ESSAYS ON LOCAL BANKING MARKETS AND THE CAPITAL CRUNCH DURING THE GREAT RECESSION

BY

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B.A., CLARK UNIVERSITY, 2010

M.A., BROWN UNIVERSITY, 2011

A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN THE DEPARTMENT OF ECONOMICS AT BROWN UNIVERSITY

PROVIDENCE, RHODE ISLAND
MAY 2016

This dissertation by David P. Glancy is accepted in its present form

by the Department of Economics as satisfying the

dissertation requirements for the degree of Doctor of Philosophy.

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ACKNOWLEDGEMENTS

I first would like to thank David Weil for providing constant feedback and support regardless of how far my research drifted from his. Without his patience, I would not have been able to pursue the topics that excited me in graduate school. Gauti Eggertsson, Neil Mehrotra and Nate Baum-Snow additionally provided invaluable feedback. Every conversation with them greatly improved the quality of my work. I'm also grateful to Ross Levine for sparking my initial interest in empirical banking research.

I'd also like to thank the research department at the Boston Federal Reserve Bank for hosting me for the last two years. The weekly lunch conversations with Victoria Ivashina, Ali Ozdagli, Joe Peek and Christina Wang have been enlightening and entertaining. These encounters have left me with a greater understanding and appreciation of the intricacies regarding the workings of the financial system than I had before.

My friends in the department, Mariá José Boccardi Chalela, Greg Casey, Morgan Hardy, Michelle Marcus, Angélica Meinhofer Santiago, Sanjay Singh and Tim Squires, deftly alternated between supporting me in and distracting me from my academic pursuits, depending on whatever was necessary at the time. Nick Coleman guided me through the ins-and-outs of both banking research and the job search process. Finally, Aaron Crootof, Anders Ohman, Ximena Ojopi and Brittany Mayweather took on the Sisyphean task of keeping me sane throughout graduate school, for which I am eternally grateful.

PREFACE

There is a vast literature studying the interactions between bank lending and the local economy. Whether it was bank failures during the savings-and-loan crisis reducing local income (Ashcraft, 2005), the lending contraction from Japanese banks during the early 90s reducing US construction activity (Peek and Rosengren, 2000), or bank branch deregulation between 1976 and 1994 increasing growth (Jayaratne and Strahan, 1996), there is substantial evidence that the performance of local banks and the local economy are tightly entwined.

However, since those periods, there has been a drastic shift in American credit markets which has the potential to decouple the health of local banks from the strength of the local economy. The removal of interstate branching restrictions in 1994 has created a banking system increasingly dominated by large geographically dispersed banks who are less subject to shocks from any given area (Morgan et al., 2004). Additionally, improvements in information and communication technology have reduced the importance of proximity in the provision of small business credit, enabling distant firms to increasingly compete with local ones (Petersen and Rajan, 2002). Finally, the continued rise of securitization has separated the act loan origination from loan funding, allowing credit risk to increasingly be held by dispersed investors instead of local banks (Loutskina and Strahan, 2009).

In this dissertation, I demonstrate that despite these changes in the banking system, the linkages between the health of local banks and the local economy remain strong. Moreover, these linkages played a fundamental role in propagating local real estate shocks to the general economy during the Great Recession. Chapter 1 demonstrates that banks locating in weak real estate markets experienced increases in non-performing loans and declines in equity, ultimately resulting in a contraction in the supply of credit to local businesses. Chapter 2 extends this work to show that this credit contraction had large employment effects during the Great Recession. Counties whose banks were exposed to real estate declines *elsewhere along their branch network* experienced contractions in small business lending and employment, especially in young firms, firms in financially dependent industries, and firms close to adversely affected banks. Chapter 3 justifies the emphasis on local banking markets, showing that bank mark-ups respond to the availability of competitors within 5 miles of their branches instead of the more conventionally used MSA level market definition.

The first two chapters are motivated by the observation that markets in the United States which experienced large declines in house prices, were plagued by bank failures, contractions in lending and falling employment during the Great Recession. These early chapters ask whether these declines in lending and employment were caused by the bank distress, or whether the ultimate cause of this regional turmoil laid outside the banking section.

Chapter 1 starts by studying how falling house prices impacted the supply of credit. I use a difference-in-differences approach to test whether commercial lending fell due to low demand, or whether banks were contracting supply. I exploit variation in banks' lending portfolios or funding structure which determine how sensitive a bank's lending capacity is to house price shocks. First, an increase in loans losses and a decline in equity should only impact a bank close to their capital constraint. Second, banks which held more construction loans would take larger losses when house prices fell, and thus should reduce commercial lending more than other banks facing the same declines. I show that only highly leveraged banks or construction oriented banks contract commercial lending, indicating that falling house prices predominantly impacted the supply of bank credit.

Chapter 2 also addresses the question of how falling house prices impacted bank lending, however it uses geographic variation in bank locations to separate supply from demand. I use bank-by-county small business lending data from the Community Reinvestment Act to estimate lending growth as a function of a bank's multimarket exposure to real estate shocks and county fixed effects. I demonstrate that bank's don't actually reallocate credit away from counties with falling house prices. Instead, exposed banks cut lending uniformly throughout their network. The county fixed effects have no impact on the relationship between bank exposure and lending growth, indicating that lending fell because exposed banks contracted credit everywhere, not because there was low demand in areas with falling house prices.

More importantly, this chapter shows that this contraction in bank lending impacted local employment. The exposure of local banks to falling house prices in other counties, MSAs, and geographically distant counties caused employment to fall within the county from 2007 to 2010. This even holds controlling for the local decline in house prices. Consistent with a contraction in the supply of bank lending driving the employment declines, employment fell the most in young firms, firms in financially dependent industries and in firms close to exposed banks. Overall, I find that bank lending contractions due to falling house prices explain over half of the relationship between housing wealth shocks and employment declines and 39% of the decline in employment during the great recession.

Chapter 3 deviates from the topic of the financial crisis and instead justifies the emphasis on local banking markets in the previous chapters. Motivated by earlier research showing that individuals and small businesses primarily rely on banks with nearby branches, I construct measures of deposit concentration in the area directly surrounding a bank's branches. Although US bank merger policy, as well as the bulk of academic work on bank market power, emphasize concentration at the MSA level, I show that this traditional measure of concentration ceases to predict bank mark-ups or profitability once the more local concentration is accounted for. I show that bank lending rates depend most strongly on the availability of competitors within 5 miles of their branches, indicating a limited ability to substitute towards distant banks. This lack of competition also matters for labor market outcomes. Firms in locally concentrated markets expand less in response to exogenous demand shocks, indicating the existence of greater financial constraints. This is particularly true of young firms, who would be the most dependent on banks for external finance.

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Chapter 1

House Price Declines and the Supply of Bank Credit

"Making credit accessible to sound small businesses is crucial to our economic recovery and so should be front and center among our current policy challenges"

-Ben Bernanke

"It's absurd to argue we need more bank lending when demand is collapsing throughout the economy"

-Atif Mian & Amir Sufi

1.1 Introduction

How did falling house prices impact bank lending during the Great Recession? Banks in weak real estate markets experienced a significant deterioration in loan performance and originated fewer commercial loans, however the degree to which this decline in lending reflected a contraction in the supply of credit remains controversial. Given the severity of the employment losses in areas with falling house prices, identifying the mechanism by which falling house prices impacted bank lending is a crucial component of understanding the recession.

This chapter presents evidence that falling house prices resulted in a contraction in the supply of bank credit. The hypothesis is that banks which located in areas where house prices fell took losses on their loan portfolio, thus harming their capital positions. Since asymmetric information problems can make issuing new equity prohibitively costly (Myers and Majluf, 1984), banks were forced to reduce lending in order to deleverage. Consequently, this capital crunch channel can explain the contraction in lending in areas where house prices fell. Furthermore, as credit supply shocks have been shown to impact labor markets (Ashcraft, 2005; Benmelech et al., 2011; Chodorow-Reich, 2014), this channel may also have contributed to the employment losses in these areas.

However, the relationship between falling house prices and lending growth could also be plausibly attributed to a reduction in the demand for loans. For example, falling house prices could reduce aggregate demand (Mian and Sufi, 2014) or the value of firm collateral (Fort et al., 2013; Mehrotra and Sergeyev, 2014). If these effects reduced either the incentive of firms to borrow or the creditworthiness of local firms, then lending would have fallen regardless of what happened to bank capital. Under this demand channel, the contraction in lending is due to a dearth of viable lending opportunities instead of adverse shocks to the health of local banks.

To disentangle supply from demand, I exploit cross sectional variation in the composition of bank balance sheets to identify banks whose ability to support new lending were more vulnerable to real estate shocks. General economic turmoil reducing the demand for loans would broadly affect the commercial lending of local banks. However, the capital crunch hypothesis predicts that some banks in particular would contract lending much more than others when local house prices fall. First, only banks close to their capital constraint should cut lending in response to a contraction in house prices. Banks with an adequate capital buffer could have their equity decline, but would have no need to shrink their assets in order to remain above regulatory capital ratios. Second, banks which devoted more of their portfolio to construction loans would experience larger losses.[1] Since these banks would experience a greater shock to equity, they should contract lending the most.

Specifically, I use a difference-in-differences approach to test how house price declines impact the growth in commercial and industrial (C&I) lending in (1) banks which are highly leveraged versus banks which are further their capital constraint, and (2) banks which are highly exposed to the construction sector versus banks which aren't. Thus I can use banks which face similar house price declines, or operate in the same market, as a control for local demand. This allows me to assess how real estate shocks impact the supply of credit.

I consistently find that it was the treated banks (banks with a high construction exposure or high leverage) who cut lending where house prices fell. Consider the effects of the national 15% decline in house prices between the beginning of 2007 and 2010. Untreated banks are predicted to have only minimally responded to this shock, with low leverage banks cutting commercial lending by 1.2% and low construction banks cutting lending by 0.1% between the start of 2008 and end of 2010. Treated banks are another story; this decline is predicted to have caused a 5.0% decline in commercial lending in leveraged banks and a 6.1% decline in construction oriented banks over those three years. Essentially the only banks which reduced lending in response to falling house prices

[1] Cole and White (2012); Friend et al. (2013) note that it was predominantly banks whose portfolios were concentrated in construction lending who failed during the Great Recession. I also show that falling house prices resulted in an increase in non-performing construction loans that dwarfed the effects on loan performance in other categories.

were the banks whose ability to lend would be sensitive to real estate declines. This suggests the contraction in lending was essentially due to a contraction in the supply of credit.

This finding is robust to numerous alternative specifications. Whether the treatment variables are binary or continuous, whether I control for demand using local house price growth or CBSA-quarter fixed effects, whether or not I weight by the size of the bank's commercial lending portfolio, and whether or not I include additional controls, makes little difference for the primary findings. I consistently find that treated banks exhibit a significantly greater sensitivity to house price declines than untreated banks.

Next, I take two approaches to provide auxiliary evidence in favor of my proposed channel. First, one may be concerned that my treatment variables are related to changes in demand. For example, the decision to operate with little capital may reflect high loan demand during the boom, which reverted during the bust. To assuage this concern, I study the impact that the treatment variables have on commercial loan utilization. If treated banks face lower loan demand in areas with falling house prices, then their customers would be less likely to draw down on their lines of credit, resulting in a decline in utilization. However, I find little difference in loan utilization in treated and untreated banks. If anything treated banks have utilization *increase* when house prices fall, indicating that they don't experience differentially low demand.

Second, I show that the findings are explained by poorer loan performance in distressed real estate markets. Banks with more non-performing loans cut lending, especially if they are highly leveraged. Once the non-performing loan rate and its interaction with bank leverage are included, the primary explanatory variables cease to predict lending growth. If leveraged banks or construction oriented banks cut lending even if their loans continued to pay off, this could indicate that they made loans to firms whose demand was more sensitive to house price declines. That loan losses take precedence over falling house prices in predicting lending increases confidence that it is indeed a capital crunch driven by non-performing loans which precipitated the decline in lending.

Lastly, I extend the analysis to other types of loans. Since the C&I lending category excludes loans backed by real estate, it may be unsurprising that the contraction reflected a decline in the ability of banks to lend. However, lending backed by real estate is more likely to fall due to declines in the value of collateral backing lending or the lack of profitable construction related investments. I find that national 15% decline in house prices resulted in a 2.4% decline in total lending for unleveraged banks versus a 5.8% decline for leveraged banks over the course of 2008 to 2010. These effects are 2.5% and 6.3% for lending backed by real estate, 10% and 13.8% for construction lending, and 1.2%

versus 3.8% for loans backed by non-farm non-residential properties.[2] Although construction lending seems to have fallen mostly due to low demand, in other categories the decline in house prices had a dramatically larger effect on lending in leveraged banks. Across the board, leveraged banks reduce lending in response to this 15% shock by about 3 or 4 percentage points more than unleveraged banks.

The ramifications of this capital crunch are thus potentially wide reaching. Previous research has demonstrated that the availability of commercial credit impacts employment and investment (Almeida et al., 2012; Campello et al., 2010; Chodorow-Reich, 2014), construction and CRE lending impacts unemployment and construction activity (Peek and Rosengren, 2000; Benmelech et al., 2011) and mortgage credit impacts employment and output growth (Mondragon, 2014; Loutskina and Strahan, 2015). The broad decline in the availability of credit across these various lending categories has the potential to explain much of the observed economic turmoil in distressed real estate markets during this period. How these bank real estate losses impacted local employment will be the subject of the second chapter of this dissertation.

1.1.1 Previous Literature

This paper fits cleanly into two literatures. First, there is an old literature demonstrating that declines in bank capital impact the lending of capital constrained banks. This was widely studied in the context of the recession in the early 1990s, with a particular emphasis on the New England banks who were reeling from the bursting of a house price and construction bubble in the late 1980s (Bernanke et al., 1991; Hancock and Wilcox, 1994; Peek and Rosengren, 1994, 1995). Further evidence in support of the importance of these capital shocks were also presented in the context of the Japanese banking crisis following the collapse of Japanese land prices in the early 1990s (Peek and Rosengren, 1997, 2000; Gan, 2007).

Peek and Rosengren (1995) and Gan (2007) are the closest to this paper methodologically. Peek and Rosengren (1995) shows that deposits fell in poorly capitalized banks with respect to better capitalized banks during a period of high bank distress in New England. Gan (2007) shows that firms borrowing from banks whose assets were highly oriented in real estate loans received less credit following the sharp contraction in Japanese land values. Similar to these papers, I exploit cross sectional variation in bank leverage or construction exposure to determine how these real estate shocks impacted the supply of bank lending. I differ by additionally using regional variation in the

[2] For construction and non-farm non-residential lending I report estimates from the weighted specifications because there are many banks who engage in a minimal amount of these types of lending. The differences are starker in the unweighted specifications.

degree of real estate distress, whereas the other papers focused on one area experiencing a negative shock.

The second strand of literature studies the determinants of bank lending during the Great Recession. Previous work has demonstrated that lending fell for numerous different reasons, including stresses on bank liquidity (Ivashina and Scharfstein, 2010; Cornett et al., 2011), mortgage backed security exposure (Santos, 2011), and losses in banks exposed to GSE preferred stocks (Rice and Rose, 2014).

The most relevant papers to me are Huang and Stephens (2011); Berrospide et al. (2013); Bord et al. (2014), who show that the multimarket exposure of banks to real estate shocks creates within county or MSA variation in lending. Namely banks with a greater exposure to real estate declines in other areas reduce lending relative to less exposed banks, indicating that falling house prices result in a contraction in the supply of lending. My difference-in-differences approach compliments these papers as it allows me to study the effects of falling house prices on predominantly single market banks. As these single market banks account for vast the majority of the banks in the US (6991 out of 7571), this is important in itself. Additionally, there is little geographically disaggregated lending data available. Thus by using a methodology only requiring aggregate balance sheet data, I can increase the scope of the work in terms of the outcome variables I analyze, in addition to expanding the sample.

The remainder of the paper proceeds as follows: The next section describes the data and empirical strategy. Section 3 presents the main findings. Section 4 provides additional evidence for the channel, and extends the methodology to other lending categories. Section 5 concludes.

1.2 Empirical Strategy and Data

1.2.1 Empirical Strategy

The primary analysis is based on the following specifications:

$$\begin{aligned} y_{b,m,q} = \beta_1 \Delta ln(House\ Price_{m,q}) \times Treat_{b,m,q-1} + \beta_2 \Delta ln(House\ Price_{m,q}) \\ + \gamma \mathbf{X}_{b,m,q-1} + \delta_q + \epsilon_{b,m,q} \end{aligned} \tag{1.1}$$

$$y_{b,m,q} = \beta_1 \Delta ln(House\ Price_{m,q}) \times Treat_{b,m,q-1} + \gamma \mathbf{X}_{b,m,q-1} + \delta_{m,q} + \epsilon_{b,m,q} \tag{1.2}$$

In the main part of the paper, $y_{b,m,q}$ is the quarterly growth in commercial and industrial lending for a bank b locating in market m. The market is taken to be the CBSA or rural county, henceforth just referred to as a CBSA for brevity.[3] $\Delta ln(House\ Price_{m,q})$ is the house price growth over the last year in m, $Treat_{b,m,q-1}$ is a bank balance sheet variable which influences how sensitive the bank's lending capacity is to real estate shocks, δ_q and $\delta_{m,q}$ are quarter and CBSA-quarter fixed effects respectively, and $\mathbf{X}_{b,m,q-1}$ a set of bank controls including $Treat_{b,m,q-1}$.[4] The sample period covers 2007 through 2010, and includes banks which held over 50% of their deposits in a single CBSA in 2006. Standard errors are clustered by CBSA.

$Treat_{b,m,q-1}$ is a measure of either the bank's exposure to the construction sector or leverage. I use one of four variables: the ratio of a bank's tangible assets to tangible equity (*Leverage*), an indicator for whether this variable is above the median for the CBSA-quarter (*High Leverage*), construction lending to bank equity ($Construction \big/ Equity$), and indicator for whether this ratio is above the median for the CBSA-quarter ($High\ Construction \big/ Equity$).

Many lenders are almost entirely specialized in real estate lending, creating a risk of overly emphasizing large percentage swings in C&I lending which actually have an inconsequential influence on aggregate lending. Thus in addition to OLS specifications, I also weight by the value of outstanding commercial loans at the end of the previous quarter. In the weighted specifications, I drop observations more than five standard deviations above the mean in commercial lending.[5]

1.2.2 Conceptual Framework

In order to interpret the coefficients in this specification, consider the following simple model of banks engaging in monopolistic competition. A bank in market m lends to a set of borrowers indexed by $i \in I_m$. Total borrowing for every i is a CES composite of borrowing from local banks, generating a standard iso-elastic demand for each bank b from borrower i.[6]

$$L_i^b = \xi_i^b L_i(\frac{r_i^b}{r_i})^{-\epsilon}$$

[3] A CBSA contains an urban center of at least 10,000 people and adjacent areas with strong commuting ties.

[4] Other control variables include: ln(assets), non-core deposit percent, mortgage back security holdings to assets, and share of lending in the commercial and industrial loan category.

[5] There are some large lenders that only locate in one market because they don't rely on local branches for lending. Including them in the weighted specification would skew the findings substantially, as the estimated coefficients would largely reflect the lending growth in a few banks which aren't actually predominantly engaging in local lending.

[6] The amount borrowed from each b, L_i^b, is done so as to minimize $\int_{\Omega_m} r_i^b L_i^b db$ *s.t.* $\left(\int_{\Omega_m} (\xi_i^b)^{\frac{1}{\epsilon}} (L_i^b)^{\frac{\epsilon-1}{\epsilon}} db\right)^{\frac{\epsilon}{\epsilon-1}} = L_i$. Solving this minimization problem, and denoting $r_i = (\int_{\Omega_m} \xi_i^b (r_i^b)^{1-\epsilon} db)^{\frac{1}{1-\epsilon}}$, gives the above demand curve.

Where r_i^b is the interest rate charged by bank b to borrower i, r_i is the overall cost of bank borrowing for i, ϵ is the elasticity of demand, and ξ_i^b is a demand shifter integrating to 1.

Given a certain level of aggregate lending L^b, the bank will allocate credit across borrowers in order to maximize profit subject to demand curves and the adding up constraint.

$$\begin{aligned} \underset{\{r_i^b\}}{\text{maximize}} \quad & \sum_{i \in I_m} L_i^b r_i^b \\ \text{subject to} \quad & \sum_{i \in I_m} L_i^b = L^b, \ \{L_i^b = \xi_i^b L_i (\frac{r_i^b}{r_i})^{-\epsilon}\} \ \forall i \end{aligned}$$

This results in a constant optimal lending rate for bank b:

$$r^b = (\frac{D^b}{L^b})^{\frac{1}{\epsilon}} \ \forall i \tag{1.3}$$

where $D^b = \sum_{i \in I_m} \xi_i^b L_i r_i^\epsilon$ measures the level of demand for loans from b.

Next, assume that the marginal cost of lending for a bank is an increasing function $c()$ of its leverage $\frac{L^b}{E^b}$, where E^b is the bank's equity. Using the previous expression and equating the marginal revenue from lending with the marginal cost, we get the following inverse supply curve:

$$r^b = \frac{\epsilon}{\epsilon - 1} c(\frac{L^b}{E^b}) \tag{1.4}$$

Combining the demand equation in (3) with the supply equation in (4) and log-linearizing produces the following equations governing the growth in lending and interest rates:

$$\hat{L}^b = \eta^b \hat{E}^b + (1 - \eta^b)\hat{D}^b \tag{1.5}$$

$$\hat{r}^b = \frac{\eta^b}{\epsilon}(\hat{D}^b - \hat{E}^b) \tag{1.6}$$

Thus lending growth is a weighted average of demand growth and equity growth, with a weight on equity growth: $\eta^b = (1 + (\epsilon c'(\frac{L^b}{E^b})\frac{(\frac{L^b}{E^b})}{c(\frac{L^b}{E^b})})^{-1})^{-1}$. This means that equity shocks matter more if borrowers are more able to substitute between banks (ϵ is high) or if there is a greater elasticity of marginal cost with respect to leverage: ($c'(\frac{L^b}{E^b})\frac{(\frac{L^b}{E^b})}{c(\frac{L^b}{E^b})}$ is high).

Since this paper focuses on C&I lending instead of total lending, consider the subset of commercial borrowers $I_{m,CI} \subset I_m$. Then the total C&I lending for b is $L_{CI}^b = (r^b)^{-\epsilon} \sum_{i \in I_{m,CI}} \xi_i^b L_i r_i^\epsilon$. Thus the growth in C&I lending is

$$\begin{aligned}\hat{L}^b_{CI} &= -\epsilon \hat{r}^b + \hat{D}^b_{CI} \\ &= -\eta^b(\hat{D}^b - \hat{E}^b) + \hat{D}^b_{CI}\end{aligned} \tag{1.7}$$

Where $D^b_{CI} \equiv \sum_{i \in I_{m,CI}} \xi^b_i L_i r^\epsilon_i$ denotes the level of demand for commercial bank loans for b. Equation (7) shows that the growth in C&I lending can be broken into two parts: a component reflecting changes in demand for commercial lending ($\hat{D}^b_{CI}$) and a component reflecting the cost of borrowing from a bank ($-\epsilon \hat{r}^b$). The object of interest in this paper is the elasticity of lending growth with respect to house price growth:

$$\frac{d\hat{L}^b_{CI}}{d\hat{H}_m} = \underbrace{-\epsilon \frac{\partial r^b}{\partial \hat{H}_m}}_{\substack{\text{Credit Crunch} \\ \text{Channel}}} + \underbrace{\frac{\partial \hat{D}^b_{CI}}{\partial \hat{H}_m}}_{\substack{\text{Demand} \\ \text{Channel}}}$$

Namely I want to test whether falling house prices reduced the supply of commercial lending ($\epsilon \frac{\partial r^b}{\partial \hat{H}_m} < 0$) or whether they reduced the demand for commercial loans ($\frac{\partial \hat{D}^b_{CI}}{\partial \hat{H}_m} > 0$). As I will show below, how this elasticity varies by leverage or construction exposure will be informative in assessing the magnitude of the demand and credit crunch channels.

1.2.3 Relation to Empirical Specification

Role of Bank Leverage Bank leverage matters because leveraged banks will face a steeper marginal cost curve. Banks with excess capital can cheaply increase deposits if they want to expand, whereas banks on their capital constraint would need to raise new equity, which is costly due to asymmetric information problems (Myers and Majluf, 1984). Additionally higher leverage increases bank risk and makes uninsured wholesale funding more expensive. As a consequence, leverage increases η^b, making lending growth more sensitive to equity growth.

To relate the theory to empirical strategy, suppose that the key variables in (7) take the following functional forms:

$$\begin{cases} \eta^b = \eta_0 + \eta_T T_b \\ \hat{E}^b = e_0 + e_H \hat{H}_m \\ \hat{D}^b = d_0 + d_H \hat{H}_m \\ \hat{D}^b_{CI} = c_0 + c_H \hat{H}_m \end{cases} \tag{1.8}$$

Where T_b is the treatment variable, indicating whether the bank is highly leveraged. These equations say that falling house prices impact bank equity, overall loan demand and commercial loan demand the same in leveraged and unleveraged banks. However, shocks to bank equity matter more for leveraged banks due to the fact that they are closer to their capital constraint ($\eta_T > 0$).

Combining (7) and (8) gives commercial lending growth as a function of bank leverage, house price growth and their interaction as in the estimating equation in (1):

$$\hat{L}^b = [\eta_0(e_0 - d_0) + c_0] + \underbrace{[\eta_T(e_H - d_H)]}_{\beta_1} T_b \hat{H}_m + \underbrace{[\eta_0(e_H - d_H) + c_H]}_{\beta_2} \hat{H}_m + [\eta_T(e_0 - d_0)]T_b$$

Thus the coefficient on the interaction term between the leverage indicator and house price growth should provide us with the term $\eta_T(e_H - d_H)$. This is easier to interpret when put in terms of partial derivatives: $\beta_1 = \frac{\partial \hat{L}^b_{CI}}{\partial \hat{r}^b} \frac{\partial r^b}{\partial \hat{H}_m}|_{T=1} - \frac{\partial \hat{L}^b_{CI}}{\partial \hat{r}^b} \frac{\partial r^b}{\partial \hat{H}_m}|_{T=0}$. Intuitively, β_1 shows the difference in the supply effect between unlevered and levered banks. A positive coefficient means that leveraged banks cut lending more when house prices fall. Under the assumption that these types of banks experience the same demand shocks, this differential can be attributed to increases in the cost of lending for leveraged banks.

The coefficient on $\hat{H}_m$ (β_2) gives us the term $\eta_0(e_H - d_H) + c_H$, which is $\frac{\partial \hat{L}^b_{CI}}{\partial \hat{r}^b} \frac{\partial r^b}{\partial \hat{H}_m}|_{T=0} + \frac{\partial \hat{D}^b_{CI}}{\partial \hat{H}_m}$. Thus the coefficient on house price growth will give the sum of the demand effect of falling house prices, and the supply effect for untreated banks. Given that $\eta_0 > 0$, and the fact that $\beta_1 > 0 \implies e_H > d_H$, we know that $\eta_0(e_H - d_H) > 0$. As a result, the coefficient on $\hat{H}_m$ provides an upper bound for the demand effect ($\frac{\partial \hat{D}^b_{CI}}{\partial \hat{H}_m}$).

The intuition here is that shocks to equity matter more for leveraged banks. If real estate shocks impact lending by increasing loan non-performance and decreasing bank equity, this matters more for banks closer to a regulatory capital ratio. A bank up against a capital constraint would need to either reduce lending or raise equity to maintain their current leverage after a period of poor loan performance. A bank further from their constraint could take losses without cutting lending or raising new equity, since they are permitted to operate at a higher level of leverage.

Conversely, demand shocks matter *less* for leveraged banks. Low leverage gives the flexibility to expand or contract lending as warranted by changes in demand. Banks on their capital constraint would continue to lend similar amounts after a demand shock because their previous lending was below what was necessitated by demand due to the capital constraint. Figure 1 demonstrates graphically that demand shocks impact lending in banks which are not capital constrained, while loan losses impact lending in banks which are constrained.

In short, the credit crunch hypothesis predicts that $\beta_1 > 0$ when $T_{b,m,q-1}$ measures bank leverage, because shocks to equity matter more for banks closer to their capital constraint. The demand hypothesis predicts falling house prices predominantly impacts loan demand ($d_H > E_H$) meaning that $\beta_1 < 0$, because unconstrained banks will cut lending most when demand falls.

Role of Construction Lending Construction exposure matters because it determines how severely house price declines impact bank equity. When house prices fall in a bank's market, loan non-performance and charge-offs increase most drastically for constructions loans. Banks with a high exposure to construction loans were also disproportionately likely to fail during this period (Cole and White, 2012; Friend et al., 2013).

To reflect this, now assume the following functional forms for the variables in equation (7):

$$\begin{cases} \eta^b = \eta \\ \hat{E} = e_0 + e_H \hat{H}_m + e_{TH} T_b \hat{H}_m \\ \hat{D}^b = d_0 + d_H \hat{H}_m + d_{TH} T_b \hat{H}_m \\ \hat{D}^b_{CI} = c_0 + c_H \hat{H}_m \end{cases} \tag{1.9}$$

Thus equity growth is more sensitive to house price shocks in construction oriented banks, as construction and land development loans performed so poorly when house prices fall. Overall demand for loans is assumed to also to be more sensitive to house price declines, because the profitability of new construction projects decreases when house prices fall. However, demand for commercial lending is assumed to be the same across banks facing similar local house price movements, since commercial lending isn't real estate backed. Under these assumptions, the equation defining lending growth is:

$$\hat{L}^b = [\eta(e_0 - d_0) + c_0] + \underbrace{[\eta(e_{TH} - d_{TH})]}_{\beta_1} T_b \hat{H}_m + \underbrace{[\eta(e_H - d_H) + c_H]}_{\beta_2} \hat{H}_m + [\eta(e_0 - d_0)] T_b$$

The coefficient on the interaction term thus reflects the degree to which a construction heavy loan portfolio impacts bank equity versus overall loan demand. If falling house prices impact lending through the credit crunch channel, it should be banks which had previously originated construction loans who cut lending the most, as losses on these construction loans cause equity to fall. Alternatively, if falling house prices predominantly impact loan demand, then this should impact banks regardless of their previous construction lending. Again, $\beta_1 > 0$ would be evidence in favor of the capital crunch channel.

1.2.4 Data

Data on lending, bank equity and non-performing loans come from the Call Reports, a quarterly filing of bank balance sheet variables. Since bank holding companies are expected to be a source of strength for distressed subsidiaries (Houston et al., 1997; Ashcraft, 2004), I aggregate the balance sheet variables of multibank holding companies to the level of the highest holding company. I use observations from the first quarter of 2007 through the end of 2010.

Dependent Variables The main dependent variable of interest is the growth in commercial and industrial lending: $\Delta ln(C\&I\ Loans)_{b,m,q}$. This measures the quarterly growth in the value of loans outstanding to businesses. This excludes business loans backed by real estate (which are reported separately). I additionally test how falling house prices impact the growth in bank assets, securities holdings, equity, as well as various other lending variables. Since these variables sometimes contain extreme outliers, I drop the highest and lowest 1% of observations of the dependent variable in the regressions.

I also demonstrate how locating in a market with falling house prices impacts loan performance. A loan is considered non-performing if it is 90 days past due or not accruing interest. The non-performing loan rate for a particular type of loan, e.g. construction loans, is the ratio of the value of non-performing loans to total lending for the category.

The final dependent variable of interest is the change in the commercial and industrial loan utilization rate: $\Delta C\&I\ Utilization_{b,m,q}$. The preferred measure of the utilization rate would be:

$$C\&I\ Utilization_{b,m,q} = C\&I\ Loans_{b,m,q} \Big/ (C\&I\ Loans_{b,m,q} + Unused\ C\&I\ Loans_{b,m,q})$$

However, unused commitments on commercial and industrial loans is unavailable until 2010, so I follow Kashyap et al. (2002) and use "other commitments" which predominantly reflects commitments to make C&I loans instead. This variable reflects changes in the tendency of firms to draw on their lines of credit. If a certain type of bank experiences a decrease in the demand for loans, this could show up as a decrease in the utilization of available credit.

Independent Variables I calculate leverage as the ratio of tangible assets to tangible equity: $Leverage = (Assets - Intangible\ Assets) \Big/ (Equity - Intangible\ Assets)$. Where intangible assets include variables such as good will or mortgage serving rights.[7] My measure of exposure to the

[7] Results are essentially unchanged using tier 1 leverage or the ratio of assets to capital.

construction sector is $Construction \Big/ Equity$, where *Construction* is the value of outstanding construction and land development loans. *High Leverage* is an indicator variable taking the value of 1 if *Leverage* is above the median for the CBSA-quarter. $High\ Construction \Big/ Equity$ is defined analogously. When I use the variables in their continuous form, I winsorize at the 5% level.[8]

Finally, house price data comes from the FHFA, who construct a repeat sales index on single family properties securitized by Fannie Mae or Freddie Mac. For banks locating in an MSA, I use the MSA level index. For banks outside an MSA, I use the index for rural areas within the state.[9] I match banks to CBSAs or counties using deposit data from the 2006 Summary of Deposits. The dependent variable of interest is the growth in house prices over the previous year in the CBSA where the bank held the majority of their 2006 deposits. I exclude banks (or holding companies) which didn't have any individual market containing at least 50% of their deposits.

Summary statistics are found in Table 1. Focusing on the variables weighted by commercial lending,[10] we see that banks faced an average annual decline in house prices of 2%, with a standard deviation of 6%. The ratio of construction loans to equity averaged about 1 with a considerable spread; the interquartile range runs from .34 to 1.48. The leverage ratio averages 11.1 with a standard deviation of 2.1. The mean quarterly growth rate of commercial lending is virtually 0, but with a standard deviation of 9%.

1.3 Findings

1.3.1 Background

Before turning to the difference-in-differences approach to distinguish between the capital crunch and demand channel, I first demonstrate that falling house prices did indeed result in increases in non-performing loans, and a contraction in the size of bank balance sheets.

Housing Declines and Loan Performance Table 2 estimate the non-performing loan rate for different types of loans as a function of the house price growth over the last year in the bank's market and quarter fixed effects. Banks in regions with falling house prices unsurprising see increases in non-performing loans. Focusing on panel 1 with the unweighted regressions, a 5% decline in house

[8]This matters little for the construction variable, however it is important for the findings with the leverage variable. Banks at either extreme of leverage will be either already past their capital constraint, or not needing to worry about their capital constraint, so it would make sense that incremental changes in leverage at the extremes wouldn't impact the sensitivity of loan supply to equity shocks.

[9]Results are mostly unchanged when just using MSAs, although it reduces the sample substantially.

[10]These exclude banks over five standard deviations above the mean as in the regressions.

prices is found to increase the overall non-performing loan rate from by 0.8% relative to a mean of 2.2%. Columns 2 and 3 show that this coefficient largely reflects the effect that falling house prices has on construction loans. The 5% decline in house prices increases the non-performing loan rate for non-construction loans by only 0.4%, while it raises the non-performing loan rate for construction loans by 2.5%. Thus while construction lending accounted for less than 10% of bank lending, it was a primary culprit for the rise in non-performing loans in banks located in distressed real estate markets.

The effects of falling house prices on loan performance in non-construction categories is typically an order of magnitude smaller than for construction loans. The non-performing loan rate for commercial loans and loans to individuals rise by 0.2% and 0.1% respectively in response to a 5% decline in house prices. Even the performance of other real estate loans are much less sensitive to real estate shocks, with a 5% decline raising the non-performing loan rate by 0.3% for commercial real estate (CRE) loans and 0.6% for loans backed by multifamily property.[11] Every coefficient is significant at the 1% level, except for loans to individuals which is significant at the 5% level.

Panel 2 presents regressions of the same specification, but weighting by the value of loans outstanding in the category to account for the fact that some banks may participate in very little of some types of lending and may thus have noisier non-performing loan rates. Overall, the insights from the OLS regressions remain in tact. A 5% decline in house prices raises the non-performing loan rate on construction loans by 2.2%, compared to 0.4% for non-construction loans. The coefficient for multifamily lending falls, and the coefficient for loans to individuals becomes insignificant despite increasing somewhat in value. However, the key take away doesn't change: banks in areas with falling house prices saw a deterioration in loan performance which was largely attributable to construction loans.

Housing Declines and Lending Growth How did falling house prices impact the size and composition of local bank balance sheets? Table 3 shows that banks in areas with falling house prices shrink across the board. The 15% decline in house prices experienced in the US between the start of 2007 and start of 2010 is predicted to have lowered assets by 2.9%, equity by 7.4%, lending by 4.1% and commercial lending by 3.4%.[12] The lending declines are stronger for real estate loans, mostly due to a large decline in construction lending.

Findings are mostly comparable in the unweighted (Panel 1) and weighted (Panel 2) specifica-

[11] CRE loans here refer to loans secured by non-farm non-residential property, and don't include construction and land development loans as in some definitions.

[12] An average of a 5% per year decline over the course of 12 quarters (2008-2010) would reduce lending by $.05 \times 12 \times \beta$. Where β is the coefficient on house price growth in Table 3.

tions. I find evidence of securities holdings falling only in the unweighted specification, while I find evidence of CRE lending falling only in the weighted specification. The effects on equity are smaller when I weight (4.6% decline after 3 years of 5% annual declines) but the effects on commercial lending are larger (4.2% decline over 3 years).

Recall the mechanism in the capital crunch channel: (1) falling house prices cause loans to perform poorly, (2) loan losses result in declines in equity pushing banks towards their capital constraint, (3) banks reduce lending in order to decrease their leverage. All of these elements are present in the data; banks in distressed real estate markets did have poorly performing loans and declining lending and equity. However, this isn't sufficient to prove that the capital crunch channel was operative. If demand fell faster than the capacity for banks to lend, then the decline in lending wasn't due to the decline in equity. It is still possible that banks were able to raise new equity affordably, but declined to do so due the lack of viable lending opportunities. In order to demonstrate that the real estate losses actually caused the decline in lending, I next turn to the analysis using variation across banks facing the same house price declines.

1.3.2 Main Findings

Difference-in-Differences By Leverage Table 4 shows that it was predominantly highly leveraged banks who cut commercial lending in response to falling house prices. In Column 1 of the first panel, I estimate quarterly C&I lending growth as a function of the house price growth over the previous year, an indicator for whether the bank is above the median in leverage for the area, the interaction of leverage and house price growth and quarter fixed effects. I find that the elasticity of quarterly lending growth with respect to house price growth is 0.02 for low leverage banks, but 0.08 for highly leveraged banks, with the difference being significant at the 1% level. The 15% decline in house prices would thus be predicted to have reduced lending by 5.0% in high leverage banks and only 1.2% in low leverage banks over the course of 2008 to 2010.

In the second column, I include CBSA-quarter fixed in order to compare lending of banks which are operating in the same market, instead of just markets with similar house price appreciation. The difference in the elasticity of lending growth with respect to house price growth between high leverage and low leverage banks increases modestly (from 0.0632 to 0.0652) but is almost the same as before. The extra bank controls in the third column change nothing.

One might be concerned that many predominantly single market banks have a very small commercial loan portfolio, making the average growth in commercial lending potentially not reflective of actual changes in credit availability. Columns 4-6 account for differences in the importance of banks in commercial lending by weighting by the value of the bank's commercial loan portfolio at the end of the previous quarter. Here the findings are qualitatively similar and still significant, albeit somewhat less stark. The lending elasticity is 0.04 for low leverage banks, and statistically different from zero unlike in the previous specification. For leveraged banks, the elasticity is again 0.08 and statistically different from the elasticity for unleveraged banks.

In the bottom panel, I use leverage in its continuous form instead of an indicator and get similar results. A bank at the 25th percentile in the leverage distribution (8.65) would have an elasticity of 0.0, namely they don't reduce commercial lending when house prices fall. A bank at the 75th percentile (12.05) however has an elasticity of 0.09, comparable to the high leverage group in the previous specification. The inclusion of the CBSA-quarter fixed effects diminishes the effect somewhat, with the movement along the interquartile range of leverage now increasing the elasticity by 0.07 instead of 0.09. The difference is still significant at the 1% level, and is unchanged by the inclusion of the bank controls.

The findings with the continuous form of leverage are weaker in the weighted regressions, but more consistent in magnitude. Regardless of controls or fixed effects, movement along the interquartile range of leverage now increases the elasticity of lending with respect to housing price growth by 0.04, although it is insignificant in the specification with CBSA-quarter fixed effects and bank controls.

Difference-in-Differences By Construction Table 5 repeats the same analysis, except using exposure to the construction sector instead of leverage. Here we see that the decline in commercial lending in areas experiencing negative real estate shocks was entirely due to contractions in banks holding a high value of construction loans. In Column 1 of panel 1, I find that the elasticity of lending growth with respect to house price growth is 0.00 for banks below the median in construction lending to equity, but 0.10 for banks highly exposed to the construction sector, with the difference significant at the 1% level. The 15% national decline in US house prices would thus be predicted to reduce lending by 6.1% in construction oriented banks but only 0.1% in other banks over the course of 2008 to 2010.

The inclusion of CBSA-quarter fixed effects and bank controls in Columns 2 & 3 only strengthens the findings, raising the difference in elasticities from 0.10 to 0.11. Weighting by the size of the commercial loan portfolio also strengthens the findings slightly, producing differences in elasticities between 0.10 and 0.12.

Turning to the specifications using the ratio of construction lending to equity in its continuous form in the bottom panel, we reach a similar conclusion. A bank at the 25th percentile in the distribution (0.12) is found to *increase* quarterly commercial lending by 0.046% in response to a 1% decline in house prices.[13] A bank at the 75th percentile of the distribution (1.02) has an elasticity which is 0.07 higher than at the 25th percentile. The inclusion of the CBSA-quarter fixed strengthens the finding marginally, with the interaction between house price growth and construction exposure remaining consistent throughout.

Weighting by commercial lending in Columns 4-6 results in slightly smaller differences in elasticities across different values of construction exposure. Moving from the 25th to the 75th percentile in construction exposure raises the lending elasticity from 0.012 to 0.053. However, the qualitative result is consistent throughout: bank's with minimal exposure to construction loans mostly didn't cut lending in response to falling house prices. The bulk of the contraction in commercial lending in weak real estate markets occurred in banks who had initially been originating construction loans, and hence were taking large losses on their loan portfolio.

1.4 Extensions

1.4.1 Commercial Loan Utilization

Showing that leveraged and construction oriented banks respond more to housing declines can only be taken to be indicative of a supply shock if these banks aren't subject to different demand shocks.[14] As one cannot directly observe loan demand, I test for a differential effect on a proxy for loan demand: loan utilization. If treated banks have demand fall more in distressed real estate markets, then their customers would be less willing to draw down any unused loan commitments, resulting in a decline in utilization.

Tables 6 and 7 repeat the primary difference-in-differences specifications as in the previous two tables, but using the change in the percentage of commercial loan commitments which are utilized as the dependent variable. A positive interaction between the treatment variable and house price growth would indicate that clients of treated banks are less prone to draw down their lines of credit when house prices decline, indicating potentially larger demand shocks for treated banks.

Overall, the utilization rate of commercial loan commitments rises when house prices fall. If falling house prices were to result in a reduction in the availability of credit from local banks, this is

[13] An important caveat in this finding is that construction exposure is correlated with house price movements, so some of the lending effects of falling house prices may be appearing in the coefficient on construction exposure, which is much more strongly negative than in the other specifications.

[14] In the context of the model, $\frac{\partial \hat{D}^b}{\partial \hat{H}_m}|_{T=1} = \frac{\partial \hat{D}^b}{\partial \hat{H}_m}|_{T=0}$

precisely what would be expected. When less credit is available from other sources, this could make a firm more likely to lean on existing commitments.

However, there is little evidence of utilization responding to real estate shocks differently in high leverage banks. The interaction between the leverage variable and house price growth is significant at the 5% level in only 2 out of 12 specifications, and in none of the specifications with CBSA-quarter fixed effects. When it is significant, I find that utilization rises more in leveraged banks when house prices fall, contrary to what would be likely to happen were demand to be falling disproportionately in these banks.

There is more evidence of a difference in utilization when construction exposure is the treatment variable. I find that utilization rises in construction oriented banks when house prices fall. This consistently holds true when $Construction \Big/ Equity$, is the treatment variable, but is less robust for $High\ Construction \Big/ Equity$. Again, this indicates that the declines in commercial lending in construction oriented banks wasn't due to firms desiring less credit.

1.4.2 Are Results Driven by Loan Losses?

Another way to provide evidence that falling house prices impact lending by impairing loan performance is to include non-performing loans in the specification. If falling house prices resulted in a contraction in lending because banks took losses on their loan portfolio and forced capital constrained banks to deleverage, then falling house prices should cease to be important when the interaction of leverage and non-performing loan rates are controlled for. If banks within distressed real estate markets cut lending even when their loans continue to pay out, it could indicate that the contraction reflects something different than a reduced capacity to make loans.

Tables 8 and 9 support the claim that the declines in commercial lending are indeed due to loan losses. When I include the non-performing loan rate, bank leverage and their interaction in the primary specifications presented in Tables 4 and 5, I find that: (1) banks with high non-performing loans cut lending, (2) this contraction is amplified in leveraged banks and (3) house price growth is mostly insignificant once loan losses are controlled for.

For the first finding, banks with more non-performing loans are consistently shown to contract lending. The first panel of Table 8 adds the non-performing loan rate and its interaction with $High\ Leverage$ to the primary difference-in-differences specifications with $High\ Leverage$ as the treatment variable. Across the six specifications, banks below the CBSA median in leverage are found to reduce quarterly lending growth by between 0.24% and 0.29% in response to a 1 percentage point increase in the non-performing loan rate. The first panel of Table 9 repeats this for the specifications with $High\ Construction \Big/ Equity$ as the treatment variable. Here, the elasticity lending growth with respect to non-performing loans is found to run between -0.28 and -0.34 for unleveraged banks. The coefficient on non-performing loans is significant at the 1% level in all 12 specifications.

For the second finding, the declines in lending are even greater in leveraged banks. The interaction between non-performing loans, and the measure of leverage is significant at at least the 5% level in 22 of 24 specifications, and significant at the 10% level in the other two.[15] The coefficient on the interaction of $High\ Leverage$ and $Non\text{-}performing\ Loans$ runs between -0.11 and -0.17. Taking the mid point of the range of values, a 1% higher non-performing loan rate over the course of a year would thus reduce C&I lending by roughly 1.16% in unleveraged banks and 1.72% in leveraged banks.

Finally, and most relevant to the questions at hand, controlling for non-performing loans causes house price growth to lose its explanatory power. House price growth is always insignificant. The interaction of house price growth with the treatment variable is only significant at the 5% level in the two specifications with $High\ Construction \Big/ Equity$ as the treatment variable and CBSA-quarter fixed effects. This isn't merely caused by inflated standard errors stemming from the inclusion of correlated regressors, the magnitude of the coefficients on the majority of the housing variables drop drastically once non-performing loans are controlled for. The interaction effect between house price growth and the treatment variable drops by over half in 22 of 24 specifications, usually substantially more.

1.4.3 Effects on Other Lending

How did falling house prices impact the supply of credit in other loan categories? Since C&I lending only accounts for about 15% of the lending of the banks, ignoring other loan categories gives an incomplete picture of how falling house prices impacted the supply of credit. Furthermore, since C&I lending isn't backed by real estate, there is less of a reason to expect falling house prices to impact lending for reasons other than the health of local banks. Real estate backed lending may fall because people or firms experience a decline in the value of their real estate assets and can thus have less collateral to support borrowing. Additionally, construction lending is likely to fall because there aren't good investments to be made. Thus it is more likely that even banks far from their capital constrain would cut lending, indicating a greater role for demand than I found for commercial

[15] The 24 specifications come from combinations of the following: (leverage,construction)×(indicator,continuous)×(quarter fixed effect, CBSA-quarter fixed effect, CBSA-quarter fixed effect and bank controls)×(unweighted,weighted).

lending.

Tables 10-13 test whether leveraged banks disproportionately cut different types of lending in response to falling house prices. I examine how bank leverage impacts the elasticity of lending growth with respect to house price growth for total lending (Table 10), lending backed by real estate (Table 11), construction lending (Table 12) and commercial real estate lending (Table 13). Overall, there is more evidence of demand driven lending declines when the loan category includes real estate loans, although the capital crunch channel significantly impacts every type of lending.

In Table 10, we see that total lending responds more to house price declines in highly leveraged banks. However, unlike with commercial lending, unleveraged banks cut lending too. The elasticity of quarterly total lending growth with respect to house price growth is 0.040 for low leverage banks and 0.097 for leveraged banks. This difference in elasticities isn't substantially changed by the inclusion of CBSA-quarter fixed effects, bank controls, or weighting by initial loan volume. Similar insights are drawn from the use of leverage in its continuous form in the bottom panel. A 15% decline in house prices over the course of three years would reduce lending by 2.4% for banks below the median in leverage, and 5.8% for banks above the median.

In Table 11, we see that the findings for lending backed by real estate is very similar to the findings for overall lending. The elasticity of quarterly real estate lending growth with respect to house price growth is 0.042 for low leverage banks and 0.106 for leveraged banks in the unweighted specification. These elasticities are 0.055 and 0.096 in the weighted specification. Again, using more conservative fixed effects, additional bank controls, or the continuous measure of leverage don't materially change the finding.

Table 12 shows that the decline in construction lending seems to be more driven by declines in demand in areas where house prices fall. The elasticity of construction loan growth with respect to house price growth is 0.303 for low leverage banks and 0.389 for leveraged banks in the unweighted specification. These elasticities are 0.169 and 0.231 in the weighted specification. Although falling house prices decrease construction lending significantly more for highly leveraged banks, low leverage banks contract lending to a strong degree, indicating that the declines predominantly reflected a lack of desirable construction investments.

Commercial real estate lending on the other hand follows patters more similar to the non-real estate backed C&I loans. Table 13 shows that the contractions in lending were predominantly in leveraged banks. In the unweighted specification, unleveraged banks are found to *increase* non-farm non-residential lending by .023% in response to a 1% decline in house prices, while leveraged banks *decrease* lending growth by 0.031% in response to a 1% decline in house prices. As many banks originate very few CRE loans, the weighted specification might be more reflective of changes in credit. Here we find that the elasticity of CRE lending with respect to house prices is 0.021 for unleveraged banks and 0.063 for leveraged banks, with the difference still being statistically significant.

1.4.4 How Much of the Decline is Due to Supply Shocks

In this section I attempt to quantify the degree to which banks cut lending due to demand versus supply factors. Recall that the elasticity of quarterly lending growth in some category G with respect to last year's house price growth was decomposed into a credit crunch channel and a demand channel:

$$\frac{d\hat{L}_G^b}{d\hat{H}_m} = \underbrace{\frac{\partial \hat{L}_G^b}{\partial \hat{r}^b}\frac{\partial r^b}{\partial \hat{H}_m}}_{\substack{\text{Credit Crunch}\\ \text{Channel}}} + \underbrace{\frac{\partial \hat{D}_G^b}{\partial \hat{H}_m}}_{\substack{\text{Demand}\\ \text{Channel}}}$$

Between 2007 and 2010, house prices declined on average by 5% per year. Over the course of 12 quarters, this means that the predicted lending decline due to the credit crunch effect is: $.05 \times 12 \times E(\frac{\partial \hat{L}_{CI}^b}{\partial \hat{r}^b}\frac{\partial r^b}{\partial \hat{H}_m})$ and the expected decline due to demand is: $.05 \times 12 \times E(\frac{\partial \hat{D}_{CI}^b}{\partial \hat{H}_m})$.

In oder to determine these expectations, recall that the coefficients from (1) can be interpreted as:

$$\beta_{1,G} = \frac{\partial \hat{L}_G^b}{\partial \hat{r}^b}\frac{\partial r^b}{\partial \hat{H}_m}|_{T=1} - \frac{\partial \hat{L}_G^b}{\partial \hat{r}^b}\frac{\partial r^b}{\partial \hat{H}_m}|_{T=0}$$
$$\beta_{2,G} = \frac{\partial \hat{L}_G^b}{\partial \hat{r}^b}\frac{\partial r^b}{\partial \hat{H}_m}|_{T=0} + \frac{\partial \hat{D}_G^b}{\partial \hat{H}_m}$$

Since we have two equations and three unknowns, I need to make an additional assumption in order to identify how the regression coefficients map into these elasticities. Note that the parameterization in equation 8 implies that:

$$\frac{\partial \hat{L}_G^b}{\partial \hat{r}^b}\frac{\partial r^b}{\partial \hat{H}_m}|_{T=1} = \underbrace{\frac{\eta_o + \eta_T}{\eta_0}}_{1+\chi} \times \frac{\partial \hat{L}_{CI}^b}{\partial \hat{r}^b}\frac{\partial r^b}{\partial \hat{H}_m}|_{T=0}$$

Denoting the ratio $\frac{\eta_T}{\eta_0} \equiv \chi$, one can solve this system of 3 equations for all of the elasticities of interest as a function of the regression coefficients and χ.

$$\begin{cases} \frac{\partial \hat{D}_G^b}{\partial \hat{H}_m} = \beta_{2,G} - \frac{\beta_{1,G}}{\chi} \\ \frac{\partial \hat{L}_G^b}{\partial \hat{r}^b} \frac{\partial r^b}{\partial \hat{H}_m}|_{T=0} = \frac{1}{\chi}\beta_{1,G} \\ \frac{\partial \hat{L}_G^b}{\partial \hat{r}^b} \frac{\partial r^b}{\partial \hat{H}_m}|_{T=1} = \frac{1+\chi}{\chi}\beta_{1,G} \end{cases} \tag{1.10}$$

Thus the decline in lending due to falling demand is: $.6 \times E(\frac{\partial \hat{D}_G^b}{\partial \hat{H}_m}) = .6 \times (\beta_{2,G} - \frac{\beta_{1,G}}{\chi})$. Since half of the banks are high leverage and half low leverage, the decline due to the credit crunch channel is: $.6 \times E(\frac{\partial \hat{L}_G^b}{\partial \hat{r}^b} \frac{\partial r^b}{\partial \hat{H}_m}) = .6 \times \frac{1+.5\chi}{\chi}\beta_{1,G}$.

To bound these effects, one must make an assumption regarding the value of χ, which parameterizes how much more important equity shocks are to leveraged banks than unleveraged banks. A high χ means that unleveraged banks minimally respond to equity shocks, meaning that the coefficient on $\hat{H}_m$ mostly reflects the influence on falling house prices on demand. Low values of χ mean that even low leverage banks are sensitive to equity shocks, and thus give larger predicted supply effects.

Consider two polar sets of assumptions to bound potential supply and demand effects. First, lets make the assumption that maximizes the predicted demand effect. Specifically, assume that low leverage banks can take losses without it impacting the cost of lending ($\frac{\partial \hat{L}_G^b}{\partial \hat{r}^b} \frac{\partial r^b}{\partial \hat{H}_m}|_{T=0} = 0$). This corresponds with $\chi = \infty$, making the credit crunch channel equal to: $.3\beta_{1,G}$ and the demand channel equal to $.6\beta_{2,G}$.

Second, assume that the entire contraction in C&I lending was due to supply. Based on equation 10 and the findings in Table 4, this implies that $\chi = \frac{\beta_{1,CI}}{\beta_{2,CI}} = \frac{6.32}{2.02}$. I can then use this χ to assess how supply and demand shocks impacted lending in other categories.

Using the estimated coefficients from Table 4, and Tables 10-13 gives the following estimates of how the 15% decline in house prices in the US impacted bank lending through the credit crunch and demand channels under the two assumptions regarding χ. Note that for construction loans and CRE loans I use the weighted specification, as these types of lending are more concentrated in fewer banks, whereas real estate lending in more generally an important part of a bank's portfolio.

	Demand Friendly Assumption $\chi = \infty$		Supply Friendly Assumption $\chi = \frac{6.32}{2.02}$	
Loan Type	Demand Channel	Supply Channel	Demand Channel	Supply Channel
Commercial	1.2%	1.9%	0.0%	3.1%
Overall	2.4%	1.7%	1.3%	2.8%
Real Estate	2.5%	1.9%	1.3%	3.1
Construction	10.1%	1.9%	9.0%	3.0%
CRE	1.3%	1.3%	0.5%	2.1%

Under the demand friendly assumption, which attributes any lending declines in unleveraged banks as the result of declining loan demand, we typically have falling house prices resulting in a contraction in the supply of credit accounting for slightly less than a 2% decline across the different lending categories. Under the supply friendly assumptions, which assume that the decline in commercial lending was entirely a supply side phenomenon, we have falling house prices explaining a roughly 3% decline in lending. Although this may sound small, total lending in commercial banks was around $7 trillion before the crises, thus this implies a supply driven contraction of between $140-210 billion.

1.5 Conclusion

One of the most salient features of the Great Recession was the strong relationship between falling house prices and the local employment losses. While these housing declines were undoubtedly central to the economic turmoil, the exact mechanism is unclear. Were the employment losses a consequence of the loss in housing wealth and a resultant decline in consumption? Were they a consequence of the extreme losses in construction and related industries? Were the rash of bank failures a cause or a consequence the economic turmoil?

This paper takes an important step in evaluating these questions, namely I ask whether falling house prices impacted the supply of credit. I show that falling house prices didn't uniformly impact the commercial lending of local banks, instead lending fell in the banks for whom falling house prices would have resulted in the greatest contraction in the capacity to lend. Specifically, only construction oriented banks and leveraged banks reduced lending in areas with falling house prices.

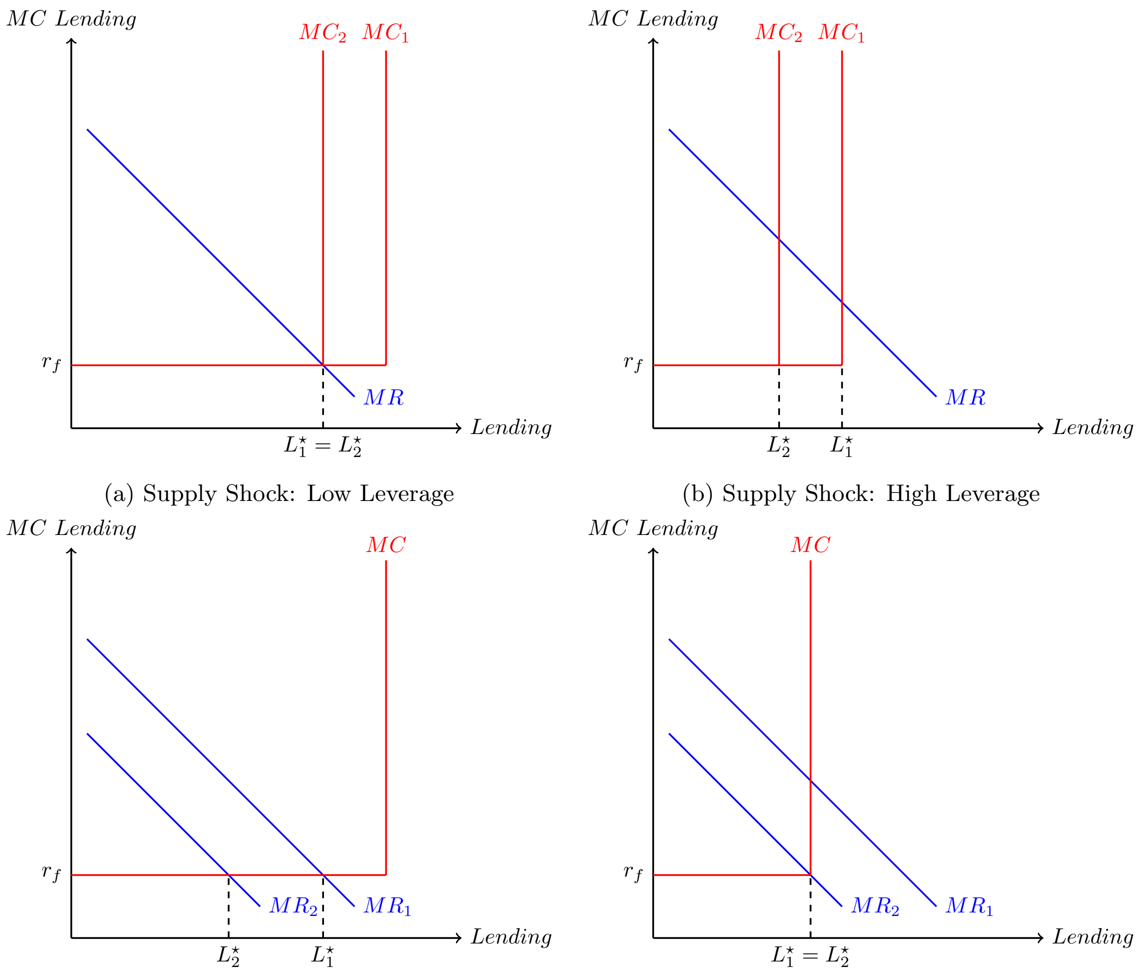
However, one must be cautious in interpreting this result as it ignores the sort of adjustments which should occur in equilibrium. I have shown that lending predominantly fell due to supply shocks instead of demand shocks *at the bank level*. However, a contraction in one bank may increase the demand for loans from another. With perfect banking markets, firms would move out of capital constrained banks and into the banks in a position to lend more cheaply. Overall lending would fall due to demand, and the differentials between banks would be uninformative regarding the aggregate availability of credit.

Despite this cause for caution, there are good reasons to believe that substituting away from a bank is costly. Chodorow-Reich (2014) shows that even for the relatively large firms borrowing from very large banks, banking relationships are sticky. A shock to a firm's bank was shown to have a large impact on employment decision of firms who didn't have access to the bond market. Given that the customers of the small single market banks in my sample disproportionately make information sensitive loans to small opaque firms (Berger et al., 2005), it is unlikely that they'd be more able to substitute away from a banking relationship than the firms active in syndicated loan markets appearing in the sample in Chodorow-Reich (2014).

In short, this large disruption in the supply of lending at the bank level has the potential to disrupt the economy, but it is difficult to quantify the degree with this approach. This will be the goal of the next chapter.

1.6 Appendix

1.6.1 Figures



(a) Supply Shock: Low Leverage

(b) Supply Shock: High Leverage

(c) Demand Shock: Low Leverage

(d) Demand Shock: High Leverage

Figure 1.1: Lending Elasticities: By Bank Leverage

Notes: This figure demonstrates the differential effect of bank leverage on the responsiveness of bank lending to a supply versus a demand shock. Deposits are supplied inelastically at the market rate r_f, but banks have a leverage constraint so that lending cannot be greater than a certain multiple of their equity, causing the supply curve to go vertical. The top panels show that a decline in equity (a leftward shift of the supply curve) only impacts lending if a bank is on its capital constraint. The bottom panels show that a decline in demand only impacts lending if a bank is not on its capital constraint. This means that the empirical finding that falling house prices result in a contraction in lending for leveraged banks implies that these declines predominantly impact the supply of lending.

1.6.2 Tables

Table 1.1: Summary Statistics

	Mean	Standard Deviation	Percentile 25th	Percentile 75th	Obs
Primary Variables					
Weighted by C&I Lending					
House Price Growth (annual)	-0.020	0.062	-0.042	0.014	68895
$Construction \Big/ Equity$	0.995	0.787	0.344	1.475	68895
Leverage	11.145	2.084	9.853	12.577	68895
$\Delta ln(C\&I\ Loans)$	-0.001	0.087	-0.044	0.044	67739
Unweighted					
House Price Growth (annual)	-0.010	0.050	-0.026	0.017	70639
$Construction \Big/ Equity$	0.697	0.755	0.116	1.022	70639
Leverage	10.344	2.369	8.654	12.052	70639
$\Delta ln(C\&I\ Loans)$	0.002	0.114	-0.053	0.056	67945
Other Outcome Variables (unweighted)					
Non-performing Loans (%)					
Overall	0.022	0.033	0.004	0.028	70430
Real Estate	0.024	0.036	0.003	0.031	70082
Construction	0.058	0.122	0.000	0.059	65198
Multifamily Residential	0.020	0.091	0.000	0.000	52782
HELOC	0.009	0.047	0.000	0.003	51241
Commercial and Industrial	0.020	0.043	0.000	0.022	69119
Individuals	0.009	0.025	0.000	0.009	69899
Quarterly Growth Rates					
Assets	0.008	0.035	-0.012	0.030	69912
Equity	0.006	0.049	-0.008	0.028	69511
Total Lending	0.008	0.041	-0.015	0.029	69628
Real Estate Lending	0.010	0.045	-0.015	0.031	69155
Construction Lending	-0.011	0.235	-0.102	0.077	63374
CRE Lending	0.015	0.084	-0.024	0.047	68219
Multifamily Residential Lending	0.020	0.207	-0.024	0.026	51058
Home Equity Lines of Credit	0.020	0.143	-0.031	0.063	49915
Lending to Individuals	-0.011	0.098	-0.052	0.027	68827
Credit Utilization (%)					
$\Delta CI\ Loan\ Utilization$	0.001	0.062	-0.027	0.030	68440

Notes: This table reports summary statistics of the main bank-quarter level variables in this paper. The most important explanatory variables (leverage, construction exposure and annual local house price appreciation) and the key outcome variable (quarterly commercial lending growth) are summarized both as weighted by the level of commercial lending at the end of the previous quarter and unweighted. As in the regressions, I drop any observation more than five standard deviations above the mean in commercial lending when weighting. Other outcome variables pertaining to loan performance, balance sheet growth, or credit utilization are unweighted.

Table 1.2: Housing Declines and Loan Non-performance

	(1) Total	(2) Non-Construction	(3) Construction	(4) Commercial	(5) Individual	(6) CRE	(7) Multifamily
Panel 1: Unweighted							
House Price Growth	-0.155**	-0.0798**	-0.496**	-0.0484**	-0.0172*	-0.0529**	-0.127**
	(0.0197)	(0.0129)	(0.0613)	(0.0110)	(0.00708)	(0.0126)	(0.0347)
Constant	0.0209**	0.0166**	0.0527**	0.0195**	0.00864**	0.0214**	0.0188**
	(0.00107)	(0.000680)	(0.00348)	(0.000636)	(0.000284)	(0.000703)	(0.00142)
Observations	70430	70430	65198	69119	69899	69479	52782
R^2	0.106	0.074	0.093	0.019	0.004	0.031	0.011
Panel 2: Weighted by Level of Lending							
House Price Growth	-0.136**	-0.0755**	-0.431**	-0.0412**	-0.0207	-0.0525**	-0.0779+
	(0.0292)	(0.0204)	(0.0852)	(0.0121)	(0.0144)	(0.0158)	(0.0464)
Constant	0.0246**	0.0170**	0.0753**	0.0175**	0.00828**	0.0200**	0.0248**
	(0.00230)	(0.00123)	(0.00715)	(0.000724)	(0.00107)	(0.00130)	(0.00365)
Observations	70186	70174	64452	68861	69764	69047	51856
R^2	0.128	0.117	0.236	0.055	0.015	0.102	0.026
Quarter Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < .01$

Notes: This table reports coefficients from regressions of quarterly bank level non-performing loan rates for different types of loans on local house price growth and quarter fixed effects. The dependent variable is the non-performing loan rate overall in (1), on loans besides construction and land development loans in (2), construction and land development loans in (3), commercial loans in (4), loans to individuals in (5), loans backed by non-farm non-residential properties in (6), and loans backed by multifamily properties in (7). The non-performing loan rate is the percentage of the value of loans which are 90 days past due or not accruing interest. The first panel is estimated with OLS. The second panel weights by the level of lending in the given category at the end of the previous quarter, dropping observations more than 5 standard deviations above the mean in the lending category. The sample runs from 2007 to 2010 and includes banks which hold over 50% of their deposits in one CBSA or county. Standard errors are clustered by CBSA/county.

Table 1.3: Housing Declines and Loan Growth: By Loan Type

	(1) Assets	(2) Equity	(3) Securities	(4) Lending	(5) C&I	(6) RE	(7) Construction	(8) CRE
Panel 1: Unweighted								
House Price Growth	0.0481**	0.124**	0.0511**	0.0684**	0.0569**	0.0767**	0.350**	0.00788
	(0.00715)	(0.0129)	(0.0178)	(0.0116)	(0.0144)	(0.0131)	(0.0297)	(0.0117)
Observations	69912	69511	68223	69628	67945	69155	63374	68219
R^2	0.024	0.109	0.008	0.075	0.017	0.057	0.022	0.009
Panel 2: Weighted by Initial Level								
House Price Growth	0.0436**	0.0771**	-0.00712	0.0686**	0.0697**	0.0820**	0.212**	0.0446**
	(0.0166)	(0.0272)	(0.0401)	(0.0212)	(0.0146)	(0.0150)	(0.0417)	(0.0121)
Observations	69790	69347	68159	69402	67739	68928	63118	67855
R^2	0.033	0.072	0.017	0.128	0.054	0.121	0.120	0.031
Quarter Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < .01$

Notes: This table reports coefficients from regressions of quarterly bank level growth rates for different balance sheet variables on local house price growth and quarter fixed effects. The dependent variable is the growth rate of assets in (1), equity in (2), securities in (3), total lending in (4), commercial lending in (5), lending backed by real estate in (6), construction and lend development lending in (7), and lending backed by non-farm non-residential properties in (8). The first panel is estimated with OLS. The second panel weights by the initial level of the balance sheet variable at the end of the previous quarter, dropping observations more than 5 standard deviations above the mean. The sample runs from 2007 to 2010 and includes banks which hold over 50% of their 2006 deposits in one CBSA or county. Standard errors are clustered by CBSA/county.

Table 1.4: Housing Declines and Commercial Lending Growth: By Leverage

	(1)	(2)	(3)	(4)	(5)	(6)
Panel 1: Indicator for High Leverage						
High Leverage	-0.00227*	-0.00233*	-0.00235+	0.000626	-0.000845	-0.000652
	(0.00105)	(0.00118)	(0.00122)	(0.00208)	(0.00224)	(0.00241)
House Price Growth	0.0202			0.0383*		
	(0.0137)			(0.0182)		
High Leverage × *House Price Growth*	0.0632**	0.0652**	0.0653**	0.0413*	0.0547**	0.0528**
	(0.0204)	(0.0230)	(0.0229)	(0.0185)	(0.0171)	(0.0181)
Observations	56214	56214	56214	56013	56013	56013
R^2	0.020	0.245	0.246	0.065	0.324	0.325
Panel 2: Leverage						
Leverage	-0.000866**	-0.000815*	-0.000874*	-0.000448	-0.000568	-0.000575
	(0.000250)	(0.000331)	(0.000355)	(0.000627)	(0.000677)	(0.000739)
House Price Growth	-0.235**			-0.0660		
	(0.0418)			(0.0510)		
Leverage × *House Price Growth*	0.0268**	0.0203**	0.0205**	0.0119*	0.0118+	0.0116
	(0.00414)	(0.00591)	(0.00589)	(0.00471)	(0.00699)	(0.00718)
Observations	66672	66672	66672	66468	66468	66468
R^2	0.020	0.290	0.291	0.062	0.360	0.360
Quarter Fixed Effect	Yes	No	No	Yes	No	No
CBSA-Quarter Fixed Effect	No	Yes	Yes	No	Yes	Yes
Weighted	No	No	No	Yes	Yes	Yes

Standard errors in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < .01$

Notes: This table reports coefficients from regressions of quarterly bank level commercial and industrial lending growth on bank leverage, CBSA house price growth and their interaction. Leverage is the ratio of tangible assets to tangible equity. In first panel, I use an indicator for whether leverage is above the median for the CBSA-quarter. The second panel uses leverage in its continuous form, winsorized at the 5% level. Columns 1 & 4 include quarter fixed effects, while Columns 2,3,5 & 6 include CBSA-quarter fixed effects. Columns 1-3 are unweighted, while columns 4-6 weight by the size of the bank's C&I loan portfolio in the previous quarter. The sample runs from 2007 to 2010 and includes bank holding companies which hold over 50% of their deposits in one CBSA or county, dropping observations in the highest or lowest percentile of lending growth. The weighted regressions additionally drop banks 5 standard deviations above the mean in commercial lending. Standard errors are clustered by CBSA/county.

Table 1.5: Housing Declines and Commercial Lending Growth: By Construction Exposure

	(1)	(2)	(3)	(4)	(5)	(6)
Panel 1: High Construction Exposure						
$High\ \ Construction \Big/ Equity$	-0.000571	-0.000597	-0.000577	0.00331	0.00283	0.00323
	(0.000988)	(0.00112)	(0.00126)	(0.00262)	(0.00239)	(0.00259)
$House\ Price\ Growth$	0.00117			0.00928		
	(0.0152)			(0.0275)		
$High\ \ Construction \Big/ Equity\ \times$	0.101^{**}	0.108^{**}	0.111^{**}	0.104^{**}	0.120^{**}	0.118^{**}
$House\ Price\ Growth$	(0.0196)	(0.0222)	(0.0221)	(0.0321)	(0.0332)	(0.0321)
Observations	55766	55766	55766	55575	55575	55575
R^2	0.020	0.246	0.247	0.066	0.328	0.329
Panel 2: Construction to Equity Ratio						
$Construction \Big/ Equity$	-0.00321^{**}	-0.00175	-0.00244^{*}	-0.00251^{+}	-0.00160	-0.00219
	(0.000650)	(0.00109)	(0.00122)	(0.00128)	(0.00204)	(0.00251)
$House\ Price\ Growth$	-0.0551^{**}			0.00617		
	(0.0196)			(0.0235)		
$Construction \Big/ Equity\ \times$	0.0773^{**}	0.0814^{**}	0.0821^{**}	0.0459^{**}	0.0739^{**}	0.0739^{**}
$House\ Price\ Growth$	(0.0148)	(0.0177)	(0.0176)	(0.0155)	(0.0197)	(0.0196)
Observations	66672	66672	66672	66468	66468	66468
R^2	0.020	0.290	0.291	0.063	0.361	0.361
Quarter Fixed Effect	Yes	No	No	Yes	No	No
CBSA-Quarter Fixed Effect	No	Yes	Yes	No	Yes	Yes
Weighted	No	No	No	Yes	Yes	Yes

Standard errors in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < .01$

Notes: This table reports coefficients from regressions of quarterly bank level commercial and industrial lending growth on bank construction exposure, CBSA house price growth and their interaction. Construction exposure is the ratio of bank construction lending to equity. In first panel, I use an indicator for whether construction exposure is above the median for the CBSA-quarter. The second panel uses construction exposure in its continuous form, winsorized at the 5% level. Columns 1 & 4 include quarter fixed effects, while Columns 2,3,5 & 6 include CBSA-quarter fixed effects. Columns 1-3 are unweighted, while columns 4-6 weight by the size of the bank's C&I loan portfolio in the previous quarter. The sample runs from 2007 to 2010 and includes bank holding companies which hold over 50% of their deposits in one CBSA or county, dropping observations in the highest or lowest percentile of lending growth. The weighted regressions additionally drop banks 5 standard deviations above the mean in commercial lending. Standard errors are clustered by CBSA/county.

Table 1.6: Housing Declines and Commercial Loan Utilization: By Leverage

	(1)	(2)	(3)	(4)	(5)	(6)
Panel 1: Indicator for High Leverage						
High Leverage	-0.000108	-0.0000898	-0.000259	-0.000307	0.0000111	-0.000226
	(0.000475)	(0.000537)	(0.000551)	(0.000759)	(0.000855)	(0.000931)
House Price Growth	-0.0260**			-0.0124		
	(0.00686)			(0.0109)		
High Leverage × *House Price Growth*	0.00318	0.00399	0.00447	-0.00395	0.00894	0.0117
	(0.00702)	(0.00793)	(0.00799)	(0.00880)	(0.0118)	(0.00976)
Observations	57818	57818	57818	57685	57685	57685
R^2	0.006	0.240	0.241	0.014	0.293	0.297
Panel 2: Leverage						
Leverage	0.0000257	0.0000760	0.0000726	-0.000253+	-0.000161	-0.000211
	(0.0000968)	(0.000148)	(0.000154)	(0.000147)	(0.000163)	(0.000200)
House Price Growth	0.00803			0.0485		
	(0.0170)			(0.0347)		
Leverage × *House Price Growth*	-0.00323*	-0.00322	-0.00299	-0.00590*	-0.000399	0.00000137
	(0.00148)	(0.00218)	(0.00219)	(0.00268)	(0.00261)	(0.00238)
Observations	68440	68440	68440	68304	68304	68304
R^2	0.006	0.292	0.293	0.014	0.337	0.340
Quarter Fixed Effect	Yes	No	No	Yes	No	No
CBSA-Quarter Fixed Effect	No	Yes	Yes	No	Yes	Yes
Weighted	No	No	No	Yes	Yes	Yes

Standard errors in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < .01$

Notes: This table reports coefficients from regressions of changes in quarterly bank level commercial and industrial loan utilization on bank leverage, CBSA house price growth and their interaction. Leverage is the ratio of tangible assets to tangible equity. In first panel, I use an indicator for whether leverage is above the median for the CBSA-quarter. The second panel uses leverage in its continuous form, winsorized at the 5% level. Columns 1 & 4 include quarter fixed effects, while Columns 2,3,5 & 6 include CBSA-quarter fixed effects. Columns 1-3 are unweighted, while columns 4-6 weight by the size of the bank's C&I loan portfolio in the previous quarter. The sample runs from 2007 to 2010 and includes bank holding companies which hold over 50% of their deposits in one CBSA or county, dropping observations in the highest or lowest percentile of $\Delta C\&I\ Utilization_{b,m,q}$. The weighted regressions additionally drop banks 5 standard deviations above the mean in commercial lending. Standard errors are clustered by CBSA/county.

Table 1.7: Housing Declines and Commercial Loan Utilization: By Construction Exposure

	(1)	(2)	(3)	(4)	(5)	(6)
Panel 1: Indicator for High Construction Exposure						
High Construction / Equity	0.00170**	0.00178**	0.00170**	0.00192*	0.00320**	0.00222**
	(0.000351)	(0.000401)	(0.000416)	(0.000812)	(0.00124)	(0.000759)
House Price Growth	-0.0163*			-0.0101		
	(0.00634)			(0.00921)		
High Construction / Equity ×	-0.0157*	-0.0152+	-0.0137	-0.0196	-0.000247	0.00246
House Price Growth	(0.00796)	(0.00902)	(0.00897)	(0.0122)	(0.0213)	(0.0207)
Observations	57320	57320	57320	57190	57190	57190
R^2	0.006	0.240	0.240	0.015	0.298	0.301
Panel 2: Construction Lending to Equity Ratio						
Construction / Equity	0.00176**	0.00163**	0.00144**	0.00119*	0.00218**	0.000996
	(0.000237)	(0.000375)	(0.000384)	(0.000498)	(0.000769)	(0.000806)
House Price Growth	0.0000881			0.0209		
	(0.00771)			(0.0149)		
Construction / Equity ×	-0.0169**	-0.0179**	-0.0174**	-0.0309**	-0.0187*	-0.0191*
House Price Growth	(0.00452)	(0.00612)	(0.00626)	(0.00761)	(0.00863)	(0.00871)
Observations	68440	68440	68440	68304	68304	68304
R^2	0.007	0.292	0.293	0.016	0.338	0.341
Quarter Fixed Effect	Yes	No	No	Yes	No	No
CBSA-Quarter Fixed Effect	No	Yes	Yes	No	Yes	Yes
Weighted	No	No	No	Yes	Yes	Yes

Standard errors in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < .01$

Notes: This table reports coefficients from regressions of changes in quarterly bank level commercial and industrial loan utilization on bank construction exposure, CBSA house price growth and their interaction. Construction exposure is the ratio of bank construction lending to equity. In first panel, I use an indicator for whether construction exposure is above the median for the CBSA-quarter. The second panel uses construction exposure in its continuous form, winsorized at the 5% level. Columns 1 & 4 include quarter fixed effects, while Columns 2,3,5 & 6 include CBSA-quarter fixed effects. Columns 1-3 are unweighted, while columns 4-6 weight by the size of the bank's C&I loan portfolio in the previous quarter. The sample runs from 2007 to 2010 and includes bank holding companies which hold over 50% of their deposits in one CBSA or county, dropping observations in the highest or lowest percentile of $\Delta C\&I\ Utilization_{b,m,q}$. The weighted regressions additionally drop banks 5 standard deviations above the mean in commercial lending. Standard errors are clustered by CBSA/county.

Table 1.8: Are Results Driven By Real Estate Losses: Leverage Specifications

	(1)	(2)	(3)	(4)	(5)	(6)
Panel 1: Indicator for High Leverage						
High Leverage	0.00135	0.00105	0.000792	0.00553*	0.00381	0.00393
	(0.00130)	(0.00148)	(0.00155)	(0.00282)	(0.00298)	(0.00327)
House Price Growth	-0.00181			0.0163		
	(0.0186)			(0.0211)		
High Leverage × *House Price Growth*	-0.00558	0.00166	0.00150	0.0102	0.0189	0.0180
	(0.0217)	(0.0241)	(0.0239)	(0.0214)	(0.0220)	(0.0217)
Non-performing Loans	-0.293**	-0.265**	-0.278**	-0.286**	-0.242**	-0.252**
	(0.0443)	(0.0577)	(0.0591)	(0.0706)	(0.0765)	(0.0788)
High Leverage × *Non-performing Loans*	-0.166**	-0.157**	-0.157**	-0.136*	-0.130*	-0.137*
	(0.0396)	(0.0461)	(0.0471)	(0.0613)	(0.0639)	(0.0632)
Observations	57317	57317	57317	57114	57114	57114
R^2	0.028	0.241	0.243	0.073	0.323	0.324
Panel 2: Leverage						
Leverage	-0.000150	-0.000169	-0.000269	0.00109	0.000637	0.000636
	(0.000316)	(0.000427)	(0.000442)	(0.000940)	(0.000877)	(0.00103)
House Price Growth	-0.0641			-0.00608		
	(0.0533)			(0.0586)		
Leverage × *House Price Growth*	0.00549	0.00126	0.00151	0.00255	0.00491	0.00477
	(0.00490)	(0.00633)	(0.00623)	(0.00532)	(0.00523)	(0.00539)
Non-performing Loans	-0.0608	-0.00461	-0.0166	-0.0353	-0.0208	-0.0231
	(0.0849)	(0.107)	(0.107)	(0.160)	(0.145)	(0.144)
Leverage × *Non-performing Loans*	-0.0287**	-0.0307**	-0.0308**	-0.0301*	-0.0268*	-0.0280*
	(0.00783)	(0.00953)	(0.00949)	(0.0135)	(0.0122)	(0.0123)
Observations	67945	67945	67945	67739	67739	67739
R^2	0.028	0.286	0.287	0.071	0.361	0.362
Quarter Fixed Effect	Yes	No	No	Yes	No	No
CBSA-Quarter Fixed Effect	No	Yes	Yes	No	Yes	Yes
Weighted	No	No	No	Yes	Yes	Yes

Standard errors in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < .01$

Notes: This table reports coefficients from regressions of quarterly bank holding company level commercial and industrial lending growth on MSA level house price growth, the bank level non-performing loan rate, and the interaction of these variables with bank leverage. Leverage is the ratio of tangible assets to tangible equity. In first panel, I use an indicator for whether leverage is above the median for the CBSA-quarter. The second panel uses leverage in its continuous form, winsorized at the 5% level. Columns 1 & 4 include quarter fixed effects, while Columns 2,3,5 & 6 include CBSA-quarter fixed effects. Columns 1-3 are unweighted, while columns 4-6 weight by the size of the bank's C&I loan portfolio in the previous quarter. The sample runs from 2007 to 2010 and includes bank holding companies which hold over 50% of their deposits in one CBSA or county, dropping observations in the highest or lowest percentile of lending growth. The weighted regressions additionally drop banks 5 standard deviations above the mean in commercial lending. Standard errors are clustered by CBSA/county.

Table 1.9: Are Results Driven By Real Estate Losses: Construction Specifications

	(1)	(2)	(3)	(4)	(5)	(6)
Panel 1: Indicator for High Construction Exposure						
High Construction/Equity	0.0023*	0.0019	0.0016	0.0065*	0.0065**	0.0060*
	(0.0011)	(0.0013)	(0.0014)	(0.0030)	(0.0024)	(0.0025)
House Price Growth	-0.0192			-0.0081		
	(0.0184)			(0.0290)		
High Construction/Equity ×	0.0320	0.0410+	0.0441+	0.0491	0.0849*	0.0821*
House Price Growth	(0.0219)	(0.0247)	(0.0244)	(0.0358)	(0.0382)	(0.0374)
Non-performing Loans	-0.3026**	-0.2718**	-0.2828**	-0.3126**	-0.2582**	-0.2614**
	(0.0455)	(0.0612)	(0.0624)	(0.0673)	(0.0747)	(0.0784)
High Leverage	0.0002	0.0001	0.0000	0.0035	0.0019	0.0024
	(0.0014)	(0.0016)	(0.0016)	(0.0028)	(0.0030)	(0.0033)
High Leverage ×	-0.1516**	-0.1433**	-0.1437**	-0.1137*	-0.1147+	-0.1236+
Non-performing Loans	(0.0383)	(0.0453)	(0.0462)	(0.0556)	(0.0674)	(0.0678)
Observations	53738	53738	53738	53548	53548	53548
R^2	0.029	0.252	0.253	0.076	0.329	0.330
Panel 2: Construction Lending to Equity Ratio						
Construction/Equity	0.0021**	0.0030*	0.0020	0.0023*	0.0026	0.0017
	(0.0007)	(0.0013)	(0.0014)	(0.0011)	(0.0019)	(0.0023)
House Price Growth	-0.0232			0.0258		
	(0.0206)			(0.0272)		
Construction/Equity ×	0.0183	0.0182	0.0186	-0.0022	0.0334	0.0320
House Price Growth	(0.0141)	(0.0217)	(0.0217)	(0.0174)	(0.0222)	(0.0221)
Non-performing Loans	-0.0467	-0.0075	-0.0161	-0.0197	-0.0036	-0.0048
	(0.0791)	(0.1012)	(0.1018)	(0.1470)	(0.1322)	(0.1269)
Leverage	-0.0003	-0.0004	-0.0004	0.0009	0.0004	0.0005
	(0.0003)	(0.0004)	(0.0004)	(0.0010)	(0.0009)	(0.0011)
Leverage ×	-0.0309**	-0.0315**	-0.0313**	-0.0332**	-0.0286*	-0.0293**
Non-performing Loans	(0.0074)	(0.0092)	(0.0092)	(0.0123)	(0.0113)	(0.0110)
Observations	67945	67945	67945	67739	67739	67739
R^2	0.028	0.286	0.288	0.072	0.361	0.362
Quarter Fixed Effect	Yes	No	No	Yes	No	No
CBSA-Quarter Fixed Effect	No	Yes	Yes	No	Yes	Yes
Weighted	No	No	No	Yes	Yes	Yes

Standard errors in parentheses

+ $p < 0.10$, * $p < 0.05$, ** $p < .01$

Notes: This table reports coefficients from regressions of quarterly bank holding company level commercial and industrial lending growth on the interaction between bank exposure to construction loans and MSA house price growth and the interaction between the bank non-performing loan rate and leverage. Construction exposure is the ratio of bank construction lending to equity and leverage is the ratio of tangible assets to tangible equity. In first panel, I use an indicator for whether construction exposure or leverage is above the median for the CBSA-quarter. The second panel uses construction exposure and leverage in their continuous forms, winsorized at the 5% level. Columns 1 & 4 include quarter fixed effects, while Columns 2,3,5 & 6 include CBSA-quarter fixed effects. Columns 1-3 are unweighted, while columns 4-6 weight by the size of the bank's C&I loan portfolio in the previous quarter. The sample runs from 2007 to 2010 and includes bank holding companies which hold over 50% of their deposits in one CBSA or county, dropping observations in the highest or lowest percentile of lending growth. The weighted regressions additionally drop banks 5 standard deviations above the mean in commercial lending. Standard errors are clustered by CBSA/county.

Table 1.10: Housing Declines and Total Lending: By Leverage

	(1)	(2)	(3)	(4)	(5)	(6)
Panel 1: Indicator for High Leverage						
High Leverage	-0.00304**	-0.00307**	-0.00295**	-0.00183+	-0.00241*	-0.00217*
	(0.000558)	(0.000630)	(0.000679)	(0.000936)	(0.000953)	(0.000966)
House Price Growth	0.0404**			0.0328		
	(0.0130)			(0.0298)		
High Leverage ×	0.0565**	0.0559**	0.0543**	0.0592**	0.0505**	0.0522**
House Price Growth	(0.0116)	(0.0130)	(0.0128)	(0.0201)	(0.0193)	(0.0201)
Observations	58872	58872	58872	58651	58651	58651
R^2	0.079	0.321	0.324	0.136	0.393	0.397
Panel 2: Leverage						
Leverage	-0.00100**	-0.00105**	-0.00113**	-0.000884**	-0.000875**	-0.000842**
	(0.000147)	(0.000181)	(0.000200)	(0.000238)	(0.000284)	(0.000296)
House Price Growth	-0.139**			-0.0972**		
	(0.0295)			(0.0350)		
Leverage ×	0.0198**	0.0149**	0.0144**	0.0152**	0.00956*	0.0103**
House Price Growth	(0.00283)	(0.00356)	(0.00344)	(0.00310)	(0.00379)	(0.00352)
Observations	69628	69628	69628	69402	69402	69402
R^2	0.083	0.362	0.365	0.139	0.419	0.423
Quarter Fixed Effect	Yes	No	No	Yes	No	No
CBSA-Quarter Fixed Effect	No	Yes	Yes	No	Yes	Yes
Weighted	No	No	No	Yes	Yes	Yes

Standard errors in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < .01$

Notes: This table reports coefficients from regressions of quarterly bank level lending growth on bank leverage, CBSA house price growth and their interaction. Leverage is the ratio of tangible assets to tangible equity. In first panel, I use an indicator for whether leverage is above the median for the CBSA-quarter. The second panel uses leverage in its continuous form, winsorized at the 5% level. Columns 1 & 4 include quarter fixed effects, while Columns 2,3,5 & 6 include CBSA-quarter fixed effects. Columns 1-3 are unweighted, while columns 4-6 weight by the size of the bank's C&I loan portfolio in the previous quarter. The sample runs from 2007 to 2010 and includes bank holding companies which hold over 50% of their deposits in one CBSA or county, dropping observations in the highest or lowest percentile of lending growth. The weighted regressions additionally drop banks 5 standard deviations above the mean in commercial lending. Standard errors are clustered by CBSA/county.

Table 1.11: Housing Declines and Real Estate Lending: By Leverage

	(1)	(2)	(3)	(4)	(5)	(6)
Panel 1: Indicator for High Leverage						
High Leverage	-0.00220**	-0.00226**	-0.00198**	-0.00262**	-0.00291**	-0.00260**
	(0.000614)	(0.000695)	(0.000735)	(0.000923)	(0.000929)	(0.000974)
House Price Growth	0.0424*			0.0551**		
	(0.0165)			(0.0187)		
High Leverage ×	0.0633**	0.0637**	0.0586**	0.0404**	0.0517**	0.0464**
House Price Growth	(0.0132)	(0.0148)	(0.0142)	(0.0140)	(0.0176)	(0.0173)
Observations	58422	58422	58422	58202	58202	58202
R^2	0.061	0.277	0.288	0.128	0.370	0.383
Panel 2: Leverage						
Leverage	-0.000742**	-0.000817**	-0.000884**	-0.00101**	-0.00101**	-0.00100**
	(0.000158)	(0.000198)	(0.000213)	(0.000250)	(0.000305)	(0.000306)
House Price Growth	-0.155**			-0.0678		
	(0.0317)			(0.0532)		
Leverage ×	0.0220**	0.0183**	0.0168**	0.0131*	0.0110+	0.00984+
House Price Growth	(0.00276)	(0.00328)	(0.00317)	(0.00534)	(0.00662)	(0.00566)
Observations	69155	69155	69155	68928	68928	68928
R^2	0.063	0.318	0.328	0.129	0.399	0.412
Quarter Fixed Effect	Yes	No	No	Yes	No	No
CBSA-Quarter Fixed Effect	No	Yes	Yes	No	Yes	Yes
Weighted	No	No	No	Yes	Yes	Yes

Standard errors in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < .01$

Notes: This table reports coefficients from regressions of the growth quarterly bank level real estate backed lending on bank leverage, CBSA house price growth and their interaction. Leverage is the ratio of tangible assets to tangible equity. In first panel, I use an indicator for whether leverage is above the median for the CBSA-quarter. The second panel uses leverage in its continuous form, winsorized at the 5% level. Columns 1 & 4 include quarter fixed effects, while Columns 2,3,5 & 6 include CBSA-quarter fixed effects. Columns 1-3 are unweighted, while columns 4-6 weight by the size of the bank's C&I loan portfolio in the previous quarter. The sample runs from 2007 to 2010 and includes bank holding companies which hold over 50% of their deposits in one CBSA or county, dropping observations in the highest or lowest percentile of lending growth. The weighted regressions additionally drop banks 5 standard deviations above the mean in commercial lending. Standard errors are clustered by CBSA/county.

Table 1.12: Housing Declines and Construction Lending: By Leverage

	(1)	(2)	(3)	(4)	(5)	(6)
Panel 1: Indicator for High Leverage						
High Leverage	-0.0110**	-0.0109**	-0.00842**	-0.00596*	-0.00809**	-0.0115**
	(0.00192)	(0.00223)	(0.00237)	(0.00238)	(0.00290)	(0.00242)
House Price Growth	0.303**			0.169**		
	(0.0366)			(0.0370)		
High Leverage × *House Price Growth*	0.0857*	0.0871*	0.0818+	0.0616+	0.0782*	0.0714*
	(0.0364)	(0.0430)	(0.0438)	(0.0354)	(0.0319)	(0.0311)
Observations	53435	53435	53435	53182	53182	53182
R^2	0.023	0.300	0.301	0.127	0.377	0.380
Panel 2: Leverage						
Leverage	-0.00360**	-0.00286**	-0.00220**	-0.00215**	-0.00240*	-0.00354**
	(0.000477)	(0.000605)	(0.000670)	(0.000749)	(0.00119)	(0.00108)
House Price Growth	-0.0268			0.122		
	(0.101)			(0.104)		
Leverage × *House Price Growth*	0.0354**	0.0309**	0.0295**	0.00792	0.0154+	0.0136+
	(0.00914)	(0.0106)	(0.0108)	(0.0101)	(0.00888)	(0.00784)
Observations	63374	63374	63374	63118	63118	63118
R^2	0.024	0.347	0.348	0.121	0.405	0.408
Quarter Fixed Effect	Yes	No	No	Yes	No	No
CBSA-Quarter Fixed Effect	No	Yes	Yes	No	Yes	Yes
Weighted	No	No	No	Yes	Yes	Yes

Standard errors in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < .01$

Notes: This table reports coefficients from regressions of the growth quarterly bank level construction and land development lending on bank leverage, CBSA house price growth and their interaction. Leverage is the ratio of tangible assets to tangible equity. In first panel, I use an indicator for whether leverage is above the median for the CBSA-quarter. The second panel uses leverage in its continuous form, winsorized at the 5% level. Columns 1 & 4 include quarter fixed effects, while Columns 2,3,5 & 6 include CBSA-quarter fixed effects. Columns 1-3 are unweighted, while columns 4-6 weight by the size of the bank's C&I loan portfolio in the previous quarter. The sample runs from 2007 to 2010 and includes bank holding companies which hold over 50% of their deposits in one CBSA or county, dropping observations in the highest or lowest percentile of lending growth. The weighted regressions additionally drop banks 5 standard deviations above the mean in commercial lending. Standard errors are clustered by CBSA/county.

Table 1.13: Housing Declines and CRE Lending: By Leverage

	(1)	(2)	(3)	(4)	(5)	(6)
Panel 1: Indicator for High Leverage						
High Leverage	0.000342	0.000318	-0.000761	0.000187	0.0000452	-0.000235
	(0.000913)	(0.00104)	(0.00105)	(0.00115)	(0.00128)	(0.00121)
House Price Growth	-0.0226			0.0210		
	(0.0189)			(0.0152)		
High Leverage × *House Price Growth*	0.0539^{**}	0.0566^{**}	0.0514^{*}	0.0418^{*}	0.0492^{*}	0.0412^{*}
	(0.0189)	(0.0214)	(0.0208)	(0.0169)	(0.0197)	(0.0184)
Observations	57671	57671	57671	57321	57321	57321
R^2	0.010	0.233	0.236	0.033	0.288	0.291
Panel 2: Leverage						
Leverage	-0.000114	-0.000185	-0.000647^{*}	-0.000644^{*}	-0.000373	-0.000555
	(0.000206)	(0.000293)	(0.000293)	(0.000324)	(0.000394)	(0.000374)
House Price Growth	-0.159^{**}			-0.0519		
	(0.0425)			(0.0562)		
Leverage × *House Price Growth*	0.0158^{**}	0.0153^{**}	0.0136^{**}	0.00875^{+}	0.0130^{**}	0.0108^{*}
	(0.00355)	(0.00512)	(0.00498)	(0.00456)	(0.00462)	(0.00449)
Observations	68219	68219	68219	67855	67855	67855
R^2	0.010	0.275	0.278	0.032	0.329	0.332
Quarter Fixed Effect	Yes	No	No	Yes	No	No
CBSA-Quarter Fixed Effect	No	Yes	Yes	No	Yes	Yes
Weighted	No	No	No	Yes	Yes	Yes

Standard errors in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < .01$

Notes: This table reports coefficients from regressions of the growth quarterly bank level non-farm non-residential real estate backed lending on bank leverage, CBSA house price growth and their interaction. Leverage is the ratio of tangible assets to tangible equity. In first panel, I use an indicator for whether leverage is above the median for the CBSA-quarter. The second panel uses leverage in its continuous form, winsorized at the 5% level. Columns 1 & 4 include quarter fixed effects, while Columns 2,3,5 & 6 include CBSA-quarter fixed effects. Columns 1-3 are unweighted, while columns 4-6 weight by the size of the bank's C&I loan portfolio in the previous quarter. The sample runs from 2007 to 2010 and includes bank holding companies which hold over 50% of their deposits in one CBSA or county, dropping observations in the highest or lowest percentile of lending growth. The weighted regressions additionally drop banks 5 standard deviations above the mean in commercial lending. Standard errors are clustered by CBSA/county.

Chapter 2

Housing Bust, Bank Lending & Employment: Evidence From Multimarket Banks

2.1 Introduction

Prior to the financial crisis of 2008, house prices in the US dropped precipitously. During the ensuing recession, employment dropped by over 8.5 million as banks drastically tightened lending standards.[1] By the time real GDP per capita rebounded to its previous peak at the end of 2013, over 500 banks had failed. This economic turmoil was predominantly concentrated in the regions that experienced the greatest decline in house prices, raising the question of how real estate declines impacted the supply of credit and the general economy.

The previous chapter established that banks which were exposed to falling house prices contracted the supply of commercial credit. Given prior work demonstrating that contractions in the availability of credit can impact labor markets (Ashcraft, 2005; Chodorow-Reich, 2014), this suggests that a contraction in bank lending may have contributed to the strong relationship between real estate declines and employment growth during the Great Recession. This chapter quantifies the effect that declining bank health due to falling house prices had on employment during this period.

[1] The Survey of Terms of Business Lending reports that the quarterly spread on commercial and industrial loans over the intended federal funds rate varied between 3.05 and 3.49 in the two years following the failure of Lehman Brothers. It had never previously exceeded 2.67 since the survey began in 1986. Banks responding to the Senior Loan Officer Opinion Survey also reported an unprecedented tightening of lending standards during the recession (Bassett et al., 2014).

The primary difficultly in isolating this effect is that falling house prices can impact the economy through numerous other channels. One leading explanation is that declining house prices reduce household wealth and the ability to borrow against home equity, thus reducing aggregate demand and employment (Midrigan and Philippon, 2011; Mian et al., 2013; Mian and Sufi, 2014; Eggertsson and Krugman, 2012; Guerrieri and Lorenzoni, 2015). Other explanations include real estate declines impairing business collateral or prompting a sectoral shift out of construction.[2]

I disentangle the quantitative significance of the bank lending channel from these other channels using variation in the exposure of multimarket banks to real estate declines in other counties. While each theory predicts that declining house prices within a county will result in falling lending and employment, they differ in predictions regarding the impact of declines elsewhere along the branch network of locally operating banks. If adverse shocks matter through bank losses, then borrowers located in strong real estate markets will still face a contraction in credit if their bank is exposed to real estate declines elsewhere. On the other hand, if real estate shocks predominantly impact demand, then outside declines should induce a substitution of credit towards local borrowers and not be associated with adverse outcomes.

In short, I ask whether it was falling house prices locally which impacted the economy, or whether it was instead the overall exposure of local banks to housing declines. This approach is enabled by three characteristics of the banking sector. First, most bank lending is done by large multimarket banks. Thus, the health of a typical borrower's bank depends largely on conditions in other counties where the bank has branches. Second, most small business lending is highly local. Thus, a reduction in the supply of credit from a bank will predominantly affect counties in which the bank operates, especially within a small window around its branches. Finally, asymmetric information problems make switching banks costly. Consequently, the incidence of a shock to a bank will largely fall on the bank's existing customers instead of on the aggregate supply of credit. Taken together, these characteristics imply that the availability of credit in a particular area will be impacted by conditions in different and often distant markets where the nearby banks have other branches.

First, I demonstrate that banks which were exposed to falling house prices contracted credit. Using county level small business lending data from the Community Reinvestment Act (CRA), I estimate lending growth as a function of a bank's exposure to falling house prices, and county controls or fixed effects. A one standard deviation decline in bank health, i.e. a greater average decline in housing wealth where the bank has branches, results in a 13.4% reduction in county originations of

[2] See Chaney et al. (2012); Fairlie and Krashinsky (2012); Adelino et al. (2013); Fort et al. (2013); Mehrotra and Sergeyev (2014) for evidence of the collateral channel and Hadi (2011); Rognlie et al. (2014); Hoffmann and Lemieux (2014) for evidence of the construction channel.

small business loans. The magnitude of this estimate *increases* slightly when real estate controls or county fixed effects are included. Banks which are exposed to real estate declines uniformly cut lending throughout their network, not in the actual counties experiencing falling house prices. This is consistent with real estate declines impacting the supply of credit instead of demand.

Second, and most importantly, I show that this contraction in lending caused a decline in employment. A one standard deviation increase in the exposure of local banks to negative housing wealth shocks, controlling for the shock in the county, decreases total employment by 1.2% between 2007 and 2010. Although changes in housing wealth do directly relate to employment growth, bank exposure is found to a more important driver of employment declines.

Given that bank health impacts the availability of mortgage credit (Berrospide et al., 2013) and mortgage credit impacts house price growth (Loutskina and Strahan, 2015), falling house prices locally might be a consequence of bank distress. This would make controlling for the local growth in house prices overly conservative. To overcome this, I next use an alternative method to separate the bank lending channel from the direct effects of house price declines which doesn't require the use of the endogenous control. Specifically, I instrument for the health of local banks using only exposure to real estate declines in other markets. When I instrument for bank health using the exposure of locally operating banks to real estate shocks in different CBSAs, I find that a one standard deviation decline in bank health reduces employment by 2%.[3] Similar results are found when instrumenting for bank health using only the exposure to shocks in geographically distant counties.

The IV estimate of the effect of bank health on employment growth is virtually identical to the corresponding OLS estimate: a 2.0% employment response to the one standard deviation shock for IV vs. 2.1% for OLS. Thus the relationship between bank health and employment growth is not driven by local house price movements. Instead, it is the total multimarket exposure of the local banks which relates to employment growth, with falling house prices elsewhere along the branch network having a virtually symmetric effect on employment growth as declines in the actual county. Furthermore, the relationship between bank health and employment growth is not driven by spillovers from neighboring counties, as declines in geographically distant counties or in other CBSAs also impact local employment growth. This is consistent with an adverse shock to a bank in one area propagating through the bank's internal capital market and uniformly impacting the availability of credit anywhere the bank operates.

Finally, I use two sources of within county variation to provide further support for the proposed mechanism. First, employment losses are concentrated in firms most reliant on bank finance. Some

[3] A CBSA contains an urban center of at least 10,000 people and adjacent areas with strong commuting ties.

industries are more prone to rely on external finance for technological reasons reflecting, for example, the degree of economies of scale or length of product gestation periods (Rajan and Zingales, 1998). I show that employment growth in industries with a high dependence on external finance is over 50% more sensitive to local bank health. Similarly, as young firms have had little opportunity to retain earnings and have minimal access to direct finance, they tend to rely more on bank lending (Black and Strahan, 2002; Cetorelli and Strahan, 2006; Robb and Robinson, 2012). I show that firms under six years old are over twice as sensitive to bank health as mature firms.

Second, employment losses disproportionately occur in tracts close to unhealthy banks. Since small business lending is highly local and switching lenders is costly, differential shocks to the health of local banks creates fine spatial variation in the availability of credit. A one standard deviation decline in the health of the banks within 3km of a tract decreases employment by 1.7% relative to other tracts in the county. As the county fixed effect should account for local demand or any other county level confounder, this provides strong evidence that bank losses from real estate declines result in a contraction in bank lending and harm to the general economy.

Overall, my findings suggest that these effects are economically large. Even conservative estimates have declining bank health from exposure to real estate shocks explaining roughly half of the relationship between housing net worth shocks and employment declines, and 39% of the decline in employment from 2007 to 2010.

2.1.1 Relation to Previous Literature

This paper contributes to several strands of the macroeconomics and finance literature. I add to a vast literature identifying the degree to which shocks to the supply of bank credit impact the economy.[4] Additionally, I contribute to work studying the transmission of shocks through the internal capital markets of geographically dispersed banks.[5] This paper also complements work on the roles of relationships and distance in the provision of bank credit, as the highly localized effects I find require either high switching costs or difficulty obtaining a loan from distant banks.[6]

First and foremost, this paper fits into the literature studying the effect of credit market frictions on employment in the Great Recession. Existing work provides mixed evidence regarding the channel

[4] Gertler and Gilchrist (1994); Peek et al. (2003); Ashcraft (2005); Bassett et al. (2014) find that bank credit supply shocks impact employment or investment, Driscoll (2004); Ashcraft (2006); Jiménez et al. (2014) on the other hand find no real effects.

[5] Peek and Rosengren (2000); Chava and Purnanandam (2011); Cetorelli and Goldberg (2012) for example study spillovers through multinational banks, while Morgan et al. (2004); Huang and Stephens (2011); Berrospide et al. (2013); Bord et al. (2014) focus on the United States.

[6] Slovin et al. (1993); Khwaja and Mian (2008); Chodorow-Reich (2014) demonstrate adverse outcomes for clients of banks who experienced a negative shock. Kwast et al. (1997); Petersen and Rajan (2002); Brevoort and Hannan (2006); Brevoort and Wolken (2009) find that small businesses rely on nearby banks.

emphasized in this paper. Chodorow-Reich (2014) finds that a contraction in bank lending can explain roughly 40% of the decline in employment in small and medium sized firms in the year following Lehman's bankruptcy. However, Greenstone et al. (2014) find that the contraction in small business lending explains less than 3% of the decline in small business employment. Regarding the role of falling house prices, Huang and Stephens (2011); Bord et al. (2014) find that banks exposed to real estate declines reduced small business lending. On the other hand, Mian and Sufi (2014) find that the employment losses in counties with falling house prices were attributable to falling aggregate demand instead of credit supply. As my paper relates closely to each of these studies, I will briefly describe each one in turn.[7]

My approaches to identifying supply shocks closely follows Huang and Stephens (2011) and Bord et al. (2014). They similarly create bank level measures of exposure to real estate declines, and demonstrate that highly exposed banks cut small business lending relative to other banks operating in the same area. My primary contribution is to assess how the supply contraction impacts employment. As these papers largely rely on area fixed effects to account for local loan demand, they have more to say about the composition of which banks lend in the county than on aggregate impacts.

The findings of this paper are most similar to Chodorow-Reich (2014). He finds that the large contraction in syndicated lending documented by Ivashina and Scharfstein (2010) translates into employment declines in firms with a prior relationship to banks which contracted credit. He takes advantage of impressive data on firm-lender relationships to document that banking relationships are sticky and that shocks to banks impact their customers. However, he acknowledges two difficulties in the identification of aggregate effects. First, there is a concern about external validity. The credit contraction only significantly influenced employment in firms with fewer than 1000 employees, a category severely underrepresented in the syndicated loan data.[8] If the rare small firm borrowing in the syndicated loan market is more financially dependent than the norm, the aggregate employment effects could be overstated. Second, employment losses at the firm level are difficult to relate to losses in aggregate without precise knowledge of the extent of general equilibrium effects. Wage or price adjustments may influence the quantity of labor demanded by unconstrained firms and offset much of the decline in employment due to a shock to a particular firm.

[7] This review is far from exhaustive. Additionally, Almeida et al. (2012) and Duchin et al. (2010) find evidence of financial constraints among Compustat firms, while Kahle and Stulz (2013) does not. Campello et al. (2010) uses a survey approach to identify real effects of financial constraints. Duygan-Bump et al. (2015) find that workers in small firms and financially dependent industries were most likely to become unemployed. Goetz and Gozzi (2010) show MSAs with banks relying on wholesale funding experienced larger employment declines.

[8] His data includes 798 large firms (1000+ employees) and 1242 small/medium firms (<1000 employees). Based on the 2008 Business Dynamics Statistics, there were 10,839 large firms in the US versus 5.2 million small/medium firms.

Using county level data in my study lessens these concerns. The employment data includes almost every firm in the county, and the bank data includes every bank or savings and loan with a branch in the county, so external validity is no longer a problem. Additionally, using the county as the unit of observation means that general equilibrium effects felt within the county are incorporated into the aggregate effects. If a person is laid off by a constrained firm, but hired by another firm in the same county, this would not appear as a decline in employment in my data.[9]

The estimating equations in this paper closely follow Mian and Sufi (2014), who demonstrate that non-tradable employment falls in counties experiencing adverse real estate shocks. They argue that the lack of an employment response in tradable industries indicates that the employment losses are due to low aggregate demand stemming from the loss in housing wealth. My empirical approach separates the employment losses attributable to the decline in bank health from the direct effects of local house price declines. I find that much of the decline in employment is due to differences in bank exposure instead of directly due to local house price movements.

I do find that bank exposure disproportionately impacts non-tradable employment, however this can be reconciled with a credit supply shock in a couple ways. First, unhealthy banks may cut consumer credit and thus reduce local aggregate demand. This is supported by Gropp et al. (2014), who find that renters reduced their levels of debt in places with falling house prices, suggesting that the decline in credit operated through channels besides household wealth. Second, the general equilibrium effects of a shock to business credit would cause a shift of employment into tradable industries. A credit contraction reduces the demand for labor (Benmelech et al., 2011), then falling wages and employment decrease demand for local non-traded goods. In the appendix, I demonstrate that a contraction in credit has an ambiguous effect on tradable employment due to wage adjustments. In support of this explanation, I show in the robustness section that counties with exposed banks experience declines in the cost of unskilled labor.

Finally, Greenstone et al. (2014) investigate the role of small business lending in explaining the contraction in employment. They identify shocks to the supply of small business lending using the CRA data, and argue that the reduction in small business lending can only account for a small fraction of the overall decline in employment.[10] Like this paper, they test how the average health

[9] This does not completely address the concern about general equilibrium effects. Falling incomes locally will reduce the demand for traded goods elsewhere, and rising prices of constrained firms would increase demand for competing firms. However, these effects are likely less concerning than within county wage adjustments offsetting a reduction in a firm's employment.

[10] Specifically, they use the CRA data to estimate bank×county level loan growth using county and bank fixed effects, taking the bank fixed effect to be a bank level supply shock. They instrument for small business lending with the average supply shock of the banks operating in the county, and find that the elasticity of employment growth with respect to lending is too small to have played a large role in the overall losses during the Great Recession.

of the banks in a county impact employment. However, they rely on a sample of large banks[11] and a narrow type of bank lending: loans to firms with less than $1 million in revenue which aren't backed by real estate. However, small banks disproportionately lend to small firms and are more prone to rely on soft information in lending decisions (Berger and Udell, 2002; Berger et al., 2005). As a result, this sample excludes many lending relationships, and particularly ones for which the adverse selection problem in switching banks would be most severe. Furthermore, bank losses could impact mortgage lending, other lending to individuals, commercial lending backed by real estate and lending to larger firms, none of which are included in their data. My county level measure of bank health incorporates the condition of every bank or savings and loan which locates within a county, and more generally reflects the availability of credit for any type of lending which occurs through bank branches. This broader scope may explain why I find much larger effects of bank distress than Greenstone et al. (2014).

The remainder of the paper proceeds as follows: Section 2 describes the data. Section 3 discusses the empirical strategies. Section 4 presents the findings. Section 5 discusses robustness with regard to alternative outcome variables, bank health measures and controls. Section 6 concludes.

2.2 Data Sources

2.2.1 Real Estate Shock Variables

I follow Mian and Sufi (2014) and measure real estate distress using the change in household net worth due to house price movements. Their primary explanatory variable is:

$$\Delta NetWorth_c = \Delta ln(HousePrice)_{c,06-09} \frac{H_{c,2006}}{NW_{c,2006}}$$

Where $\Delta ln(HousePrice)_{c,06-09}$ is house price growth from Core Logic, $H_{c,2006}$ is housing wealth and $NW_{c,2006}$ is the net worth of residents in the county.[12]

This variable estimates the loss in home equity for residents of a county as a fraction of their net worth. More leverage means a given decline in house prices has a larger wealth effect. However, since the majority of household wealth is held in housing (Iacoviello, 2011), high leverage is also

[11] In their sample, 654 banks operate at some point from 1997-2010, with the number being smaller during the crisis due to a change in reporting thresholds in 2005.

[12] Housing wealth is imputed from 2000 census data on the housing stock and subsequent house price growth, while the net worth of residents is the sum of housing wealth and financial wealth less debt. Stock and bond holdings are imputed based on IRS Statistics of Income data on stock and bond income combined with market returns. Debt data come from Equifax. See Mian et al. (2013) for more details. This variable was downloaded from the replication files available on the Econometrica website.

indicative of high loan to value ratios on the mortgages in the county. Consequently, banks in areas where housing net worth declines steeply would experience greater loan losses.

My measure of bank distress is based on the degree to which a bank locates in counties with declining housing net worth. I use deposit and branch location data from the FDIC's Summary of Deposits (SOD) to determine a bank's exposure to a particular county.[13] A bank is deemed unhealthy if it holds deposits in weak real estate markets.[14] A county is deemed unhealthy if local deposits are in unhealthy banks. Specifically:

$$Bank\_Health_b = \sum_{c \in C} \frac{D_c^b}{D^b} \Delta NetWorth_c$$

$$Bank\_Health\_Cnty_c = \sum_{b \in B} \frac{D_c^b}{D_c} Bank\_Health_b$$

Where D_c^b is the deposits held by bank b in county c and D^b and D_c are the aggregate deposits in the bank and the county respectively. Deposits are as of June 30th, 2006 for the main analysis, although I additionally use bank health based on 2002 deposits as a robustness check. I additionally try weighting by the value of 2006 mortgage originations and get similar results.

For the tract level employment regressions, I additionally create a variable calculating the health of the banks within a certain distance of a tract:

$$Bank\_Health\_Tract_t(d) = \sum_{b \in B} \omega_{c,b}(d) Bank\_Health_b$$

where $\omega_{c,b}(d)$ is the share of deposits within $d$kms of tract t's centroid held in branches of b.[15]

2.2.2 Lending Growth

I use Community Reinvestment Act data for county level small business lending. This includes business loan originations under \$1 million in value originated by banks with over \$1 billion in assets in 2005 dollars. The variable of interest is growth in originations during the crisis (2008-2010) relative to the pre-crisis period (2004-2006). I drop county×bank observations if the bank acquired another bank in the same CBSA during the period of observation, if it is in the highest or lowest

[13] The SOD is an annual survey of branch offices for all FDIC-insured institutions, including commercial banks, thrifts, and US branches of foreign banks.

[14] Banks which are part of a multibank holding company are aggregated to the level of the regulatory high holder. Houston et al. (1997) shows that subsidiary loan growth depends more on the cash flows and capital of the holding company than of the subsidiary, making the holding company the proper unit of analysis.

[15] I use the ARCGIS10 North American Address Locater to geocode the location for each bank branch in order to calculate the distances to census tracts.

percentile of lending growth or if the bank didn't have a branch within the county in 2006.

2.2.3 Labor Market Outcomes

County×industry employment data comes from the County Business Patterns (CBP). CBP provides mid-march employment at the county level for NAICS industries constructed from the US Census Bureau's Business Register. I use the Mian and Sufi (2014) classification of 4-digit NAICS industries as tradable or non-tradable.[16] I follow Rajan and Zingales (1998) and measure financial dependence based on the ability of firms in the industry to fund capital expenditures with cash flows. An industry is classified as financially dependent if the median Compustat firm in the 3-digit industry had capital expenditures exceeding cash flows from operations.[17] Total employment for a given category (e.g. non-tradable or financially dependent) is calculated by aggregating the employment across the industries within a category.[18] The dependent variable of interest is employment growth from 2007 to 2010, either overall or for a particular set of industries.

I use Quarterly Workforce Indicators (QWI) for data disaggregated by firm age or worker education. QWI combines data from Unemployment Insurance matched with employer characteristics from the Business Dynamic Statistics. The quarterly employment growth in a given age category is the difference in the log of stable employment from the previous quarter.[19] Growth from 2007 to 2010 is the sum of the quarterly growth rates from Q2 2007 to Q1 2010.[20] Young firms are defined as firms which are five years old or younger and mature firms are older than five.

Additionally, I use QWI data on earnings and employment by education category to measure wage growth. The wage for a particular type of worker (e.g. college educated workers) is the total earnings of stable employees divided by the number of stable employees. I then calculate wage growth from 2007 to 2010.[21]

Tract employment comes from the Longitudinal Employer-Household Dynamics Origin-Destination Employment Statistics (LODES) Workplace Area Characteristics. LODES provides employment at the 2-digit NAICS level for 2010 census blocks, omitting Massachusetts and DC. Data are con-

[16]Restaurant and retail industries are classified as non-tradable, industries prominent in the world trade data are classified as tradable.

[17]Cash flows and capital expenditures come from Compustat data on U.S. firms in the 1990s. This was used in Coleman and Feler (2014). Thanks to Nick Coleman for sharing this with me.

[18]Some county×industry observations have data suppressed and instead provide a range containing the employment value. Following Mian and Sufi (2014), I take the employment to be the midpoint of the range.

[19] Stable employment in a given quarter is the number of jobs where the employee was employed at the beginning and end of the quarter.

[20]One cannot simply look at changes in employment by age group between 2007 and 2010 as firms will change age categories in that period.

[21]People with low education disproportionately lost their jobs in areas with unhealthy banks. The increased share of employment in highly educated people masks changes in average earnings in the county. Consequently, the disaggregation by education type is needed to demonstrate how the cost of labor changed.

structed from state unemployment insurance records which are combined with Quarterly Census of Employment and Wages data. I aggregate this to the 2010 census tract level. Growth is again measured between 2007 and 2010.

Table 1 presents summary statistics of the main variables of interest. The average county experiences a decline in housing net worth of 9.5% from 2006 to 2009 with a standard deviation of 10%. The average decline in $Bank\_Health\_Cnty$ is similar at 8.4%, but less variable with a standard deviation of 4.2%. Banks in places with severely falling house prices tend to have other branches in stronger markets, mitigating some of the damage from local real estate losses. However, there is still far from perfect integration, creating cross county variation in the health of banks. Employment dropped by 7.7% on average from March 2007 to March 2010.

2.3 Empirical Strategy

The goal of this paper is to demonstrate two things: First, banks which were exposed to real estate declines contracted credit. Second, this credit contraction resulted in employment declines in areas reliant on exposed banks.

The primary difficulty is that bank exposure is likely correlated with other variables impacting the demand for credit or demand for labor. In this section, I describe the empirical approaches to control for these demand side effects. In the appendix, I present a simple model of bank credit and employment to assist in the interpretation of the regression coefficients from the different approaches.

2.3.1 Impact of Real Estate Exposure on Small Business Lending

While the last chapter focused on smaller, predominantly single market banks, using cross sectional differences across the banks locating in the same area, here I focus on larger multimarket banks. I again separate supply from demand by comparing banks lending in the same area. However, now I exploit geographic variation in the degree of exposure to house price declines elsewhere along the bank's branch network as in Huang and Stephens (2011) and Bord et al. (2014). I estimate the equation:

$$\Delta ln(SB\ Loans)_{b,c} = \beta_1 Bank\_Health_b + \beta_x' \mathbf{X}_{b,c} + \delta_c + \epsilon_{b,c}$$

The dependent variable is the growth in the number of small business loans the bank originated in the county during the crisis (2008-20110) relative to before the crisis (2004-2006). As the county fixed effect δ_c should account for demand, the coefficient on $Bank\_Health$ should reflect the effect that bank exposure to real estate declines has on the supply of credit. The hypothesis of this paper is that banks which were exposed to real estate declines reduced lending, meaning that $\beta_1 > 0$.

The difference in the estimated effect of bank health in the fixed effect and simple regression omitting δ_c will be informative as to the degree to which the relationship between bank health and lending growth is driven by loan demand. If county lending growth has a supply and a demand component: $\Delta ln(SB\ Loans)_{b,c} = d_c + s_b + \epsilon_{b,c}$, then the difference between the estimate in the fixed effect and simple regression should be $\frac{cov(Bank\_Health, d_c)}{var(Bank\_Health)}$. If $Bank\_Health$ reflects the supply of credit, then the fixed effect and simple regression should be similar. If $Bank\_Health$ mostly reflects demand, then including the fixed effect should reduce the point estimate.

Similarly I assess how the real estate shock variables impact the demand for loans by estimating:

$$\Delta ln(SB\ Loans)_{b,c} = \beta_1 Bank\_Health\_Cnty_c + \beta_2 \Delta NetWorth_c + \beta_x' \mathbf{X}_{b,c} + \delta_b + \epsilon_{b,c}$$

The bank fixed effect δ_b accounts for bank level supply shocks, thus the coefficients reflect how local real estate movements and changes in the health of local banks impact the demand for credit from a particular bank. The hypothesis of this paper is that the health of the banks in the county impacts the supply of credit. If this is true, we would expect $\beta_1 < 0$. Namely, a contraction in lending among other banks in the county would increase the demand for credit for a particular bank, causing it to increase lending relative to other areas in which it operates. Conversely, if high values of $Bank\_Health\_Cnty$ reflected some omitted variable positively related to demand, then individual banks should increase lending when competitors are measured as healthy, making $\beta_1 > 0$.

2.3.2 Impact of Real Estate Exposure on Employment

Employment Approach 1: OLS, County Controls

The simplest approach to identifying the employment effect of bank losses from real estate exposure is to estimate the equation:

$$\Delta ln(Emp)_{i,c} = \beta_B Bank\_Health\_Cnty_c + \beta_H \Delta NetWorth_c + \beta_x' \mathbf{X}_c + \epsilon_{i,c} \tag{2.1}$$

Where $ln(Emp)_{i,c}$ is the employment for a given category i (total, non-tradable, or tradable), and $\mathbf{X}_c$ is a set of variables giving the share of 2006 employment in each 2 digit NAICS industry.

The assumption underlying this approach is that the control for $\Delta NetWorth$ adequately accounts for direct demand side effects of declining house prices so that β_B reflects the employment effects of a credit contraction, instead of a direct effect of falling house prices. The bank lending channel would predict that $\beta_B > 0$, meaning that counties with healthier banks perform better than counties with similar house price shocks, but local banks more exposed to other distressed counties.

There are two major flaws in this strategy. First, real estate shocks are not exogenous. Falling house prices could be a result of decreased mortgage lending from unhealthy banks, in which case I would be over-controlling.[22] Moreover, omitted variables impacting employment could correlate with house price movements and bias the regression coefficients.[23] For these reasons, the inclusion of the control could bias β_B downward. Second, the effects of low bank health could reflect spillovers from declining wealth in other areas instead of declining lending. For example, people in adjoining counties might reduce spending in local restaurants if they experience a negative wealth shock. This could create an upward bias in β_B. The next approach overcomes these concerns.

Employment Approach 2: Instrument with Exposure from Distant Markets

A similar strategy is to instrument for bank health using the exposure of local banks to house price declines in other markets. This has two major benefits. First, this allows me to remove the effects of own county house price declines without introducing an endogenous control. Thus the IV approach without the control may fix a downward bias in the estimated coefficient on bank health in the OLS specification including the control.

Second, this approach reduces concerns about bank health reflecting spillovers from neighboring counties. Falling house prices in other MSAs or hundreds of miles away are unlikely to directly affect local demand as nearby declines would, thus any relationship between outside bank exposure and local non-tradable employment can more comfortably to attributed to the bank lending channel. Thus, I run IV regressions:

$$\begin{aligned} \text{Second Stage: } \Delta ln(Emp)_{i,c} &= \beta_B \widehat{Bank\_Health}_c + \beta_x' \mathbf{X}_c + \epsilon_{i,c} \\ \text{First Stage: } \widehat{Bank\_Health}_{i,c} &= \rho_B Outside\_Shock_c + \rho_x' \mathbf{X}_c + u_{i,c} \end{aligned} \tag{2.2}$$

The outside shock is the component of bank health coming from the exposure of local banks to real

[22]Loutskina and Strahan (2015) find that an expansion in mortgage lending due to exogenous changes in the ease of GSE securitization results in greater house price growth and employment growth.

[23]Contrary to this, Mian and Sufi (2014) find larger estimated effects when they instrument for changes in housing net worth with the Saiz (2010) measure of the housing supply elasticity. However, the elasticity measure is highly spatially correlated and only available at the MSA level. As a result, the instrument actually better correlates with $Bank\_Health\_Cnty$ than $\Delta NetWorth$. This may contribute to why Mian and Sufi (2014) find larger point estimates in their IV specifications.

estate shocks in other markets:

$$Outside\_Shock_c = \sum_{b\in B} \sum_{c'\in\{C\setminus m(c)\}} \frac{D_c^b}{D_c} \frac{D_{c'}^b}{D^b} \Delta NetWorth_{c'}$$

where $m(c)$ denotes the set of counties in the same market as c. I define the market as the county, the 2010 Core Based Statistical Area/rural county (CBSA) or the set of counties within a certain distance of c.

If the coefficient on bank health merely reflects spillovers from neighboring counties, then excluding variation from nearby counties should remove the effect of bank health. If real estate declines matter though changes in bank equity, then it doesn't matter whether the bank is exposed to declines locally or in distant branches as the effect on the aggregate effect on the bank balance sheet would be symmetric. In the extreme case with no direct demand effects, the OLS and IV estimates should be the same.

Employment Approach 3: Difference in Differences by Bank Dependence

Once it is established that declining bank health results in employment losses, a natural follow-up question is to what extent are the employment losses due to a contraction in commercial credit versus consumer credit. One way to assess the role of declining business credit, is to test whether bank dependent firms reduce employment more in areas with unhealthy banks.

I use two definitions of bank dependence. First, I use the industry based classification of Rajan and Zingales (1998). They measure financial dependence based on the cash flows and capital expenditures of the firms in the industries. Being in an industry in which the majority of the firms were unable to finance their capital expenditure with cash flows is taken to be an indicator of a technological reliance on external finance.

Second, I use an age based classification. Young firms have had little time to accumulate and retain earnings. They also generally lack the transparency or size to make direct finance feasible. As a result they are more reliant on banks than mature firms.

I estimate equations as in the previous two sections and compare the coefficient for employment growth in the high dependence and low dependence category. If the relationship between growth and bank health solely reflects omitted demand related variables or a decline in consumer credit, there would be little reason for them to impact financially dependent firms or young firms more. However, as these firms are more reliant on banks, a greater sensitivity of employment to bank health would support the claim that declining commercial credit contributed to the employment losses.

Employment Approach 4: Tract Growth, County Fixed Effects

Lastly, I exploit within county variation in proximity to exposed banks. A wide range of studies have demonstrated that small business lending disproportionately occurs within a couple miles of a bank's branches (Kwast et al., 1997; Petersen and Rajan, 2002; Brevoort and Hannan, 2006; Brevoort and Wolken, 2009). These findings are replicated in Figure 1, which plots the distribution of distances between small businesses and their lender using data from the Survey of Small Business Finance and Community Reinvestment Act.

If either switching lenders is costly as in Sharpe (1990) or Chodorow-Reich (2014), or the reliance on local banks reflects a spatial friction in lending as in Degryse and Ongena (2005) or Agarwal and Hauswald (2010), then this would mean that an adverse shock to local banks would impact nearby firms. In the first case, the localized nature of banking is a pure equilibrium outcome, but proximity proxies for relationships. A shock to a bank would impact it's existing customers due to the adverse selection problem in switching lenders, and would thus disproportionately impact the firms near their branches as they are most likely to have a relationship with that bank. In the second case, distant firms are a poor substitute for near firms due to an actual advantage of proximity. For example, if there is location specific soft information, only local lenders may be willing to make a particular loan. If these lenders are contracting credit, it would be difficult to obtain a loan even for new firms without an existing relationship. Either way, this spatial variation in the ability of local banks to lend generates within county variation in the availability of credit. This allows me to estimate:

$$\Delta ln(Emp)_{t,c} = \beta_B Bank\_Health\_Tract_t(d) + \beta_x' \mathbf{X}_t + \delta_c + \epsilon_t$$

where t indexes census tracts, $Bank\_Health\_Tract(d)$ is the average health of the branches within $d$kms of t, δ_c is a county fixed effect and $\mathbf{X}_t$ is a set of variables giving employment shares by 2-digit NAICS industries. By comparing growth in tracts within the same county, I can remove any county level demand effects and be more confident that the findings are due to a contraction in bank credit.

Additionally I include an interaction with an indicator for whether the tract disproportionately has employment in small establishments (establishments with fewer than 100 workers).[24] Although establishment size is an imperfect measure of financial dependence, having small establishments is a necessary condition for having small firms. As such, these tracts should have an increased sensitivity

[24] Zip Code Business Patterns provides counts of establishments by size bin and industry. I can thus estimate the amount of employment in small establishments and large establishments at the zip code × 2-digit industry level using the midpoint of the size range. I then allocate this to the tract level using the 2006 two digit block level employment data from LODES as a cross-walk between zip codes and census tracts.

to the health of nearby banks.

2.4 Findings

2.4.1 Exposed Banks Cut Small Business Lending

Table 2 estimates the impact of $Bank\_Health$ on county level small business lending growth. A 10% shock to a bank causes it to reduce small business loan originations by 19%. When controls for county shocks to net worth or county fixed effects are included, the predicted effect *increases* to 21% or 22%. If real estate shocks impacted the demand for loans, then the reduction in lending would be concentrated in the actual counties experiencing the shock. The fact that exposed banks uniformly cut lending throughout their branch network indicates that real estate shocks predominantly impact the supply of credit.

That controlling for demand has such a minimal effect on the relationship between $Bank\_Health$ and lending may seem anomalous, but specifications (5) and (6) provide an explanation of what is happening. The inclusion of bank fixed effects account for credit supply shocks, allowing one to observe how county level variables influence loan demand. Counties with declining net worth see demand increase, albeit insignificantly. However, once the average health of the banks in the county are accounted for, the coefficient on $\Delta NetWorth$ switches signs. Banks cut lending where house prices fall, but they allocate significantly more credit to places where the other banks are unhealthy. A 10% decline in the health of the banks in the county, controlling for $\Delta NetWorth$, results in an 11% increase in loan originations relative to other markets the bank lends in. This suggests that demand doesn't fall in places with declining net worth because of a contraction in the supply of credit of competitors.

This last point merits elaboration as it will support the findings in the employment section. Conditional on $\Delta NetWorth$, banks increase lending in counties with unhealthy banks, indicating an elevated return to lending. This increase in demand could be due to a contraction in the supply of loans from competing banks, or an increase in the overall demand for credit among small businesses. Given that firms in these counties are laying off workers, and exposed banks are cutting lending, it is unlikely that overall demand is rising. Consequently, this finding substantiates the claim that the exposure of local banks to real estate declines adversely impacts the supply of bank credit.

2.4.2 Bank Exposure Causes Employment Declines

Having now informally established the "first stage" whereby the health of locally operating banks impacts the supply of credit (conditional on county real estate conditions), the remainder of this paper will be devoted to determining the labor market effects of this decline in bank health.

Employment Approach 1: OLS, County Controls

Table 3 directly estimates the relationship between employment growth and the real estate shock variables as in equation 1. Adverse shocks to the net worth of households and to the health of local banks are associated with declines in total employment and employment in the non-tradable sector. When the variables of interest are included separately, a one standard deviation decline in $Bank\_Health\_Cnty$ (.042) reduces total employment by 2.1% and non-tradable employment by 2.7%. A one standard deviation decline in $\Delta NetWorth$ (.1) reduces overall employment by 2% and non-tradable employment by 2.1%.

The more informative regressions are those in columns (3) and (6), which include both variables. A one standard deviation decrease in $Bank\_Health\_Cnty$, controlling for $\Delta NetWorth$, reduces employment by 1.2% and non-tradable employment by 2.7%. $Bank\_Health\_Cnty$ remains significant in both specifications.

Combined with the finding of the previous section, we have that counties with exposed banks (conditional on $\Delta NetWorth$) see increased lending from large healthy banks but experience a contraction in employment. This indicates a high return to lending despite poor economic conditions, consistent with a negative shock to the supply of bank credit.

Tradable employment is not significantly related to either variable. As Mian and Sufi (2014) note, the fact that I only find effects for non-tradable industries, i.e. industries reliant on local demand, could be suggestive that employment declines are due to low aggregate demand. However, as falling wages or employment from a credit disruption also would influence local demand, this doesn't rule out a shock to the supply of bank credity. In the robustness section, I present evidence that the cost of labor fell in counties with unhealthy banks, a factor which could offset the effects of a contraction in credit for tradable firms.

Employment Approach 2: Instrument with Exposure from Distant Markets

In Table 4, I instrument for $Bank\_Health\_Cnty$ using only bank exposure to real estate declines in different counties or CBSAs. Panel 1 presents the findings omitting the control for $\Delta NetWorth$.

Interestingly, the estimated effects of a shock to bank health on overall or non-tradable employment are virtually identical whether I instrument or not. The elasticity of employment growth with respect to bank health only falls from .5 in the OLS specification to .47 in the IV specifications. For non-tradable employment growth, the elasticity is .63 in the OLS specification and .62 or .66 in the IV specifications. These results show that the relationship between bank health and employment growth is not driven by falling house prices within the actual county, nor is it driven by falling house prices in economically integrated areas. As individuals living in other MSAs account for a small portion of the demand for local non-traded goods, this should increase confidence that the results are actually driven by bank lending instead of aggregate demand.

Accounting for direct effects of house price declines by excluding declines within the same market may result in a better estimate than the previous approach. A contraction in the supply of bank credit due to real estate losses would be likely to particularly impact mortgage availability, as banks would be unwilling to take on additional real estate risk. This could make real estate declines in part a consequence of poor bank health so that controlling for it would result in an understatement the true effects. However, due to spatial correlation in house price movements and bank locations, the outside exposure of local banks is likely to still be correlated $\Delta NetWorth$ for reasons beyond the health of local banks impacting house prices.

Panel 2 additionally controls for $\Delta NetWorth$ to address this concern. Again, point estimates for the effects on overall and non-tradable employment are nearly identical in the OLS and the two IV specifications. Instrumenting for $Bank\_Health\_Cnty$, causes the elasticity of employment growth with respect to bank health decline from .28 in the OLS specification to .27 in both the IV specification. For non-tradable employment growth, the estimates are .60 and .72 in the IV specifications compared to .64 in the OLS specification. $Bank\_Health\_Cnty$ is significant at the 5% or 10% level for overall employment growth and significant at the 1% level for non-tradable employment growth, while $\Delta NetWorth$ remains insignificant. Both real estate shock variables remain insignificant in the tradable employment specifications.

Figure 2 presents a similar analysis using distance based market definitions. For each distance up to 300kms, I calculate the component of bank health coming from counties more than that distance from the county in question, and plot the coefficient on bank health in the employment regression. In the total employment regressions, the estimate falls from .5 in the OLS specification to .37 when instrumenting for bank health with exposure from counties over 300 km away. The estimate when $\Delta NetWorth$ is controlled for drops from .28 to .18, although estimates quickly become imprecise. Point estimates for non-tradable employment are remarkably stable. Without the control, the estimated effect of bank health rises from .63 to .65, with the control it rises from .64 to .68.

Overall, this approach demonstrates that adverse shocks to banks have a roughly symmetric effect on employment whether they occur locally or whether they occur in distant counties with common banks. This is consistent with real estate declines causing a uniform contraction in lending through out a bank's branch network, but contrary to the demand channels where only local house price declines should impact employment.

Employment Approach 3: Difference in Differences by Bank Dependence

Table 5 shows that these effects are magnified in firms in financially dependent industries. The difference in the elasticity of growth with respect to bank health between highly and lowly dependent industries is .23 in the IV regression using out of county exposure, .27 in the OLS specification, and .33 with the outside CBSA instrument. Differences are significant at the 5% or 10% level. In the OLS specification, a one standard deviation decline in bank health reduces employment by 1.6% in low dependence industries but 2.8% in high dependence industries.

In the second panel, I control for $\Delta NetWorth$. Bank health is always significant for growth in highly dependent industries. The difference in elasticities is still positive in every specification, although it is no longer statistically significant. The estimated effect of local net worth shocks is always small and statistically insignificant.

A concern with the Rajan and Zingales (1998) definition of financial dependence is that it is based on the financing needs of large Compustat firms. As a result, it may not be representative of the financial dependence of the types of businesses which would rely on local banks. Another approach is to test how the sensitivity varies by firm age.

Table 6 shows that employment growth in young firms responds more to differences in bank health. When omitting $\Delta NetWorth$ control, the difference in the elasticity between young firms and mature firms varies between .43 and .67 and is always significant at at least the 5% level. In the OLS specification, a one standard deviation decline in bank health is found to reduce employment by 1.6% in mature firms and 3.6% in young firms. Additionally controlling for the own county shock causes the difference in elasticities to shrink to .25 and .2 in the OLS and outside county specification, and become insignificant. When instrumenting with outside CBSA exposure, the difference increases to .85 and remains significant at the 5% level despite the larger standard errors.

In short, the decline in employment occurred predominantly in the firms most likely to be impacted by a contraction in commercial credit. As there is little reason to think that these firms would be more sensitive to demand shocks, this provides evidence that the findings are largely not driven by a decline in consumer credit or some other demand related variable.

Employment Approach 4: Tract Growth, County Fixed Effects

A decline in small business lending from a particular bank would also differentially affect firms based on their location within the county. Since small business lending is very local, the firms within a couple miles of the exposed banks should face the greatest employment declines. Table 7 shows that having the banks within 3km of a tract be highly exposed to falling house prices results in lower employment growth relative to other tracts in the same county. I find that a 10% shock to nearby banks reduces employment growth by 3.9%.

Exposure to unhealthy banks matters predominantly for tracts with more employment in small establishments. A 10% shock reduces growth by 2.4% in tracts above the county median in the share of employment in large establishments and 4.6% in tracts more reliant on small establishments. I still find a significant impact on employment and a significantly larger effect on small establishments when I do not weight by 2006 tract employment, although the point estimates are smaller.

In the last four columns, I measure $Bank\_Health\_Tract$ with an indicator for whether the banks within 3kms are healthier than the county median. Tracts close to unhealthy banks experience employment growth 1.4% lower than tracts near healthy banks. When I include the interaction for whether the tract is reliant on small establishments, I find that tracts reliant on large establishments, regardless of bank health, and tracts reliant on small establishments near healthy banks all perform almost identically. However, tracts with small establishments and unhealthy banks experience growth which is 2.1% lower than the rest of the county. Omitting the employment weights again results in qualitatively similar findings but lower magnitudes.

Figure 3 shows how the finding depends on the distance used to define a tract's banking market. The left panel plots coefficients from regressions of tract employment growth on bank health and county fixed effects. For each value d on the x-axis, bank health is measured as the deposit weighted health of the branches within $d$km of the tract. For distances from 2km to 16km, there is little noticeable trend, with the coefficient on bank health being mostly around .3 or .4 and always significantly different from 0.

The right panel presents similar results, except using the discrete bank health measure, and including the interaction for whether the tract is composed of small establishments. Each line shows the predicted growth rate for a tract of a given health and size category relative to a tract with large establishments near healthy banks. Here the distance parameter is more relevant. For low values (2-7km) we see that tracts with healthy banks or large establishments mostly have similar growth rates, with employment growth in tracts with small establishments and unhealthy banks being about 2% lower. Larger distance parameters attenuate the predicted effect of bank health on small establishment growth.

Much like with the heterogeneous effects by bank dependence, this finding provides evidence that a contraction in commercial credit from unhealthy banks resulted in employment losses. Two firms in the same county are likely to face similar market wages, and similar levels of demand from consumers. However, by virtue of banking markets being more local than labor or housing markets, there would still be within county spatial variation in the availability of credit. The concentration of employment losses in the firms most likely to borrow from unhealthy banks provides strong evidence in favor of the bank lending channel.

2.5 Robustness and Extensions

2.5.1 Wage Adjustment

Most of the evidence in this paper supports the theory that real estate declines resulted in a contraction in bank commercial credit and, as a result, a decline in employment. The observed declines in lending to small businesses, employment in bank dependent firms, and employment in firms near unhealthy banks would all be explained by this theory. However, the greater sensitivity of employment in non-tradable industries may be taken as evidence of a demand channel.[25]

The minimal relationship between tradable employment and bank health can however be reconciled with a credit supply shock if falling wages offset the effects of tighter credit conditions for tradable firms. If a contraction in credit lowers labor demand, this would result in a reductions in wages and employment. This decline in local income would in turn reduce the demand for firms in local non-tradable industries. The impact on tradable employment would thus depend on the strength of wage adjustments. With an inelastic labor supply and flexible wages, tradable employment would rise as workers move into the industries with relatively higher demand. With perfectly rigid wages, tradable employment falls due to the contraction in credit. With imperfect adjustment, the falling wages and credit availability could offset, leaving employment unchanged. Under this chain of events, non-tradable employment does fall due to low local demand, but that low demand is a consequence of falling labor demand instead of the cause.

[25] Note that this demand channel needn't be the housing wealth channel. Bank deleveraging could cause a reduction in consumer credit resulting in a contraction in demand. This would explain why bank health matters beyond local real estate declines.

For this to be a credible explanation however, I need to demonstrate that wages fell in places with unhealthy banks. Mian and Sufi (2014) address this issue, demonstrating that the average wage growth largely did not respond to changes in the net worth of households.[26] Their wage measure, the average payroll of the workers in the county, might not accurately reflect the cost of labor though. If temporary or low skilled workers have lower search or training costs, they could be more readily laid-off. Wage declines could then be masked by a change in the composition of the workforce to include a higher percentage of high wage individuals.

To mitigate this issue, I use the QWI earnings data disaggregated by education category. Table 8 provides evidence that places with unhealthy banks did indeed have declining labor costs. The first panel estimates the impact of bank health on changes in average earnings from 2007 to 2010. Specification (1) shows that the average wage overall doesn't significantly respond to bank health, with a 10% shock to bank health only reducing wages by 1.6%. However, specifications (2)-(4) show that a 10% shock reduces the cost of young workers (under 25 years) by 3.8%, workers without a high school diploma by 2.9%, and workers with no college by 2.3%. All are significant at the 1 or 5% level. Workers with a college education see a modest and insignificant decline in wages, similar in magnitude to the average decline in wages in (1).[27]

The second panel shows that declining bank health disproportionately results in employment losses for workers under 25 and workers who did not complete high school. As these individuals have the lowest wages, their job losses obscure the actual changes in the cost of labor as observed using overly aggregated data. Given that education is an imperfect proxy for skill, it is likely that this disaggregation by education bin doesn't entirely fix the composition bias. Any worker with higher match specific human capital is likely to generate surplus for both the employer and employee, making the job higher paying than for similarly educated people, and making the employee less likely to lose their job.

2.5.2 Instrumenting with Earlier Branch Locations

While most of this paper focuses on ruling out demand side explanations, another threat is that bank locations are not exogenous. A bank may have a high exposure to real estate declines not because of historical accident, but because it specifically chose to enter markets with certain characteristics. Thus a relationship between unhealthy banks and unemployment declines could reflect an omitted

[26]Other work on the wage rigidities during the Great Recession using national data have found mixed results. Daly et al. (2012) presents evidence of downward nominal rigidity in wages. Elsby et al. (2013) argues that this rigidity may be less binding than typically hypothesized.

[27]These findings should be taken as weaker than the employment findings, as including the control for $\Delta NetWorth$ makes both variables insignificant.

variable which induced particular banks (subprime specialists for example) to enter the market.

To overcome this concern, I test the robustness of my main findings to using 2002 branch locations to compute the bank health measures. As the spike in subprime mortgage originations and private label securitization occurred in 2004, there should be less concern about locations in 2002 reflecting unobserved variables relating to the housing boom. In Tables 9 and 10, I replicate the primary county level and tract level findings instrumenting for the bank health measures using analogous measures constructed from 2002 branch locations and deposit levels, instead of the 2006 ones as in the main paper. The results are virtually identical to the equivalent specifications in Tables 3 and 7, alleviating concerns about endogenous location decisions in response to the housing boom driving my results.

2.5.3 Alternative Bank Health Measures

There are numerous potential measures of county real estate distress or ways of measuring a bank's exposure to a given county. The first six tables of the supplementary materials show that the primary findings are not sensitive to my measure of bank health. In addition to $\Delta NetWorth_c$, I also measure county real estate health as $(1 - Delinquency_c)$, where $Delinquency_c$ is the December 2009 delinquency rate on mortgages in county c from the New York Fed Consumer Credit Panel (a 5% sample of US consumers with a credit report). I additionally measure a bank's exposure to a county based on the value of mortgage originations for home purchases in 2006, using Home Mortgage Disclosure Act county lending data. This has the benefit of picking up exposure from mortgages originated by non-depository affiliates of bank holding companies or other mortgage lending in counties where the bank doesn't have branches.[28] Combinations of these two exposure measures with the two county shocks provide four potential bank health measures.

Which measure of bank health appears to matter relatively little on average. Using one of the three new measures tends to strengthen the out of market IV findings and external financial dependence findings, but weakens the findings by age and at the tract level. However, using a different measure of bank health never changes the qualitative predictions.

2.5.4 Alternative Controls

Tables 7-9 in the supplemental materials also present robustness for four different control sets. I either include nothing besides the variables of interest, 2-digit industry shares as in the paper,

[28]Since small banks and banks outside of MSAs are exempt from filing, I limit the sample to MSAs in the employment regressions.

industry shares along with the demographic controls used in Mian and Sufi (2014)[29], or the industry controls with state fixed effects. Overall, the estimates provided in the paper tend to be on the lower end, although qualitatively similar to the findings with the alternative control sets. The largest difference occurs when state fixed effects are used. The state fixed effects strengthen the findings based on external financial dependence. However, their inclusion makes $\Delta NetWorth$ and $Bank\_Health\_Cnty$ insignificant for young and mature firms alike.

2.6 Conclusion

Determining the reason that falling house values translated into employment declines is difficult due to the similarity in the aggregate implications of different channels. Both declining aggregate demand and loan supply would result in falling consumption, lending and employment.

Yet despite the near observational equivalence of the channels, the policy prescriptions can vary substantially. Proponents of the demand view might favor empowering bankruptcy judges to reduce the amount of principle owed on a mortgage, a provision of the Helping Families Save Their Homes Act of 2009 which was dropped in the senate. Those believing the banking channel would advocate for the liquidity support and capital injections as were undertaken by government during the height of the crisis. Forced principle reductions here could be counterproductive if they caused further losses to banks in areas with depressed real estate values. These starkly different policy implications of similarly plausible channels has resulted in a contentious debate regarding the policy response to the crisis.

In this paper, I demonstrate that losses in the banking system contributed to the decline in lending and employment between 2007 to 2010. Counties with exposed banks saw increases in lending from large healthy banks, but falling employment. This set of outcomes is consistent with a contraction in credit in these counties, but is hard to reconcile with demand based narratives. The disproportionate employment declines in young firms, financially dependent firms and firms close to unhealthy banks lends further credence to the banking view.

A back of the envelope calculation indicates that the employment declines due to this contraction in bank lending were substantial. The less conservative approach in estimating the aggregate effect of these bank losses is to assume that county housing net worth declines are endogenous and thus controlling for them causes a downward bias on the coefficient for bank health. Instrumenting for

[29]This includes: percentage white, median household income, percentage owner-occupied, percentage with less than a high school diploma, percentage with only a high school diploma, unemployment rate, poverty rate, and percentage urban.

bank health with real estate movements in counties over 300km away produces an estimated elasticity of employment growth with respect to bank health of .37. If one is more concerned about spatial correlation in house prices than their endogeneity, the specification controlling for $\Delta NetWorth$ would be appropriate, generating a coefficient of .28. The average population weighted decline in county level bank health was .085, thus these estimates imply that declining bank health from real estate exposure reduced employment by between 2.4% and 3%. US employment at the beginning of the sample in March 2007 was 137.72 million, thus this amounts to a loss of between 3.3 and 4.1 millions jobs accounting for between 39% and 48% of the aggregate decline in employment.

In addition to the bank lending channel being significant in aggregate, it also goes a long way in explaining why employment fell in places with falling house prices. Controlling for bank health causes the coefficient on $\Delta NetWorth$ to fall from .2 to .11, thus bank health also explains almost half of the relationship between shocks to the net worth of households and employment.[30] I am by no means dismissing the existence of a direct effect of housing declines on employment, or the efficacy of policies to assist homeowners during the crisis. However, my analysis demonstrates that those direct effects are not the entire story. The ability of banks to lend was a significant driver of labor market strength in the Great Recession, and played a large part in explaining why employment declines were so pronounced in places with falling house prices. This all suggests that the dramatic actions by the Fed and the Treasury to rehabilitate the financial system after the failure of Lehman Brothers was vitally important in preventing the crisis from being worse than it already was.

[30] Even though $Bank\_Health\_Cnty$ is consistently statistically significant and $\Delta NetWorth$ is never more than marginally significant when controlling for $Bank\_Health\_Cnty$, one must still be cautious in interpreting their relative importance. Figure 4 plots the bootstrap distribution of coefficients on $Bank\_Health\_Cnty$ and $\Delta NetWorth$. The joint 95% confidence interval for aggregate employment growth includes values where $\Delta NetWorth$ matters as much or more than $Bank\_Health\_Cnty$.

2.7 Appendix

2.7.1 Figures

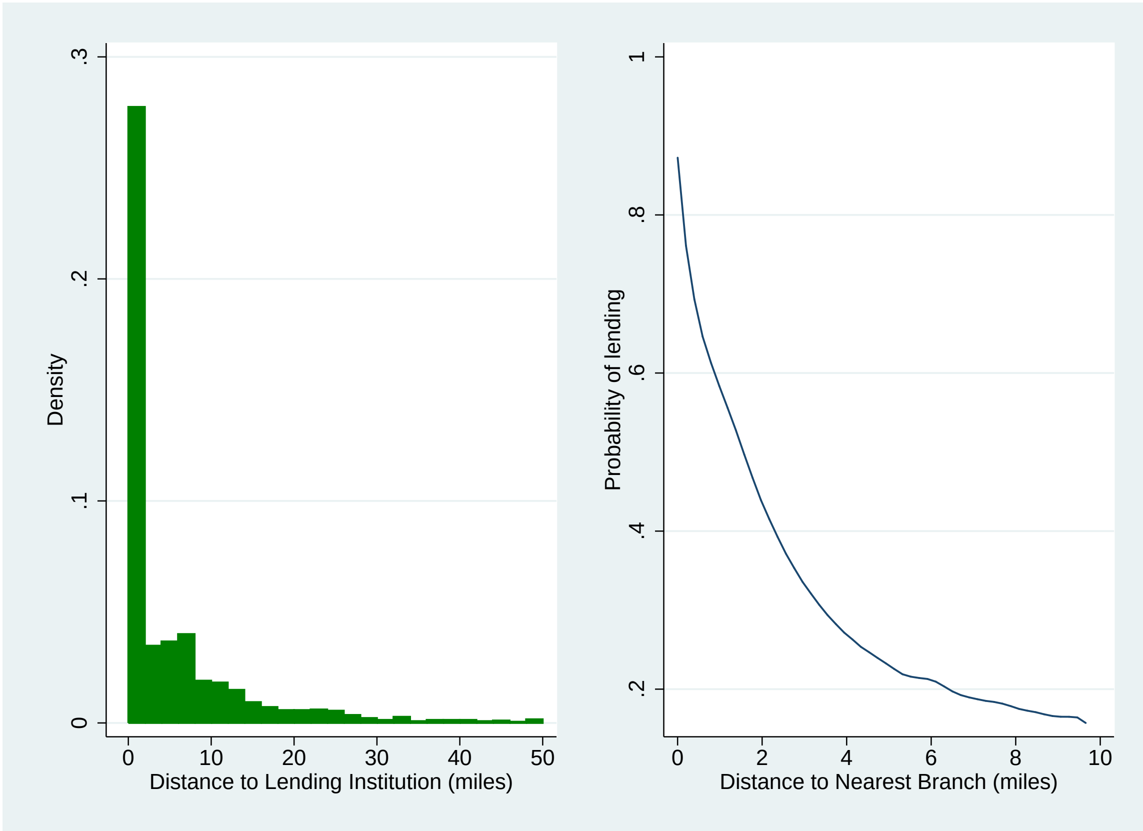


Figure 2.1: Distribution of Lender Distances

Notes: The left figure shows the distance to the depository institution offering a small business a line of credit from the 2003 Survey of Small Business Finance, excluding loans in banks more than 50 miles away. The right figure shows how the probability of a CRA reporting institution making a small business loan in a particular census tract varies with the distance between the tract centroid and the nearest branch of an institution. Probabilities are determined by local linear regression on the 0-1 loan indicator using an Epanechnikov kernel with a bandwidth of .2 miles. This is done for the year 2006.

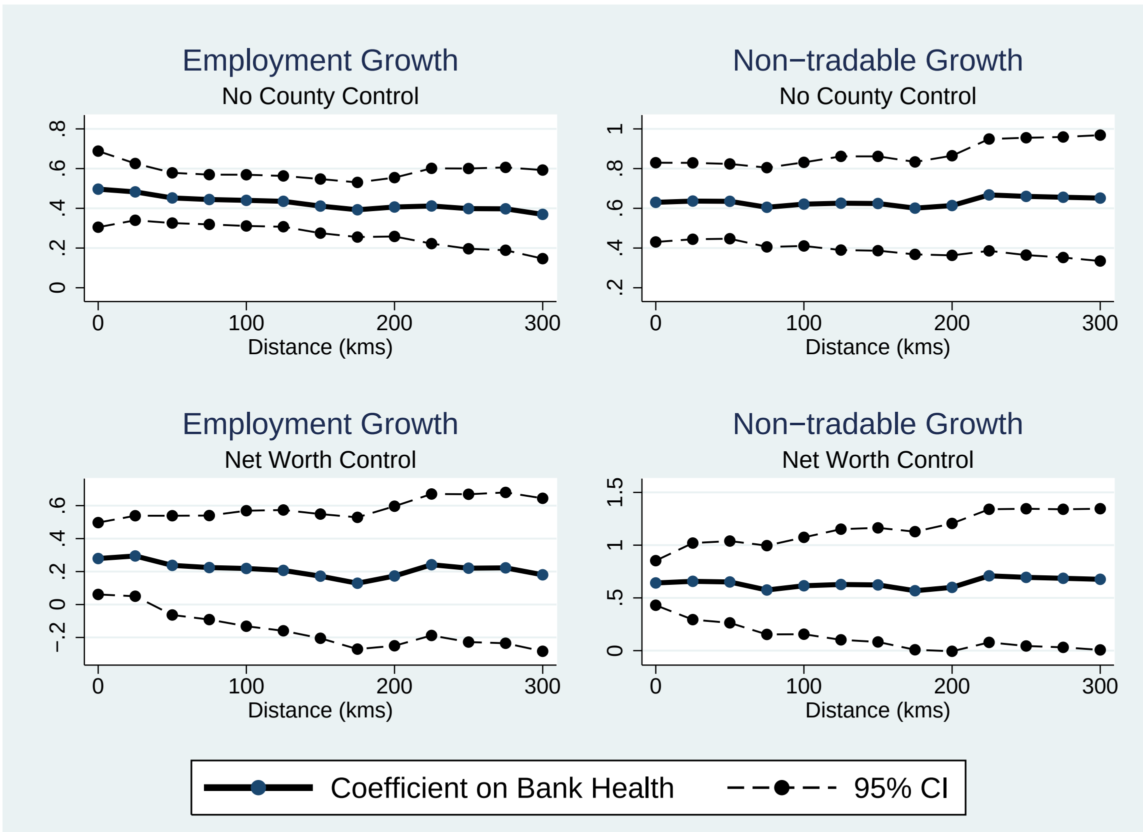


Figure 2.2: Effect of Bank Health: Distance Based Instruments

Notes: This figure presents the results of IV regressions as done in Table 4. However, instead of using county or CBSA market definitions, I use distance based definitions. Specifically, $Bank\_Health\_Cnty$ is instrumented using $Outside\_Shock\_c = \sum_{b \in B} \sum_{c' \in \{C \setminus m^d(c)\}} \frac{D_{b,c}}{D_c} \frac{D_{b,c'}}{D^b} \Delta NetWorth_{c'}$ where $m^d(c)$ is the set of counties within $d$kms of c. The graph plots the coefficient and 95% confidence for $Bank\_Health\_Cnty$ for different values of the distance parameter d. The left panels have total employment growth from 2007 to 2010 as the independent variable, while the right have non-tradable employment growth. The top panels omit the control for $\Delta NetWorth$, while the bottom panels include it.

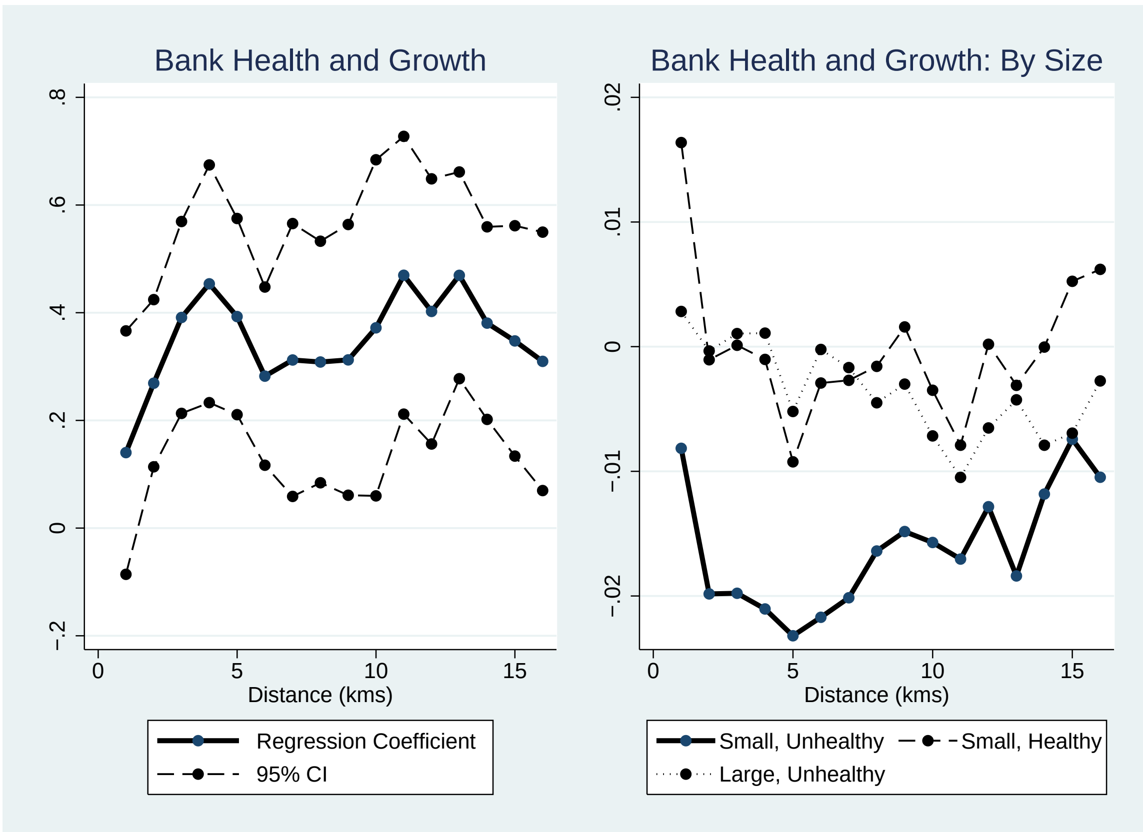


Figure 2.3: Effects of Bank Health on Tract Growth: By Distance

Notes: Both panels demonstrate how the health of banks within a certain distance of a census tract impact the employment growth from 2007 to 2010. The left panel plots the coefficient and 95% confidence interval from the regression $\Delta ln(Emp)_{t,c} = \beta_B Bank\_Health\_Tract_t(d) + \beta_x' \mathbf{X}_t + \delta_c + \epsilon_t$ weighting by 2006 employment, following specification (1) of Table 7. $Bank\_Health\_Tract_t(d)$ is the deposit weighted health (bank exposure to real estate appreciation) of the branches within d kms of the tract centroid. The right panel plots the expected growth of tracts within different categories. "Large" tracts have below the county median share of employment in small establishments, "Unhealthy" tracts have a value for $Bank\_Health\_Tract(d)$ below the county median. The expected growth for each size-health pair relative to the Large-Healthy category are plotted. These coefficients are derived from regressions following specification (6) in Table 7.

Figure 2.4: Joint Confidence Regions

Notes: These figures plot the bootstrap coefficients and 95% confidence interval for the coefficients on $\Delta NetWorth$ and $Bank\_Health\_Cnty$. These figures correspond to specifications (3) and (6) in Table 3 and (2) and (4) in Panel 2 of Table 4. The IV specification uses the outside CBSA instrument for bank health. I use 500 replications. The elongated confidence regions are a consequence of a high correlation between the key explanatory variables. This shows that although one can be confident that the coefficient on $Bank\_Health\_Cnty$ is greater that 0, one can't precisely assess the relative magnitude of the banking channel and the demand channel.

2.7.2 Tables

Table 2.1: Summary Statistics

	Mean	Standard Deviation	Percentile 10th	Percentile 90th	Obs
Bank Level					
Bank_Health	-0.059	0.070	-0.144	0.001	2092
Bank × County Growth					
$\Delta ln(SB\ Loans)$	-0.038	1.160	-1.269	1.485	20995
County Level (Weighted by Households)					
Bank_Health_Cnty	-0.084	0.042	-0.153	-0.038	944
$\Delta NetWorth$	-0.095	0.100	-0.218	-0.006	944
Outside_Shock (*County*)	-0.065	0.031	-0.108	-0.030	944
Outside_Shock (*CBSA*)	-0.057	0.030	-0.101	-0.025	944
Employment Growth:2007-2010					
Total	-0.077	0.053	-0.146	-0.012	944
Nontradable	-0.056	0.065	-0.112	0.018	944
Tradable	-0.188	0.156	-0.371	-0.034	944
HighDependence	-0.105	0.088	-0.208	-0.009	944
LowDependence	-0.062	0.060	-0.124	0.004	944
Young	0.267	0.113	0.152	0.392	900
Mature	-0.040	0.051	-0.101	0.019	900
Tract Level (Weighted by Employment)					
$\Delta ln(Emp\_tract)$	-0.049	0.272	-0.308	0.196	55843
Bank_Health_Tract (*3km*)	-0.084	0.043	-0.144	-0.037	46828

Table 2.2: Growth in Number of Small Loans

	(1)	(2)	(3)	(4)	(5)	(6)
Bank_Health	1.987**	2.105**	2.202**	2.249**		
	(0.711)	(0.751)	(0.763)	(0.793)		
$\Delta NetWorth$		-0.265+	0.300+		-0.0762	0.305*
		(0.151)	(0.155)		(0.0907)	(0.137)
Bank_Health_Cnty			-1.618**			-1.113**
			(0.558)			(0.397)
Observations	17519	17519	17519	17519	17519	17519
R^2	0.147	0.147	0.149	0.185	0.423	0.424
Fixed Effect				CNTY	BANK	BANK

Standard errors in parentheses

+ $p < 0.10$, * $p < 0.05$, ** $p < .01$

Notes: This table reports coefficients from regressions of bank×county growth in small business originations on bank health measures. The dependent variable is the growth in the number of small business loans originated by the bank in the county from 2008-2010 relative to 2004-2006. *Bank_Health* is the average change in household net worth in *b*'s counties, weighted by *b*'s deposits in the county. $\Delta NetWorth$ is the percentage change in household net worth from falling house prices for the actual county, while *Bank_Health_Cnty* is the deposit weighted average value of *Bank_Health* of the banks in the county. County fixed effects are used in (4), while bank fixed effects are used in (5) & (6). I additionally control for 2-digit industry shares and the natural logarithm of the number of loans made from 2004-2006. Standard errors are clustered by bank. I drop any observation in which the bank holding company acquired another bank within the CBSA, observations in the highest or lowest percentile of growth, and observations where the bank didn't have a 2006 branch within the county.

Table 2.3: Employment Growth: By Tradability

	All Industries			Nontradable			Tradable		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$Bank\_Health\_Cnty$	0.497**		0.279*	0.630**		0.642**	0.221		-0.131
	(0.0977)		(0.111)	(0.102)		(0.108)	(0.216)		(0.292)
$\Delta NetWorth$		0.201**	0.105+		0.214**	-0.00568		0.125	0.170
		(0.0477)	(0.0577)		(0.0493)	(0.0655)		(0.0953)	(0.124)
Observations	944	944	944	944	944	944	944	944	944
R^2	0.414	0.413	0.423	0.241	0.208	0.241	0.075	0.077	0.077

Standard errors in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < .01$

Notes: This table reports coefficients from regressions of county level employment growth from 2007 to 2010 on measures of bank health and shocks to housing net worth. The dependent variable is the growth in total employment in 1-3, the growth in non-tradable employment (restaurants and retail establishments) in 4-6, and growth in tradable employment in 7-9. $\Delta NetWorth$ is the percentage change in net worth of the households of a county and $Bank\_Health$ is average multimarket exposure to $\Delta NetWorth$ of local banks weighted by local deposit share. Controls for the share of employment in each 2 digit NAICS industry are included in each regression. I weight by the total households in the county and cluster the standard error by state.

Table 2.4: Employment Growth: IV with Out of Market Shocks

	All Industries		Nontradable		Tradable	
Market	CNTY	CBSA	CNTY	CBSA	CNTY	CBSA
	(1)	(2)	(3)	(4)	(5)	(6)
Panel 1: No County Control						
Bank_Health_Cnty	0.475**	0.466**	0.616**	0.660**	0.244	0.0604
	(0.0709)	(0.0718)	(0.0903)	(0.112)	(0.216)	(0.217)
Observations	944	944	944	944	944	944
R^2	0.414	0.414	0.241	0.240	0.075	0.073
F	419.853	216.516	419.853	216.516	419.853	216.516

Panel 2: Own County Control						
Bank_Health_Cnty	0.272*	0.270+	0.599**	0.715**	0.0202	-0.440
	(0.118)	(0.153)	(0.179)	(0.230)	(0.376)	(0.449)
$\Delta NetWorth$	0.107	0.108	0.00894	-0.0308	0.118	0.276
	(0.0725)	(0.0781)	(0.0910)	(0.103)	(0.156)	(0.173)
Observations	944	944	944	944	944	944
R^2	0.423	0.423	0.241	0.240	0.077	0.076
F	166.787	127.954	166.787	127.954	166.787	127.954

Standard errors in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < .01$

Notes: This table reports coefficients from IV regressions of county level employment growth from 2007 to 2010 on measures of bank health and shocks to housing net worth. The dependent variable is the growth in total employment in 1-3, the growth in non-tradable employment (restaurants and retail establishments) in 4-6, and growth in tradable employment in 7-9. The endogenous variables is *Bank_Health*, which is average multimarket exposure to $\Delta NetWorth$ of local banks weighted by local deposit share. This is instrumented for using bank exposure to real estate declines from other counties in odd columns, and other CBSAs in even columns. Controls for the share of employment in each 2 digit NAICS industry are included in each regression. In panel 2, I additionally control for $\Delta NetWorth$, the percentage change in net worth of the households of a county. I weight by the total households in the county and cluster the standard error by state.

Table 2.5: Employment Growth: By Financial Dependence

	OLS		IV:Outside Cnty		IV:Outside CBSA	
Financial Dependence:	High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)
Panel 1: No County Control						
Bank_Health_Cnty	0.661**	0.391**	0.627**	0.394**	0.689**	0.363**
	(0.109)	(0.103)	(0.100)	(0.0835)	(0.115)	(0.0870)
Difference:	.27+		.233+		.325*	
	(.15)		(.131)		(.144)	
Observations	944	944	944	944	944	944
R^2	0.339	0.264	0.338	0.264	0.338	0.264
Panel 2: Own County Control						
Bank_Health_Cnty	0.451*	0.291**	0.406*	0.323*	0.593**	0.251
	(0.199)	(0.0955)	(0.201)	(0.139)	(0.216)	(0.195)
$\Delta NetWorth$	0.101	0.0485	0.117	0.0375	0.0531	0.0622
	(0.0698)	(0.0591)	(0.0792)	(0.0804)	(0.0790)	(0.0937)
Difference:	.161		.083		.342	
	(.221)		(.245)		(.291)	
Observations	944	944	944	944	944	944
R^2	0.341	0.265	0.341	0.265	0.340	0.265

Standard errors in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < .01$

Notes: This table reports coefficients from regressions of county level employment growth from 2007 to 2010 on measures of bank health and shocks to housing net worth. The dependent variable is the growth in employment in industries with a high dependence on external finance in odd columns, and growth in industries with low financial depdendence in even columns. The first two columns are estimated with OLS, while the last four instrument for *Bank_Health_Cnty* using only the component coming from other counties or CBSAs. The difference in the coefficients for highly and lowly financially dependent industries is reported below the regression coefficient. Controls for the share of employment in each 2 digit NAICS industry are included in each regression. In panel 2, I additionally control for $\Delta NetWorth$, the percentage change in net worth of the households of a county. I weight by the total households in the county and cluster the standard error by state.

Table 2.6: Employment Growth: By Age

	OLS		IV:Outside Cnty		IV:Outside CBSA	
	Young	Old	Young	Old	Young	Old
	(1)	(2)	(3)	(4)	(5)	(6)
Panel 1: No County Control						
Bank_Health_Cnty	0.853**	0.384**	0.794**	0.361**	0.926**	0.257**
	(0.171)	(0.114)	(0.163)	(0.0917)	(0.120)	(0.0640)
Difference:	.469*		.432*		.669**	
	(.206)		(.187)		(.136)	
Observations	900	900	900	900	900	900
R^2	0.299	0.286	0.298	0.286	0.298	0.279
Panel 2: Own County Control						
Bank_Health_Cnty	0.599+	0.349**	0.491	0.294*	0.877*	0.0229
	(0.316)	(0.117)	(0.310)	(0.127)	(0.357)	(0.204)
$\Delta NetWorth$	0.121	0.0165	0.157	0.0353	0.0268	0.127
	(0.128)	(0.0648)	(0.135)	(0.0775)	(0.168)	(0.108)
Difference:	.25		.198		.854*	
	(.337)		(.335)		(.411)	
Observations	900	900	900	900	900	900
R^2	0.301	0.286	0.301	0.286	0.299	0.272

Standard errors in parentheses

$^+$ $p < 0.10$, * $p < 0.05$, ** $p < .01$

Notes: This table reports coefficients from regressions of county level employment growth from 2007 to 2010 on measures of bank health and shocks to housing net worth. The dependent variable is the growth in employment for young firms (five years and younger) in odd columns, and growth in mature firms in even columns. The first two columns are estimated with OLS, while the last four instrument for *Bank_Health_Cnty* using only the component coming from other counties or CBSAs. The difference in the coefficients for young and mature firms is reported below the regression coefficient. Controls for the share of employment in each 2 digit NAICS industry are included in each regression. In panel 2, I additionally control for $\Delta NetWorth$, the percentage change in net worth of the households of a county. I weight by the total households in the county and cluster the standard error by state.

Table 2.7: Tract Employment Growth

	Continuous Health Measure				High Bank Health Indicator			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bank_Health_Tract	0.391**	0.240+	0.139*	0.00846	0.0135**	-0.000112	0.00848**	0.00263
	(0.0909)	(0.121)	(0.0598)	(0.0798)	(0.00384)	(0.00698)	(0.00268)	(0.00410)
Bank_Health_Tract × *SM*		0.222+		0.262**		0.0209+		0.0121*
		(0.112)		(0.0832)		(0.0109)		(0.00471)
SM		0.00901		-0.00139		-0.0199*		-0.0301**
		(0.00970)		(0.00790)		(0.00900)		(0.00618)
Observations	45923	45901	45923	45901	45923	45901	45923	45901
R^2	0.103	0.104	0.055	0.057	0.103	0.104	0.055	0.057
Fixed Effect	CNTY	CNTY	CNTY	CNTY	CNTY	CNTY	CNTY	CNTY
Weighted?	Y	Y	N	N	Y	Y	N	N

Standard errors in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < .01$

Notes: This table reports coefficients from regressions of tract level employment growth from 2007 to 2010 on tract level measures of bank health and county fixed effects. In the first four columns, *Bank_Health_Tract* is the average health of the banks within 3km of the tract centroid, weighted by the deposits in branches within 3km of the tract. In the last four columns, *Bank_Health_Tract* is an indicator for whether the aforementioned measure is above the county median. I additionally control for 2-digit NAICS employment shares of the tract in 2006. Even columns additionally include an interaction for whether the tract is above the county median in terms of the share of employment in small establishments. Regressions are weighted by 2006 tract employment in 1,2,5, &6 and unweighted in the rest. Standard errors are clustered by state. Observations in the highest and lowest percentile of employment growth are dropped.

Table 2.8: Evidence of Wage Adjustment

	ALL	Under 25 yrs	Less Than High School	High School	Some College	College
	(1)	(2)	(3)	(4)	(5)	(6)
Panel 1: Wage Growth						
Bank_Health_Cnty	0.157	0.383**	0.286**	0.231*	0.172	0.143
	(0.113)	(0.0852)	(0.0879)	(0.101)	(0.109)	(0.126)
Observations	929	931	927	929	928	919
R^2	0.161	0.378	0.340	0.238	0.179	0.127

Panel 2: Employment Growth						
Bank_Health_Cnty	0.344**	0.480**	0.509**	0.241	0.330**	0.319*
	(0.124)	(0.144)	(0.133)	(0.149)	(0.116)	(0.122)
Observations	932	932	928	932	932	931
R^2	0.249	0.268	0.308	0.281	0.237	0.191

Standard errors in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < .01$

Notes: This table reports coefficients from regressions of 2007 to 2010 employment or wage growth within an education category on bank health. The first panel uses wage growth as the dependent variable, while the second uses stable employment growth. The wage in a given year is the income of stable workers divided by the number of stable workers of a given education type. Column 1 includes all workers, while the proceeding columns include only (2) workers under 25, (3) less than high school, (4) high school, (5) some college, and (6) college. *Bank_Health* is average multimarket exposure to $\Delta NetWorth$ of local banks weighted by local deposit share. Controls for the share of employment in each 2 digit NAICS industry are included in each regression. I weight by the total households in the county and cluster the standard error by state.

Table 2.9: County Growth: Health of 2002 Branches

	All Industries		Nontradable		Tradable	
	(1)	(2)	(3)	(4)	(5)	(6)
Bank_Health_Cnty	0.507**	0.273*	0.637**	0.672**	0.218	-0.217
	(0.0949)	(0.134)	(0.0997)	(0.160)	(0.203)	(0.342)
$\Delta NetWorth$		0.107		-0.0159		0.200
		(0.0703)		(0.0837)		(0.156)
Observations	944	944	944	944	944	944
R^2	0.414	0.423	0.241	0.241	0.075	0.077

Standard errors in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < .01$

Notes: This table reports coefficients from IV regressions of county level employment growth from 2007 to 2010 on measures of bank health and shocks to housing net worth. The dependent variable is the growth in total employment in 1-3, the growth in non-tradable employment (restaurants and retail establishments) in 4-6, and growth in tradable employment in 7-9. $\Delta NetWorth$ is the percentage change in net worth of the households of a county and *Bank_Health_Cnty* is average multimarket exposure to $\Delta NetWorth$ of local banks weighted by local deposit share. I instrument for *Bank_Health_Cnty* using the equivalent definition as in the text except with 2002 branch deposits. Controls for the share of employment in each 2 digit NAICS industry are included in each regression. I weight by the total households in the county and cluster the standard error by state.

Table 2.10: Tract Growth: Health of 2002 Branches

	Continuous Health Measure		High Bank Health Indicator	
	(1)	(2)	(3)	(4)
Bank_Health_Tract	0.391**	0.181*	0.00991	0.0191**
	(0.127)	(0.0898)	(0.00779)	(0.00629)
Observations	44898	44898	44898	44898
R^2	0.105	0.056	0.105	0.056
Fixed Effect	CNTY	CNTY	CNTY	CNTY
Weighted?	Y	N	Y	N

Standard errors in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < .01$

Notes: This table coefficients from IV regressions of tract level employment growth from 2007 to 2010 on tract level measures bank health and county fixed effects. In the first two columns, *Bank_Health_Tract* is the average health of the banks within 3km of the tract centroid, weighted by the deposits in branches within 3km of the tract. In the third and fourth column, *Bank_Health_Tract* is an indicator for whether the aforementioned measure is above the county median. I instrument for *Bank_Health_Tract* using the equivalent definition as from the text, except with 2002 branch locations and deposits. I additionally control for 2-digit NAICS employment shares of the tract in 2006. Regressions are weighted by 2006 tract employment in 1 & 3 unweighted in 2 & 4. Standard errors are clustered by state. Observations in the highest and lowest percentile of employment growth are dropped.

2.7.3 Theory Appendix

To motivate the empirical work, I present a simple model of bank credit and employment. First, I derive how how banks choose their aggregate lending and allocate credit across counties. Then, I calculate how county and industry employment are affected by credit and demand shocks. In the end, I discuss the implications of the model for the different empirical approaches.

Model

Bank's Problem Suppose that banks engage in monopolistic competition in the provision of business loans. A borrower i in county c uses a CES composite of borrowing from a continuum of banks to engage in production. They choose the amount to borrow from banks b, $L^b_{c,i}$, so as to minimize $\int\limits_{\Omega_c} r^b_{c,i} L^b_{c,i} db \ s.t. \left(\int\limits_{\Omega_c} (L^b_{c,i})^{\frac{\epsilon-1}{\epsilon}} db\right)^{\frac{\epsilon}{\epsilon-1}} = L_{c,i}$. Where $r^b_{c,i}$ is the interest rate charged by bank b to borrower i in county c, Ω_c is the set of banks operating in county c and $L_{c,i}$ is aggregate borrowing. This implies a demand curve.

$$L^b_{c,i} = L_{c,i}(\frac{r^b_{c,i}}{r_{c,i}})^{-\epsilon}$$

where $r_{c,i} = (\int\limits_{\Omega_c} (r^b_{c,i})^{1-\epsilon} db)^{\frac{1}{1-\epsilon}}$ is the cost of bank borrowing.

Given a certain level of aggregate lending L^b, the bank will allocate credit across borrowers in order to maximize profit subject to demand curves and the adding up constraint. Denoting the set of counties b operates in C_b and the set of borrowers in the county I_c, b's maximization problem is:

$$\begin{aligned} \underset{\{r^b_{c,i}\}}{\text{maximize}} \quad & \sum_{c\in C_b}\sum_{i\in I_c} L^b_{c,i} r^b_{c,i} \\ \text{subject to} \quad & \sum_{c\in C_b}\sum_{i\in I_c} L^b_{c,i} = L^b, \ \{L^b_{c,i} = L_{c,i}(\frac{r^b_{c,i}}{r_{c,i}})^{-\epsilon}\} \ \forall c, i \end{aligned}$$

This results in a constant optimal lending rate for bank b:

$$r^b = (\frac{D^b}{L^b})^{\frac{1}{\epsilon}} \ \forall i, c \tag{2.3}$$

where $D^b = \sum\limits_{c\in C_b}\sum\limits_{i\in I_c} L_{c,i} r^\epsilon_{c,i}$ measures the level of demand for loans from b. This is increasing in the aggregate demand for bank finance among clients and in the interest rate charged by competitors.

Next, to determine the optimal size of the bank's loan portfolio, suppose that the marginal cost of funds for a bank is an increasing function $c()$ of its leverage $\frac{L^b}{E^b}$, where E^b is the bank's equity.

Then the first order condition implicitly defining the bank's optimal lending is:

$$\frac{\epsilon - 1}{\epsilon}(\frac{D^b}{L^b})^{\frac{1}{\epsilon}} = c(\frac{L^b}{E^b})$$

This equation equates marginal revenue to marginal cost, and thus defines the bank's supply curve. Log-linearizing this equation, and combining it with the demand curve in (3), we find that the growth in lending and interest rates as a function of the growth in demand and equity:

$$\hat{L}^b = \eta_b^{BE}\hat{E}^b + (1 - \eta_b^{BE})\hat{D}^b \tag{2.4}$$

$$\hat{r}^b = \frac{\eta_b^{BE}}{\epsilon}(\hat{D}^b - \hat{E}^b) \tag{2.5}$$

where $\eta_b^{BE} = (1 + (\epsilon c'(\frac{L^b}{E^b})\frac{(\frac{L^b}{E^b})}{c(\frac{L^b}{E^b})})^{-1})^{-1}$ parameterizes the degree of bank financial constraints. Note that growth in lending is more related to equity growth if the elasticity of marginal cost with respect to leverage is high. In the extreme, if banks have a constant marginal cost of funds up until they hit a binding leverage constraint, η_b^{BE} would be 1 for any bank at the regulatory capital ratio, and 0 for any bank below it.

Bank County Lending Summing over the industry demand curves within a county, and using that the optimal bank interest rate is constant at the bank level, we get that the county level lending for b is $L_c^b = (r^b)^{-\epsilon} \sum\limits_{i \in I_c} L_{c,i} r_c^{\epsilon}$. Thus the growth in lending at the bank-county level is:

$$\begin{aligned} \hat{L}_c^b &= -\epsilon\hat{r}^b + \hat{D}_c \\ &= -\eta_b^{BE}(\hat{D}^b - \hat{E}^b) + \hat{D}_c \end{aligned} \tag{2.6}$$

Where $D_c \equiv \sum\limits_{i \in I_c} L_{c,i} r_c^{\epsilon}$ denotes the level of demand for bank loans in county c and $r_c = (\int\limits_{\Omega_c} (r^b)^{1-\epsilon} db)^{\frac{1}{1-\epsilon}}$ is the interest rate charged for bank lending in county c.

Firm's Problem

To endogenize the loan demand, and understand how changes in credit spreads impact employment, consider the following optimization problem. A representative firm in industry i in county c produces output $Y_{c,i}$ with a constant returns to scale production function using labor $N_{c,i}$ such that:

$$Y_{c,i} = A_{c,i} N_{c,i}$$

The wage bill $w_c N_{c,i}$ is financed by a combination of bank finance $L_{c,i}$ and direct finance $d_{c,i}$ according to the relationship $w_c N_{c,i} = L_{c,i}^{\delta_{c,i}} d_{c,i}^{1-\delta_{c,i}}$. Recall the cost of bank finance is r_c and denote the cost of direct finance ρ. The firm's cost minimization problem is:

$$min\ r_c L_{c,i} + \rho d_{c,i}\ s.t.\ w_c N_{c,i} = L_{c,i}^{\delta_{c,i}} d_{c,i}^{1-\delta_{c,i}}$$

The marginal cost of output and demand for bank funds are then:

$$mc_{c,i} = c_o r_c^{\delta_{c,i}} \rho^{1-\delta_{i,c}} \frac{w_c}{A_{c,i}}$$

$$L_{c,i} = b_o \left(\frac{r_c}{\rho}\right)^{\delta_{c,i}-1} w_c N_{c,i}$$

Where c_o and b_o are constants.[31]

Assuming perfect competition and a unit elastic demand curve, expenditure on i's good is fixed at $X_{c,i}$ and output is priced at marginal cost. Consequently $Y_{c,i} = \frac{X_{c,i}}{mc_{i,c}}$. Normalizing ρ to one for notational simplicity, labor demand is

$$N_{c,i} = \frac{Y_{c,i}}{A_{c,i}} = X_{c,i} \left(c_o r_c^{\delta_{c,i}} w_c\right)^{-1}$$

Combining the previous two expressions gives us the demand for bank finance:

$$L_{c,i} = \delta_{c,i} \frac{X_{c,i}}{r_c}$$

Aggregate Employment Effects Log linearizing the firm's labor demand:

$$\hat{N}_{c,i} = \hat{X}_{c,i} - \delta_{c,i} \hat{r}_c - \hat{w}_c$$

To determine $X_{c,i}$, let expenditure growth be a weighted average of national consumption growth $\hat{\bar{C}}$, and local consumption growth, with weight $\theta_{c,i}$ on local consumption growth. Furthermore, let

[31] $c_o = \delta_{c,i}^{-\delta_{c,i}} (1-\delta_{c,i})^{\delta_{c,i}-1},\ b_o = \left(\frac{\delta_{c,i}}{1-\delta_{c,i}}\right)^{1-\delta_{c,i}}$

local consumption growth be determined by the growth in income $\hat{W}_c \equiv \hat{w}_c + \hat{N}_c$ and housing wealth $\hat{H}_c$ with elasticities η^{XW} and η^{XH} respectively. Growth in expenditure for an industry's output is then:

$$\hat{X}_{c,i} = (1 - \theta_{c,i})\hat{\hat{C}} + \theta_{c,i}(\eta^{XW}\hat{W}_c + \eta^{XH}\hat{H}_c)$$

To pin down wages, let the inverse labor supply curve be $w_c = N_c^{\psi}$, then total payments to labor are $w_c N_c = N_c^{\psi+1}$. This implies income growth $\hat{W}_c = (\psi + 1)\hat{N}_c$. Combining this with the previous two equations thus yields the county×industry employment growth:

$$\hat{N}_{c,i} = \alpha(\theta_{c,i}) + \theta_{c,i}\eta^{XH}\hat{H}_c - \delta_{c,i}\hat{r}_c + \beta^{GE}(\theta_{c,i})\hat{N}_c \tag{2.7}$$

Where $\alpha(\theta_{c,i}) = (1 - \theta_{c,i})\hat{\hat{C}}$ denotes the growth in demand from national sources, and $\beta^{GE} = \theta\eta^{XW}(\psi + 1) - \psi$ summarizes the general equilibrium effect of changes in aggregate labor demand on industry labor demand.

This equation says that a decline in house values reduces local demand (assuming $\eta^{XH} > 0$) and impacts employment in industries which are dependant on local demand (i.e. $\theta_{c,i}$ is high). This is the channel emphasized in Mian and Sufi (2014). Also, an increase in the cost of bank credit impacts employment in firms which are bank dependent ($\delta_{c,i}$ is high). This is the channel emphasized by this paper and Chodorow-Reich (2014). Third there are general equilibrium effects which depend on the tradability of the industry. A contraction in employment lowers the cost of labor for all firms, however there is an offsetting effect on firms which are dependent on local demand, as the decline in income reduces expenditure.

To calculate aggregate employment growth, sum over the growth rates of the industries within a county (weighting by initial employment) to get:

$$\hat{N}_c = \mu_c(\alpha(\theta_c) + \theta_c\eta^{XH}\hat{H}_c - \delta_c\hat{r}_c) \tag{2.8}$$

where $\mu_c \equiv \frac{1}{1-\beta^{GE}(\theta_c)}$ is a multiplier reflecting the extent of general equilibrium wage and income effects and θ_c and δ_c denote the (weighted) average value of the corresponding industry level parameters across the industries within the county.

Implication for Empirical Approaches

Small Business Lending, County Fixed Effects Equation (6) provides the formula for the growth in lending at the county level. It has a supply component corresponding to changes in the interest rate the bank charges, and a demand component reflecting the availability of credit from competitors and the demand for the firm's product. Regressing county lending growth on bank health (denoted BH^b) without county fixed effects would produce a point estimate: $\beta^{L,BH} = \epsilon\frac{cov(\hat{r}^b,BH^b)}{var(BH^b)} + \frac{cov(\hat{D}_c,BH^b)}{var(BH^b)}$. This includes both the effect on interest rates, and on demand. To isolate the effect of bank health on the cost of credit, I add county fixed effects to absorb the $\hat{D}_c$. This should produce the point estimate reflecting the impact of bank health on lending rates: $\beta^{L,BH}|_{d_c} = \epsilon\frac{cov(\hat{r}^b,BH^b)}{var(BH^b)}$

Similarly, using a bank fixed effect allows me to isolate supply shocks and test how changes in housing net worth impacts demand. Regressing county lending growth on the shock to housing net worth, $\hat{H}$, and bank fixed effects should provide an estimate: $\beta^{L,H}|_{\delta_b} = \frac{cov(\hat{D}^b_c,\hat{H}_c)}{var(\hat{H}_c)}$. The fact that this is found to be indistinguishable from 0, and slightly negative, indicates that the decline in lending wasn't due to falling demand in places with declining housing net worth.

Employment Approaches 1& 2 Equation (8) calculates employment growth as a function of the credit supply shock $\hat{r}_c$ and the housing net worth shock $\hat{H}_c$. Assume that $Bank\_Health\_Cnty$ (denoted BH_c for brevity) isn't related to demand except through it's influence on lending rates so that $\hat{r}_c = \eta^{rB}BH_c + u_c$, where the residual is orthogonal to demand, then equation 8 becomes:

$$\hat{N}_c = \mu_c\left(\alpha(\theta_c) + \theta_c\eta^{DH}\hat{H}_c - \delta_c\eta^{rB}BH_c - \delta_c u_c\right) \tag{2.9}$$

Approach 1 directly estimates this equation using $\Delta NetWorth_c$ to control for $\hat{H}_c$ and the controls for industry shares to control for differences in θ_c. If the model is correctly specified and the variables are exogenous, the coefficient on BH_c should be $\mu\delta\eta^{rB}$ (or more plainly: $\frac{\partial\hat{N}}{\partial\hat{r}}\frac{\partial\hat{r}}{\partial BH}$).

However, direct estimation requires $\hat{H}_c$ to be exogenous, a condition which is unlikely to hold as unobservables increasing demand for labor will impact house prices as a consequence. Thus the second approach is to omit the control, and instrument for $Bank\_Health\_Cnty$ using only the exposure of banks to falling house prices in markets which don't directly impact local employment.

Employment Approach 3: Difference in Differences by Bank Dependence Note from equation (7) that a regression of employment growth in an industry i on $Bank\_Health\_Cnty$ will produce a coefficient:

$$plim\ \beta_i^{N,BH} = \theta_i\eta^{XH}\frac{cov(\hat{H},BH_c)}{var(BH_c)} - \delta_i\frac{cov(\hat{r},BH_c)}{var(BH_c)} + \beta^{GE}(\theta_i)\frac{cov(\hat{N},BH_c)}{var(BH_c)}$$

Suppose that industries differ only by their bank dependence, with the difference in importance of bank credit between the high and the low group being denoted $\Delta\delta \equiv \delta_{high\ dep} - \delta_{low\ dep}$. Then the difference in point estimates for high dependence and low dependence firms would be:

$$plim(\beta^{N,BH}_{high\ dep} - \beta^{N,BH}_{low\ dep}) = \Delta\delta \frac{cov(\hat{r}, BH_c)}{var(BH_c)} = \Delta\delta\eta^{rB}$$

Thus a positive differential would demonstrate that $Bank\_Health\_Cnty$ impacts the supply of credit, since the high and the low group experience the same shocks to demand and wages.

Reconciliation with Mian and Sufi My findings suggest that declining house prices translate to employment losses due to a contraction in bank credit. This can be reconciled with the finding in Mian and Sufi (2014) that deficient aggregate demand was an important driver in the relationship between house price movements and employment.

Note from (7) that a completely tradable firm (θ_i=0) would experience employment growth:

$$\begin{aligned}\hat{N}_{c,\text{perfectly tradable}} &= \hat{\hat{C}} - \delta_{c,i}\hat{r}_c - \psi\hat{N}_c \\ &= \hat{\hat{C}} - \delta_{c,i}\hat{r}_c - \psi\mu_c\Big(\alpha(\theta_c) + \theta_c\eta^{XH}\hat{H}_c - \delta_c\hat{r}_c\Big)\end{aligned}$$

This shows that a contraction in credit has an ambiguous effect on tradable employment. On one hand, it costs more to borrow ($\delta_{c,i}\hat{r}_c \uparrow$), on the other labor becomes cheaper due to constraints at other firms ($\psi\mu_c\delta_c\hat{r}_c \uparrow$).

More generally, a regression of employment growth on house price growth would produce the estimate:

$$plim\ \beta_i^{N,H} = \theta_i\eta^{XH} - \delta_i\frac{cov(\hat{r}, \hat{H}_c)}{var(\hat{H}_c)} + \beta^{GE}(\theta_i)\frac{cov(\hat{N}, \hat{H}_c)}{var(\hat{H}_c)}$$

Now, consider the difference in growth rates in two groups of firms which differ only in tradability. Non-tradable industries are more reliant on local demand ($\Delta\theta \equiv \theta_{c,nontrade} - \theta_{c,trade} > 0$). Then the difference in the effect of a house price decline in tradable and non-tradable industries will be estimated as

$$
\begin{aligned}
plim(\ \beta^{H}_{nontrade} - \beta^{H}_{trade}) &= \Delta\theta\eta^{XH} + \Delta\beta^{GE}\frac{cov(\hat{N}_c, \hat{H}_c)}{Var(\hat{H}_c)} \\
&= \Delta\theta\eta^{XH} + \Delta\theta(\eta^{XW}(\psi+1)\frac{cov(\hat{N}_c, \hat{H}_c)}{Var(\hat{H}_c)} \\
&= \Delta\theta\left(\underbrace{\eta^{XH}}_{\substack{\text{Direct}\\ \text{Effect}}} + \underbrace{(\eta^{XW}(\psi+1)}_{\substack{\text{Sensitivity of Demand}\\ \text{to Labor Demand}}}\underbrace{\mu\left(\theta_c\eta^{XH} - \delta_c\frac{cov(\hat{r}_c, \hat{H}_c}{Var(\hat{H}_c)}\right)}_{\substack{\text{Labor Demand}\\ \text{Change}}}\right)
\end{aligned}
$$

This equation shows that if falling house prices adversely impacts the supply of credit ($\frac{cov(\hat{r}_c, \hat{H}_c}{Var(\hat{H}_c)} < 0$), then this will impact non-tradable industries the most. Thus a greater sensitivity of employment growth with respect to house price growth doesn't prove the existence of a housing wealth effect. Even if $\eta^{XH} = 0$, you would still find that non-tradable industries respond more.

Intuitively a decline in credit in a county has three effects: (1) a direct effect on labor demand by increasing the cost of capital for bank dependent firms, (2) an offsetting general equilibrium effect on the cost of labor through declining wages, and (3) an amplifying effect through the reduction in local demand due to lower wages or employment. The first two effects hit both tradable, and non-tradable industries, while the third effect in only borne by non-tradable industries. In short, although the decline in labor demand in non-tradable industries suggests a decline in local demand, this does not necessarily rule out credit supply. Weak labor market conditions stemming from credit disruptions can also cause spending to decline, thus harming industries which are reliant on local demand.

Chapter 3

A Spatial Measure of Banking Competition

3.1 Introduction

Banks play a fundamental role in the allocation of capital within an economy. When these banks can exert market power, it may have a significant adverse effect on the ability of the economy to function efficiently. An understanding of the competitive pressures within the banking system is thus of vital importance.

The first step of any empirical analysis of banking competition is proper measurement. Although there is a vast literature attempting to measure the influence of bank competition, there is still no consensus on how competition itself should actually be measured. When regulators are trying to determine the probable competitive effects of a merger, their starting point is to use a Herfindahl-Hirschman Index (HHI) of deposits within a market, where the market is defined roughly as an MSA or a rural county.[1] This methodology is also common in the academic literature when trying to either control for bank competition or determine its impacts.

However, this market definition is at odds with the literature on distance and banking. Studies utilizing various sources of data and time periods have found that individuals and small businesses rely predominantly on very nearby banks, and that banks price discriminate based on location. If banks are able to geographically segment the market and exert market power in those segments, a

[1] The conventional Herfindahl measure is defined as: $HHI_{mkt} = \sum_{b=1}^{B} s_b^2$ where s_b is the share of the total deposits in the market held by bank b.

market may be uncompetitive without being concentrated. The conventional MSA level Herfindahl is a flawed measure of competition because it fails to take into account the location of banks within the MSA. Thus, while it may address the ability of banks to collude on pricing, it fails to pickup how the location of banks within a market can impact market power arising from spatial frictions in lending.

The primary contribution of this paper is the introduction of a new measure of banking concentration which takes into account the local nature of banking. Specifically, I create a tract level measure of concentration, which amounts to the deposit Herfindahl for all branches within a certain distance of the tract centroid. My market level measure, referred to from here on out as the Local Herfindahl, is then the average concentration of the tracts within the market. This measure of concentration reflects both the availability of competitors within a market as well as the degree to which they geographically segment the market.

With this new measure of concentration, I weigh in on three existing questions in the banking literature. (1) Does bank market structure impact pricing and profitability? (2) What is the proper geographic extent of banking markets? (3) Is bank market power detrimental to the ability of young firms to obtain finance?

The first question this paper addresses is how bank market structure impacts the ability of banks to behave uncompetitively. If concentration results in less competition, this should impact a bank's pricing decisions and ultimate profitability (the Structure-Conduct-Performance hypothesis). Consistent with this, concentration has been found to be associated with low deposit rates (Berger and Hannan, 1989; Heitfield and Prager, 2004), deposit rates which are less prone to rise with market rates (Hannan and Berger, 1991; Neumark and Sharpe, 1992), high loan rates (Hannan, 1991; Hannan and Liang, 1995), and high profitability (Pilloff and Rhoades, 2002; Rhoades, 1995). However, other papers have questioned the hypothesis that market structure impacts bank performance and argue that concentration may reflect high market shares of more efficient firms, and thus higher profitability (Smirlock, 1985; Rhoades, 1985; Evanoff and Fortier, 1988; Berger, 1995). Additionally, Weiss (1989) finds that the positive relationship between concentration and loan rates is inconstant across different studies.

Measuring concentration using the Local Herfindahl results in stronger findings in support of the Structure-Conduct-Performance hypothesis. Local concentration is consistently more predictive of bank market power than conventional concentration. A one standard deviation increase in the conventional MSA Herfindahl raises average loan rates by 3 basis points. A one standard deviation increase in the new Local Herfindahl, even controlling for the conventional Herfindahl, raises lending rates by 10 basis points and makes the conventional Herfindahl insignificant. Similar results holds for other indicators of bank market power; banks in locally concentrated markets charge higher interest rates on commercial and industrial loans, have higher service charges, offer lower deposit rates, and as a result experience higher net profit margins and returns on equity.

The greater magnitude and significance for local concentration suggests that previous studies using the conventional Herfindahl suffered from attenuation bias, possibly explaining the lack of consistent findings. Furthermore, since variation in the Local Herfindahl comes from different location patterns within the market instead of only differences in aggregate market shares, the results are less likely to be explained by heterogeneity in bank efficiency.

The second question is how one should define a banking market. Regulators define markets at roughly the level of the MSA or the rural county. This market definition has been supported by numerous studies of bank pricing and profitability (Heitfield, 1999; Heitfield and Prager, 2004; Pilloff and Rhoades, 2002). However, several authors have argued that financial innovations and deregulation has resulted in markets which may be statewide or national (Jackson III and Eisenbeis, 1997; Radecki, 1998; Petersen and Rajan, 2002). In the other direction, the observation of a disproportionate reliance on local banks (Kwast et al., 1997; Brevoort and Hannan, 2006; Brevoort and Wolken, 2009) and on spatial price discrimination (Degryse and Ongena, 2005; Agarwal and Hauswald, 2010; Bellucci et al., 2013) raises the possibility of bank markets being substantially smaller due to either transport costs or information problems associated with distant lending. An understanding of the appropriate market definition is important for both the regulators responsible for approving mergers, and academics studying the sources and implications of bank market power.

My measure of concentration is well suited for addressing this question because it includes a distance parameter pertaining to how far from a tract a branch can be and still be included in the tract's market. I can thus test how the relationship between concentration and bank pricing varies depending on the market definition. I find that the Local Herfinadhl with a distance parameter of 4 km is most predictive of lending rates. Additionally, I find that the Tract Herfinadhl reflecting the concentration in the 8kms surrounding a bank's branches is most predictive of its lending rates.[2]

The final question I address is how market structure impacts firm financial constraints and the allocation of capital. Bank market power may help young risky firms obtain credit, as banks will be more able to build a relationship with them and earn rents in the future (Information

[2] Note that these measures reflect different things. The Tract Herfindahl reflects the availability of competitors within a certain distance of a bank's branches. The Local Herfindahl is the average concentration of the tracts within a conventionally defined market. This accounts for the fact that segmentation elsewhere in an MSA may impact the outside option of nearby borrowers.

Hypothesis). Consistent with this, Petersen and Rajan (1995) and Cetorelli and Gambera (2001) find concentration benefits young firms. Alternatively, young firms are less able to fund themselves or obtain non-bank external finance, making financial frictions due to bank market power potentially more damaging (Market Power Hypothesis). Cetorelli and Strahan (2006) and Chong et al. (2013) find that young firms particularly struggle in concentrated markets.

One reason for the lack of consistent findings could be the inability to measure market power properly with the conventional Herfinadahl. The within US studies use MSA/rural county market definitions, while most of the cross country studies assume national banking markets. Ignoring the spatial distribution of bank branches would be particularly problematic for studying small business lending, as the opaque information environment exacerbates asymmetric information problems.[3] Furthermore, the small loan sizes make any distance related costs to lending proportionally more of a deterrent.

In order to analyze how market structure relates to firm financial constraints, I test how bank market structure impacts the ability of firms to expand following a shock to investment demand. Imperfect financial markets make firm growth more dependent on the availability of internal funds than on demand, reducing the synchronization between the firm's growth and the national growth rate of the industry. I find that in locally concentrated markets firm employment growth is less responsive to changes in national employment growth, especially for firms less than 6 years old. However, the conventional MSA concentration is not significantly related to this elasticity for young firms, suggesting a weaker correlation with firm financial constraints.

Taken together, this paper provides evidence that banks obtain market power stemming from spatial frictions in lending. More segmented markets allow higher bank markups and result in higher financial constraints for young firms. This is significant in understanding the potential effects of the recent consolidation of the banking system. Since the removal of interstate branching restrictions following the 1994 Riegle-Neal Interstate Banking and Branching Efficiency Act, there has been a dramatic consolidation of the banking system resulting in more concentrated MSAs. However, the remaining banks have been more spread across sub-markets within MSAs, causing concentration at finer levels to decline. As local concentration is found to be what matters for bank pricing, this suggests an increase in the the competitiveness of the banking sector since 1994, while previous findings with regard to the trend and effect of market concentration would suggest the opposite.

[3] Claessens and Laeven (2005) and Carbó-Valverde et al. (2009) present evidence that concentration fails to measure bank market power as is relevant to young firms. They find that competition is beneficial to growth, when measured using New Empirical Industrial Organization based measures of market power. However, competition as measured by low concentration is found to be either unimportant or to have the opposite effect.

The remainder of the paper will proceed as follows: Section 2 documents the evidence that banking is a local activity, and motivates the new measure of concentration. Section 3 describes the construction of the Local Herfindahl, and compares it to the conventional measure. Section 4 justifies that the new measure better relates to lending rates, deposit rates, and profitability. Section 5 presents an application to the study of financial frictions for young firms. Section 6 concludes.

3.2 Background and Motivation

3.2.1 Bank Concentration and Competition

A primary factor determining the effectiveness of the banking system is its competitiveness. A monopolist bank may be able to offer low rates on deposits and high rates on loans, bringing about an inefficiently low quantity of intermediation. Such a bank may also face minimal costs to inefficiency and be able to enjoy a quiet life with minimal effort engaged in screening investments, thus harming allocative efficiency. Finally, a bank with sufficient market power may act so as to support incumbents to whom they've made loans at the expense of new entrants and inhibit the process of creative destruction. Given that a well developed financial system is critical for economic growth (King and Levine, 1993; Levine, 2005), supporting competition in the banking sector is an important policy goal.

One of the determinants of the competitiveness of the banking sector seems to the availability of competitors in the local market. Numerous academic studies have found evidence that banks in concentrated markets (MSAs or rural counties) behave uncompetitively. High level of concentration have been found to be associated with low deposit rates (Berger and Hannan, 1989; Heitfield and Prager, 2004), deposit rates which are less responsive to interest rates (Hannan and Berger, 1991), high loan rates (Hannan, 1991), and low efficiency (Berger and Hannan, 1998).

The effects of bank competition have also been shown to extend beyond just the banking system. Within the US, the increase in banking competition following the removal of branching restrictions was found to increase growth by improving the quality of lending (Jayaratne and Strahan, 1996), decreasing loan rates (Jayaratne and Strahan, 1998), and decreasing financial barriers to firm entry (Cetorelli and Strahan, 2006). Cross country evidence also suggests that banking competition is important. Restrictions on the entry of foreign banks have been found to increase the likelihood of a banking crisis (Barth et al., 2004), while nationwide concentration in assets has been found to increase firm financing obstacles in developing countries (Beck et al., 2004).

This evidence that bank competition is important, and that banks in concentrated markets behave uncompetitively, supports US competition policy regarding bank mergers. When evaluating a potential merger between two banks, the key approach to assessing the likely effect on competition is to look at the effect on the MSA level deposit Herfindahl. Typically, if the merger leaves the Herfindahl for an MSA under .18 or doesn't raise the Herfindahl by over .02, then the Federal Reserve board will not look an further (ABA, 2006).[4]

Despite this emphasis on leaving markets unconcentrated, the removal of restrictions on within state bank branching between 1976 and 1994 and cross-state branching after 1994 have dramatically changed the structure of the market. Whereas in 1980 there were 14,434 FDIC-Inusured commercial banks, by 2012 there were only 6,096.[5] However, during this time period, the number of offices increased from 53,172 to 89,805 as larger banks took advantage of the ability to expand into new markets. This simultaneous decline in the number of institutions and increase in the geographic spread of these institutions makes how one defines a banking market of critical importance in determining the probable competitive impacts of this consolidation. The exit of small banks makes concentration at more aggregate levels rise, while the geographic expansion of the branch network of the remaining banks may have the opposite effect on concentration measured at a finer level.

3.2.2 Importance of Proximity in Banking

Although the MSA level Herfindahl is effective at predicting bank behavior, it is still an open question whether or not this market definition is the appropriate one for measuring bank concentration. A second strand of the banking literature has studied the importance of proximity in banking, and found banking to be very local. Due to transportation costs and the existence of local knowledge, nearby banks will have an advantage relative to distant banks. This may result in banks achieving market power depending on the availability of other banks in close proximity.

Kwast et al. (1997) and Brevoort and Wolken (2009) use survey data to document that individual financial services and small business lending disproportionately occur in branches of banks within a few miles of their customers. Brevoort and Hannan (2006) use disclosure data from the Community Reinvestment Act to study the location of small business lending. They find that the probability of a bank lending to a tract falls rapidly as the distance between the tract and the nearest branch of a bank grows.

[4]As a point of reference, a market where 4 banks held 20% of the deposits each, and two banks held 10% of the deposits each, would have a Herfindahl of .18. If the two smaller banks merged, this would increase the Herfindahl by .02.

[5]http://www2.fdic.gov/hsob/HSOBRpt.asp

Figure 1 demonstrates the Brevoort and Hannan (2006) findings graphically. We see that the probability of an institution making a loan to a particular tract is declining rapidly in the distance from the tract centroid to the nearest branch of the institution. Although the levels shift for different years, the slope seems to change little, suggesting that distance is not becoming less important. Overall, the probability of a bank making a loan to a tract declines from over 80% if the bank is very close, to about 30% if the bank is 5 kms away, and the rate of decline slows down thereafter.[6]

There is also evidence of spatial price discrimination, suggesting that these lending patterns reflect actual spatial frictions instead of merely being an equilibrium outcome. Degryse and Ongena (2005) and Agarwal and Hauswald (2010) show that loan rates for a particular bank vary based on proximity of the borrower to the bank, as well as the proximity of the borrower to the nearest competitor. Although the former attributes the findings to transportation costs and the latter location specific soft information, both papers suggest that distant banks may be a poor substitute for near banks.

3.2.3 Implications for Bank Market Definition

In short, the research on distance and lending has consistently found that proximity to depository institutions remains highly relevant to the majority of individuals and small firms. These customers almost exclusively use banks within a few miles of them and are subject to price discrimination based on their location. Transportation costs and asymmetric access to soft information over space make it so that distant banks are often not viable substitutes for local banks. The finding that there are significant difficulties to lending at a distance raises questions regarding the appropriateness of the MSA level market definition.

To see how the MSA level concentration measure could be problematic, consider the two stylized banking markets presented in Figure 2. In the left figure, each institution locates in one neighborhood, in the right, each institution is evenly spread across neighborhoods. These markets will have the same concentration as measured by the MSA Herfindahl, as this measure only depends on the total market share of each institution without regard to the location of their branches. However, if people bank predominantly in their own neighborhood, then the competitiveness of the two markets differ substantially. In one case, every bank has a local monopoly, in the other, every bank has three competitors wherever it operates.

[6]This probably understates the true effect of distance. For one, there is measurement error in distance due to occasional geocoding errors and due to the fact that I measure distance to centroids instead of actual borrower locations. These errors will tend to attenuate the observed relationship between lending and distance. Secondly, only large banks need to report. These large banks are more prone to rely on hard information than engage in proximity dependent relationship lending, making distance more of a deterrent for the small local banks which don't report.

Although the allocation of branches in Figure 2a is highly stylized, it still may be relevant. Take for example banking laws in Illinois in the early 90s: banks could have up to five branches, two could be out of county so long as they were within ten miles of the home office (Rice and Davis, 2007). Even this was a liberalization as previously the only branching allowed was a drive up facility within 1500 feet of the loan office. Furthermore, banks had one mile of "home office protection" prohibiting other banks from operating within one mile of their home bank without their permission. This restriction to branching only locally and protection from outside entry could easily produce the type of market structure shown in Figure 2a. Although such restrictions have since been removed, opening a new branch is costly enough that the effects on market structure could persist. As a result, firms or individuals in a market deemed competitive by the conventional metric could still contend with having limited banking options within their area.

3.3 Local Concentration Measure

3.3.1 Index Definition

If distance creates obstacles for lending or imposes costs on bank customers, then market level concentration measures can be misleading. In this case, the level of concentration relevant to a firm or individual could be the concentration of banks within a certain radius of their location. This is what I measure.

In order to construct this more local measure of concentration, I use the ARCGIS10 North American Address Locater to geocode the location of each bank branch in the US from 1994 to 2012. Branch addresses and deposits come from the FDIC's Summary of Deposits (SOD), an annual survey of branch offices for all FDIC-insured institutions. It includes commercial banks, thrifts, and US branches of foreign banks.

I then calculate the deposit Herfindahl for each census tract, using the set of branches within a certain distance of the tract centroid. Denote $s_{b,d,c}$ the portion of the total deposits in branches within d kilometers of the centroid of census tract c which are held by institution $b \in B$.[7] Then the tract level herfindahl for the distance parameter would be:

$$HHI\_tract_c^d = \sum_{b \in B} s_{bdc}^2 \tag{3.1}$$

[7] For example, suppose there are three branches within 2km of tract c: 2 for bank of America and 1 for Wells Fargo. If the branches have equal deposits, then $s_{BA,2,c} = \frac{2}{3}$ and $s_{WF,2,c} = \frac{1}{3}$, and thus the Tract Herfindahl would be $\frac{5}{9}$.

My measure of concentration for market m is then the average tract Herfindahl of census tracts in the market. Denoting C_m the set of census tracts in market m, my measure of concentration is:

$$HHI\_loc_m^d = \frac{1}{|C_m|} \sum_{c \in C_m} \sum_{b \in B} s_{bdc}^2 \tag{3.2}$$

Consider again the market structure hypothesized in Figure 2 and assume each bank holds equal deposits. While the conventional Herfindahl would treat the two markets as equally concentrated at $\frac{1}{4}$, the Local Herfinadahl would take into account the segmentation within the markets and thus differ. Where every bank had an equal share in each market in panel (b), the local Herfindahl would remain $\frac{1}{4}$, however, where every bank had a local monopoly, the local Herfindahl would be 1.

3.3.2 How Do Local and MSA Concentration Differ?

If local concentration is indeed a better indicator for competition, how well does the conventional measure capture this? Figure 3 provides scatter plots for the MSA Herfindahl and the Local Herfindahl for various distance parameters. The left panel is for the year 1994 and the right 2012. Of the most interest are the leftmost columns which have the MSA Herfindahl on the x axis and the Local Herfindahl at a particular distance on the y axis. Although the MSA and the local concentration measures are strongly positively correlated, the relationship is far from perfect, especially for finer distance measures. The bottom panel shows how the correlation of the Local Herfindahl with the MSA Herfindahl varies by the distance parameter. For the year 2012, the correlation is around .2 at a distance of 2 kms, and rises to around .8 at 16 kms. The key take away is that if banks compete over only a small area, the MSA Herfindahl may be a poor proxy for the competitiveness of the local banking sector.

Another question is how concentration changed following the allowance for interstate branching. The ability of large banks to expand and take over small banks could result in increases in concentration. However, the removal of entry restrictions could also allow these banks enter areas which previously had limited banking options. Figure 4 plots average values (weighted by the 2010 population) for the MSA Herfindahl and the Local Herfindahl at various parameters for the years 1994 to 2012. Although conventionally measured MSA concentration rises drastically from .105 to .146, concentration when measured at a more local level is actually declining over time. This suggests that although larger banks may be expanding their market share and taking over small local banks, they are increasingly competing over a wider area within each market and thus possibly making each locality more competitive.

To understand what it means for more aggregate concentration to be rising, and local concentration falling, note that the Local Herfindahl can be decomposed into a term relating to the MSA concentration and a term relating to the variance of banks' market shares across the sub-markets:

$$HHI\_loc^d_m = \sum_{b \in B} var(s_b) + \sum_{b \in B} \bar{s}_b^2 \qquad (3.3)$$

Where $var(s_b) = \frac{1}{|C_m|} \sum_{c \in C_m} \left((s_{bc} - \bar{s}_b)^2 \right)$, and $\bar{s}_b = \frac{1}{|C_m|} \sum_{c \in C_m} s_{bc}$. The second term is nearly identical to the MSA Herfindahl. Thus to have MSA concentration rising, but local concentration falling, means that the variance of market shares is falling faster than aggregate concentration has been rising. Namely, banks are competing more widely within markets, causing deposits in a particular bank to be spread more evenly throughout MSAs instead of concentrated in one area.

3.4 Local Market Structure and Bank Performance

3.4.1 Data & Methodology

Local and MSA concentration are thus different, but which better reflects the competitiveness of the banking market? In this section, I demonstrate that the Local Herfindahl and Tract Herfindahl better relate to variables pertaining to bank pricing or profitability. Namely, the location pattern of the banks within the market impacts the competitiveness, not just aggregate market shares.

I use balance sheet data for US banks from the Consolidated Report of Condition and Income (Call Report) to assess how concentration in a bank's markets impacts their decisions and performance. The variables computed from the Call Reports frequently have a few extreme outliers, most likely due to reporting errors or small denominators, so I drop the lowest and highest 1% of the observations for each variable every year. I also drop any institutions which merged with or acquired another institution in a given year.

I don't have branch level data, so I can't assess, for example, how Bank of America behaves in concentrated versus unconcentrated markets. Instead, I use the geocoded branch locations to calculate the deposit weighted average concentration in the markets (MSA or Rural County) or tracts that the bank locates in.[8] If a bank i has a set of branches $j \in J_i$, with $D_{j,i,c,m,t}$ denoting the deposits in branch j, tract c, market m and year t, then the relevant measures of concentration will be:

[8] Over half of the institutions hold deposits in only one market, and about 95% have a single market accounting for over 50% of their deposits. Results are robust to using concentration in the largest market as the institution level measure of exposure to concentration

$$HHI\_mkt_{i,t} = \frac{1}{D_{i,t}} \sum_{j \in J_i} D_{j,i,c,m,t} HHI\_mkt_{m,t}$$

$$HHI\_loc^d_{i,t} = \frac{1}{D_{i,t}} \sum_{j \in J_i} D_{j,i,c,m,t} HHI\_loc^d_{m,t}$$

$$HHI\_tract^d_{i,t} = \frac{1}{D_{i,t}} \sum_{j \in J_i} D_{j,i,c,m,t} HHI\_tract^d_{c,t}$$

Where $D_{i,t}$ is aggregate deposits for bank i in year t. Thus I have three bank specific measures of concentration: market concentration reflecting the availability of competitors within the MSA or county, local concentration reflecting the availability of competitors in the MSA or county as well as the degree to which those banks geographically segment the market, and tract concentration, reflecting the availability of competitors in the areas directly surrounding a bank's branches. I then run regressions to assess which concentration measure impacts bank decision variables:

$$y_{i,t} = \alpha + \beta' \mathbf{HHI}_{i,t-1} + \gamma' \mathbf{X}_{i,t} + \delta_t + \eta_i + \epsilon_{i,t} \tag{3.4}$$

Where $y_{i,t}$ is the institution level outcome variable from the Call Reports data relating to either bank pricing or profitability. δ_t and η_i are year and institution fixed effects respectively. $\mathbf{HHI}_{i,t-1}$ is a vector of variables relating to the institution's exposure to concentration, and $X_{i,t}$ is a set of controls.[9] Standard errors are clustered by bank.

If the relevant market is the more aggregate one, as assumed by most the previous literature, then one would expect the conventional market Herfindahl to be significant, and the others insignificant after controlling for the conventional measure. In this situation, tract concentration would be subject to measurement error due to the fact that it excludes far off banks which are in fact relevant. Local concentration would be subject to measurement error as the component of the measure relating to the spread of the institutions within the market would just be adding noise to the proper measure.

However, if the relevant market is highly local, we get different predictions. In this case, it is more important to have competing banks in the near area than in the MSA. The conventional Herfindahl would be flawed as it identifies an area as competitive if there is low concentration at a highly aggregate level, even if individual banks are able to dominate smaller segments of the market. The Local Herfindahl would account for this segmentation and should thus better predict bank markups. The Tract Herfindahl directly measures the concentration in the area around the bank's branches,

[9] $\mathbf{X}_{i,t}$ includes log total deposits, log number of branches, share of market deposits in banks headquartered in another state, and the bank's market share in its largest market. None of the estimates are very sensitive to the control set, so it is emphasized little throughout the rest of the paper.

and should thus also predict markups better than the conventional Herfindahl. Generally, the data support the claim that local concentration is what matters.

3.4.2 Effects of 6km Local Concentration

Lending Rates Table 1 shows the relationship between concentration and lending rates. In Columns 1-3, the dependent variable is the average rate charged for lending: $100 \times \frac{loan\ income}{loans}$.[10] If higher concentration results in greater market power, then this should allow banks to charge borrowers higher interest rates.

Column 1, suggests that this is indeed the case. The coefficient implies that a one standard deviation increase in market concentration raises the lending rate by about 3 basis points, which is economically small but statistically significant at the 1% level. When local concentration is included in a horse race regression in Column 2, the coefficient on the conventional Herfindahl falls by almost 75% and becomes insignificant while local concentration is significant at the 1% level. Even controlling for the conventional Herfindahl, a one standard deviation increase in the local Herfindahl raises the lending rate by about 9 basis points. Column 3 additionally includes the concentration in the 6km neighborhood surrounding the bank branches, which is significant at the 1% level with a one standard deviation increase raising the average lending rate by 6 basis points, after controlling for the market level concentration measures. The local concentration measure remains significant at the 5% level and larger in magnitude than the conventional Herfindahl.

This measure of lending rates can be problematic as not all lending is likely to be sensitive to local market structure. For example, mortgage lending is less sensitive to the common information problems from lending at a distance due to the fact that the loans are collateralized and easily sold on the secondary market.

Next I look at the rate charged on commercial and industrial loans. If a bank is close to a firm, it may reduce the costs of monitoring and thus help the bank overcome some of the agency problems associated with debt finance. Proximity may be particularly important for small businesses for whom hard information such as a history of financial statements is unavailable. If soft information is proximity dependent, then it may be that only banks close to a business are willing to lend. This would make the distinction between market concentration and local concentration particularly important for commercial lending.

In Columns 4-6, the dependent variable is the average interest rate charged on commercial and

[10] Income and expenditure measures like loan income and deposit interest are totals for the calendar year, while stock variables like loans and deposits are the average of the first and fourth quarter reported value.

industrial loans (business loans not secured by real estate). In Column 4, we see that the magnitude of the effect of conventionally measured concentration is higher by about a third compared to when average loan rate was the dependent variable, although it is insignificant.[11] Adding local concentration in Column 5 causes the coefficient to become virtually zero. A one standard deviation increase in local concentration, controlling for market concentration, is found to raise commercial and industrial lending rates by 20 basis points, although it is only significant at the 10% level. The most dramatic effect is seen for the concentration in the 6kms surrounding a bank's branches. A one standard deviation increase in the tract concentration, holding market and local concentration constant, raises the lending rates by 17 basis points. The coefficient on local concentration falls by almost 60% and becomes insignificant while, conventionally measured concentration remains near 0.

Deposit Rates How are depositors are impacted? Table 2 shows that the increased returns on loans in concentrated markets are not passed on to depositors. In Columns 1-3, the independent variable is the interest rate on deposits: $100 \times \frac{interest\ on\ deposits}{deposits}$, in Columns 4-6 it is the service charge rate on deposits: $100 \times \frac{service\ charges\ on\ deposits}{deposits}$.

In Column 1, we see that higher conventional concentration is associated with lower rates offered on deposits. A one standard deviation increase lowers the average deposit rate by 2.5 basis points, and is significant at the 1% level. Controlling for local concentration causes the coefficient to fall by almost half, while local concentration is significant at the 1% level. A one standard deviation increase in local concentration lowers the deposit rate by 4.5 basis points. Tract concentration in Column 6 is insignificant.

The distinction between local and MSA concentration is less significant for deposit rates than for other variables. This could be attributed to deposit insurance ensuring that deposit accounts are roughly homogeneous, thus removing any room for local information to be relevant. Alternatively, since ATMs are not counted as bank branches, the geographic spread of branches may not reflect access to bank services as well as for loans, where the interactions are with loan officers located in a bank branch.

Columns 4-6 show that local concentration not only results in lower interest payments to depositors, but also results in depositors needing to pay more in service charges. Conventionally measured concentration in Column 4 is unrelated to the service charge rate, however local concentration is found to increase the service charge rate and is significant at the 1% level. When the 6km concentra-

[11] Until 2001, only larger banks had to report how much income was derived from commercial and industrial loans. The lack of significance is likely attributable to the greater weight place on crisis years, and on larger banks who are less sensitive to local market structure

tion is added, it is also significant at the 1% level in the same direction, while the local concentration measure remains significant at the 1% level.

Profits Finally, Table 3 demonstrates that the increased interest margins translates into higher profits. In the first three columns, profits are measured by the return on equity: $100 \times \frac{Net\ Income}{Equity}$, in the second three it is measured as the Net Profit Margin: $100 \times \frac{Net\ Income}{Income}$. Qualitatively the results are similar for either measure of profitability. Banks in more concentrated markets earn higher profits, with market concentration being significant at the 5 or 10% level. Including local concentration makes market concentration insignificant, while the predicted impact of a 1 standard deviation increase in concentration is about 4 times as large as with the conventional concentration measure. Tract concentration is insignificant.

Overall, these results provide support for the idea that the local market structure impacts bank performance. In concentrated markets, banks charge higher interest rates, offer lower deposit rates, have higher service charges, and earn higher profits. These effects are uniformly larger in magnitude and significance when local concentration is used instead of market concentration. Market concentration only remains significant in the horse race regression for deposit rates, even then the predicted impact is greatly diminished. This is all consistent with local concentration being the superior measure of market power, and raises the possibility that previous failures to support the structure-conduct performance paradigm were due to attenuation bias stemming from the mismeasurement of market power.

3.4.3 Effects by Distance Parameter

For which distance parameter does concentration best relates to bank markups? The results thus far with the 6km distance parameter suggest that market structure at a finer level than the MSA determines the competitive pressures faced by banks, but they do not answer the question of how fine a measure is needed. Here I assess the proper geographic extent of bank markets by testing which distance best relates to bank markups.

This exercise is particularly important in light of the findings in Figure 4, which shows that while concentration at the MSA level has been rising over time, concentration at a finer level has been falling. On average, there are more banks available within 4km than in the past, but fewer banks available within 10km. This makes the presumed competitive effects of the recent consolidation depend critically on the proper market definition. If concentration for higher parameter values is found to matter, then the recent consolidation is likely to have harmed competition. If instead lower parameters are found to be more predictive, then the decline in highly local concentration would suggest that the diminished tendency of banks to segment the market would more than make up for the increase in concentration at more aggregated levels.

Figure 5 shows how the findings for the relationship between concentration and lending rates vary by distance parameter. Each point represents the result of a horse race regression following the specification in equation 3. The left panel includes the conventional Herfindahl and the Local Herfindahl for a particular distance parameter. The distance parameter is given on the X-axis, with a value of 0 being the regression with just the conventional Herfindahl. The solid black line gives the coefficient for the Local Herfindal, and the dashed line the 95% confidence interval. The light gray line is the coefficient on the conventional Herfindahl. To facilitate comparison, all the concentration measures are standardized, so the value on the y-axis can be interpreted as the percentage point increase in lending rates from increasing concentration by one standard deviation.

The coefficient on local concentration is maximized when the distance parameter is 4 kms. Here a one standard deviation increase in local concentration is found to raise the lending rate by about 10 basis points, compared to about 1 basis point for the conventional Herfindahl. The coefficient for local concentration declines monotonically as the distance parameter increases after 4.

The right panel presents the same analysis as the left, except it uses the concentration around the institution's actual branches instead of average local concentration in the markets where the institution has branches. For every distance, tract concentration is significant at at least the 5% level and larger than the coefficient on the conventional Herfindahl. The maximum occurs at a distance of 8km, with a coefficient just under .075.

Figure 6 does the same for the commercial and industrial loan rate. The pattern with the local Herfindahl in the left panel is comparable to before. The coefficient is maximized at 4kms, mostly declines thereafter, and the effect of local concentration is found to be higher than for conventional concentration so long as the distance parameter is less than 12km. The magnitude of the effect is much higher than before, with the coefficient taking a maximum value around .25 as opposed to .1, but it is much less precisely estimated, with the effect only being statistically significant from 0 at the 5% level for the distance parameter of 4kms.

The right panel has a clearer message. The coefficient for tract concentration is maximized at 8km, and declines linearly for smaller or larger coefficients. A one standard deviation increase in concentration in the 8km around a bank's branches raises the rate charged on commercial and industrial loans by over 25 basis points, with the coefficient on conventionally measured concentration essentially being 0. Increasing or decreasing the distance parameter by 4km, cuts the predicted impact by almost half. Namely it is the banks within 5 miles that account for the competitiveness of a bank's commercial lending rates, and when this concentration is controlled for, conventional concentration has no explanatory power.

3.5 Local Concentration and Young Firm Finance

3.5.1 Background

One direction where an improved measure of banking concentration could yield substantial gains is in the study of how bank market structure impacts the allocation of credit. Whether bank market power is beneficial or harmful to the ability of young firms to obtain finance is theoretically ambiguous while empirical work has been inconclusive.

The findings of the last section support the claim that local concentration provides banks with market power, however the aggregate implications of this market power regarding the allocation of credit are not straight forward. One school of thought is that concentration is beneficial for young firms. Petersen and Rajan (1995) argue that banks may lend to young firms at subsidized rates because they can extract rents in the future. In competitive markets without the same potential for future capture, banks may be unwilling to lend to young, informationally difficult, firms profitably. Using data from the Survey of Small Business Finance, they demonstrate that in concentrated markets (measured as the deposit Herfindahl for the MSA or rural county), younger firms are charged lower interest rates and receive more credit. Similarly, Cetorelli and Gambera (2001) find that bank concentration promotes the growth of financially dependent sectors by improving credit access to young firms, despite exerting a negative effect on growth overall.[12] Seeing as young firms are a significant driver of job creation (Haltiwanger et al., 2013), this raises the question of whether the greater market power is actually a problem.

However, there are good reasons to think that young firms would be especially harmed by concentration. Young firms may struggle to obtain non-bank external finance due to their opaqueness or their size making the fixed costs of securities issuances problematic. Furthermore, young firms may struggle to self finance due to not having had sufficient time to accumulate earnings. This is further amplified if young firms face start up costs resulting in low initial profitability. Consistent with this, Cetorelli and Strahan (2006) shows that MSA concentration has a negative effect on business entry while Beck et al. (2004) and Chong et al. (2013) find that concentration is associated with greater

[12] See Fischer (2000) and Zarutskie (2003) for more evidence in support of the information hypothesis

financial constraints for small businesses.

3.5.2 Methodology

On top of the difficulties measuring banking concentration, determining the extent to which firms are financially constrained is problematic. First, one can not simply run growth regressions with concentration as an explanatory variable as high growth for young firms could either be attributed to a lack of financial constraints fueling capital accumulation, or to the existence of financing constraints forcing firms to enter at an inefficiently small scale then grow fast with the use of retained earnings.[13] Second, comparing the age or size distribution of firms in concentrated and unconcentrated markets is problematic as the entry of new firms could allow more banks to profitably operate, creating concerns over the direction of causality. Finally, firm level measures of constraints tend to only be available for publicly listed firms who are less financially constrained and less bank dependent.

In this section I test how well firms in an MSA are able to expand following a demand shock. With perfect capital markets, firms should face an elastic capital supply curve and thus be able to increase their scale substantially when it is profitable to do so. However, if firms are financially constrained, investing more than can be financed with their own cash flows may be prohibitively costly. If labor and capital are complements, this diminished sensitivity of capital to demand due to financial frictions will result in a similarly diminished sensitivity of employment to demand. If firms use finance to hire labor, the effects can be even more dramatic, with financial frictions directly inhibiting employment expansion instead of operating indirectly through capital. Either way, financially constrained firms will increase labor less in response to a positive.

Specifically, I instead investigate how the elasticity of local employment growth with respect to the national growth in the local industries varies by bank market structure.[14] An increase in national employment in a given industry is likely to reflect some sort of national shock to productivity, demand or expectations, increasing the return to investment in areas with employment in the industry, but unrelated local financial markets. In the appendix, I show that this elasticity is a decreasing function of the elasticity of the marginal cost of capital with respect to capital of the firms in the city.

Figure 7 provides the graphical intuition for the relationship between financial frictions and the response to demand shocks. Consider, a firm with a downward sloping capital demand curve for capital. For a given shift in demand, the output response will depend on the shape of the loan offer

[13] Kerr and Nanda (2010) show that following an increase in competition due to branch deregulation, firms entered closer to their maximum size.

[14] This exercise is similar in spirit to Wurgler (2000), which demonstrates that countries with a larger financial sector allocate more investment to growing industries and less to declining industries.

function. If there is premium for external finance as in Gerali et al. (2010) or Cúrdia and Woodford (2010), then firms for whom the marginal product of capital is within the interest rate wedge would not adjust their capital stock. Since high local concentration is found to be associated with higher rates on commercial loans, this means that there is a wider range of productivities such that firms would be unwilling to borrow in response to a demand shock. These firms will have capital growth determined by cash flows and thus be less synchronized with national employment growth. If firms have leverage constraints as in Buera and Shin (2013) or Moll (2014), then productive firms will be unable to borrow to fund expansion up to the point where the marginal product of capital is equal to the interest rate. Again constrained firms will have growth depend on asset growth instead of productivity growth. Finally, if higher leverage increases expected bankruptcy costs as in costly state verification model (Townsend, 1979), this would result in an upward sloping marginal cost of capital curve.

3.5.3 Data and Specification

My strategy is to test for financing constraints by examining how responsive firm growth is to a shock to the return to investment. I follow Bartik (1991) and use national industry level growth as a shifter of demand which is exogenous to local conditions. By using exogenous demand shocks, this methodology overcomes the reverse causality concerns mentioned before. Secondly, by using aggregated data, I'm able to include small and young firms, who would be more sensitive to bank competition but, by virtue of not being publicly listed, have little available data.

The measure of the demand shock is:

$$shock_{m,t} = \sum_{i=1}^{I} \theta_{i,m,t-1} emp\ growth_{i,t}$$

where $\theta_{i,c,t-1}$ is the share of private march employment in MSA m in industry i in previous year, and $emp\ growth_{i,t}$ is HP-filtered national employment growth in the industry for the year.

The primary specification used is:

$$growth_{m,t} = \alpha + \beta_1 shock_{m,t} + \beta_2 shock_{m,t} \times HHI_{m,t} + \beta_3 HHI_{m,t} + \delta_t + \eta_m + \epsilon_{m,t}$$

where $growth_{m,t}$ is MSA level wage or employment growth. $HHI_{m,t}$ is a measure of concentration, either the conventionally measured MSA concentration, or the 6km local concentration. The concentration measure is normalized, so the coefficient on $shock_{m,t}$ is the elasticity of local growth with respect to national growth in an MSA with an average concentration, while the coefficient on $shock_{m,t} \times HHI_{m,t}$ is how much the elasticity falls when concentration rises by one standard deviation. If concentration is associated with higher financial frictions, this would imply $\beta_2 < 0$, so that higher concentration results in a smaller elasticity of MSA growth with respect to national growth.

Industry level data comes from the Quarterly Census of Employment and Wages (QCEW) for the years 1990 to 2006 at the three digit 2002 NAICS level. This is used to calculate the national growth at the industry level, and the employment share at the industry×MSA level to create the *shock* variable. It is also used to calculate wage and employment growth at the MSA level. The QCEW doesn't include data disaggregated by firm age. I use the Business Dynamic statistics (BDS) to calculate the annual employment growth rate of young firms and mature firms at the MSA level, where I define young firms as firms which are 0-5 years old and mature firms as firms which are 6 years or older. A more detailed description of the data is in the appendix.

3.5.4 Findings

Table 4 presents the results without the age breakdown. The first three columns use the 6km local Herfindahl as the measure of concentration, and the last three use the conventional MSA level concentration. National growth in the local industry is unsurprisingly strongly with MSA employment growth. A one percentage point shock results in employment growth of .87 and .96 percentage points for MSAs with an average local and MSA concentration respectively. Of greater interest is how this elasticity varies across cities. Looking at the coefficient on the interaction term, we see that cities with a 1 standard deviation higher local Herfinadahl have an elasticity of growth with respect to the Bartik instrument which .16 percentage points lower. Having a 1 standard deviation higher conventional concentration lowers the elasticity by .1 percentage points.

The findings when the QCEW employment growth measure is used is comparable to with the BDS, with the difference between the effect of local concentration vs MSA concentration being slightly starker. Unlike the BDS, the QCEW includes wage data, allowing me to check if the findings are attributable to differences in the elasticity of labor supply. Higher local concentration results in wages which are less responsive to demand shocks, suggesting that heterogeneity in the response to demand shocks is attributable to differences in the size of the labor demand shift instead of differences in the elasticity of labor supply. However, the coefficient is insignificant for local concentration and even slightly positive for MSA concentration.

The goal of the section is to show how concentration relates to financial frictions by age group. Table 5 conducts the analysis for the BDS data broken down by firm age. The first two columns demonstrate that local concentration is particularly harmful for firms which are five years old or younger. A one standard deviation increase in local concentration lowers the elasticity of employment growth with respect to the Bartik instrument by .34 percentage points for young firms but only .12 for mature firms. These effects are .1 and .08 respectively when conventional concentration is used, with the effect of concentration on young firms becoming insignificant.

In short, local concentration is found to inhibit growth following a demand shock, particularly for young firms. This is consistent with the hypothesis that young firms are more reliant on bank finance, and are thus disproportionately harmed by a low degree of competition. The fact that concentration is found to inhibit growth for young firms only when the local measure is used, suggests that previous studies relating concentration to young firm finance may have not been measuring concentration as is relevant to young firms. Finally, having local concentration matter more for young firms raises confidence that the channel of influence is actually through bank relationship lending. Young firms are more bank dependent and informationally opaque, making proximity and the access to soft information it provides more important. Thus it makes perfect sense that the location patterns of the banks in an MSA are more important for young than mature firms.

3.6 Conclusion

There has been a debate in the banking literature as to whether the proper extent of a bank market is the state or something more local, namely the county or MSA. I present evidence that the proper market is actually even more local than previously suggested. My proposed measure of concentration, which uses the average concentration of small sub-markets within the conventionally defined banking markets, consistently outperforms the conventional MSA/county level Herfindahl in horse race regressions. This suggests that it isn't enough to have many banks competing in the same market, instead competitiveness requires banks to locate near competitors as opposed to clustering and dominating areas within the market. The conventional Herfindahl measure doesn't account for the location of branches within markets and thus fails to effectively measure concentration.

These findings are relevant to merger policy, which frequently use the market Herfindahl to assess the likely competitive effects of a horizontal merger. In light of the results of this paper, it isn't sufficient to look at the change in market shares within the market, but instead one must look at the locations of the acquiring and acquired branches. If the two banks tend to locate in different sub-markets, the merger is unlikely to be damaging. However, if the bank branches tend to be close to one another, the merger is more likely to result in a decline in the competitiveness of the bank market.

These findings are also relevant to the academic literature, which frequently uses a market Herfindahl to measure competition. Studies which use it as a control variable may not be sufficiently controlling for bank market power. Studies which have concentration as the variable of interest may be understating its effects due to this measurement error. For example, while the market level Herfindahl isn't significantly related to the responsiveness of young firms to a demand shock, the local concentration is strongly related. Consequently, this improvement in the measurement of concentration is important for understanding the effects of bank market structure on the allocation of credit and growth.

Finally, these findings are important in the construction of an accurate narrative of the consolidation of the banking sector over the last 20 years. The nearly 40% rise in the MSA Herfindahl after the onset of interstate branching could be a cause for concern given the existing findings that this concentration is associated with higher interest margins and barriers to firm entry. However, upon closer analysis, we see that local concentration is what is associated with a lack of competitiveness on the part of banks. That concentration at this level is falling should assuage some of the fears regarding the competitive effects of the consolidation of the banking industry.

3.7 Appendix

3.7.1 Figures

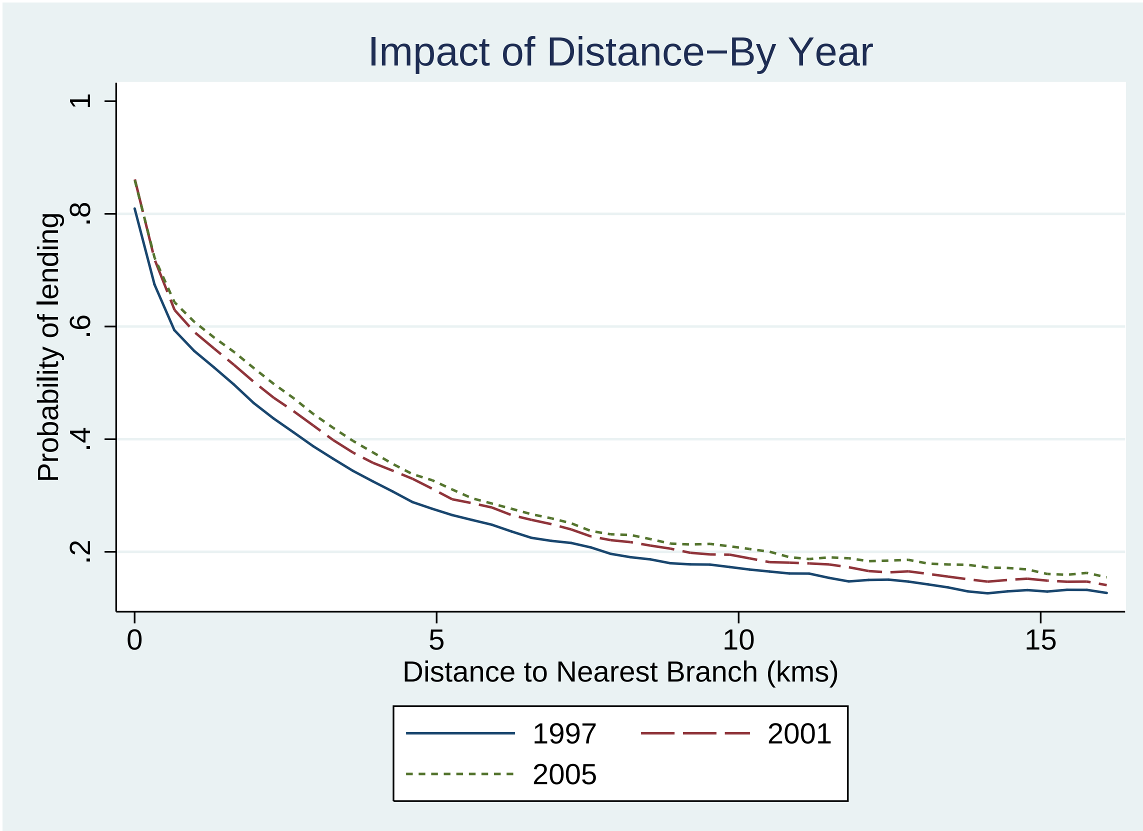
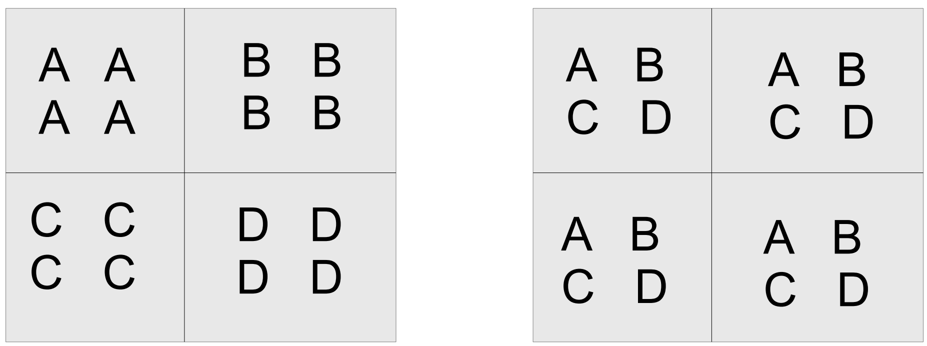


Figure 3.1: Declining Probability of Lending Over Distance

Notes: This shows how the probability of a CRA reporting institution making a small business loan in a particular census tract varies with distance between the tract centroid and the nearest branch of an institution. Probabilities are determined by local linear regression on the 0-1 loan indicator using an Epanechnikov kernel with a bandwidth of .2 kilometers. This is done separately for the years 1997, 2001 and 2005.



(a) Locally Concentrated (b) Locally Competitive

Figure 3.2: Hypothetical Bank Markets

Notes: This figure presents two hypothetical bank markets. Each letter corresponds to a branch location of a particular institution. The left figure presents a locally concentrated market, as the branches of each institution cluster in one part of the market, giving it a local monopoly. The right figure presents a locally competitive market, with the branches spread evenly throughout and competing with the other institutions in every locality.

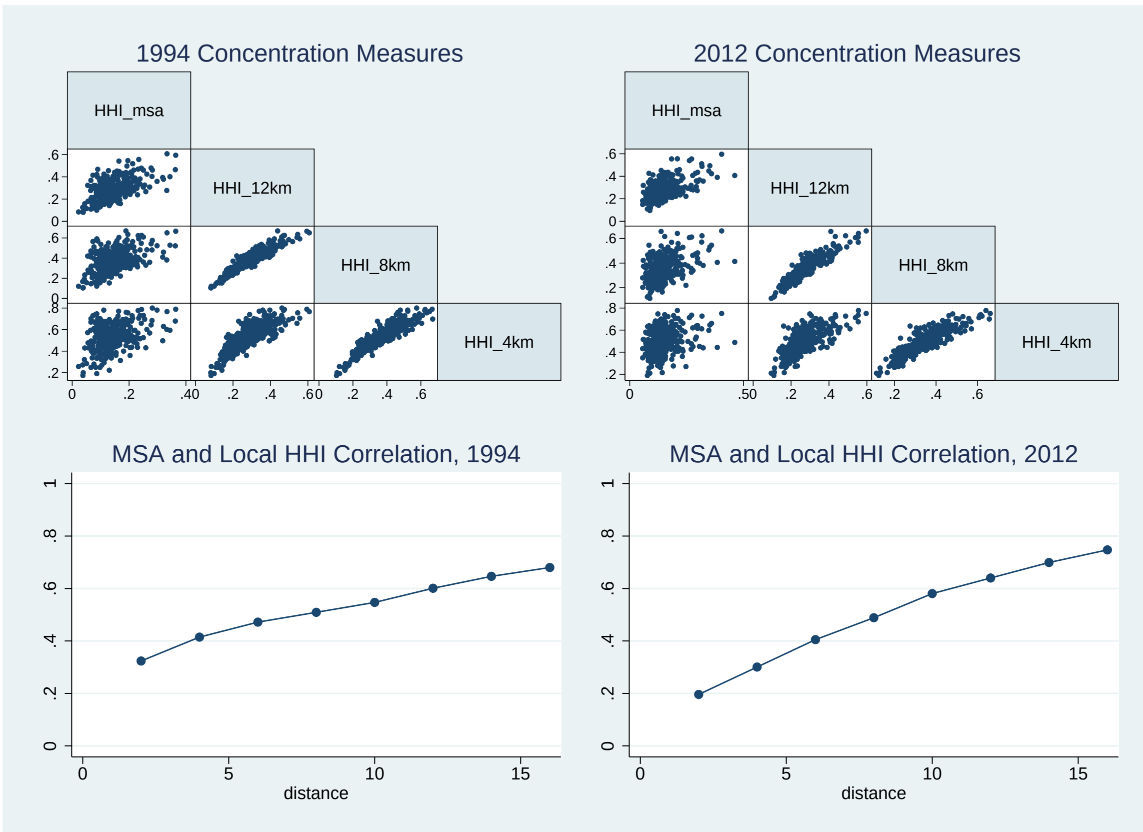


Figure 3.3: How Similar Are MSA and Local Concentration?

Notes: The top panels present scatter plots for the year 1994 (left) and 2012 (right). The left most column of each scatter plot has the conventional Herfindahl on the x axis, and the 4, 8, or 12 km local concentration on the y. The other scatters are of the local concentration measure for different distances. A small number of MSAs with an MSA concentration above .5 are dropped to help with the display of the points in the more common range of values.

The bottom graphs display the correlation of the local concentration measure with the conventional MSA concentration measure for different distances. Again 1994 is on the left and 2012 on the right.

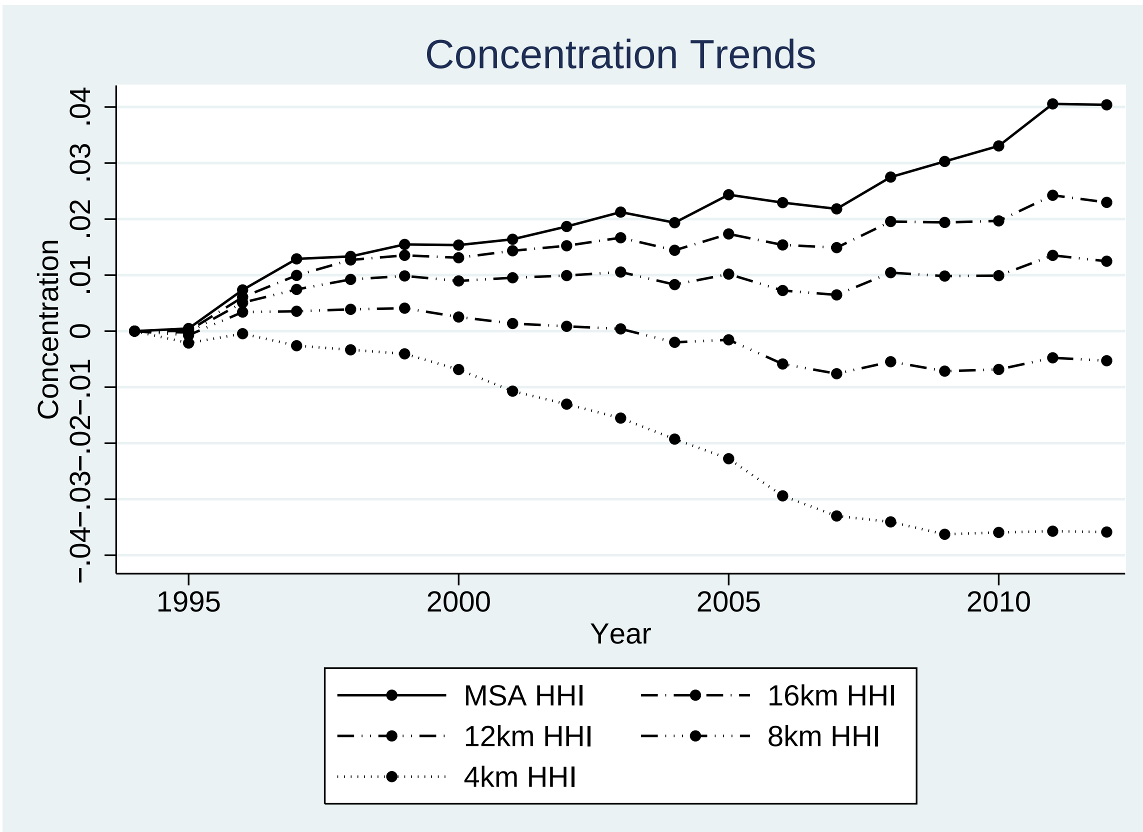


Figure 3.4: Different Trends in Concentration

Notes: This figures display the trend in concentration as measured by the 4, 8, 12, and 16km local concentration and the conventional MSA Herfindahl from 1994 to 2012. Each point gives the 2010 population weighted average concentration of the all MSAs in the US for a given year. All values are relative to their respective 1994 concentration level.

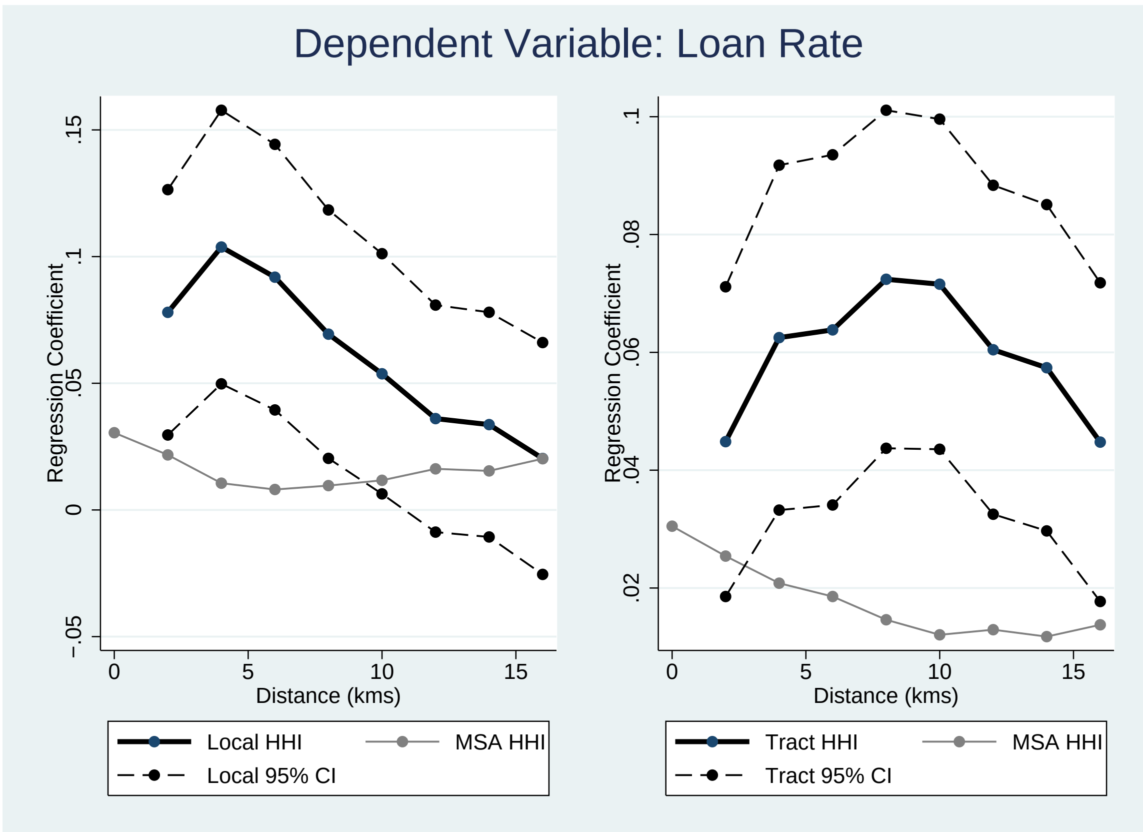


Figure 3.5: Impact of Concentration on Loan Rates

Notes: Each point reports coefficients from regressions of the form :$Loan\ rate = \alpha + \beta Concentration_{i,t} + \gamma X_{i,t} + \delta_t + \eta_i + \epsilon_{i,t}$. In the left panel $Concentration_{i,t}$ includes conventional concentration and local concentration, in the right it includes conventional concentration and tract concentration. The distance parameter is given on the x-axis, with a value of 0 being the specification where only conventional concentration is included. Concentration measures are standardized to having a standard deviation of 1. Standard errors are clustered by bank.

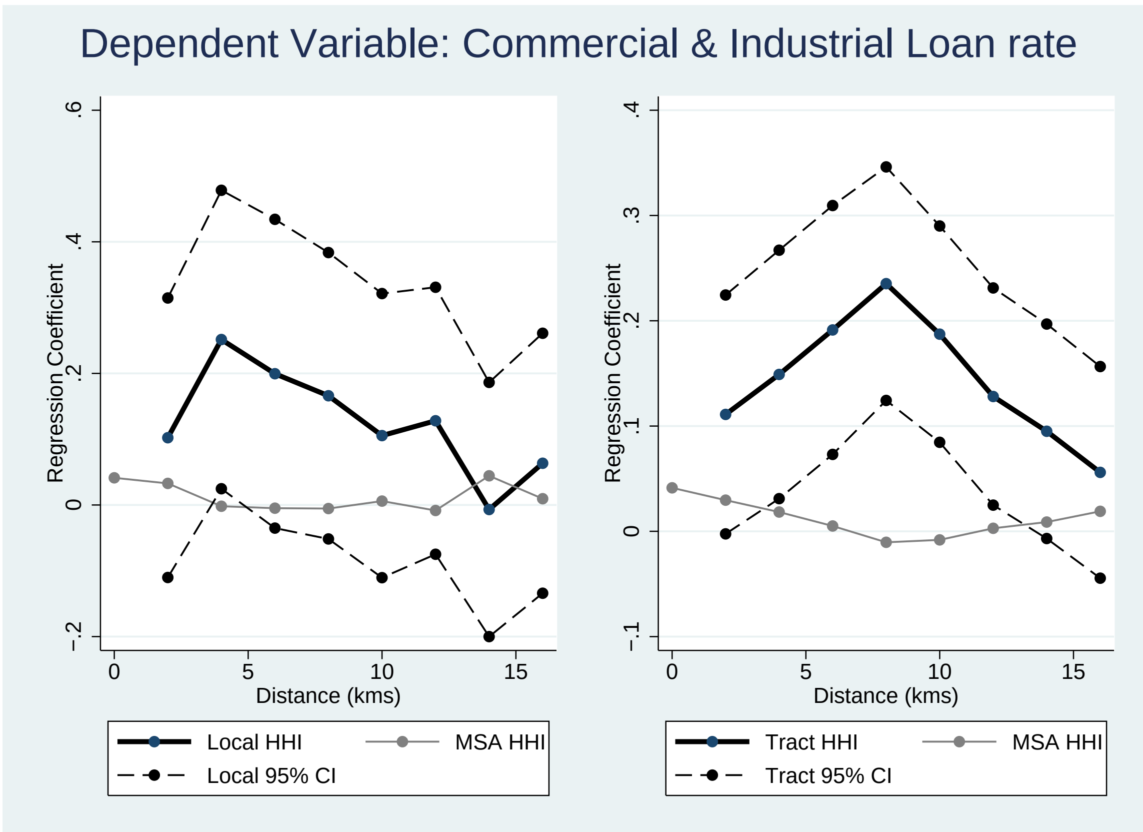
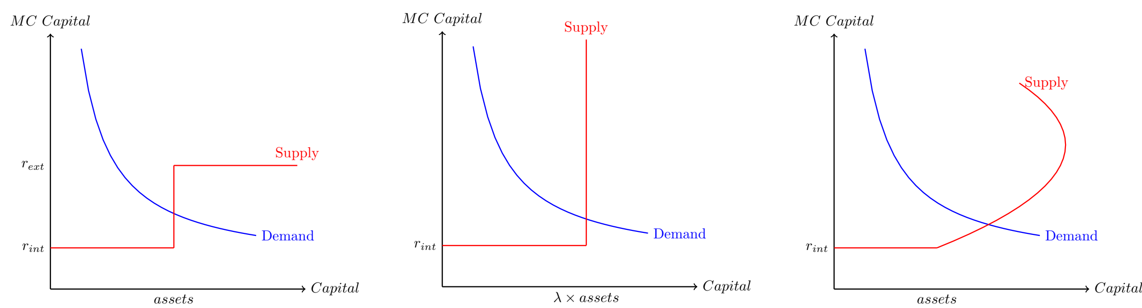


Figure 3.6: Impact of Concentration on Commercial Loan Rates

Notes: Each point reports coefficients from regressions of the form :$CI\ Loan\ rate = \alpha + \beta Concentration_{i,t} + \gamma X_{i,t} + \delta_t + \eta_i + \epsilon_{i,t}$. In the left panel $Concentration_{i,t}$ includes conventional concentration and local concentration, in the right it includes conventional concentration and tract concentration. The distance parameter is given on the x-axis, with a value of 0 being the specification where only conventional concentration is included. Concentration measures are standardized to having a standard deviation of 1. Standard errors are clustered by bank.

Figure 3.7: Financial Constraints and Response to Demand Shocks



(a) External Mark-up (b) Leverage Constraint (c) Costly Verification

Notes: Each figure shows an example of how financial constraints would make a firm's growth less responsive to a demand shock. If there is a premium to external finance as in (a), there is a wedge between the cost of internal funds and external funds creating a range of productivities such that a firm will not increase capital when it becomes more productive. In (b), there is a leverage constraint, so that firms above a certain level of productivity will grow only when assets grow, not when demand grows. In (c), there is an upward sloping loan offer curve reflecting a greater probability of default at higher leverage. As the curve gets steeper, expansion becomes more costly and firms will respond less to changes in demand.

3.7.2 Tables

Table 3.1: Impact of Concentration on Loan Rates

	Loan Rates			CI-Loan Rates		
	(1)	(2)	(3)	(4)	(5)	(6)
HHI_mkt	0.249***	0.0660	0.0528	0.337	-0.0395	-0.0989
	(2.80)	(0.69)	(0.55)	(0.95)	(-0.09)	(-0.23)
HHI_loc		0.396***	0.250**		0.861*	0.380
		(3.44)	(2.12)		(1.67)	(0.70)
HHI_tract			0.169***			0.556***
			(3.40)			(2.77)
Observations	136705	136705	136705	76663	76663	76663
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table reports coefficients from regressions of the form :$y_{i,t} = \alpha + \beta Concentration_{i,t} + \gamma X_{i,t} + \delta_t + \eta_i + \epsilon_{i,t}$. The dependent variable is the average loan rate in Columns 1-3 and the average loan rate for commercial and industrial loans in Columns 4-6. In Columns 1 &4, concentration is the average market Herfindahl for the markets in which the institution holds deposits, weighted by deposits. Columns 2 & 4, add the average 6km local concentration for the bank. Columns 3 & 6 additionally includes the average deposit concentration of the banks operating within 6km of tracts where the bank's branches are located, again weighted by deposits. All specifications cover the years 1994 to 2010 and include year and institution fixed effects and bank controls. Standard errors are clustered by institution.

Table 3.2: Impact of Concentration on Deposit Rates

	Deposit Rates			Service Charge Rates		
	(1)	(2)	(3)	(4)	(5)	(6)
HHI_mkt	-0.212***	-0.120**	-0.117**	0.00315	-0.0794***	-0.0828***
	(-4.05)	(-2.03)	(-1.97)	(0.12)	(-2.77)	(-2.89)
HHI_loc		-0.200***	-0.166**		0.178***	0.143***
		(-2.79)	(-2.23)		(4.64)	(3.67)
HHI_tract			-0.0384			0.0408***
			(-1.20)			(2.73)
Observations	137196	137196	137196	135829	135829	135829
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table reports coefficients from regressions of the form :$y_{i,t} = \alpha + \beta Concentration_{i,t} + \gamma X_{i,t} + \delta_t + \eta_i + \epsilon_{i,t}$. The dependent variable is the average rate on deposits columns 1-3 and the average service charge rate in columns 4-6. In columns 1 &4, concentration is the average market Herfindahl for the markets in which the institution holds deposits, weighted by deposits. Columns 2 & 4, add the average 6km local concentration for the bank. Columns 3 & 6 additionally includes the average deposit concentration of the banks operating within 6km of tracts where the bank's branches are located, again weighted by deposits. All specifications cover the years 1994 to 2010 and include year and institution fixed effects and bank controls. Standard errors are clustered by institution.

Table 3.3: Impact of Concentration on Bank Profits

	Return on Equity			Net Profit Margin		
	(1)	(2)	(3)	(4)	(5)	(6)
HHI_mkt	1.626*	-0.374	-0.338	3.348**	-0.924	-0.970
	(1.68)	(-0.34)	(-0.31)	(2.29)	(-0.55)	(-0.58)
HHI_loc		4.392***	4.722***		9.345***	8.904***
		(3.25)	(3.38)		(4.36)	(4.10)
HHI_tract			-0.385			0.509
			(-0.71)			(0.65)
Observations	137185	137185	137185	137218	137218	137218
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table reports coefficients from regressions of the form :$y_{i,t} = \alpha + \beta Concentration_{i,t} + \gamma X_{i,t} + \delta_t + \eta_i + \epsilon_{i,t}$. The dependent variable is the return on equity in Columns 1-3 and the profit margin in Columns 4-6. In Columns 1 &4, concentration is the average market Herfindahl for the markets in which the institution holds deposits, weighted by deposits. Columns 2 & 4, add the average 6km local concentration for the bank. Columns 3 & 6 additionally includes the average deposit concentration of the banks operating within 6km of tracts where the bank's branches are located, again weighted by deposits. All specifications cover the years 1994 to 2010 and include year and institution fixed effects and bank controls. Standard errors are clustered by institution.

Table 3.4: Concentration and Response to Demand Shocks

	Employment Growth		Wage Growth	Employment Growth		Wage Growth
	BDS	QCEW	QCEW	BDS	QCEW	QCEW
Market Definition	6km	6km	6km	MSA	MSA	MSA
	(1)	(2)	(3)	(4)	(5)	(6)
$shock_{c,t}$	0.870***	0.720***	0.270	0.958***	0.791***	0.288*
	(4.68)	(5.12)	(1.61)	(5.29)	(5.58)	(1.78)
$shock_{c,t} \times HHI_{c,t}$	-0.162***	-0.149***	-0.0630	-0.0977**	-0.0631**	0.0140
	(-3.88)	(-4.88)	(-1.45)	(-2.44)	(-2.44)	(0.42)
$HHI_{c,t}$	0.0000597	-0.00193	-0.000437	-0.000387	-0.00188***	-0.00129*
	(0.04)	(-1.35)	(-0.21)	(-0.57)	(-2.78)	(-1.66)
N	4322	4227	4229	4322	4227	4229

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table reports regressions of the form $growth_{c,t} = \alpha + \beta_1 shock_{c,t} + \beta_2 shock_{c,t} \times HHI_{c,t} + \beta_3 HHI_{c,t} + \delta_t + \eta_c + \epsilon_{i,t}$. $growth_{c,t}$ is either the growth in employment or payroll per worker for the MSA. $shock_{c,t}$ is the average growth in national industries, weighted by the share of MSA employment in the industry. $HHI_{c,t}$ is the 6km local Herfindahl in columns 1-3 and the conventional MSA Herfindahl in columns 4-6, normalized to have a mean of zero and standard deviation of 1. MSA and year fixed effects are used in each specification, and standard errors are clustered by MSA.

Table 3.5: Concentration and Response to Demand Shocks: By Age

	Young	Mature	Young	Mature
Market Definition	6km	6km	MSA	MSA
$shock_{c,t}$	1.265**	0.733***	1.422***	0.799***
	(2.45)	(4.15)	(2.70)	(4.65)
$shock_{c,t} \times HHI_{c,t}$	-0.335**	-0.118***	-0.0970	-0.0781**
	(-2.57)	(-2.96)	(-0.89)	(-2.18)
$HHI_{c,t}$	-0.00306	-0.000380	-0.00144	-0.000309
	(-0.59)	(-0.21)	(-0.72)	(-0.44)
N	4287	4322	4287	4322

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table reports regressions of the form $growth_{c,t} = \alpha + \beta_1 shock_{c,t} + \beta_2 shock_{c,t} \times HHI_{c,t} + \beta_3 HHI_{c,t} + \delta_t + \eta_c + \epsilon_{i,t}$. $growth_{c,t}$ is the growth in employment for age category in the MSA. $shock_{c,t}$ is the average growth in national industries, weighted by the share of MSA employment in the industry. $HHI_{c,t}$ is the 6km local Herfindahl in columns 1 & 2 and the conventional MSA Herfindahl in columns 3 &4, normalized to have a mean of zero and standard deviation of 1. MSA and year fixed effects are used in each specification, and standard errors are clustered by MSA.

3.7.3 Decomposition

One can think of a market as being uncompetitive for two reasons. First, it could be dominated by a few small firms, enabling tacit collusion with loan or deposit pricing. A second source of a lack of competitiveness could be that banks tend to concentrate their branches geographically and exhibit market power in small areas. Conveniently, the local Herfindahl can be simply decomposed into a component relating to the market level concentration and a component relating to within institution clustering. After some algebra[15], the local Herfindahl can be written as:

$$\sum_{b=1}^{B} var(s_b) + \sum_{b=1}^{B} \bar{s}_b^2$$

Where $var(s_b) = \frac{1}{T}\sum_{t=1}^{T}\left((s_{bt} - \bar{s}_b)^2\right)$, and $\bar{s}_b = \frac{1}{T}\sum_{t=1}^{T} s_{bt}$. The first part of this expression can be seen as a measure of the degree to which branches of an institution cluster around other branches of the institution. A high variance of local deposit shares mean that there are some areas where the banks hold a very large portion of deposits, and some where they hold very little. Even if a market is unconcentrated, if the institutions within it dominate the areas in which they operate, then each locality may be uncompetitive. Lower variance means that banks are more evenly spread across the market.

The second part of this expression, $\sum_{b=1}^{B} \bar{s}_b^2$, is similar to the conventional Herfindahl[16]. The difference is that instead of s_b being measured as the share of deposits in the market held by bank b, $\bar{s}_b$ is the average share held by bank b across the different sub-markets. These measures of market share differ for two reasons. First, increasing deposits in an area increase measured MSA market share more than it raises $\bar{s}$ if there are already a lot of deposits in that area as the denominator (total deposits) is larger in that region. Second, there may be double counting as deposits in a bank included in the intersection of multiple localities will be adding deposits to several markets.

15

$$\begin{aligned} HHI_{local} &= \frac{1}{T}\sum_{t=1}^{T}\sum_{b=1}^{B} s_{bt}^2 \\ &= \frac{1}{T}\sum_{t=1}^{T}\sum_{b=1}^{B}\left[(s_{bt} - \bar{s}_b)^2 + 2s_{bt}\bar{s}_b - \bar{s}_b^2\right] \\ &= \sum_{b=1}^{B}\left[\frac{1}{T}\sum_{t=1}^{T}\left((s_{bt} - \bar{s}_b)^2\right) + \bar{s}_b^2\right] \end{aligned}$$

16 It has a correlation coefficient over .7

3.7.4 Theory

Suppose that production utilizes technology z and inputs capital k and labor l to produce output according to the function $f(z,k,l)$. Where f has positive first derivatives, positive cross derivatives and negative second derivatives. Firms hire labor in a competitive market at cost w. However, due to financial frictions they face a weakly increasing marginal cost of capital curve $c(k,a)$ where $c_k \geq 0$ and a indexes borrowing costs so that $c_a \leq 0$.[17] The first order conditions of this maximization problem implicitly determine the factor demands:

$$f_l(z,k,l) = w \implies l^\star(z,k,w)$$

$$f_k(z,k,l) = c(k,a) \implies k^\star(z,l,a)$$

Letting $\eta_{l,x} \equiv \frac{\partial l^\star}{\partial x}\frac{x}{l^\star}$, $\eta_{k,x} \equiv \frac{\partial k^\star}{\partial x}\frac{x}{k^\star}$denote the elasticity of demand for labor with respect to variable x, and $\hat{x} \equiv \frac{\partial x}{\partial t}\frac{1}{x}$ denote the growth rate of x, we can calculate the growth rate of labor[18]:

$$\hat{l} = \eta_{l,z}\hat{z} + \eta_{l,k}\hat{k} + \eta_{l,w}\hat{w}$$

$$\hat{k} = \eta_{k,z}\hat{z} + \eta_{k,l}\hat{l} + \eta_{k,a}\hat{a}$$

Combining these equations gives an individual firm's growth rate:

$$\hat{l} = \frac{1}{1-\eta_{l,k}\eta_{k,l}}[(\eta_{l,z} + \eta_{l,k}\eta_{k,z})\hat{z} + \eta_{l,k}\eta_{k,a}\hat{a} + \eta_{l,w}\hat{w}]$$

For brevity, write this as:

$$\hat{l} = \beta^z\hat{z} + \beta^a\hat{a} + \beta^w\hat{w}$$

The growth in employment in industry i in city c will come from integrating over the firms growth within the industry city:

$$\hat{l}_{i,c,t} = \int_\Omega \hat{l}(\omega) g_{i,c,t}(\omega) d\omega$$

where ω is the firm type, and $g_{i,c,t}(\omega)$ the density of employment of the firm type. Assume that pro-

[17] If a is taken to be assets, this can be seen as a reduced form version of a costly state verification model where an increase in capital relative to a firm's assets raises the default probability and thus the cost of external finance. Alternatively as a firm grows larger, they may be more able to pay the fixed costs of issuing securities lowering the cost of capital.

[18] By the implicit function theorem and the assumptions on the production function: $\eta_{l,z} = -\frac{f_{l,z}}{f_{l,l}}\frac{z}{l^\star} > 0$, $\eta_{l,k} = -\frac{f_{l,k}}{f_{l,l}}\frac{k}{l^\star} > 0$, $\eta_{l,w} = \frac{1}{f_{l,l}}\frac{w}{l^\star} < 0$, $\eta_{k,z} = -\frac{f_{k,z}}{f_{k,k}-c_k}\frac{z}{k^\star} > 0$, $\eta_{k,l} = -\frac{f_{l,k}}{f_{k,k}-c_k}\frac{l}{k^\star} > 0$, $\eta_{k,a} = \frac{c_a}{f_{k,k}-c_k}\frac{c}{k^\star} > 0$

ductivity growth depends on an industry level shock $\hat{z}_{i,t}$ and idiosyncratic noise which is integrated out in aggregation. Let wage growth $\hat{w}_{i,c,t}$ be determined at the industry×city×year level[19] Finally, assume an elasticity of labor supply $\psi_{i,c,t}$, so that $\hat{l}_{c,t} = \psi_{i,c,t}\hat{w}_{c,t}$.

Under these assumptions, industry MSA employment growth will be:

$$\hat{l}_{i,c,t} = \frac{\psi_{i,c,t}}{\psi_{i,c,t} - \bar{\beta}^w_{i,c,t}}[\bar{\beta}^z_{i,c,t}\hat{z}_{i,t} + \int\limits_{\Omega} \beta^a(\omega)\hat{a}(\omega)g_{i,c,t}(\omega)d\omega]$$

Where $\beta^x_{i,c,t} \equiv \int\limits_{\Omega} \beta^x(\omega)g_{i,c,t}(\omega)d\omega,\ x \in \{w, z\}$ is the average sensitivity of employment growth to factor x.

MCA employment growth will then be:

$$\hat{l}_{c,t} = \sum_{i\in I}\theta_{i,c,t}\hat{l}_{i,c,t} = \bar{\beta}^z_{c,t}\sum_{i\in I}\theta_{i,c,t}\hat{z}_{i,t} + E_{c,t}(\beta^a\hat{a})$$

where $\theta_{i,c,t}$ denotes the share of employment in industry i, and $\bar{\beta}^z_{c,t} = \sum\limits_{i\in I}\frac{\theta_{i,c,t}\hat{z}_{i,t}}{\sum\limits_{i\in I}\theta_{i,c,t}\hat{z}_{i,t}}(\frac{\psi_{i,c,t}}{\psi_{i,c,t}-\bar{\beta}^w_{i,c,t}}\bar{\beta}^z_{i,c,t})$ is the weighted average sensitivity of industry×city employment growth to national growth. $E_{c,t}(\beta^a\hat{a}) \equiv \sum\limits_{i\in I}\theta_{i,c,t}\frac{\psi_{i,c,t}}{\psi_{i,c,t}-\bar{\beta}^w_{i,c,t}}\int\limits_{\Omega}\beta^a(\omega)\hat{a}(\omega)g_{i,c,t}(\omega)d\omega$ is the average growth due to asset accumulation.

Notice that the sensitivity of labor growth to idiosyncratic productivity growth $\beta^z = \frac{1}{1-\eta_{l,k}\eta_{k,l}}(\eta_{l,z}+\eta_{l,k}\eta_{k,z})$ depends positively on $\eta_{k,z} = -\frac{f_{k,z}}{f_{k,z}-c_k}\frac{z}{k}$ and negatively on $\eta_{k,l} = -\frac{f_{k,l}}{f_{k,l}-c_k}\frac{l}{k}$. Using the first order condition that $c(k^\star, a) = f_k(z, k^\star, l^\star)$ These can be written as:

$$\eta_{k,z} = \frac{\frac{\partial f_k}{\partial z}\frac{z}{f_k}}{\frac{\partial f_k}{\partial k}\frac{k}{f_k} - \frac{\partial c}{\partial k}\frac{k}{c}},\ \eta_{k,l} = \frac{\frac{\partial f_k}{\partial l}\frac{l}{f_k}}{\frac{\partial f_k}{\partial k}\frac{k}{f_k} - \frac{\partial c}{\partial k}\frac{k}{c}}$$

Thus a greater elasticity of marginal cost of capital with respect to capital ($\frac{\partial c}{\partial k}\frac{k}{c}$), ie a steeper capital supply curve, results in a lower sensitivity of labor growth with respect to productivity growth.[20]

What this model shows is that labor growth can come from two sources. First, productivity growth increases the optimal scale of production bringing about growth in employment, particularly among firms with lower financial constraints (a flatter capital supply curve). Second, productivity growth can come from a reduction in the cost of capital. For example if external finance is prohibitively costly, firms will grow by accumulating profits. This form of growth reflects credit frictions prohibiting firms from entering at an efficient scale.

The concern is that asset growth and productivity growth are unobservable. Thus we need a

[19]Since the focus is on cyclical movements instead of a long term equilibrium, this seems more reasonable than allowing frictionless movement across industries.

[20]There is also a general equilibrium effect of capital constraints on wages when there is an aggregate productivity shock, as capital constraints make demand less elastic. But this is second order to the others

proxy for productivity growth which is uncorrelated with asset growth to identify differences in $\bar{\beta}_{c,t}$ by county. Note that aggregate growth by industry is

$$\hat{l}_{i,t} = \sum_{c\in C} \tilde{\theta}_{i,c,t}\hat{l}_{i,c,t} = \hat{z}_{i,t}E_{i,t}(\frac{\psi_{i,c,t}}{\psi_{i,c,t} - \bar{\beta}^{w}_{i,c,t}}\bar{\beta}^{z}_{i,c,t}) + E_{i,t}(\beta^{a}\hat{a})$$

Where the expectation is the expected value over cities weighted by the density of i's employment in city c. Simply using national growth as a proxy for productivity shocks is problematic as trend growth may be correlated with past profits and thus available assets. Also, correlation of asset growth is problematic. For example, if productivity follows a jump process, unconstrained firms may quickly reach their maximum scale, while constrained firms lag behind. However, after the jump there may be high national growth as many firms want to increase their scale. But it will be the constrained firms which have high growth, making the correlation related to frictions instead of the lack thereof. Asset growth will depend on profits and thus the level of productivity instead of its changes, making it a slow moving variable. Detrending the series should roughly remove the employment growth attributable to trend productivity or asset accumulation. Thus the cyclical component of employment growth should be:

$$\hat{l}^{cyc}_{i,t} \simeq \hat{z}^{cyc}_{i,t}E_{i,t}(\frac{\psi_{i,c,t}}{\psi_{i,c,t} - \bar{\beta}^{w}_{i,c,t}}\bar{\beta}^{z}_{i,c,t})$$

Returning to the expression for county-industry growth,

$$\hat{l}_{i,c,t} = \frac{\psi_{i,c,t}}{\psi_{i,c,t} - \bar{\beta}^{w}_{i,c,t}}[\bar{\beta}^{z}_{i,c,t}(\hat{z}^{cyc}_{i,t} + \hat{z}^{trend}_{i,t}) + \int_{\Omega} \beta^{a}(\omega)\hat{a}(\omega)g_{i,c,t}(\omega)d\omega]$$

$$\hat{l}_{i,c,t} = \frac{\frac{\psi_{i,c,t}}{\psi_{i,c,t}-\bar{\beta}^{w}_{i,c,t}}\bar{\beta}^{z}_{i,c,t}}{E_{i,t}(\frac{\psi_{i,c,t}}{\psi_{i,c,t}-\bar{\beta}^{w}_{i,c,t}}\bar{\beta}^{z}_{i,c,t})}\hat{l}^{cyc}_{i,t} + \epsilon_{i,c,t} = \bar{\beta}^{l}_{i,c,t}\hat{l}^{cyc}_{i,t} + \epsilon_{i,c,t}$$

Where ϵ is the growth attributable to trend productivity and to asset growth. Thus the sensitivity of local growth employment to national employment growth reflects how responsive a city×industry is to a productivity shock relative to other the industry in the other cities. This sensitivity has been shown to depend on the level of financial frictions in the city. Aggregating to the city level:

$$\hat{l}_{c,t} = \sum_{i\in I} \theta_{i,c,t}\hat{l}_{i,c,t} = \bar{\beta}^{l}_{c,t}\sum_{i\in I}\theta_{i,c,t}\hat{l}_{i,t} + \epsilon$$

where $\theta_{i,c,t}$ denotes the share of employment in industry i, and $\bar{\beta}^l_{c,t} = \sum_{i \in I} \frac{\theta_{i,c,t}\hat{l}_{i,t}}{\sum_{i \in I}\theta_{i,c,t}\hat{l}_{i,t}} \bar{\beta}^l_{i,c,t})$ is the weighted average sensitivity of industry×city employment growth to national growth. Suppose that $\bar{\beta}^l_{i,c,t} = \alpha_1 - \alpha_2 HHI_{c,t}$, then we get the estimating equation used in the empirical section. α_2 tells us how much the bartik sensitivity declines when concentration goes up, thus informing us of the degree to which firms are facing upward sloping supply curves.

3.7.5 Data Sources

Summary of Deposits The Summary of Deposits (SOD) is an annual survey of all FDIC-insured institutions. Each branch of commercial banks or savings and loans located within the US reports the value of the deposits at that branch as of June 30. For institutions with more than one branch, the assignment of deposits over the institution's branches are instructed to be done in a "manner consistent with their existing internal record keeping practices", for example nearest branch to account, most active branch of the account, place of origination, etc. I use the years 1994-2012. Also included in the data are the address of the branch, the range of services available at the branch, and identifiers for the financial institution and, if applicable, the holding company the branch is part of.

Call Reports Report of Condition and Income data (Call Reports) are available on a quarterly basis for banks regulated by the Fed, FDIC, and the Comptroller of the Currency. I use data from 1994-2010, the first year SOD data is publicly available to the last year the Chicago Fed makes the Call Report data. It provides information on the balance sheet, incomes and expenditures of banks. Banks are linked to their locations in the SOD data using their RSSD ID. Stock variables (e.g. loans) are measured as the average of the first quarter and last quarter reported amounts, while income and expenditure variables (e.g. loan income, interest paid on deposits) use the fourth quarter reports giving the total received or paid during the calendar year.

Variables often exhibit some extreme outliers, likely due to reporting errors or small denominators, so the highest and lowest 1% of values every year are dropped.

Quarterly Census of Employment and Wages The Quarterly Census of Employment and Wages (QCEW) provides payroll and employment data at the MSA level for NAICS industries using administrative records from state unemployment insurance programs. It covers roughly 97% of the employment in the US. Employment is measured as filled jobs, so that people working multiple jobs will be counted multiple times in the data. Each establishment is allocated to an NAICS code, based on their primary activity.

I only include people working in private industries, since public sector establishments aren't going to be subject to sensitive to credit market frictions, and won't make hiring decisions with the objective of profit maximization.

Business Dynamic Statistics The Business Dynamics Statistics (BDS) is developed by the Center for Economic Studies using the the US Census Bureau's Longitudinal Business Database, a panel of US business establishments. Employment is full and part time employment as of march 12th. A firm is assigned an initial age of the age of the oldest establishment at time of birth. Firm age then increase by 1 every year thereafter. A firm is considered young in year t if it's age is five or below and mature otherwise.

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