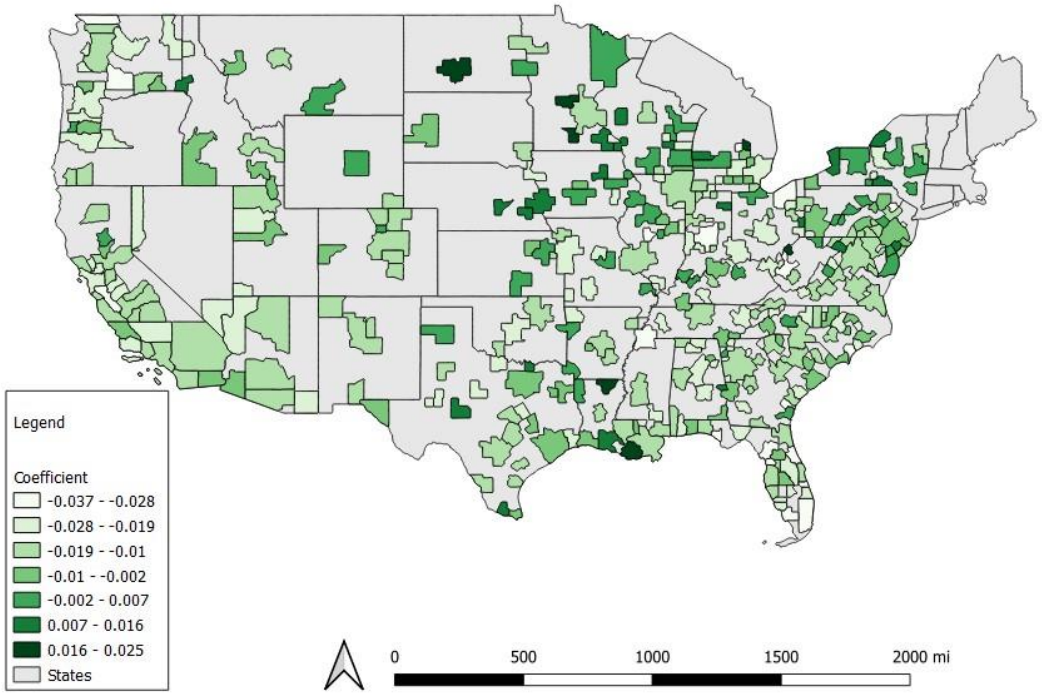
Table 3.5: Effect of Deposits on Household Leverage by Increasing or Decreasing Deposits

This table presents the results for diverging deposit growth as the main independent variable. The dependent variable is the annual change in household leverage (using the debt-to-income ratio as proxy). The deposits growing column limits the sample to bank branches that had an increase in deposits year over year, whereas the deposits shrinking column limits to those with a decrease in deposits year over year. ***, **, * represent 1, 5, and 10% significance levels, respectively. Standard errors clustered at the MSA level are shown in parentheses below coefficient estimates.

VARIABLES	(1)	(2)
DV: Debt-to-Income Ratio	Deposits Growing	Deposits Shrinking
Deposits		
Pre-Crisis	0.0366***	-0.0361***
	(0.0033)	(0.0029)
Crisis	-0.0292***	0.0286***
	(0.0043)	(0.0032)
Post-Regulation	-0.0301***	0.0245***
	(0.0023)	(0.0019)
Loan Growth	0.0112***	0.0026
	(0.0037)	(0.0030)
Delinquent Loans	-1.2632***	-0.9345***
	(0.3524)	(0.2826)
Fed Funds Rate	0.0111***	0.0116***
	(0.0008)	(0.0007)
Unemployment Rate	0.1105***	0.1067***
	(0.0125)	(0.0080)
Constant	-0.0048***	-0.0073***
	(0.0011)	(0.0011)
MSA Fixed Effects	Yes	Yes
Observations	537,946	279,271
Adjusted R2	0.1599	0.1515

Figure 3.3 shows the mapped coefficients for the MSA fixed effects with the New York City metro area as the reference region. Compared to the NYC metro area, the South and West regions have, on average, lower household leverage growth, and only a few MSAs in the Midwest and Texas had greater household leverage growth when compared to the reference region. However, as many of the MSAs show similar household leverage growth throughout the country, the possibility that the effects of changing deposits are stronger over time than across the different areas of the country is explored.

Figure 3.3: MSA Regression Coefficients – Reference region: New York City MSA



This figure presents the coefficients for the MSAs from the base regression model. Lighter green colors represent lower household leverage growth in comparison to the NYC MSA, while darker green colors represent higher household leverage growth.

3.4.2 Deposit levels affecting household leverage over time or across MSAs

Having found that changing levels of deposits at bank branches within different MSAs show a similar pattern across many of the MSAs, the next step is to examine the source of these similarities. An attempt to determine the impact of deposits over time uses the multilevel repeated measures model in equation (5), with bank branches nested within MSAs. If the impacts on household leverage are relatively similar across the country, then it is expected that the closer it gets to the crisis, the greater the impact of changing deposits will be on the household leverage.

Table 3.6 presents the results of the multilevel model. Across MSAs and banks, deposits are not significant predictors of household leverage. However, across banks, deposits are a significant predictor of household leverage. In all models, over time, the change in deposits is statistically significantly associated with decreasing household leverage in comparison to the pre-crisis period.

The effects are stronger over time periods than across MSAs, where 1.8% of the variation in household leverage can be explained by MSAs and the fixed effect factors, 98.2% of the variation in household leverage is accounted for over time. The effects are also stronger between banks within MSAs, at 8%, than solely across MSAs at 1.7%; however, the effects over time are still the strongest. Similarly, running the model across banks and over time presents 11.2% variation across banks and 88.8% over time.

Table 3.6: Multilevel Repeated Measures Model

This table presents results for bank deposit levels changing, and the impact on household leverage (with debt-to-income as proxy) over time and across MSAs (column 1), banks (column 2), and MSAs and banks (column 3). Variables for the period during the crisis (Crisis) and the post regulation period (Post-regulation) are reported as compared to the Pre-crisis period. ***, **, * represent 1, 5, and 10% significance levels, respectively. Standard errors clustered at the MSA level are shown in parentheses below coefficient estimates.

VARIABLES	(1)	(2)	(3)
DV: Debt-to-Income Ratio	Across MSAs	Across Banks	Across MSA and Banks
Years (Pre-crisis omitted)			
Crisis	-0.0759***	-0.0735***	-0.0729***
	(0.0003)	(0.0003)	(0.0003)
Post-Regulation	-0.1004***	-0.0987***	-0.0978***
	(0.0002)	(0.0002)	(0.0002)
Effects on intercept			
Deposits	0.0001	0.0227***	0.0103
	(0.0204)	(0.0043)	(0.0231)
Loan Growth	0.0859***	0.1987***	0.1059***
	(0.0305)	(0.0069)	(0.0348)
Delinquent Loans	-15.9286**	-15.2950***	-18.5411**
	(6.6712)	(1.5867)	(7.5838)
Unemployment Rate	0.0004	-0.0594***	0.0187
	(0.0317)	(0.0067)	(0.0357)
Effects over time			
Deposits	-0.0006***	-0.0006***	-0.0007***
	(0.0002)	(0.0002)	(0.0002)
Loan Growth	-0.0038***	-0.0062***	-0.0054***
	(0.0005)	(0.0005)	(0.0005)
Delinquent Loans	-0.1079**	-0.1024**	-0.1235***
	(0.0432)	(0.0439)	(0.0432)
Unemployment Rate	0.0724***	0.0726***	0.0724***
	(0.0004)	(0.0005)	(0.0004)
Intercept	0.0714***	0.0593***	0.0672***
	(0.0033)	(0.0011)	(0.0038)
Intraclass Correlation			
MSA	0.018		0.017
Bank		0.112	0.080
Time	0.982	0.888	0.920
Observations	817,236	817,236	817,236

Significant results are found over time and across banks in this model, without including MSA random effects. For example, the coefficient on *deposits* in regression 2

across banks is 0.023, and over time is -0.0006 (both significant at the 1% level), suggesting that while household leverage decreases over time, the effect of the change in deposits varies across the banks, impacting the intercept. The effects are very small in magnitude based on the coefficients.

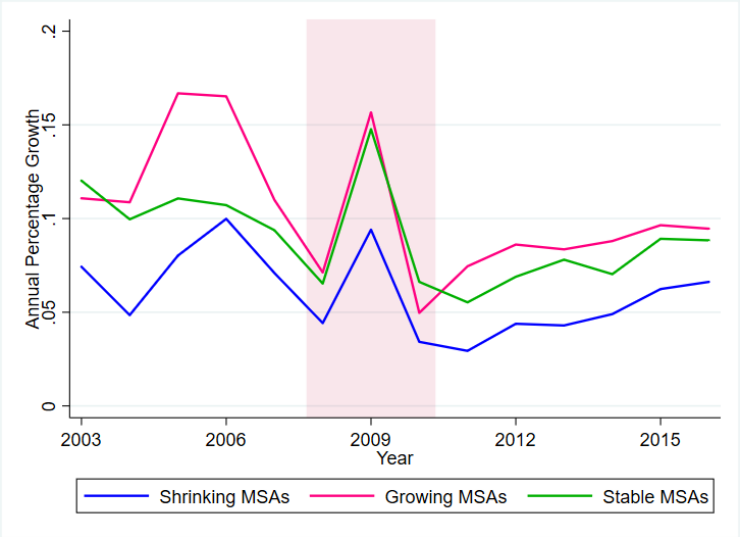
3.4.3 Cluster analysis

Another option to consider is that the impact on household leverage in the MSAs may have been similar based on geographic location, but different based on the socioeconomic conditions of each area. Specifically, to examine the possibility that lower-income areas were affected differently than higher-income areas, and the possibility that areas with shrinking populations were affected differently than areas with growing populations.

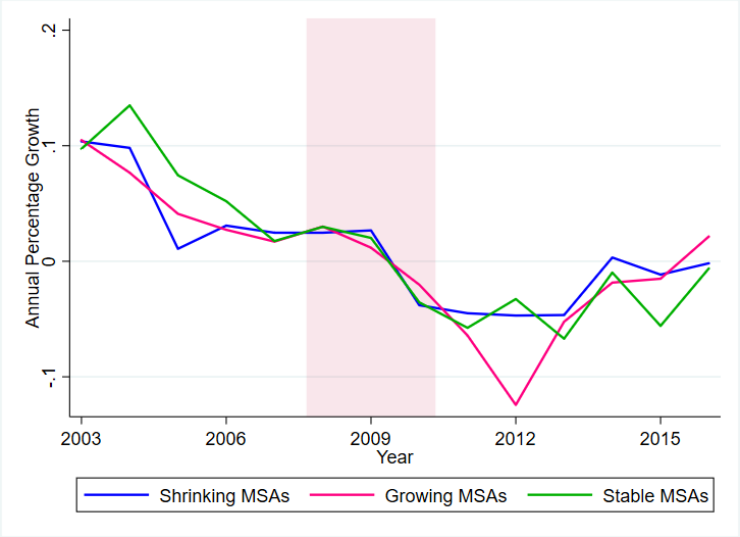
Figure 3.4 shows the average deposits (Figure 3.4*a*) and household leverage (Figure 3.4*b*) by cluster through time. It is clear from Figure 3.4*a* that the shrinking MSAs have a lower level of deposits in all years, but otherwise follow the same trends as growing MSAs and stable MSAs. In Figure 3.4*b*, the trends in household leverage are similar by cluster apart from the growing MSAs in 2012 showing a large drop in household leverage that the other clusters do not appear to be experiencing.

Figure 3.4: Average Deposits and Household Leverage by Cluster, Through Time

3.4a. Average Annual Percentage Growth in Deposits, by Cluster



3.4b. Average Household Leverage Percentage Growth Annually, by Cluster



These figures show the changes in deposits (Figure 3.4*a*) and household leverage (Figure 3.4*b*) over the time period of the analysis. The changes are separated by cluster to visualize the differences in the shrinking MSAs, stable MSAs, and growing MSAs.

To examine this further, the regression in equation (1) is run using the clustered regions. MSAs are clustered by population growth and population levels, education

levels, median annual income, unemployment, and percentage of employment in manufacturing and construction. Table 3.7 presents the cluster analysis results for the different population clusters: shrinking, stable and growing. The results are similar in sign and magnitude to the initial analysis using OLS with MSA fixed effects for stable regions, but when the regions are separated, the coefficients for the shrinking and growing regions differ in magnitude.

Shrinking regions have a significant increase in household leverage during the pre-crisis period smaller than the initial analysis, where the coefficient on *pre-crisis* in regression 1 is 0.009 (significant at the 1% level, as compared to 0.02 in the initial analysis). Also, in the shrinking regions, increasing deposits are associated with a decrease in household leverage in the crisis and post-regulation period; the coefficient on *crisis* in regression 1 is -0.007 and on *post-regulation* is -0.003 (both significant at the 1% level).

Growing regions show significance for the pre-crisis period as well, but larger than the shrinking regions, where the coefficient on *pre-crisis* in regression 3 is 0.013 (significant at the 1% level). For all regions, the increase in deposits leads to a decrease in household leverage post-crisis (e.g., the coefficients on *post-regulation* in regressions 1-3 are all negative).

These results suggest that, along with the results for shrinking and growing deposits, people in stable (e.g., Chicago and New York City) and growing areas (e.g., Charlotte and Dallas) were more likely to increase their household debt before the crisis

period even as they were saving money at a greater rate than those in shrinking regions (e.g., Detroit and Pittsburgh).

Table 3.7: Cluster Analysis

This table reports the fixed effects regression using clusters as specified in methods section. ***, **, * represent 1, 5, and 10% significance levels, respectively. Standard errors are shown in parentheses below coefficient estimates.

VARIABLES	(1)	(2)	(3)
	Cluster 1	Cluster 2	Cluster 3
DV: Debt-to-Income Ratio	Shrinking	Stable	Growing
Deposits			
Pre-Crisis	0.0090***	0.0254***	0.0125***
	(0.0019)	(0.0041)	(0.0015)
Crisis	-0.0071***	-0.0184***	-0.0114***
	(0.0016)	(0.0050)	(0.0036)
Post-Regulation	-0.0030***	-0.0141***	-0.0116***
	(0.0010)	(0.0020)	(0.0029)
Loan Growth	-0.0039	0.0099**	0.0197**
	(0.0035)	(0.0044)	(0.0091)
Delinquent Loans	-0.5590*	-2.2740***	-1.3694
	(0.3209)	(0.6826)	(0.9006)
Fed Funds Rate	0.0124***	0.0148***	0.0076***
	(0.0012)	(0.0011)	(0.0013)
Unemployment Rate	0.0885***	0.1258***	0.1338***
	(0.0083)	(0.0226)	(0.0190)
Constant	-0.0099***	-0.0123***	0.0064**
	(0.0016)	(0.0015)	(0.0029)
MSA Fixed Effects	Yes	Yes	Yes
Observations	309,835	313,080	220,738
Adjusted R^2	0.1331	0.1916	0.1718

People in stable regions were also more likely to decrease their household debt during the crisis than those in shrinking and growing regions.

Households with the lowest income levels experienced the greatest financial distress post-crisis (Hurd & Rohwedder, 2010), and those with the greatest losses were the most likely to decrease risky investing (Necker & Ziegelmeyer, 2016). MSAs within the shrinking cluster had the lowest level of income (with a mean of $20,000 lower

median annual income than MSAs within the growing cluster), indicating that people in these MSAs had both less money to save and less of an ability to take on debt.

On the other hand, MSAs within the growing and stable regions were less affected financially by the crisis and recession. Stable regions in particular contain large agglomerations such as New York City, which had relatively less severe impact during the recession than other areas in the country (McMahon, 2018). Further, the income of people within growing and stable MSAs is, on average, higher than the income of people in shrinking MSAs, and they were also less likely to get turned down for loans or mortgages prior to and during the crisis (Mian & Sufi, 2009). This suggests that people within these regions had more money to save during any period. While they were more likely to take on debt before the crisis, they were also less likely to default even during the crisis (Mian & Sufi, 2009).

3.4.4 Direction of growth between household leverage and deposits

To determine if the deposit growth precedes household leverage, the reverse relationship is analyzed, regressing deposits on household leverage (Table 3.8). An MSA fixed effects regression using the change in deposits[29] as dependent variable provides statistically significant results for the pre-crisis and crisis period, but not for the post-regulation period.

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[29] Measured as the change in deposits from the previous year (in time *t* divided by deposits in time *t – 1*; i.e., the same variable as the key explanatory variable, but not separated by crisis periods). The variable for household leverage is separated by the same three periods in this analysis to make a fair comparison.

Table 3.8: Robustness Check (Reverse Analysis)

***, **, * represent 1, 5, and 10% significance levels, respectively. Standard errors clustered at the MSA level are shown in parentheses below coefficient estimates.

VARIABLES	(1)	(2)	(3)
DV: Change in Deposits	MSA Fixed Effects	MSA Fixed Effects and Lagged HL	OLS
Debt-to-Income Ratio			
Pre-Crisis	0.0912***	0.0768***	0.088***
	(0.0157)	(0.0138)	(0.018)
Crisis	-0.0954**	-0.1131***	-0.127***
	(0.0389)	(0.0382)	(0.0441)
Post-Regulation	0.0025	-0.0148	-0.0038
	(0.0222)	0.0768***	(0.0184)
DTI – lag (t-1)			
Pre-Crisis	-	0.072***	-
		(0.0230)	
Crisis	-	-0.1646***	-
		(0.0551)	
Post-Regulation	-	-0.0516***	-
		(0.0182)	
Loan Growth	0.0549***	0.0542***	0.0545***
	(0.0079)	(0.0077)	(0.0083)
Delinquent Loans	1.4837***	1.7442***	1.5646***
	(0.4530)	(0.4578)	(0.4466)
Fed Funds Rate	0.0088***	0.0091***	0.0083***
	(0.0015)	(0.0015)	(0.0014)
Unemployment Rate	0.0209***	0.0271***	0.0189***
	(0.0061)	(0.0063)	(0.0063)
Constant	0.065***	0.0629***	0.066***
	(0.0026)	(0.0028)	(0.0022)
MSA Fixed Effects	Yes	Yes	No
Observations	823,400	823,400	823,400
Adjusted R^2	0.0071	0.0075	0.0026

The coefficient on *pre-crisis* in column 1 is 0.091, and on *crisis* is -0.095 (significant at the 1% level and the 5% level, respectively), both similar in sign but greater in magnitude to the initial MSA fixed effects regression (column 1 in Table 3.4).

This analysis suggests that in the pre-crisis and crisis period, changing household leverage significantly impacts the level of deposits in bank branches. Interestingly, when the periods are separated further, into individual years, only 2008 is significant within the crisis period; this is the opposite of regressing household leverage on deposits, wherein 2007 and 2009 are significant and 2008 is not.

Neither dependent variable (deposits or household leverage) produces significant results for 2006. Since regressing deposits on household leverage growth provides significant results in 2007, while the reverse regression becomes significant in 2008, the negative impact of the change in the level of deposits precedes the negative impact of household leverage growth.

To further examine the impact that deposits have on household leverage and regional economic outcomes, a similar analysis to the one by Mian and Sufi (2010) is performed.

Several economic outcomes are examined at the MSA level (house price growth,[30] unemployment rate,[31] and delinquent loans[32]) substituting deposit growth for household leverage growth in their equation and using household leverage growth as one of the control variables:

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[30] Using data from the Federal Housing Finance Agency (FHFA).
[31] Using the change in the unemployment rate from 2006 to 2009 rather than the annual change in unemployment rate, to match their analysis. Data for unemployment rate comes from the Bureau of Labor Statistics (BLS).
[32] While Mian and Sufi (2010) use mortgage default rates, this data is proprietary, so delinquent loan rates are substituted from the BHCs measured as the change in loan delinquencies from 2006 to 2009.

$$\left(\frac{Outcome_{j,2009}}{Outcome_{j,2006}} - 1\right) =$$

$$\beta_0 + \beta_1\left(\frac{\Delta Log\ Deposits_{i,2006}}{\Delta Log\ Deposits_{i,2002}} - 1\right) + \boldsymbol{\lambda} MSA_j + \boldsymbol{\gamma X}_{i,t} + \boldsymbol{\zeta Z}_{j,t} + u_{i,t} \qquad (6)$$

where $Outcome_j$ is the economic outcome measured (house price growth, unemployment rate, or delinquent loans) in MSA j, and $\Delta Log\ Deposits_i$ represents the change in log deposits from branch i. Control variables as described above are contained in the vector $\boldsymbol{X}_{i,t}$ for branch-level variables and $\boldsymbol{Z}_{j,t}$ for MSA-level variables. MSA_j is a vector of MSA dummy variables, controlling for regional fixed effects.

Rather than examining annual growth, Mian and Sufi examine the change in the explanatory variable prior to the crisis, and its impact on the economic outcomes of the crisis period; thus, the variables are constructed in the same manner for comparison. The regressions are weighted by the population in each MSA in 2006, where appropriate, to substitute for number of households.

Results are presented in Tables 3.9, 3.10, and 3.11, which show that the change in deposits from 2002 to 2006 are a significant predictor of the three economic outcomes.

Table 3.9 presents the results for the dependent variable house price growth from 2006 to 2009; in column 3, the coefficient on *deposits* is 0.0049 (significant at the 5% level). The regressions include the change in household leverage (as the change in the debt-to-income ratio), which has a negative coefficient on the regression (i.e., in column 4, *debt-to-income* is -0.2719, significant at the 1% level). This is in line with Mian and Sufi; however, the change in deposits has a positive coefficient.

Table 3.9: Deposit Change from 2002Q2 to 2006Q2 and House Price Growth from 2006Q4 to 2009Q2

This table reports OLS regression results, based on using the publicly available "economic outcomes" dependent variables from Mian and Sufi (2010). This analysis uses the dependent variable house price growth from 2006Q4 to 2009Q2. Independent variable used is the growth rate in deposits from 2002Q2 to 2006Q2. Regressions in column 2 through 4 are weighted by the population in each MSA in 2006. ***, **, * represent 1, 5, and 10% significance levels, respectively. Standard errors shown in parentheses below the coefficient estimates.

	DV: House price growth, '06Q4 to '09Q2			
VARIABLES	(1)	(2)	(3)	(4)
	Unweighted	Weighted	Weighted	Weighted
Change in deposits '02 to '06	0.0153***	0.0137***	0.0049**	0.0044*
	(0.0024)	(0.0029)	(0.0024)	(0.0024)
Change in debt to income '02 to '06			-0.2679***	-0.2719***
			(0.0110)	(0.0111)
Loan Growth '06			-0.0677***	-0.0453***
			(0.0130)	(0.0127)
Delinquent Loans '06			-0.0000***	-0.0000***
			(0.0000)	(0.0000)
Change in GDP			0.0051***	0.0052***
			(0.0004)	(0.0004)
Unemployment Rate '06			0.0815***	0.0810***
			(0.0020)	(0.0020)
Fraction of Loans '06				
Commercial Real Estate				0.0117
				(0.0288)
Residential				0.0728**
				(0.0362)
Consumer Loans				0.0153
				(0.0361)
Commercial and Industrial				0.1556***
				(0.0425)
Constant	-0.1311***	-0.1447***	-0.4291***	-0.4850***
	(0.0011)	(0.0015)	(0.0119)	(0.0319)
Observations	16,420	16,420	13,396	13,396
R^2	0.0025	0.0019	0.3662	0.3695

Thus, an increase in deposits from 2002 to 2006 is associated with increased house price growth from 2006 to 2009, while an increase in household leverage is

associated with decreased house price growth in the same period. This corresponds with the results that increasing deposits are associated with decreasing household leverage in the crisis period. The increased growth in housing prices during the crisis likely discouraged people from pursuing home loans and that led to the decrease in household leverage that is visible in the analysis.

Regressing the unemployment rate change for 2002 to 2006 on deposit growth (Table 3.10) provides similar results to Mian and Sufi's results, albeit with a coefficient that is smaller in magnitude (the coefficient on *deposits* in columns 3 and 4 is 0.016, both significant at the 1% level).

Similarly, regressing delinquent loan growth on deposit growth (Table 3.11) is positive and significant (the coefficient on *deposits* in column 3 is 40.283, significant at the 5% level and in column 4, the coefficient is 40.159, significant at the 1% level). However, when the change in the debt-to-income ratio is included in the delinquent loans model, the coefficient on *debt-to-income* is not significant. This could be due to using different control variables based on availability. These results, along with the other results, suggest that the change in levels of bank deposits is a useful indicator of economic distress.

Table 3.10: Deposit Change from 2002Q2 to 2006Q2 and Change in Unemployment Rate from 2006Q4 to 2009Q2

This table reports OLS regression results, based on using the publicly available "economic outcomes" dependent variables from Mian and Sufi (2010): This analysis uses the dependent variable change in the unemployment rate from 2006Q4 to 2009Q2. Independent variable used is the growth rate in deposits from 2002Q2 to 2006Q2. Regressions in column 2 through 4 are weighted by the population in each MSA in 2006. ***, **, * represent 1, 5, and 10% significance levels, respectively. Standard errors shown in parentheses below coefficient estimates.

	DV: Change in unemployment rate, '06Q4 to '09Q2			
VARIABLES	(1)	(2)	(3)	(4)
	Unweighted	Weighted	Weighted	Weighted
Change in deposits '02 to '06	-0.0178***	0.0067*	0.0161***	0.0156***
	(0.0048)	(0.0040)	(0.0045)	(0.0045)
Change in debt to income '02 to '06			0.1471***	0.1384***
			(0.0133)	(0.0136)
Loan Growth '06			0.1200***	0.0569***
			(0.0171)	(0.0190)
Delinquent Loans '06			0.0000***	0.0000***
			(0.0000)	(0.0000)
Change in GDP			-0.0006	-0.0002
			(0.0011)	(0.0011)
Unemployment Rate '06			-0.2157***	-0.2176***
			(0.0052)	(0.0052)
Fraction of Loans '06				
Commercial Real Estate				0.0819***
				(0.0092)
Residential				0.0917***
				(0.0111)
Consumer Loans				-0.2250***
				(0.0286)
Commercial and Industrial				0.1777***
				(0.0306)
Constant	1.1579***	1.1900***	2.1104***	2.0575***
	(0.0023)	(0.0019)	(0.0271)	(0.0282)
Observations	39,044	39,044	32,852	32,852
R^2	0.0004	0.0001	0.2036	0.2067

Table 3.11: Deposit Change from 2002Q2 to 2006Q2 and Loan Delinquencies from 2006Q4 to 2009Q2

This table reports OLS regression results, based on using the publicly available "economic outcomes" dependent variables from Mian and Sufi (2010): This analysis uses the dependent variable delinquent loans 90 days or more for 2009Q2. Independent variable used is the growth rate in deposits from 2002Q2 to 2006Q2. Regressions in column 2 through 4 are weighted by the population in each MSA in 2006. ***, **, * represent 1, 5, and 10% significance levels, respectively. Standard errors shown in parentheses below coefficient estimates.

	DV: Loan Delinquencies, '06Q4 to '09Q2			
VARIABLES	(1)	(2)	(3)	(4)
	Unweighted	Weighted	Weighted	Weighted
Change in deposits '02 to '06	12.1106***	37.0191**	40.2831**	40.159***
	(2.8015)	(15.2470)	(15.7601)	(15.3942)
Change in debt to income '02 to '06			9.1430	2.5538
			(18.4305)	(16.8975)
Loan Growth '06			259.466***	52.2386***
			(43.4037)	(15.5755)
Delinquent Loans '06			-0.0000***	0.0000***
			(0.0000)	(0.0000)
Change in GDP			-0.5899	-1.1851
			(0.8146)	(0.9568)
Unemployment Rate '06			4.2091***	3.1427*
			(1.4178)	(1.8135)
Fraction of Loans '06				
Commercial Real Estate				110.268***
				(33.9836)
Residential				-141.6468***
				(50.0898)
Consumer Loans				-212.5326***
				(28.7812)
Commercial and Industrial				-367.4581***
				(90.2129)
Constant	14.6098***	30.463***	-1.6739	122.8318**
	(1.2756)	(3.8618)	(18.0291)	(49.0129)
Observations	27,285	27,285	26,419	26,419
R^2	0.0007	0.0026	0.0135	0.0341

3.5 Discussion

This paper adds to the growing literature on the impacts of the crisis and the post-crisis regulations, by using deposits and household leverage to examine banking regulations and their impact on society. The results suggest that prior to the crisis, deposit growth is associated with an increase in the debt-to income ratio, meaning that household leverage increased along with an increase in bank branch deposits. Further, during the crisis and after regulation was passed, deposit growth is associated with a decrease in the debt-to-income ratio, wherein household leverage decreased with an increase in deposits.

There are two possible explanations for this: as people were making more money prior to the crisis (thus, increased deposits), they were then taking out more debt. On the other hand, when the deposit levels decreased, household debt decreased as well; this suggests that no lenders may have been willing to underwrite loans to these consumers. A look at deposit growth and shrinkage and their effects on the household leverage growth suggests the results are due to this diverging change in the level of deposits: deposit shrinkage leads to a different result than deposit growth.

Performing analyses on MSAs clustered by levels of population, population growth, education, median household income, unemployment, and percentages of employment in construction and manufacturing allows an assessment of differences across the various types of regions throughout time. The results show the smallest decrease in household leverage for shrinking regions. This suggests the impact of the regulations was stronger for areas people were leaving, like Detroit and New Orleans,

which both consistently had negative population growth throughout the crisis period and afterwards.

Finally, robustness checks done by adjusting the deposits for inflation using the Consumer Price Index (CPI) then running the analysis show the same results as the base analysis. Thus, the results hold even with inflation adjustments on the deposits.

While the intention of the Federal Reserve regulations was to improve banking practices and the economy as a whole, they may not have been as beneficial as intended in this case. The decrease in household leverage associated with changing levels of bank branch deposits started in 2007. However, if the change were due to the regulations, the decrease in household leverage would most likely have started instead in or after 2010, when the regulations were implemented.

3.5.1 Policy Implications

The results indicate that prior to the crisis, increasing bank deposits were associated with an increase in household leverage. This is likely related to the subprime mortgage bubble, wherein people were taking out loans they could not pay back, due to overleveraging their homes. This leads to questions regarding whether there needs to be a greater focus on consumer deposit history as well as net worth and household leverage when loan applications are considered. During the crisis, household leverage began decreasing with increasing bank deposits, suggesting that when people realized they were in trouble financially, they started behaving more as the literature would suggest – saving money and not taking out large loans.

The crisis, and the notion that the entire economy was in trouble, appears to have more impact than the banking regulations have on the change in household leverage. In considering policy to improve economic outcomes, this concept is an important one for policymakers to examine further. The Dodd-Frank Act has changed the way that banks are regulated by the Federal Reserve but has not changed the way that people interact with banks regularly (e.g., their deposit behaviors). Future research into the continued success of the Dodd-Frank Act may be necessary, as a policy issued in 2018 has weakened the regulations on all but the largest banks in the U.S. (Rappeport & Flitter, 2018).

Another policy implication this analysis presents is whether there should be changes in the required debt-to-income ratios for borrowers utilizing conforming loans that the government will purchase or insure. This is important because the U.S. government guarantees approximately half of the mortgage loans in the U.S. through Fannie Mae and Freddie Mac,[33] both of which required a significant financial bailout from the government during the crisis (Gordon, 2019). This may be even more critical as consideration is underway to privatize these entities and remove them from the current level of federal regulation and oversight (Sandler, 2019).

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[33] Fannie Mae and Freddie Mac are both currently regulated and supervised by the Federal Housing Finance Agency (FHFA). They are also regulated under the Dodd-Frank Act and required to undergo the Dodd-Frank Act stress tests annually (Federal Housing Finance Agency, 2019).

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CHAPTER 4: IMPACTS OF POST-CRISIS BANKING REGULATIONS ON REGIONAL ECONOMIC GROWTH

4.1 Introduction

The Financial Crisis of 2007-08 and the Great Recession that followed led to an increase in the unemployment rate within the United States, from 5% at the start of the recession up to 10% at its peak in October of 2009.[34] Local demand shocks had a large impact on both local and regional changes in employment, with firms diffusing the adverse effects through regional risk sharing within their networks, such that a failed business in one region led to declining employment growth in other regions where that firm had built branches (Giroud & Mueller, 2017). Firm formation is intrinsically linked to the unemployment rate, though the direction of this linkage is not certain; there may be a positive (Audretsch & Fritsch, 1994) or negative relationship (Garofoli, 1994) between firm formation and economic development. Consequently, important implications for policymakers are the impacts that regulation changes after the crisis may have had on the unemployment rate as well as firm formation countrywide, and how the impacts varied by region within the United States.

The purpose of this paper is to examine the regional effects that post-crisis banking regulation had on employment and firm creation; this is done through the lens of commercial real estate loans, as their impact on bank failure was an important aspect

[34] The recession began in December 2007 and ended in June 2009 according to the Bureau of Labor Statistics, though the end of the recession did not mean the unemployment rate stopped increasing at that time (Bureau of Labor Statistics, 2012).

during the crisis. In addition to the increased unemployment rate and falling real estate values, an increase in the number of establishment deaths occurred during the crisis, precipitating the overall decline in economic activity and growth.[35] Smaller banks hold a greater percentage of their holdings in commercial real estate (CRE) loans, and overexposure in the CRE market during the crisis was associated with greater likelihood of bank failure (D'Erasmo, 2019).[36]

This paper looks at the effect that commercial real estate loan growth has on firm and employment growth at the Metropolitan Statistical Area (MSA) level, measured year over year within the United States, specifically using loans originated for commercial real estate purposes. The effect of CRE loan growth on firm growth and employment growth is examined, as well as the impact of the Dodd-Frank Wall Street Reform and Consumer Protection Act regulations (hereafter, Dodd-Frank). The analysis uses regression with instrumental variables and MSA fixed effects using clusters of MSAs, as well as a separate cluster analysis. Results indicate that the growth in CRE loans leads to a statistically significant increase in employment growth, with additional positive employment growth occurring after the implementation of Dodd-Frank. Analyzing CRE loan growth on firm growth has the same effect, with an increase in firm creation associated with increased CRE loans, and increased firm creation after the regulations.

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[35] 235,000 establishment deaths occurred during the first quarter of 2009, with an overall decrease of 63,000 establishments (Bureau of Labor Statistics, 2012).

[36] Small banks hold 27% of the commercial real estate loans in the market, comprising 30% of their assets, as compared to the largest 35 banks that hold 75% of all bank assets and 43% of the commercial real estate market, with only 5% of their total holdings composed of commercial real estate loans (D'Erasmo, 2019).

Additionally, results from using cluster analysis indicate that areas of the country were affected differently by both the changes in CRE loans and the implementation of the banking regulations. Results show that stable clusters of MSAs had the greatest growth in number of firms, while shrinking clusters of MSAs had the smallest firm growth. However, shrinking MSA clusters had the greatest employment growth, suggesting that firm and employment growth were not as intrinsically linked in all areas of the country.

The results suggest that the post-crisis regulations are associated with improved employment and firm growth following the recession, and that employment growth and firm growth are related in times of crisis. However, given that Dodd-Frank was implemented in 2010, just after the recession ended, it is unclear whether the post-recession growth is directly due to the regulations or is simply a consequence of the recovery period. Examination of the literature and further analyses in this paper attempt to disentangle the effects of the recession from the regulations. Additionally, the analyses attempt to determine whether employment growth led to firm growth or vice versa. Results indicate that firm growth preceded employment growth when linked with CRE loan growth.

The rest of this paper is organized as follows: Section 4.2 discusses the related literature. Section 4.3 presents the data and methodology. Section 4.4 discusses the results. Finally, Section 4.5 discusses potential policy implications and concludes this paper.

4.2 Related Literature

The impacts of the financial crisis on unemployment produced a large field of literature, often with a focus on macroeconomic and macroprudential policy. Much of the public policy analysis focuses on firm-level outcomes rather than on direct effects of the crisis and post-crisis regulation on financial growth and policy outcomes. For example, Chodorow-Reich (2014) analyzes the direct effects of bank lending on employment; the data contain the years of the crisis and the years just prior, with a focus on the employment and banking relationships of 2,000 nonfinancial firms. He finds that changes in employment were directly impacted by lender health, by up to 5 percentage points (Chodorow-Reich, 2014).

Prior recessions are also examined in comparison with the financial crisis, with the literature reaching divergent conclusions. It is largely agreed upon that the Great Recession had weaker employment growth in its aftermath than prior recessions, the worst since the Great Depression (Hoynes et al., 2012). However, there is not a consensus on whether the slow recovery from the Great Recession was predictable based on past U.S. recessions. Comparing the financial crisis to previous recessions, Duygan-Bump et al. (2015) examine unemployment as a result of constraints in financing due to lending cuts, finding that reduced lending led to higher unemployment in small firms. They repeat their analysis for two prior recessions (1990 and 2001) and find that only the 1990 recession – also a recession that originated in banking – had a similar growth in unemployment (Duygan-Bump et al., 2015). On the other hand, Taylor (2014) finds that recovery was far slower than expected based on past recessions; the economic growth

rate per year following the Great Recession was 2 percent, while the recovery from prior recessions was closer to 6 percent growth per year. Finally, Dominguez and Shapiro (2013) suggest that given the more recent recessions of 1990 and 2001, the slower economic recovery following the Great Recession is not unusual.

While the US was the epicenter for the crisis in terms of large bank failures, European banks were also negatively affected by the crisis, leading to a decrease in lending and an increase in the unemployment rate. Huber (2018) looks at the effects of a lending cut by a major German bank on the economy; he finds that while the lending cuts affected firms borrowing from the bank, they also had a negative impact on local economic activity, which did not improve after lending returned to normal levels. Huber (2018) also examines the effect of the reduction of lending on employment, which was the inspiration for looking at the employment rate and how it is impacted by loan growth within the US, as the literature has no similar US based studies.

Several studies in Europe examine the regional aspects of unemployment and regional economic growth rates due to the crisis, though they do not specifically use bank lending growth within their analyses. Blažek and Netrdová (2012) look at the unemployment rates in Europe to assess the regional disparities post-crisis. They find no regional pattern to unemployment but find that capital city MSAs were less severely affected by the crisis in most areas in Europe, demonstrating that these MSAs were likely to recover quicker than the surrounding areas. In terms of regional economic growth, Dijkstra et al. (2015) study economic growth in pre-, during, and post-crisis European regions and find that proximity to cities is important for growth in rural regions. Like

Blažek and Netrdová (2012), they find that cities in more robust economies helped to boost growth in surrounding areas post-crisis, but that in more stagnant economies the urban centers themselves suffered greater adverse effects from the crisis than those nearby rural regions (Dijkstra et al., 2015). These regional studies indicate that there are regional disparities in loan growth and economic growth post-crisis, which are difficult to precisely determine.

Other studies look at the relationship between bank lending and credit constraints (Beck et al., 2018) or lending and stock performance (Beltratti & Stulz, 2012), but do not look at the effect on firm growth or employment outcomes that result from these changes in bank performance. For example, de Ridder (2017) looks at industrial research and design corporations within the US, finding that the crisis negatively affected productivity growth, suggesting that the lack of investments slowed down productivity; this is likely to be directly related to the decrease in bank lending during and just after the crisis.

The literature is at odds regarding the level of bank lending during the crisis. One study finds that new loans made directly to large borrowers, particularly corporations, declined during the crisis (Ivashina & Scharfstein, 2010). On the other hand, Chari et al. (2008) find that bank lending did not decrease as of October of 2008, and in some cases may even have increased to both consumers and corporations. Ivashina and Scharfstein (2010) note that this could be due to the different analysis methods used.

One of the potential contributors of commercial bank failures during the crisis was nontraditional banking activities, such as less diversified loan portfolios (DeYoung & Torna, 2013). Low interest rates for real estate with perceived high rates of return led

to banks misallocating investment resources in real estate – specifically in mortgage-backed securities (Diamond & Rajan, 2009). Another contributor to bank failure was a high concentration of commercial real estate loans, which involve higher levels of risk and are not covered by the current banking regulations and capital requirements (Cole & White, 2012). Additionally, smaller firms had a larger response to the real estate shocks on their overall investments than larger firms (Chaney et al., 2012), so smaller banks are expected to have a greater likelihood of failure due to their higher percentage of commercial real estate loans. The relationship between commercial real estate lending and firm growth and the related employment is a potential source for analyzing the regional effects of the crisis on unemployment.

An increase in commercial real estate lending is expected to be positively related to employment and new firm growth, as the loans enable firms to start up and hire new employees. Additionally, as firms grow, they demand more employees and more space, which may lead to pursuing loans for expansion. However, if there are no prospects for building, then firms might be less likely to pursue loans or hire more employees. Thus, it is expected that new firm growth and employment will be positively impacted by an increase in commercial real estate lending growth. A different result is expected for smaller or regional banks as compared to larger national banks. The banks loaning within a region rather than nationally or globally will have a smaller asset base and may not be

subject to the stress tests of Dodd-Frank.[37] As the stress tests cost banks money in both the conducting of the tests and hiring employees to build models, it is expected that these banks will be spending some of their liquid capital to cover these costs. This is expected to lower the loan growth in larger banks, and subsequently, impact the employment growth in the region. Thus, MSAs with multiple large bank headquarters would be expected to have lower overall loan growth after the implementation of Dodd-Frank.

The theoretical literature on regional economic growth surrounding the crisis offers some indication of the expected effects of financial growth on employment growth and how these effects might vary across geographical locations. Dijkstra et al. (2015) suggest that several economic growth theories are valid for explaining regional growth patterns, with new neo-classical urban economics predicting that people relocating for jobs produce agglomeration economies, which lead to higher growth in metropolitan regions compared to rural areas. This theory is in line with the hypothesis that commercial real estate growth leads to greater employment growth and that MSAs have greater growth than rural areas.

Further, research indicates that MSAs had differing economic growth depending on factors within the MSAs. For example, MSAs with more entrepreneurial firms and greater creative employment in one year have greater regional growth a year later (Stephens et al., 2013; Stolarick et al., 2011), and MSAs with higher housing prices had

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[37] As of 2018/2019, if they have under $10 billion in total consolidated assets, banks are not subject to the company-run stress tests; banks with between $10 and $50 billion in assets are only subject to annual company-run stress tests, and not subject to the Dodd-Frank stress tests (DFAST) annually (Hou & Warusawitharana, 2018).

greater economic growth (Miller et al., 2011). Conversely, Drennan et al. (2004) find that income and economic growth is higher in areas with lower income, though MSAs focused on service industries have greater economic growth than those focused on manufacturing or distribution.

The new neo-classical urban economics theory suggests that the supply of housing limits the growth of population in regions, potentially limiting the migration and labor force in an area (Storper, 2011). Thus, an increase in CRE growth, which includes multifamily property such as apartments, could lead to an initial influx of jobs within the construction industry, and later an influx of job seekers themselves. Job seekers move in part because of the perceived availability of jobs in an area, as reflected in job ads and local narratives surrounding jobs (Graves & Kozar, 2015). Metropolitan areas see an increase in economic growth subsequent to increasing levels of population in years prior, though these areas do not necessarily experience growth in per capita income (Stansel, 2005).

After the crisis and recession, unemployment rates increased dramatically. However, there is not a significant amount of literature that directly tests whether lending growth, particularly via commercial real estate, has any impact on employment or how the effects are spread out throughout the country. The literature suggests that the impact on employment will not be the same throughout the country.

Geographical studies focusing on foreclosures post-crisis find that middle-income census tracts in a smaller county had the greatest foreclosure rates (Delgadillo & Erickson, 2006), while suburbs and inner cities had the same foreclosure rates in the 100

largest MSAs in the US (Anacker, 2015). Subprime mortgages, on the other hand, may have been targeted at racial minorities (Li, 2011), and predatory lending tended to be clustered within large cities (Crossney, 2010). The spatial outcomes of increased foreclosures post-crisis and subprime lending prior to the crisis both suggest that the employment rates, and possibly employment types, varied across geographical location.

4.3 Data and Methodology

4.3.1 Data

This paper examines the effect of CRE loan growth on employment and firm growth. Bank holding company (BHC)-level data is used to analyze the effects at the bank level rather than the branch level. BHC data include CRE loan data; these data are acquired from Wharton Research Data Systems (WRDS), which includes BHC Call Reports from 2003 through 2016. This data period allows examination of the years before the crisis and recession and the years after the regulations were implemented, to compare these periods and analyze the full effects of the post-crisis regulations on employment and firm growth. Approximately 280 MSAs are included within the analyses.[38]

The analysis of bank loan growth on employment growth utilizes OLS regression with an instrumental variable, where employment growth is the dependent variable. A separate regression uses firm growth as the dependent variable. Using these two dependent variables in separate analyses allows visualization of the effects of loan growth through two different lenses; it can be determined whether employment is increasing in each region while the number of firms stays the same, or whether employment is increasing together with the number of firms.

Employment growth as the dependent variable is measured as the percentage change year over year for each MSA. The data for this variable are obtained from the U.S. Bureau of Labor Statistics. An additional dependent variable of interest is the net

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[38] Using the latest MSA delineation as defined by the Office of Management and Budget as of April 10, 2018, as MSA boundaries change over time (Office of Management and Budget, 2018).

change in the number of establishments. This variable is measured as the year-over-year change in the number of existing establishments each year for each MSA. Data for this variable come from County Business Patterns (CBP) from the U.S. Census Bureau. These data include the share of employment in different industries and number of establishments per year, aggregated by MSA. Additionally, the CBP includes the number of firms per industry (using NAICS codes), from which percentages of employment within different industries are calculated as control variables. These data are merged with bank data to build the dataset used in this paper.

The key explanatory variable is commercial real estate loan growth for each bank in each year, measured differently depending on the analysis: either as the natural log of the dollar value of the CRE loans each year for each bank or as the year-over-year percentage change in CRE loans. The CRE loans include loans secured by real estate,[39] and the value of the loans is measured in thousands of dollars.

Control variables include the charge-off rate for loans (as a percentage of total loans), non-performing loans (as a percentage of total loans), change in capital (percentage), capital ratios, and change in overall loan growth. The control variables are measured by year and by bank. Additional control variables are acquired from the US Census Bureau based on the MSA in which each bank is headquartered. These variables include median annual income and education level measured as the percent of the population per MSA over age 25 with a bachelor's degree or greater.

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[39] Including construction, land development, and other land loans; multifamily residential properties, and nonfarm nonresidential properties; does not include loans secured by farmland.

To examine the effects of the crisis and regulations on different regions, the analysis includes MSA cluster fixed effects in the regression analyses (as discussed in section 4.3.2). To further examine regional differences, the analysis separates regions through cluster analysis to analyze the differing impact of the regulations on types of regions (stable, shrinking, and growing). Finally, an indicator variable is used to represent the post-crisis banking regulations. Since Dodd-Frank is the regulation of interest in this analysis, the years after 2010 are compared to the years prior.

Table 4.1: Summary Statistics

This table presents descriptive statistics for the variables of interest from the sample of banks within the data. The first dependent variable, employment growth, is computed as percent change each year to the next, and the second, firm births, is computed as the number change from each year to the next. The explanatory variable, CRE Loan growth, is measured as the percent change in CRE loans from each year to the next. N = 10,904

Variable	Mean	Std. Dev.	Min	Max
MSA-Level				
Employment Growth (percent change)	0.68	2.21	-21.73	15.44
Firm Births (number change/year)	36.22	117.68	-319.7	1136.55
Median Household Income (dollars)	59,950.2	11,268.9	37,097	105,809
Education (percent with bachelors, 25+)	20.6	4.14	8.0	35.2
Manufacturing industry percent	10.25	6.46	0.0	53.12
Construction industry percent	6.01	3.19	0.0	60.69
BHC-Level				
CRE Loan Growth (percent change)	17.87	53.21	-78.17	2583.8
Pre-crisis (percent change)	9.04	26.11	-64.77	969.42
Crisis (percent change)	-0.19	4.73	-75.98	128.25
Post-regulation (percent change)	3.97	21.30	-66.34	1013.08
Non-performing Loans (percent)	1.66	2.37	0.0	46.23
Charge-off Rate (percent of total loans)	0.27	0.6	0.0	17.48
Change in Capital (percent)	111.46	22.76	11.75	1078.08
Capital Ratio	14.56	5.23	1.4	97.49
Unused Loan Commitments (thousands of dollars)	62,261	584,184.8	0.0	13,800,000
Total Assets (millions of dollars)	20,400	153,000	59.9	2,520,000
Overall Loan Growth (percent change)	9.2	16.94	-84.98	259.25

Summary statistics are presented in Table 4.1. Prior to the crisis, the annual increase in CRE loan growth averaged 9.04%, while it decreased during the crisis period to -0.19% and increased post-regulation to 3.97% growth. The mean change in employment growth is 1.2% overall. Some areas experienced a decline of 21.7%, while others had an increase of 11.2% employment growth during the sample period.[40] Firm births increased at an average of 0.19% per year, with an average of 51 new firms created each year in each MSA. The average total assets for banks in the data were $20.4 billion, with the lowest total assets for any bank in the sample at $59.9 million and the highest at $2.5 trillion.[41]

4.3.2 Spatial Analysis Specification

Effects are also examined by MSA using cluster analysis. This paper uses *K*-means clustering, in which the *K*-means algorithm separates the data into *K* clusters, wherein the MSAs in each cluster are similar to each other based on the means of the variables used in the algorithm (Rokach & Maimon, 2005). Variables are standardized by MSA before clustering; as the variables are measured using different units through time (e.g., dollars, years, percentage), standardization allows all variables an equal weight in the clusters (Rokach & Maimon, 2005).

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[40] The Manhattan, KS Metropolitan Statistical Area and Laredo, TX MSA both had employment growth greater than 11% in certain years and New Orleans-Metairie-Kenner, LA MSA had employment decline greater than 20% in several years.

[41] Lowest total assets for M & F Bancorp, Inc., and highest for JPMorgan Chase & Co.

Within the *K*-means algorithm, MSAs are grouped based on base-year population levels and population growth throughout the sample period, as well as by median household income, education levels, unemployment rates, and the percentages of employment in manufacturing and construction. The MSAs are grouped into three clusters, as determined by the Caliński–Harabasz pseudo-F value. The three-cluster solution has the largest stopping value (as compared to four, five, or six clusters), suggesting that these three clusters are the most distinct and well separated within the data (Caliński & Harabasz, 1974).

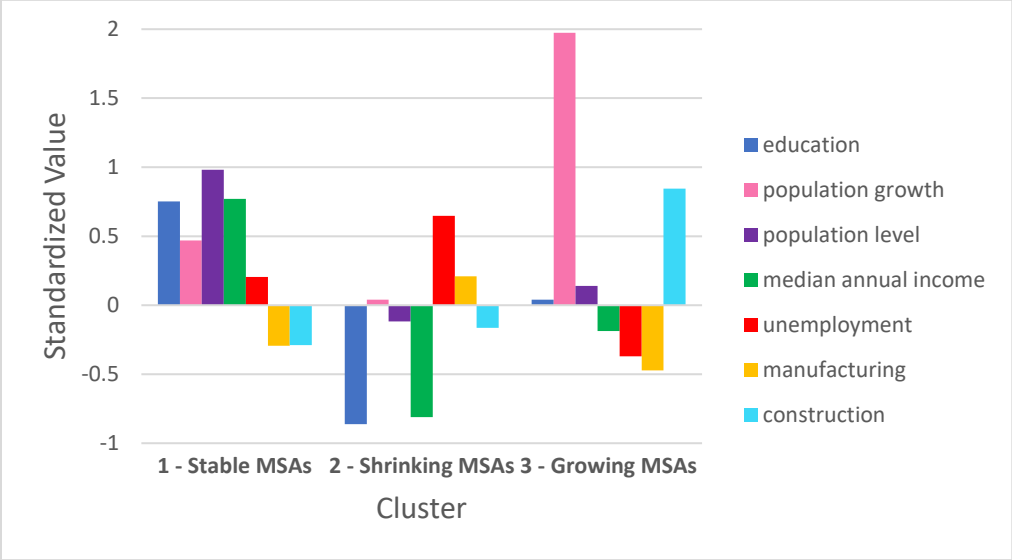
The same models in Equations (1) and (2) are then re-estimated using these clusters. This method allows comparison of results across regions of different size and growth rates, such as rapidly growing cities with banking as a main industry (e.g., Charlotte), as compared to stable agglomerations (e.g., Chicago) and shrinking cities (e.g., Detroit). Clusters are named based on these characteristics and described below:

1. Stable: this cluster has the highest levels of education and median annual income; this cluster also has some population growth and a stable population level. Within this cluster are MSAs including cities such as Chicago, New York City, and Washington DC.

2. Shrinking: this cluster has the highest unemployment rate, lowest education, and lowest median annual income; this cluster also has little to no population growth and a shrinking level of population. This cluster includes MSAs with cities such as Detroit, Memphis, and Pittsburgh.

3. Growing: this cluster has the highest population growth, as well as percentage of employment in the construction industry; this cluster also has the lowest unemployment rates. In this cluster are MSAs including cities such as Charlotte, Dallas, and San Antonio.

Figure 4.1: Description of Clusters



This figure shows the different clusters as created using k-means clustering. Cluster 1 is the stable MSA cluster, Cluster 2 is the shrinking MSA cluster, and Cluster 3 is the growing MSA cluster.

Another check of the clustering algorithm is whether the cities expected to lie within each cluster ended up in the correct cluster. As the key cities line up with the correct clusters (e.g., Detroit falls in the shrinking cluster, New York falls within the stable cluster, and Charlotte falls within the growing cluster), this is further confirmation that the *K*-means algorithm clustered the MSAs properly. Figure 4.1 presents the depiction of the standardized values of the variables used to cluster the MSAs. This figure clearly shows the three clusters have distinct differences between them, with much

greater population growth visible for the growing cluster and negative values for education and median income for the shrinking cluster.

4.3.3 Empirical Specification

To examine the relationship between commercial real estate loan growth and employment growth, this paper first estimates employment growth and firm growth models. The models are based on standard employment growth models, using independent variables that are expected to impact employment and firm growth. The regression analysis specification uses the form:

$$\left(\left(\frac{employment_{j,t+1}}{employment_{j,t}}\right) - 1\right)$$

$$= \beta_0 + \beta_1 \Delta CRE\ Loans_{i,j,t} + \beta_2 DF + \boldsymbol{\lambda} Cluster_j + \boldsymbol{\gamma X}_{i,t} + u_{i,t}, \qquad (1)$$

where the change in employment growth is measured for each MSA *j* in time *t* and *t+1*. The main explanatory variable, $\Delta CRE\ Loans$ represents the change in Commercial Real Estate loans from each year *t* to the next (*t + 1*) at bank holding company (BHC) *i* in MSA *j*, and β_1 is the main parameter of interest. An indicator variable is used for the post-regulation period to measure the effect of the crisis and regulations on employment growth. *DF* represents a dummy variable that equals 1 for the years after the regulations were implemented (specifically, Dodd-Frank Act), and 0 otherwise. To control for regional differences, fixed effects are included at the level of the MSA clusters ($Cluster_j$); the clusters are used within the fixed effects as opposed to the MSAs as there are similarities within the cities in the MSAs, and the clustering allows the analysis to

control for variation within the variables that are collected by MSA. Finally, $\boldsymbol{X}_{i,t}$ is the vector of control variables as described in the data section.

For the firm growth model, the dependent variable is changed to change in the number of firms from each year to the next $\left(numfirms_{j,t+1} - numfirms_{j,t}\right)$, with the same control variables as in equation (1).

The growth models include lags of employment (one to two years), lags of CRE loan growth (one to two years), and variables expected to impact the growth in employment. These variables include median annual income per MSA, the percentage of the population over age 25 with at least a bachelor's degree by MSA, and the percentages of employment in the manufacturing and construction industries by MSA. Finally, firm growth is included in the employment growth model, and unemployment is included in the firm growth model, to help distinguish the effects of firm and employment growth. Next, the main analysis in this paper is an OLS regression with MSA cluster fixed effects and uses an instrumental variable approach. The regression analysis uses the following specification:

$$\left(\left(\frac{employment_{j,t+1}}{employment_{j,t}}\right) - 1\right)$$

$$= \beta_0 + \beta_1 \left(\ln(CRE\ Loans) = LC\right)_{i,j,t} + \beta_2 DF + \boldsymbol{\lambda} Cluster_j + \boldsymbol{\gamma X}_{i,t} + \boldsymbol{\zeta Z}_{j,t} + u_{i,t} \quad (2)$$

where the change in employment growth is measured for each MSA *j* in time *t*. The main explanatory variable, ln $(CRE\ Loans = LC)$ represents the log of Commercial Real Estate loans in each branch *i* in each year *t* with the instrumental variable *LC* (loan

commitments), and β_1 is the main parameter of interest. This model also includes the Dodd-Frank indicator (DF) and MSA cluster fixed effects ($\boldsymbol{\lambda} Cluster_j$) as in equation (1). Finally, $\boldsymbol{X}_{i,t}$ is the vector of branch-level control variables, and $\boldsymbol{Z}_{j,t}$is the vector of MSA-level control variables, as described in the data section.

The instrument used here is loan commitments – specifically, commitments to fund loans for commercial real estate. Loan commitments, as agreements to fund borrowers, should not directly impact firm or employment growth, as the borrower does not yet have the money. However, they are expected to impact the CRE loans, as the lender is expected to honor the agreement. In the data, the loan commitments variable is correlated with CRE loans,[42] but not independently correlated with employment or firm growth, which makes it an effective instrument for the analysis. The loan commitments variable is measured in thousands of dollars.[43]

A second analysis with a regression model is also used, with the dependent variable as firm growth in terms of total number of establishments created per MSA instead of employment growth. The growth in the number of firms is measured as year-over-year change in the number of establishments in each MSA:

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[42] The loan commitments variable is correlated with CRE loans at 72.37% and with the employment growth variable at only 0.1% and the firm growth variable at 1.7%, which makes it a valid instrument.
[43] Using log of loan commitments provided results that were qualitatively the same as using the dollar value but resulted in far fewer observations.

$$\left(numfirms_{j,t+1} - numfirms_{j,t}\right)$$

$$= \beta_0 + \beta_1(\ln(CRE\ Loans) = LC)_{i,j,t} + \beta_2 DF + \boldsymbol{\lambda} Cluster_j$$

$$+ \boldsymbol{\gamma} \boldsymbol{X}_{i,t} + \boldsymbol{\zeta} \boldsymbol{Z}_{j,t} + u_{i,t}, \qquad (3)$$

where the instrument, as well as explanatory and control variables are constructed the same as the variables in equation (2).

4.4 Results

4.4.1 Employment and Firm Growth Models

The employment growth model examines the changes in employment throughout the time period, based on non-bank variables. Table 4.2 presents the results for the baseline employment growth model in equation (1). Increased CRE loan growth is associated with increased employment growth, holding the other variables constant. The effects are the same when including lags of employment for the prior two years, as well as lags of CRE loan growth for the prior two years. For example, when including all lags, the coefficient on *CRE Loan Growth* in column 3 is 0.004, significant at the 1% level. The effect is slightly smaller when including only lags of employment growth, and slightly larger with only lags in CRE loan growth. However, in all regressions, the CRE loan growth increases employment growth by less than 1%. The Dodd-Frank indicator is significant and positive in all regressions, indicating that after the regulations there was an increase in employment growth. These results suggest that while there is an impact on employment growth when CRE loans increase, it is very small.

Similar to employment growth, firm growth is examined using a model with the same variables. Results for firm growth are presented in Table 4.3.

Table 4.2: Employment Growth Model

This table presents the cluster fixed effects analysis results which examine the changes in Commercial Real Estate (CRE) loan growth for the banks within the sample and how that affects employment growth (as a percentage change). Column 1 includes two lags of Employment growth – one for the year preceding and one for two years preceding. Column 2 includes two lags of CRE loan growth – one for the year preceding and one for two years preceding. Column 3 includes 2 lags each of Employment growth and CRE loan growth. ***, **, * represent 1, 5, and 10% significance levels, respectively. Standard errors shown in parentheses below coefficient estimates.

	DV: Employment Growth		
	(1)	(2)	(3)
VARIABLES	2 Lags of Employment	2 Lags of CRE Growth	2 Lags of Employment & CRE
CRE Loan Growth	0.0040***	0.0055***	0.0043***
	(0.0005)	(0.0005)	(0.0005)
CRE Growth Lag (t-1)	-	0.0011***	0.0009***
		(0.0002)	(0.0002)
CRE Growth Lag (t-2)	-	-0.0019***	-0.0021***
		(0.0002)	(0.0002)
Employment Growth (t-1)	0.2401***	-	0.2477***
	(0.0109)		(0.0113)
Employment Growth (t-2)	-0.0667***	-	-0.0704***
	(0.0101)		(0.0104)
Dodd-Frank Indicator	0.0068***	0.0093***	0.0066***
	(0.0005)	(0.0005)	(0.0005)
Median Annual Income	-0.0000	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)
Education (25+ bachelors)	0.0004***	0.0004***	0.0004***
	(0.0001)	(0.0001)	(0.0001)
Manufacturing Percent	0.0104***	0.0190***	0.0112***
	(0.0039)	(0.0041)	(0.0040)
Construction Percent	0.0336***	0.0421***	0.0297***
	(0.0083)	(0.0087)	(0.0085)
Firm Growth	0.0000***	0.0000***	0.0000***
	(0.0000)	(0.0000)	(0.0000)
Constant	-0.0078***	-0.0123***	-0.0102***
	(0.0020)	(0.0021)	(0.0021)
Observations	8,568	7,946	7,841
R-squared	0.1919	0.1583	0.2065
Cluster Fixed Effects	Yes	Yes	Yes

Table 4.3: Firm Growth Model

This table presents the cluster fixed effects analysis results which examine the changes in Commercial Real Estate (CRE) loan growth for the banks within the sample and how that affects firm growth (in numbers of firms created per year). Column 1 includes two lags of Employment growth – one for the year preceding and one for two years preceding. Column 2 includes two lags of CRE loan growth – one for the year preceding and one for two years preceding. Column 3 includes 2 lags each of Employment growth and CRE loan growth. ***, **, * represent 1, 5, and 10% significance levels, respectively. Standard errors shown in parentheses below coefficient estimates.

	DV: Firm Growth		
	(1)	(2)	(3)
VARIABLES	2 Lags of Employment	2 Lags of CRE Growth	2 Lags of Employment & CRE
CRE Loan Growth	34.7537***	32.0163***	34.7508***
	(2.6628)	(2.6774)	(2.7740)
CRE Growth Lag (t-1)	-	0.0998	0.5015
		(0.9527)	(0.9486)
CRE Growth Lag (t-2)	-	-5.5165***	-5.2099***
		(1.0-761)	(1.0714)
Employment Growth (t-1)	-372.3425***		-354.6266***
	(75.2945)	-	(79.1428)
Employment Growth (t-2)	-468.7877***		-455.4745***
	(55.4388)		(58.3517)
Dodd-Frank Indicator	31.0997***	33.5474***	32.2698***
	(2.8663)	(3.0153)	(3.0213)
Median Annual Income	0.0019***	0.0018***	0.0019***
	(0.0002)	(0.0002)	(0.0002)
Education (25+ bachelors)	-2.4239***	-2.4366***	-2.5035***
	(0.4820)	(0.5028)	(0.5044)
Manufacturing Percent	-61.7145***	-71.0962***	-77.4069***
	(21.2620)	(22.3662)	(22.3474)
Construction Percent	-102.5491**	-101.1149**	-117.1516**
	(45.8252)	(47.6425)	(47.6115)
Unemployment Rate	-79.2129***	-55.4366***	-78.8192***
	(6.9596)	(5.8924)	(7.3923)
Constant	-22.4689**	-24.3256**	-18.9163
	(11.0810)	(11.5609)	(11.5699)
Observations	8,604	7,976	7,870
R-squared	0.1414	0.1309	0.1433
Cluster Fixed Effects	Yes	Yes	Yes

Like the employment growth model, increased CRE loan growth is associated with increased firm growth. When including all lags, the coefficient on *CRE Loan*

Growth in column 3 is 34.8 firms per year, significant at the 1% level. Results are the same when including two lags of employment growth in column 1, and slightly smaller when including two lags of CRE loan growth in column 2 (i.e., an increase of 34.8 and 32 firms respectively, both significant at the 1% level). Further, the Dodd-Frank indicator is significant and positive for all regressions (at the 5% significance level) with, on average, an increase of 31.1 to 22.5 firms created per year after the regulations were implemented. Like the employment growth model, this shows that there is an impact on firm growth with increasing CRE loans, but it is quite small in any instance, at less than 40 firms per year.

4.4.2 Instrumental Variables Analysis

The results for the instrumental variables model in equation (2) for employment growth are presented in Table 4.4. CRE loan growth is associated with a statistically significant increase in employment growth in all regressions. Including one lag of employment growth and one lag of CRE loan growth provides almost the same results as including two lags of each, and including the employment growth variables (the coefficient on *CRE Loans* in column 1 is 0.06, and the coefficients in columns 2 and 3 are 0.05, significant at the 1% level, the 1% level, and the 5% level, respectively). The impact is positive and significant at the 1% level in the years following the implementation of Dodd-Frank.

Table 4.4: Instrumental Variables: Dependent Variable – Employment Growth
This table presents the instrumental variable analysis results which examine the changes in the log of Commercial Real Estate (CRE) loans for the banks within the sample and how that affects employment growth. Instrument used is loan commitments, instrumenting the log of CRE Loans. ***, **, * represent 1, 5, and 10% significance levels, respectively. Standard errors shown in parentheses below coefficient estimates.

	DV: Employment Growth		
VARIABLES	(1) 1 Lag of Employment and CRE Growth	(2) 2 Lags of Employment & CRE Growth	(3) Including Employment Growth variables
CRE Loans (instrumented with Loan Commitments)	0.0625***	0.0532***	0.0501**
	(0.0184)	(0.0201)	(0.0202)
CRE Loan Lag (t-1)	-0.0628***	-0.0624***	-0.0589***
	(0.0179)	(0.0147)	(0.0146)
CRE Loan Lag (t-2)		0.0090*	0.0086*
		(0.0050)	(0.0052)
Employment Growth (t-1)	0.1421***	0.2121***	0.2026***
	(0.0256)	(0.0435)	(0.0455)
Employment Growth (t-2)		-0.1087***	-0.0907***
		(0.0126)	(0.0124)
Dodd-Frank Indicator	0.0121***	0.0104***	0.0105***
	(0.0010)	(0.0017)	(0.0020)
Charge-off Rate	0.3453***	0.2652***	0.2711***
	(0.0835)	(0.0997)	(0.0957)
Change in Capital	-0.0086**	-0.0062	-0.0062
	(0.0041)	(0.0044)	(0.0044)
Non-performing Loans	0.0749***	0.0403	0.0307
	(0.0289)	(0.0372)	(0.0367)
All Other Loans (post-regulation)	-0.0017	0.0018	0.0017
	(0.0051)	(0.0063)	(0.0063)
Capital Ratio	0.0150*	0.0123	0.0116
	(0.0079)	(0.0088)	(0.0096)
Manufacturing Percent			0.0123***
			(0.0044)
Construction Percent			0.0309***
			(0.0091)
Firm Growth			0.0000***
			(0.0000)
Observations	8,614	8,062	7,683
Durbin-Wu-Hausman p-value	0.004	0.022	0.038
Cluster Fixed Effects	Yes	Yes	Yes

Table 4.5: Instrumental Variables: Dependent Variable – Firm Growth

This table presents the instrumental variable analysis results which examine the changes in the log of Commercial Real Estate (CRE) loans for the banks within the sample and how that affects firm growth. Instrument used is loan commitments, instrumenting the log of CRE Loans. ***, **, * represent 1, 5, and 10% significance levels, respectively. Standard errors shown in parentheses below coefficient estimates.

	DV: Firm Growth		
	(1)	(2)	(3)
VARIABLES	1 Lag of Employment and CRE Growth	2 Lags of Employment & CRE Growth	Including Employment Growth variables
CRE Loans (instrumented with Loan Commitments)	237.1347**	210.1889*	210.5058*
	(102.5481)	(118.5648)	(118.4610)
CRE Loan Lag (t-1)	-234.4168**	-193.3920**	-193.5709**
	(99.6292)	(85.3425)	(85.2743)
CRE Loan Lag (t-2)		-13.6747	-13.9514
		(30.9998)	(30.9522)
Employment Growth (t-1)	-293.7552**	-190.4385	-180.8447
	(146.0168)	(267.6259)	(268.2063)
Employment Growth (t-2)		-572.3914***	-578.5885***
		(70.8712)	(70.8680)
Dodd-Frank Indicator	57.6714***	57.6248***	56.4681***
	(6.4285)	(11.3467)	(11.4267)
Charge-off Rate	1.6984	-297.2494	-287.3882
	(456.6173)	(566.2822)	(564.3814)
Change in Capital	-31.6279	-26.5776	-26.9014
	(23.4702)	(26.0334)	(25.9490)
Non-performing Loans	386.6568**	358.7564*	352.7318
	(163.6879)	(217.7866)	(218.3103)
All Other Loans	-0.0623	0.7658	0.0353
	(24.7360)	(37.7729)	(37.6266)
Capital Ratio	165.7909***	169.7767***	165.9458***
	(46.4372)	(56.0175)	(56.3791)
Manufacturing Percent			-56.7637**
			(26.2090)
Construction Percent			10.6384
			(54.4555)
Observations	8,259	7,711	7,711
Durbin-Wu-Hausman p-value	0.016	0.061	0.06
Cluster Fixed Effects	Yes	Yes	Yes

The results for the instrumental variables model in equation (3) for firm growth are presented in Table 4.5. These results are similar to the firm growth model, with increased firm growth in all regressions; however, the magnitude of the coefficients is much greater than the firm growth model in Table 4.3. For example, in the firm growth model, there was an increase of approximately 30 firms per year due to increased CRE loan growth, while in the instrumental variables model, there is an increase of over 200 firms per year (the coefficient on *CRE Loans* in column 1 is 237.1 firms per year, significant at the 5% level, and the coefficients in columns 2 and 3 are approximately 210 firms per year, both significant at the 10% level).

This suggests that using the instrument and bank variables is giving a much larger estimate of firm growth than the model that only included regional growth variables. Further, the Dodd-Frank indicator is statistically significant at the 1% level in all regressions, suggesting that the impact of CRE loans on firm growth was impacted positively by the regulations, with between 56 and 58 firms formed per year post-regulation.

4.4.4 Cluster Analysis

This analysis separates the MSAs into three clusters as discussed in the methods section. Estimation results are presented in Table 4.6. For the entire sample, increased CRE loan growth is statistically significant and associated with an increase in employment growth, as in the prior analyses.

Table 4.6: Cluster Analysis – Employment Growth

This table reports the cluster analysis, with Employment Growth as the dependent variable. ***, **, * represent 1, 5, and 10% significance levels, respectively. Standard errors shown in parentheses below coefficient estimates.

VARIABLES	(1)	(2)	(3)	(4)
DV: Employment Growth	All	Cluster 1 Stable MSAs	Cluster 2 Shrinking MSAs	Cluster 3 Growing MSAs
CRE Loan Growth	0.0040***	0.0023***	0.0068***	0.0040***
	(0.0005)	(0.0006)	(0.0012)	(0.0010)
CRE Growth Lag (t-1)	0.0049***	0.0030***	0.0092***	0.0050***
	(0.0004)	(0.0004)	(0.0010)	(0.0010)
Employment Growth Lag (t-1)	0.2301***	0.2313***	0.0923***	0.3765***
	(0.0106)	(0.0163)	(0.0176)	(0.0248)
Dodd-Frank Indicator	0.0086***	0.0098***	0.0103***	0.0079***
	(0.0005)	(0.0006)	(0.0010)	(0.0013)
Charge-off Rate	0.1059**	0.0916	0.2768***	-0.1026
	(0.0434)	(0.0585)	(0.1047)	(0.0755)
Change in Capital	0.0030***	0.0050***	-0.0012	0.0042*
	(0.0010)	(0.0014)	(0.0016)	(0.0026)
Non-performing Loans	-0.0156	-0.0015	-0.0421*	-0.0740**
	(0.0106)	(0.0107)	(0.0237)	(0.0311)
Capital Ratio	0.0093**	0.0031	0.0251***	0.0401***
	(0.0044)	(0.0049)	(0.0092)	(0.0097)
All Loan Growth	0.0092***	0.0040**	0.0030	0.0174***
	(0.0015)	(0.0017)	(0.0034)	(0.0030)
Median Income	-0.0000*	0.0000*	0.0000	-0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Education	0.0006***	0.0006***	0.0004**	0.0004**
	(0.0001)	(0.0001)	(0.0002)	(0.0002)
Manufacturing Percent	0.0032	0.0223***	0.0098	-0.0011
	(0.0038)	(0.0065)	(0.0064)	(0.0086)
Construction Percent	0.0672***	0.0712***	0.0887***	0.0002
	(0.0077)	(0.0169)	(0.0242)	(0.0116)
Constant	-0.0176***	-0.0289***	-0.0237***	-0.0131***
	(0.0020)	(0.0033)	(0.0048)	(0.0050)
Observations	8,614	3,363	3,073	2,178
R-squared	0.1677	0.2159	0.0911	0.2356

Results for all MSA clusters are significant and positive, with shrinking MSAs having the highest growth. For example, the coefficient for the shrinking cluster on *CRE Loan Growth* in column 3 is 0.007, while for the growing cluster in column 4, the coefficient is 0.004, and the coefficient for the stable cluster in column 2 is 0.002 (all significant at the 1% level). All clusters display employment growth after the regulations, as indicated by the positive, statistically significant coefficients for the Dodd-Frank indicator variable (e.g., the coefficient on *Dodd-Frank Indicator* in all regressions is approximately 0.01, all significant at the 1% level). The same results hold for firm growth: increased firm growth is present in all clusters, and increased firm growth is also present after Dodd-Frank in all clusters. Results for the firm growth cluster analysis are presented in Table 4.7.

For the whole sample, increased CRE loan growth is associated with an increase in the number of firms established, with the whole sample having a greater number of firms created than the shrinking and growing MSA clusters, but fewer than in the stable MSA cluster. For example, the coefficient for *CRE Loan Growth* for the stable MSA cluster in column 2 is 65.4 firms per year and for the shrinking MSA cluster in column 3, the coefficient is 12.9 firms per year (both significant at the 1% level). These results are counter to the employment growth analysis in terms of where growth is greatest, as in the shrinking MSA cluster, CRE loan growth has the greatest impact on employment growth, and in the stable MSA cluster, CRE loan growth has the greatest impact on firm growth.

Table 4.7: Cluster Analysis – Firm Growth

This table reports the cluster analysis, with Firm Growth as the dependent variable. ***, **, * represent 1, 5, and 10% significance levels, respectively. Standard errors shown in parentheses below coefficient estimates.

VARIABLES	(1)	(2)	(3)	(4)
		Cluster 1 Stable	Cluster 2 Shrinking	Cluster 3 Growing
DV: Firm Growth	All	MSAs	MSAs	MSAs
CRE Loan Growth	34.1495***	65.3952***	12.9313***	15.9458***
	(3.1077)	(7.8274)	(1.9845)	(3.0719)
CRE Growth Lag	4.5616*	5.5991	-1.2774	-2.8190
(t-1)	(2.3436)	(4.5480)	(1.6501)	(3.2098)
Employment Growth	86.4483	-466.3127**	129.4597***	103.0406
Lag (t-1)	(60.0970)	(185.0774)	(28.9223)	(79.7457)
Dodd-Frank Indicator	38.9885***	83.9289***	15.3009***	36.8821***
	(2.9973)	(7.2904)	(1.6178)	(4.3361)
Charge-off Rate	-972.5134***	-2,156.648***	-83.2098	-753.4214***
	(247.3262)	(647.3838)	(171.9449)	(248.8003)
Change in Capital	16.4019***	40.8644***	4.1074	22.3779***
	(5.6052)	(15.2580)	(2.5845)	(8.1292)
Non-performing Loans	82.9294	160.9346	122.5116***	-338.1757***
	(60.3196)	(120.2770)	(38.9834)	(105.9251)
Capital Ratio	99.5760***	145.8427***	60.7991***	88.5936***
	(24.9673)	(56.1841)	(15.2930)	(31.7274)
All Loan Growth	12.0100	12.3986	3.2422	19.6778**
	(8.4571)	(19.9623)	(5.6285)	(8.4493)
Median Income	0.0022***	0.0032***	-0.0001	0.0010***
	(0.0002)	(0.0004)	(0.0002)	(0.0003)
Education	0.2370	-10.0217***	0.9132***	0.6907
	(0.4566)	(1.5677)	(0.2990)	(0.5164)
Manufacturing Percent	-95.1394***	115.4899	2.0571	-64.3962**
	(21.4270)	(73.4057)	(10.5518)	(27.7549)
Construction Percent	-58.8850	-323.8205*	39.4881	3.9118
	(43.4694)	(189.3143)	(39.6018)	(37.1434)
Constant	-137.9722***	-19.2451	-33.6253***	-75.1576***
	(11.5855)	(36.7494)	(7.9904)	(16.0846)
Observations	8,258	3,200	2,965	2,093
R-squared	0.1063	0.1005	0.0883	0.1141

Further, the coefficients on the Dodd-Frank indicator are of different magnitude for firm growth than for employment growth, with the stable MSA cluster showing the greatest firm growth after the regulations. This suggests that in stable MSAs, the regulations had the greatest impact, as there was the smallest change in employment growth over the whole sample period. However, there was also a larger, significant change in firm growth post-Dodd-Frank (e.g., the coefficient on *Dodd-Frank Indicator* for the stable MSA cluster in column 2 is 83.9 firms, as compared to the next largest coefficient for the growing MSA cluster in column 4 of 36.9 firms).

4.4.5 Robustness Checks

Robustness checks include examining employment and firm growth by the size of total consolidated assets within banks in all MSAs. To determine whether smaller, more regional banks have a different level of growth, banks are grouped by the level of their assets in each year. Three separate groups are created: banks with greater than $1 billion in total assets, between $500 million and $1 billion, and less than $500 million.

Limiting the BHCs based on asset size leads to a larger increase in employment growth related to an increase in CRE loan growth for BHCs greater than $500 million in total assets (Table 4.8). For example, for all banks in the sample, the coefficient on *CRE Loan Growth* in column 1 is 0.004, while the coefficient in column 2 is 0.003 and in column 3 is 0.012 (all significant at the 1% level). Limiting the sample to banks with less than $500 million in total assets show no significant change in employment growth in relation to CRE loan growth. Employment growth is also greater after Dodd-Frank at all

asset levels (e.g., the coefficient on *Dodd-Frank Indicator* in all regressions is approximately 0.01, significant at the 1% level for all regressions).

Table 4.8: Results for BHCs based on Asset Size – Employment Growth

This table reports fixed effects regression for banks with different levels of total assets, with Employment Growth as the dependent variable. ***, **, * represent 1, 5, and 10% significance levels, respectively. Standard errors shown in parentheses below coefficient estimates.

VARIABLES	(1)	(2)	(3)	(4)
DV: Employment Growth	All	>$1b Total Assets	>$500m & <$1b Total Assets	<$500m Total Assets
CRE Loan Growth	0.0042***	0.0028***	0.0117***	0.0005
	(0.0005)	(0.0007)	(0.0012)	(0.0009)
CRE Growth Lag (t-1)	0.0049***	0.0037***	0.0128***	0.0026***
	(0.0004)	(0.0005)	(0.0010)	(0.0008)
Employment Growth Lag (t-1)	0.2021***	0.2124***	0.1034***	0.3577***
	(0.0109)	(0.0156)	(0.0195)	(0.0235)
Dodd-Frank Indicator	0.0089***	0.0099***	0.0153***	0.0066***
	(0.0005)	(0.0007)	(0.0010)	(0.0016)
Charge-off Rate	0.0840*	0.0690	0.3063***	-0.0909
	(0.0433)	(0.0524)	(0.0969)	(0.1267)
Change in Capital	0.0028***	0.0015	0.0014	0.0056***
	(0.0010)	(0.0012)	(0.0022)	(0.0022)
Non-performing Loans	-0.0086	0.0079	-0.0342	-0.0106
	(0.0105)	(0.0129)	(0.0228)	(0.0260)
Capital Ratio	0.0085**	0.0059	0.0034	0.0017
	(0.0043)	(0.0062)	(0.0097)	(0.0070)
All Loan Growth	0.0086***	0.0086***	0.0035	0.0100***
	(0.0015)	(0.0021)	(0.0032)	(0.0028)
Median Income	0.0000***	0.0000***	0.0000**	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Constant	-0.0106***	-0.0131***	-0.0138***	-0.0049
	(0.0020)	(0.0027)	(0.0041)	(0.0041)
Observations	8,614	4,179	2,671	1,764
R-squared	0.1744	0.1890	0.1997	0.2435
Cluster Fixed Effects	Yes	Yes	Yes	Yes

Table 4.9: Results for BHCs based on Asset Size – Firm Growth
This table reports fixed effects regression for banks with different levels of total assets, with Firm Growth as the dependent variable. ***, **, * represent 1, 5, and 10% significance levels, respectively. Standard errors shown in parentheses below coefficient estimates.

VARIABLES	(1)	(2)	(3)	(4)
DV: Firm Growth	All	>$1b Total Assets	>$500m & <$1b Total Assets	<$500m Total Assets
CRE Loan Growth	33.2696***	43.3167***	36.8359***	15.3938***
	(3.0726)	(5.1141)	(5.8235)	(3.9886)
CRE Growth Lag (t-1)	4.6494**	7.8405**	6.2475	-1.3658
	(2.3272)	(3.3435)	(5.0951)	(3.6686)
Employment Growth Lag (t-1)	-51.3496	-100.4229	-68.6847	58.9969
	(62.0075)	(104.9039)	(96.8698)	(105.9248)
Dodd-Frank Indicator	45.8813***	60.6116***	49.1929***	14.2175*
	(2.9184)	(4.6033)	(5.2060)	(7.5018)
Charge-off Rate	-952.2741***	-1,149.36***	-627.8298	-251.9737
	(245.9981)	(352.1623)	(479.2474)	(570.9934)
Change in Capital	16.2554***	11.8666	3.9296	25.5758***
	(5.5660)	(8.2029)	(10.8875)	(9.7167)
Non-performing Loans	72.4876	152.04*	104.1215	-138.0098
	(59.8906)	(86.8615)	(112.7663)	(117.3867)
Capital Ratio	108.0748***	117.6434***	152.9907***	8.7397
	(24.7642)	(42.2073)	(47.9477)	(32.0401)
All Loan Growth	11.7491	-24.6308*	30.7504*	35.8785***
	(8.3942)	(13.1819)	(15.9843)	(12.5355)
Median Income	0.0013***	0.0013***	0.0012***	0.0017***
	(0.0002)	(0.0002)	(0.0003)	(0.0002)
Constant	-97.7614***	-101.36***	-100.71***	-91.5796***
	(11.4868)	(18.1372)	(20.3663)	(18.4406)
Observations	8,258	3,842	2,654	1,762
R-squared	0.1185	0.1276	0.1049	0.2208
MSA Fixed Effects	Yes	Yes	Yes	Yes

Further, using firm growth as the dependent variable (Table 4.9) provides significant results for all banks: increased CRE loan growth is associated with an increase in the number of establishments created each year, with significant increases in firm growth in the post-regulation years related to all except the smallest banks (those with

less than $500 million in total assets). Similarly, the smaller banks have an increase that is less than half of the number of firms created as compared to larger banks, as associated with CRE loan growth (the coefficient on *CRE Loan Growth* in column 4 is 15.4 firms per year, significant at the 1% level, as compared to the coefficient for larger banks in columns 2 and 3 at 43.3 and 36.8 firms per year, respectively, both significant at the 1% level).

Next, a model with year fixed effects looks at the impact of CRE loan growth on firm and employment growth. Table 4.10 presents the results. The results show, for both employment and firm growth, an increase in 2007, and a decrease in 2008, as expected based on the impact of the financial crisis. For example, in column 1 (Table 4.10), where the dependent variable is employment growth, the coefficient on *CRE Loan Growth* in 2007 is 0.03, and in 2008 the coefficient is -0.03 (both significant at the 1% level). In column 2, where the dependent variable is firm growth, the coefficient on *CRE Loan Growth* in 2007 is 247.2, and in 2008 the coefficient is -137.5 (both significant at the 1% level). In both cases, growth decreased similarly in magnitude to the increase in the year prior.

Subsequent to Dodd-Frank, employment growth does not significantly increase again until 2013, and at that point there is under a 1% increase in employment (the coefficient on *CRE Loan Growth* in column 1 in 2013 is 0.007, significant at the 5% level). Firm growth has a seemingly better turnaround post-regulation, with strong and positive firm growth in 2011 and positive but smaller in magnitude in successive years (with the coefficient in 2011 at 159.6 firms per year and in 2013 at 48 firms per year,

both significant at the 1% level). These results suggest that firm growth was a precursor to employment growth in relation to the CRE loans market.

Table 4.10: Effect of CRE Loan Growth, with Year Fixed Effects

This table presents the year fixed effects analysis, with change in CRE loan growth as the key independent variable. Control variables not shown include one lag of both CRE loan growth and employment growth, charge-off rate, change in capital, non-performing loans, capital ratio, and median annual income. ***, **, * represent 1, 5, and 10% significance levels, respectively. Standard errors shown in parentheses below coefficient estimates.

	(1)	(2)
Pre-crisis	DV: Employment Growth	DV: Firm Growth
2003	0.0023	61.0739***
	(0.0016)	(8.7176)
2004	0.0072***	14.2596**
	(0.0013)	(7.1423)
2005	0.0161***	1.5376
	(0.0022)	(12.0986)
2006	0.0018***	-0.3638
	(0.0007)	(3.4592)
Crisis		
2007	0.0302***	247.2362***
	(0.0024)	(13.2876)
2008	-0.0298***	-137.4931***
	(0.0033)	(17.9861)
2009	-0.0204***	32.6975
	(0.0052)	(28.4022)
Post-regulation		
2010	-0.0069**	-0.3920
	(0.0028)	(15.2169)
2011	-0.0051	159.5769***
	(0.0031)	(17.2774)
2012	-0.0017	36.0449*
	(0.0036)	(19.8773)
2013	0.0068**	47.9830***
	(0.0033)	(18.4459)
2014	0.0110***	40.9963*
	(0.0040)	(21.8113)
2015	0.0097***	36.8887*
	(0.0034)	(18.8469)
2016	0.0011	-
	(0.0018)	
Observations	8,615	8,259
Adjusted R^2:	0.1733	0.1456

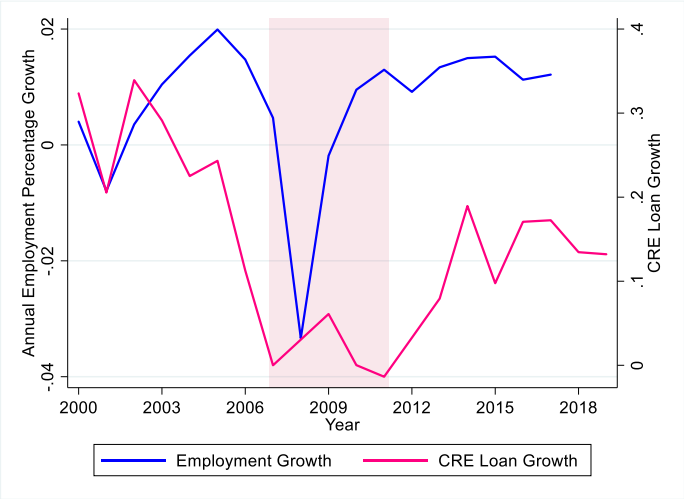
Table 4.11: Instrumental Variables: Reverse Analysis (Robustness Check)
This table presents the instrumental variable analysis results which examine the changes in log of employment growth for the banks within the sample and how that affects Commercial Real Estate (CRE) loan growth. Instrument used is loan commitments. ***, **, * represent 1, 5, and 10% significance levels, respectively. Standard errors shown in parentheses below coefficient estimates.

DV: CRE Loan Growth	EV: Employment Growth		EV: Firm Growth	
	(1)	(2)	(2)	(3)
VARIABLES	2 Lags of CRE & Employment Growth	Employment Growth variables	2 Lags of CRE & Employment Growth	Employment Growth variables
Employment Growth	-2.4354	-0.7694	-	-
	(19.6350)	(1.8506)		
Firm Growth	-	-	-0.0023	0.0311
			(0.0948)	(0.2274)
CRE Growth Lag (t-1)	-0.6228	-0.3288	0.0089	0.0090
	(3.3839)	(0.3162)	(0.0130)	(0.0144)
CRE Growth Lag (t-2)	-0.1295	0.0076	0.0388***	0.0347
	(1.6294)	(0.1533)	(0.0135)	(0.0228)
Employment Growth (t-1)	23.9546	8.7376	2.6462***	2.1560
	(178.1750)	(16.8338)	(0.7455)	(2.0920)
Employment Growth (t-2)	12.5136	4.6152	2.2011***	2.4140***
	(94.4873)	(8.9793)	(0.4056)	(0.7850)
Dodd-Frank Indicator	-0.1391	-0.1341***	-0.2404***	-0.2103***
	(0.2688)	(0.0330)	(0.0154)	(0.0267)
Charge-off Rate	6.5809	0.5633	-1.4980	-0.8026
	(70.9525)	(6.4055)	(1.5831)	(3.4191)
Change in Capital	0.5702	0.2130	-0.0196	-0.0287
	(4.1238)	(0.3937)	(0.0292)	(0.0449)
Non-performing Loans	-0.3427	-0.3401	-0.3727	-0.6057
	(1.7583)	(0.5858)	(0.8226)	(1.9821)
All Other Loans	1.6608	1.2701***	1.0452***	1.0125***
	(4.6036)	(0.4502)	(0.0816)	(0.1760)
Capital Ratio	-0.3325	-0.0907	-0.0604	-0.0365
	(2.4116)	(0.2655)	(0.1087)	(0.1160)
Median Income	-	0.0000	-	-0.0000
		(0.0000)		(0.0000)
Education	-	0.0114	-	-0.0049
		(0.0257)		(0.0104)
Manufacturing Percent	-	0.4362	-	0.4586
		(0.4028)		(0.7617)
Construction Percent	-	1.3616***	-	1.1800**
		(0.4018)		(0.4979)
Observations	6,112	6,112	5,205	5,205
Cluster Fixed Effects	Yes	Yes	Yes	Yes

Finally, a reverse analysis is conducted to see whether firm or employment growth impacted CRE loan growth, to determine the direction of the growth and check for endogeneity. Results are presented in Table 4.11. There are no significant relationships when regressing the employment or firm growth variables on CRE loan growth. Employment growth does not have a significant impact on CRE loan growth, nor does firm growth. This suggests that reverse causality is likely not present in the rest of the analyses in this paper.

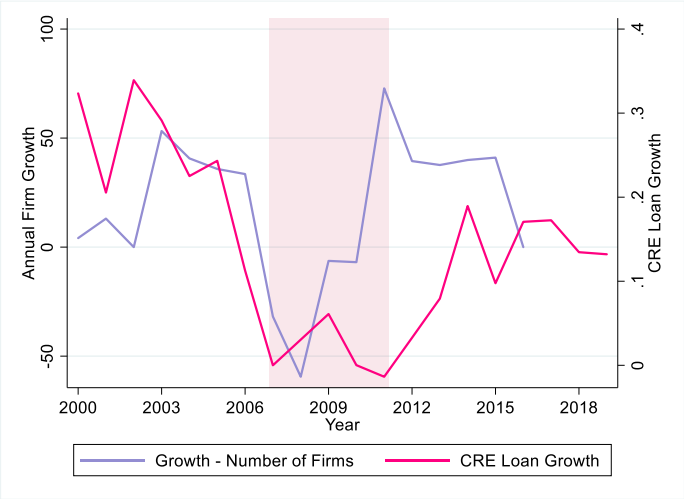
Figure 4.2 shows the percentage of annual growth for employment and CRE loans, and Figure 4.3 shows the percentage annual growth for firms and CRE loans. The graphs follow the same pattern as the regression results overall, where prior to the crisis employment growth had an upward trend that is visible in the yearly regressions in Table 4.10. Further, the employment growth decreases during the crisis period as CRE loans start to recover. This may be a result of a lag in hiring after loans are received, as commercial firms would not hire new employees immediately upon receipt of loan approval. There may also be a lag in the time between when a bank books a loan and when the CRE construction takes place and the loan is disbursed. Firm growth (Figure 4.3) has a pattern that appears to follow CRE loan growth: when CRE loan growth increases in one year, firm growth increases in the following year, and vice versa.

Figure 4.2: Annual Percentage Growth in Employment and CRE Loans 2000 – 2018



This figure shows the employment growth and CRE loan growth variables in the data as a percentage growth. Pink shaded area represents crisis and recession years (2007 – 2011).

Figure 4.3: Annual Percentage Growth in Firms and CRE Loans 2000 – 2018



This figure shows the firm growth (numbers of firms per year) and CRE loan growth variables in the data as a percentage growth. Pink shaded area represents crisis and recession years (2007 – 2011).

4.5 Discussion

The results suggest that there is a statistically significant relationship between CRE loan growth and the growth of both employment and the number of firms in a bank's MSA. The literature suggests that increased lending is expected to lead to increased employment growth in any period (Huber, 2018). However, the relationship is not necessarily what is expected when examining the relationship by year (as presented in Table 4.10). The most obvious reason for this is the crisis causing decreasing levels of employment as the number of firms was also decreasing, regardless of CRE lending.

The disparity in results may be a result of using all BHC data in the analysis, while regional employment growth may be affected more by those banks within the region rather than larger nationwide banks such as Bank of America. Robustness checks in this paper include separating the banks in the analysis by size of total assets, to determine whether bank size influences employment or firm growth in an area. Results indicate that larger and smaller banks are not significantly associated with employment growth based on their CRE loan growth, while medium-sized banks are associated with increased employment growth. Further, firm growth is significantly and positively impacted even when separating the banks by size. Another possibility for the results is given by Chodorow-Reich (2014), wherein the change in employment growth is directly correlated with the financial health of the lender; the BHCs have not been examined to see if any in the data declined in any way or failed during the crisis.

Additionally, it is suspected that there is an endogenous relationship between the loans and hiring; increased loan growth leads to employment and firm growth, but also

that increased employment or firm growth may lead to CRE loan growth. The analyses in this paper include lags of CRE loan growth along with the lags of employment growth to determine the relationship between loan and employment growth over time. Results hold when including one or two lags of CRE loan growth and one or two lags of employment growth, though in most cases the coefficients on CRE loan growth lags are negative or not significant. This suggests, along with the robustness check, that while increases in employment in prior years impacts employment growth positively in later years, neither employment nor firm growth have a direct effect on CRE loan growth. Further, the CRE growth lags indicate that CRE loan growth in prior years does not have a positive impact on employment growth in later years. In many cases, CRE loan growth one year prior actually leads to a decrease in employment growth. The same results hold for firm growth.

An examination using cluster analysis, which clusters regions by median income, population levels, and population growth in the regions, shows differing results based on the clusters. All the clusters show increased employment growth associated with increased CRE loan growth, with shrinking clusters experiencing the greatest impact on employment growth from increased CRE loans; increased firm growth is also seen, with CRE loan growth having the greatest impact on firm growth in stable clusters. These results suggest that areas of the country were affected differently by the changing CRE loan growth based on the type of region: shrinking, stable, or growing.

Finally, the analysis looks at employment growth separately by bank asset levels to see if those areas where banks maintain lower levels of total consolidated assets have

different employment or firm growth associated with CRE loans after the regulations than those banks with higher asset levels. The results indicate that banks with lower levels of total assets (less than $500 million) and higher levels (greater than $1 billion) have no significant change in employment growth based on CRE loans. However, all banks, regardless of asset levels, show increased employment growth post-Dodd-Frank. Firm growth shows similar results, with firm growth increasing in all cases, and positive change post-Dodd-Frank. This suggests that employment growth and firm growth as related to CRE loan growth both had a positive impact after the regulations.

This paper adds to the existing literature on the financial crisis and recession by examining firm and employment growth through a unique lens of commercial real estate loan growth. Results indicate that increased CRE loan growth is associated with an increase in both employment and firm growth. Additionally, results suggest that Dodd-Frank positively impacted both firm and employment growth, though effects were greater for firms than employment shortly after the regulations were implemented. Finally, results show that regions were impacted differently post-crisis, but still showed positive employment growth post-regulation. It is unclear whether the effects were directly related to the regulations, or simply a consequence of the end of the recession. However, weaker employment growth after the Great Recession was witnessed, more than in any prior recession (Hoynes et al., 2012). This suggests that the employment growth and firm growth in the analyses post-regulation was more likely due to the regulations than to the end of the recession.

4.5.1 Policy Implications

The Dodd-Frank Act impacts the level of capital that banks need to hold in order to be considered economically sound in times of financial distress, which then affects the level of loans that banks can underwrite. Based on the results in this paper, these mandated increases in capital reserves for banks lead them to make loans, which, in turn, stimulate the economy both regionally and nationally.

Within public policy, continued job growth and employment rates, as well as more commercial investment leads to increased tax revenue to localities. Investment in an area can also lead to relocation of people, as seen in Graves and Kozar (2015), where job seekers relocate to growing areas. Local growth and investment also lead to multiplier effects in the area; people moving to the area for a job become invested in the community, shop at the local stores, and pay taxes. The increased economic development in an area increases the value of real estate assets and leads to increased property tax revenue, which is often used to finance schools and municipal operations. Thus, the growth is beneficial for both local governments and school districts.

Finally, Dodd-Frank includes risk retention rules, which result in higher interest rates for borrowers, but also make the loans safer and decrease the likelihood that they will become troubled (Furfine, 2019). The risk retention aspect of Dodd-Frank was implemented in 2016 and requires the institution that securitizes the loan to maintain five percent or more of the overall risk (Furfine, 2019). Additionally, the changes made to Dodd-Frank in 2018 under the Economic Growth, Regulatory Relief, and Consumer Protection Act allow BHCs to report as high-volatility CRE loans only the loans that are

for acquisition, development, and construction, as opposed to the former regulations under Dodd-Frank that required any CRE loan with 150% risk-weight be reported as high-volatility (Quarles, 2018). Future research into these parts of bank regulation could show whether the loans are presumed to be safer by employers as well as banks, and whether the changes made to Dodd-Frank have been more – or less – effective for employment and firm growth.

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CHAPTER 5: CONCLUSION

5.1 Findings

This dissertation shows how the Federal Reserve banking regulations have impacted bank lending and regional economic growth. The analyses within the three papers add to the current literature by showing how the Dodd-Frank Act has impacted loan growth, household leverage growth, and employment and firm growth. The current literature is also extended by using data that covers the pre-crisis, crisis, and post-regulation periods. The analyses in this dissertation, and the results, also have broader impacts for policymakers by examining the effects of the banking regulations while policymakers are deciding whether to limit the regulations solely to the largest BHCs within the US. Results suggest that the regulations have had little impact on BHC behavior. The additional analyses this dissertation performs help determine the extent to which these impacts are positive for society and economic growth within and across different parts of the country.

The first chapter provided an overview of the Financial Crisis of 2007 and banking regulations that followed, specifically the Dodd-Frank Act. This banking regulation was discussed along with the overseeing of the regulations by the Federal Reserve and changes made to the Act since 2018.

The second chapter examined the impact of mandated minimum capital ratios on overall bank lending in the periods surrounding the crisis. The results indicated that the regulations were only effective during times of financial stress – the crisis years and years following multiple banks failing the CCAR stress tests. Results also showed that banks

required to undergo stress tests had lower loan growth than those that were not subject to the stress test aspect of Dodd-Frank.

The third chapter analyzed the relationship between bank branch deposits and household leverage. The results suggested that deposit growth prior to the crisis was related to increased household leverage, while during the crisis and after Dodd-Frank, the reverse was true – deposit growth was related to decreased household leverage. These results illustrate that the regulations had little to no impact on household leverage, as household leverage began decreasing during the crisis. Further, changing bank deposits appear to precede changes in household leverage, and thus, changes in consumer deposits can be useful in indicating potential economic distress.

The fourth chapter studied the impact of commercial real estate loans on firm and employment growth. The results provided evidence that CRE loan growth is positively associated with employment growth and firm growth except in times of crisis, and that growth was greater following the regulations. Regional analysis showed that different types of MSAs within the country were impacted differently by changing CRE loan growth over time.

The conclusions of this dissertation suggest that the crisis had a large impact on bank loan growth, as well as regional economic growth. However, the Dodd-Frank Act regulations passed post-crisis had less impact than previously thought on bank loan growth; loan growth began increasing prior to the implementation of Dodd-Frank. There was a positive impact seen in the analyses wherein increased firm and employment growth were seen post-regulation.

5.2 Policy Implications

The impact of the Dodd-Frank Act and Federal Reserve bank regulations on inequality and economic growth are a present concern for policymakers, especially as the regulations have been focused more each year on systemically important banks, and this means that fewer banks are subject to Federal Reserve mandated stress tests. The financial industry has argued since implementation of the regulations that they made lending more difficult and impeded economic growth, but at the same time, regulations increased transparency and gave the public the ability to hold banks accountable (Rappeport & Flitter, 2019).

In all analyses, the impacts of Dodd-Frank are less beneficial than initially expected. In particular, the impacts of mandated capital ratios and stress test monitoring were examined. The analyses show that the regulations had little to no impact outside of the actual crisis period and may have impeded bank lending after the recession ended.

Banks subject to stress tests had lower lending growth than those not under such severe Federal Reserve monitoring. This suggests that the arguments made by banks regarding the stringency of the Dodd-Frank regulations were appropriate. This also indicates that the loosening of the regulations in less economically stressed times may be more practical than initially thought. Further, the crisis had a greater impact than the regulations on decreasing household leverage, which again suggests that the regulations were overly aggressive in restricting banks post-crisis. Finally, regional economic growth was heavily impacted by the crisis, and both firm and employment growth improved in the years following the implementation of the bank regulations.

Based on these results, Dodd-Frank is less effective in improving economic outcomes during the later post-crisis period. Future efforts at bank regulation would likely be more successful if implemented during the initial period of economic distress, with the strictest requirements removed as the recession period ends and economic conditions improve.

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AFTERWORD

This dissertation focused on the effects of the Financial Crisis of 2007-08, using data ending in 2019. As a result, the implications and analyses contained within the three papers of this dissertation may not apply to the economic distress and recession caused by COVID-19 beginning in early 2020. The economic changes resulting from COVID-19 and related measures are completely unprecedented, and not yet fully determined. Moreover, as the recession is the consequence of a pandemic rather than direct financial distress, it is expected that the recovery period will look entirely different to the recovery from the Great Recession.

The Financial Crisis caused a long-lasting and deep recession, but one that was similar to prior recessions in everything but magnitude (Duygan-Bump et al., 2015). On the other hand, the economic difficulties and the recession related to COVID-19 have impacted large banks differently than the Financial Crisis. While Dodd-Frank may not have been as beneficial in the later post-crisis years, banks are better capitalized partly due to the post-crisis regulations, and thus started stronger at the onset of the 2020 recession (Buehler et al., 2020). Banks have had to plan for adverse events in order to pass Federal Reserve stress tests, which strengthened their reserves and prepared them for another crisis. Further, due to the lockdowns across the U.S., the economy contraction is expected to be far greater than during the Financial Crisis – by 20 percentage points or more (Osterland, 2020). These points combined suggest that there will be different economic implications as a result of the COVID-19 crisis, and that the results contained within this dissertation may not apply to 2021 and beyond.

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