Small Business Lending and the Bank-Branch Network

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Abstract

I tests whether the market for small business lending is integrated by examining the exposure of different credit markets to localized economic shocks when they host the same bank network. In a unified approach I quantify the effect of a positive and a negative credit-supply on local activity. I show that the market for business loans provided by smaller banks is locally segmented. Businesses in areas with increased credit were not able to expand earlier with funds from other banks and were forced to wait for funding from their local banker. Businesses in areas with reduced credit were forced to lower their activity unable to substitute funding lost to more profitable projects elsewhere.

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1 Introduction

There is a significant literature that studies how local shocks are propagated both across geographies and industries. Labor mobility or shared labor pools play a key role in driving these spillovers.[1] While capital mobility can also be an important factor it has received little consideration.[2] In this paper I test whether the market for small business lending is completely integrated and therefore capital is perfectly mobile. I do this by examining the extent to which different credit markets are exposed to localized economic shocks when they host branches of the same bank network. Under perfect capital mobility markets that share a bank network but are not exposed to common economic factors should not be exposed to shocks originating somewhere else. If a credit market without an economic shock experiences changes in credit and/or economic activity as a result of a shared bank network this will suggest that local markets are segmented.

In this paper, I provide evidence that local shocks indeed can spill to distant areas which points to segmentation in the market small business lending. I show that banks exposed to shocks in one market experience changes in their ability to lend and impose credit supply shocks in the rest of their markets, affecting the real activity of borrowers. In an integrated approach that uses the same set of banks and same type of lending I discuss a case where distant markets seemingly benefit from existing segmentation and a case where they seemingly lose from it. The first case involves new fracking wells which increase local deposits and the second involves residential booms which reduce funding to small businesses.

I combine locations of small businesses and credit provided to them by individual banks with branch locations in order to study the intra-bank capital allocation. The distance

[1] Blanchard and Katz (1992) use a structural model to study how employment and migration respond to local shocks. Black et al (2005) examine the effect of the boom/bust of coal industry had on other local industries. Greenstone et al (2010) study whether productivity of incumbent plants changes when a new plant is built within a county. Freyrer et al (2015) study both geographical and industry spillovers of fracking and argue that the size of commuting zones can explain the positive effects on income and employment as far as 100 miles away from fracking.

[2] See Becker (2007) for an example that looks at geographic segmentation. Moretti (2011) discusses the importance of capital mobility in the spatial equilibrium model.

between businesses and bank offices is used to associate census-tract lending to the closest branches, providing a granular geographical distribution of lending activity over time. The resulting geographical and temporal variation is critical for the identification of the changes in the credit supply at different branches following local funding or asset price shocks. I consider these shocks because they directly affect a portion of the network with the changes in the rest of the branches being driven by internal capital allocation. The geographical separation from the origin of the shocks is important because distance can attenuate the direct correlation between the local shock and the credit demand conditions. The presence of multiple banks in the same credit market allows me to control for common fluctuations in credit demand and rule out explanations of the spillovers which are based on the local market-wide changes.

The novel data allows me to analyze in an integrated way how the same type of credit and real activity respond to two distinct local shocks. The shocks are not novel or exclusive to this paper.[3] I rely on two different shocks that have well documented effects on bank balance sheets in order to show that the existing financial infra-structure does not allow small businesses an access to a national credit market and this can lead to positive as well as negative externalities to business activity. The combined evidence from both shocks at work in the same set of banks and type of lending suggests a stronger case for market segmentation. The branch-level lending information I develop makes it possible to explicitly consider the distance from the origin of each shock to establish the economic independence of each credit market. Explicit use of distance has not been attempted in the literature

[3]Plosser (2014) emphasizes the exogeneity of the fracking revolution and shows that banks use the increase in deposits from the energy booms to expand total lending and liquid securities. Gilje et al (2014) show that banks, which have a higher proportion of total branches in counties with fracking, originate more mortgages in counties that do not have fracking. Gilje (2012) and Freyrer et al (2015) study the impact of the energy booms on the local economy. The effect of residential appreciation on bank lending and real outcomes has also been previously studied. Chakraborty et al (2014) document that bank-holding companies which are located in states with higher residential prices increase their investments in mortgages and decrease commercial lending to bigger firms. Loutskina and Strahan (2015) show that the geographical variation in the residential prices caused banks to allocate their internal capital towards areas where mortgages are more profitable.

that documented the existence of these local shocks.[4] Importantly, the existing literature has shown that bank lending is affected by shock exposure but has not shown whether this results in pure substitution of funding sources or an alleviation of a credit constraint. The latter is consistent with segmentation while the former is not necessarily.

The paper emphasizes the importance of smaller banks, defined as having less than 30 branches, in the deviation from efficient credit markets theory. Not surprisingly, smaller banks tend to be more funding-constrained and therefore change the amount of credit supplied to small businesses when exposed to each shock. Importantly, the evidence suggests that when the amount of credit supplied changes real activity is also affected. The two shocks provide evidence that credit supply can reduce as well as increase real activity. This shows that businesses in areas with increased credit were not able to expand earlier using funds from other banks and were forced to wait for funding opportunities from their local banker. Similarly, in areas with reduced credit businesses were forced to lower their activity as they lost funding because they were not as profitable to lend to as construction projects elsewhere. While this is optimal from the bank's perspective it is not obvious whether other distant banks may not find it optimal to lend to these businesses. Since credit and activity fall the evidence suggests that businesses are not able to access other sources of credit. These results strongly indicate that the credit market for small business lending provided by smaller banks is segmented i.e. small businesses are not able to access credit from non-local small banks.

Each of the two shocks affects the balance sheet of banks with nearby branches. I find that geographical proximity to new fracking wells boosts liquidity at local bank branches and increases total deposits only at smaller institutions. A small bank with offices next to two new fracking wells sees a 0.5% increase in total deposit growth, 45% increase in large deposit growth, and a 10 basis points decrease in interest expense relative to banks without

[4] Gilje et al (2014) consider total mortgage origination at all counties outside energy booms. Chakraborty et al (2014) rely on state house price indices and percent of total deposits in each state in order to determine the level of bank exposure to real estate booms. Loutskina and Strahan (2015) aggregate total mortgage origination at the CBSA level.

exposure. In the aggregate, small banks with exposure to new wells receive \$2.6 billion of additional deposits over the sample period of 2001 to 2007, a 10.4% of the total deposits held by these banks each year. Focusing on the other shock, I show that geographical exposure to real estate booms leads to a portfolio substitution into construction and development (C&D). A small (big) bank with 70% (38%) of branches in high real estate growth area, an average level of exposure, has 0.5% (0.9%) *higher* concentration in C&D loans. Business lending capacity increases with fracking and decreases with exposure to real estate booms.

Both shocks result in actual changes in credit supply at bank locations that are disconnected by distance from the origin of the shocks. Credit changes are further associated with changes in real activity as measured by establishment growth. A small bank with two new wells increases originations by approximately 9% relative to competitors in the same credit market with no exposure. The combined increase in originations over the sample is over \$5 billion, which is 15% of the total originations of all small banks within 200 miles of areas with fracking activity. I show that lending activity expands not only in areas close to fracking but also at locations more than 100 miles away. Zip codes containing borrowers from banks exposed to fracking experience faster establishment growth compared to the rest of the zip codes. In particular, these locations experience 0.5% to 1% faster establishment growth.[5] This amounts to 50,000 new establishments between 2001 and 2007, a 13% of the aggregate change in the U.S. for this period. Each \$100,000 in small business loans is associated with an additional establishment. Turning to the real estate boom we see that small banks with average exposure reduce origination growth by 78% relative to competitors in the same credit market, while big banks contract by 23%. The aggregate reduction implied by the coefficient estimates is \$0.4 and \$3.5 billion, respectively. These are substantial decreases in lending activity, representing 25% and 9% of aggregate originations by the exposed banks in areas outside of the residential booms. Zip codes where credit was provided by small banks with average exposure experience 0.9% slower establishment growth. This amounts

[5]This excludes industries in mining, construction, finance and real estate.

to a reduction in the number of establishment of approximately 13,000, or 4.4% of the total new establishments added between 2001 and 2005. A reduction of $170,000 in small business lending is associated with the closure of one establishment.

This paper relates to the literature discussed above which originally documented the existence of the shocks I consider here. It is the first to consider the impact on small business lending. The paper is also related to the literature on the importance of bank relationships and consequences of credit disruptions as recently highlighted by Chodorow-Reich (2014). Finally, the identification strategy in this paper is related to the recent literature on bank lending which focuses on cross-country spillovers of financial shocks. The seminal papers by Peek and Rosengren (1997, 2000) study the effect of a shock to the bank balance sheet which originates from Japan on lending in the US.[6] Similarly to these papers, I separate the origin of a bank shock from the areas where I examine the effects, in order to minimize the correlation between the shock and demand conditions. This paper is also related to Bustos et al (2016) and to Cortes (2014) who also exploit a localized shock and examine its effect on bank lending and/or real activity.[7]

This paper proceeds as follows. Section 2 introduces the dataset. Section 3 outlines a simple model of multi-branch lending and discusses the identification assumptions. Section 4 includes the methodology and results regarding small business lending. Section 5 presents results regarding the impact on real activity. Section 6 includes robustness and extensions. Section 7 concludes the paper.

2 Datasets

Information on the origination of commercial and industrial (C&I) loans and loans secured by nonresidential real estate with value of less than $1 million (small business loans) is filed

[6] For additional papers in this literature see: Schnabl (2012), Cetorelli and Goldberg (2012). Also see Berrospide et al (2016) which examines how multi-market banks re-allocate capital in response to a local shock.

[7] Chavaz (2014) similarly looks at a localized shock and its credit effects across the bank network.

each year by banks that fall within the requirements set in the Community Reinvestment Act. Generally, these are independent commercial banks and savings institutions with more than $250 million in assets or banks owned by a bank-holding company with more than $1 billion in total assets.[8] The bank filings consist of the gross originations amounts, together for both types of loans, and the total count of small business loans by distinct geographical categories. The provided information allows me to identify total bank loan originations by census tract or by groups of census tracts.[9]

The exact locations of bank branches are listed in the Summary of Deposits (SOD), compiled by the Federal Deposit Insurance Corporation (FDIC). The CRA data effectively maps the locations and lending volumes for different small-business borrowers for each of the banks in the sample. I match borrowers with the set of closest locations of the bank they borrowed from. The matching algorithm involves several steps. First, I compute the distance between a given lending location and all of the retail branches of the lending bank. Locations farther than 186mi (300km) from any branch are not associated. For the rest of the locations, I extend the distance to the closest branch of the lending bank by 25% and use this distance as the radius of the circle that contains the branches that likely originated the loan. For each of these branches I use the inverse of the distance to the borrower to capture the likelihood they provided the funding. Finally, each branch is assigned the expected value of the total origination of business loans based on this likelihood i.e. the total origination amount times the probability of origination for the particular branch. This process is repeated for each of the lending locations reported in the CRA filings and for each bank that provided this information. The resulting dataset includes the expected origination value of small business lending at each branch of the bank network. I use the unique branch number, provided by the SOD, to create the panel data of branch observations.[10]

[8]After 2004 the asset requirement for commercial banks not owned by bank-holding companies was increased to $1 billion

[9]Please refer to the data appendix for more information.

[10]Notice that the matching algorithm implies that opening/closing of physical locations will decrease/increase the expected value of loan originations at branches that remain open. To account for this I control for the change in the number of bank offices in all of the estimated models in this study.

Bank balance sheet data comes from the Consolidated Report of Condition and Income (Call Reports) provided by the FDIC. The reports for each bank are matched to the Summary of Deposits data using the bank certificate number. The balance sheet variables are the annual average of quarterly observations. Data on the number of establishments is taken from the County Business Patterns (CBP). CBP is maintained by the US Census and provides detailed information on the annual number of businesses with paid employees as of March 12th.[11]

Information on fracking exposure comes from the U.S. Geological Survey which examines the historical development of drilling that utilized hydraulic fracturing between 1947 and 2010 (Gallegos and Varela, (2015)). The data provides locations of both horizontal and directional wells, aggregated to the 8-digit hydrologic unit code areas (HUC), in order to conceal the precise well locations.[12] Plosser (2014) and Giljie (2012) suggest that the purchase of the rights to drill provides a significant one-time payment for the owner of the land. Consequentially, I use the the number of new horizontal wells in a given area to capture deposit growth. The top part of Figure 1 plots the location of new horizontal wells for the period of interest between 2001 and 2007.

The information on house prices is provided by the Federal Housing Finance Agency (FHFA). The agency maintains a quarterly House Price Index (HPI) both for MSAs and for the state areas outside of the MSAs. The index is compiled by tracking price changes for repeat house sales. I use the average quarterly HPI appreciation to capture the intensity of the housing boom across locations. The evolution of this measure can be seen in the bottom part of Figure 1. In close parallel with the definition of the energy shock, I capture the bank exposure to real estate booms by the fraction of branches in the areas with appreciation above the 90^{th} percentile for the country. Alternatively, I parametrize the bank network exposure to real estate booms by the appreciation at the median branch.

[11] To match the reporting frequencies of the rest of the data, I assign the total number of establishments reported as March 12th of a given year to the end of the previous year.

[12] The original source for the well location is the proprietary IHS database (IHS Energy (2011)).

3 Model and Identification Issues

This section outlines a simple econometric model of intra-bank capital allocation.[13] It explains why banks exposed to local shocks will change credit supplied to businesses. It highlights the critical frictions that drive credit and real activity changes observed in the data. While the model assumes that markets are segmented it is useful in pointing out identification issues that can limit the interpretation of the estimation results.

The model features banks that lend to two different types of firms at different physical offices. Banks, indexed by i, have more than one branch and each of the branches, indexed by j, provides credit to one small business, L_{ij}, and to one land developer, K_{ij}. While j refers to a particular branch of a bank, I use it interchangeably to refer to the credit market where the branch is located. This is done in order to simplify notation. Business credit segmentation is captured by assuming that each bank is a monopolist with respect to both the small business and the land developer. The marginal return to L_{ij} is $r_j^L + r_i^L - \alpha_L L_{ij}$, and the marginal return to K_{ij} is $r_j^K + r_i^K - \alpha_K K_{ij}$. I assume that the marginal return to each of the loan types has a local component, indexed by j, and a bank component, indexed by i. Each branch can collect deposits up to D_{ij} at no cost. Finally, the bank can borrow B_i form the interbank market at the marginal cost of $\alpha_B^i B_i$, which is specific to each bank.

There are two periods. During the first period, t, bank i maximizes profits by choosing L_{ij}^t and K_{ij}^t at each branch subject to the constraint that total lending is equal to the total bank liabilities, $\sum_j L_{ij}^t + \sum_j K_{ij}^t = \sum_j D_{ij}^t + B_i^t$. At the end of the first period, the bank observes three different shocks: 1) the marginal return to L_{ij} increases by η_{ij}; 2) the marginal return to K_{ij} increases by κ_{ij}; 3) the deposits that the bank can collect at each branch increase by δ_{ij}. Each of these shocks is specific to a branch of i. After observing the shocks, at the beginning of $t+1$ the bank chooses L_{ij}^{t+1} and K_{ij}^{t+1} at each branch to maximize profits.

The details of the maximization problem and the derivation of the solution for the change in small business lending between the two periods are provided in Appending A2. Intuitively,

[13] The setup is an extension of Khwaja and Mian (2008).

the bank chooses K_{ij} and L_{ij} in order to equalize the marginal return of each of the loans, at each of the locations, to the marginal cost of borrowing from the interbank market.[14] It is worth emphasizing that the final expression for small business lending assumes for tractability that $\alpha_B^i = \gamma/N_i$. The assumption leads to the implication that lending depends on the average of the deposit shocks as well as the average of the shocks to the return of real estate loans. The justification of the assumption rests on the arguments in Stein (1998) of asymmetric information about banks' assets and on the discussion in Stein (2002) that horizontally integrated small banks lend to more opaque firms.

Solving for the optimal allocation at each branch and taking the difference between the two periods, I get:

$$\triangle L_{ij} = a\eta_{ij} - b_1 \frac{1}{N_i} \sum_{\bar{j}} \eta_{ij} - b_2 \frac{1}{N_i} \sum_{j} \kappa_{ij} + b_3 \frac{1}{N_i} \sum_{j} \delta_{ij} \quad (1)$$

where $\bar{j}$ refers to the branches of i different from j. a, b_1, b_2, and b_3 are positive parameters.

The model highlights how the marginal return of each loan type at different branches and the deposits throughout the network affect lending to a small business. When there is an increase in the marginal return to L at branch ij, the bank increases L_{ij}. This effect is captured by the positive term in front of η_{ij}. An increase in the marginal return to L at any other branch, $\bar{j}$, of i will decrease L_{ij}. Intuitively, when the return is higher at another location, the bank increases lending there and decreases lending at ij. This is the mirror image of the effect of η_{ij}. When the marginal return to K increases at any branch, including ij, L_{ij} will decrease. The intuition is exactly the same as when the marginal return to L increases at another branch of the network. The only difference is that local increases in the return to K, κ_{ij}, will decrease L_{ij}. Finally, an increase in deposits at any branch of the bank will increase L_{ij}. Higher deposits imply that the bank will rely less on external borrowing, which will lower the marginal cost of funds. The lower cost of funds allows the bank to fund loans that have lower marginal return.

[14] This assumes that the bank cannot provide all of the lending using only its deposits.

Two frictions in this model play a key role in the allocation of funds across the bank network. The first friction comes from the assumption that the bank is a monopolist and implies that borrowers cannot access alternative sources of financing. The second friction in the model is that banks are constrained in accessing external capital. This is captured by the fact that the marginal cost of bank borrowing depends on the total amount borrowed and on the size of the bank. In particular, I have assumed that a bank with more branches will have a lower marginal cost of borrowing, for any amount borrowed. As the size of the bank goes to infinity the cost of borrowing becomes constant in the limit. This implies that only the local shock to the marginal return of L, η_{ij} matters for L_{ij}.

The parameter b_3 captures the effect of an increase in bank deposits on lending. Let us assume that there are no real estate shocks, κ. The model highlights the importance of using an exogenous shift in deposits when identifying b_3. Usually, changes in deposits are related to changes in the marginal return of loans. I can identify their effect on lending, ceteris paribus, only with exogenous changes in deposits. This is the main reason why I resort to deposit shocks driven by the fracking revolution – Gilje (2012) and Plosser (2014) have argued that fracking is not related to changes in the marginal return of lending. If I assume that the deposit shocks from fracking are exogenous and that the shocks to the marginal return of small business lending are common to all banks within a credit market (a county) i.e. $\eta_{ij} = \eta_j$ for all i in a location j, then I can use the entire sample of bank branches, within and outside of the energy boom areas, to identify the effect of higher deposits. This is because I can include a control for the common credit-market year shocks, such as county-year fixed effects. I do not follow this approach. Instead, I exclude the areas within the energy booms. It is likely that within fracking areas $\eta_{ij} \neq \eta_j$. Banks that specialize in lending to industries related to fracking can experience an increase in the marginal return of lending within the fracking areas. Other banks may not be impacted. This means that a county-year fixed effect will not be an adequate control for demand conditions at places with energy booms. Additionally, in the case that there is a positive correlation between local deposit shocks and the local marginal return of lending, the estimate of the effect of deposits on small business lending at branches away from fracking will be a lower bound. This correlation is, nevertheless, likely to be small.

The effect of an increase in the return of real estate loans is captured by b_2. Let us assume that there are no deposit shocks, δ. I use residential appreciation to capture changes in the return of RE loans. I can identify the effect of the shock to the return of RE loans on business lending by using the entire sample of branches under two conditions: 1) local shocks η_{ij} are common to all i in the area j; 2) $\text{Corr}(\eta_{ij}, \kappa_{ij}) = 0$ i.e. local shocks to the return of each loans are not correlated. The first condition implies that county-year fixed effects will adequately control for local shocks. The second condition implies that residential appreciation will only capture the effect of changes in the return of RE loans.

It is likely that the two conditions are violated in the case of RE booms. In particular, within areas where residential appreciation results in an increase to the return of RE loans there will also be increases in the return of business loans, i.e. $\text{Corr}(\eta_{ij}, \kappa_{ij}) > 0$. It is also plausible that in these areas the shocks to the return of business loans are not common to all of the banks, i.e. $\eta_{ij} \neq \eta_j$ for all i in the area j where $\kappa_{ij} > 0$. The first assumption implies that I will not be able to identify the effect of the shock to the RE loans separately from that to the business loans. The second assumption implies that a county-year fixed effect will not adequately control for local shocks at the areas with booms. In order to accommodate both assumptions, I exclude from the estimation branches which are directly exposed to shocks to the return of RE loans. Branches not affected by a local κ shock will be affected by a κ and possibly by a η shock somewhere else in the network. Both effects lower L locally since they capture the combined increase in L and K at other branches of the network. Therefore, at branches without a local κ shock, I can identify the combined effect of higher lending elsewhere in the network. I focus on these branches in the empirical section assuming that outside of areas with RE booms I can control for local shocks to the return of business loans with county-year fixed effects.

4 Local Supply Shocks and Small Business Lending

In this section, I study how local economic factors – discovery of oil or increased demand for construction lending – affect the balance sheet of banks which have geographical exposure via the branch network. I, then, explore whether the affected banks re-optimize their lending to small businesses in accordance with the model in the previous section, particularly in the part of their branch network that is not directly exposed to the local shocks.

The literature on small business lending has provided theoretical arguments as well as empirical evidence for the difference in the types of loans originated by banks of varying size.[15] Financial intermediaries of different assets size and geographical scope are considered to be fundamentally different in terms of the business model they follow and the types of customers they service. Following the literature I differentiate between two categories of intermediaries using the size of the branch network: small if they have no more than 30 branches and big otherwise. This definition roughly corresponds to banks with less than $1.1 billion in assets. In the robustness section, I show that the results are not sensitive to the particular definition of bank size.

In order to identify the effect of exposure independently from other differences in the bank characteristics I include a set of balance sheet controls from the Call Reports.[16] Table 1 lists the bank-year averages for each of the years considered here for small and big banks.

[15]Stein (2002) argues that loans based on "soft" information favor organizations with a high degree of horizontal integration, while "hard" information loans are best handled by vertically integrated organizations. Nakamura (1994) puts forward a complementary argument suggesting that small banks have a cost advantage compared to bigger banks in providing credit to opaque businesses. Berger et al (2005) and Brickley et al (2003) find empirical evidence for the organizational difference across bank size and in terms of the type of loans extended. Smaller banks are also restricted in their ability to expand their assets both for regulatory reasons (Nakamura (1994)) and for agency problems arising in the interbank-lending market (Kashyap and Stein (1997)). DeYoung and Rice (2004) show that intermediaries with less than $1 billion in assets follow a traditional lending-based business model, while bigger intermediaries increasingly focus on a non-interest, fee-based, business model driven by investment banking and securitization activities.

[16]The list of controls includes one year lags of Log of Assets, Deposits over Assets, Interest Expense on Deposits, Tier-1 Capital Ratio, C&I Loans over Assets, Mortgage Loans over Assets, Net Income over Assets, Unused Loan Commitments over Assets, and also Indicators for Bank Holding Company Ownership, Change in the number of offices.

4.1 Definition of Shocks

Each shock can be traced to a particular area and is not expected to cause additional shocks at longer distance. Bank exposure depends on the number of branches close to a fracking well or real estate boom.

The main premise behind the effect of fracking on bank liabilities is that land owners receive renumeration from the oil companies which they deposit at the local branches. It follows that communities which include owners of land used for fracking will be an important source of deposits for banks servicing these areas. I assume that most of the owners live in proximity to the wells and that the deposits are made relatively close to the actual drilling locations. Since the data on the fracking wells is aggregated at Hydrological Unit Codes (HUC), I designate a branch as exposed to fracking deposits if it is located within one of the HUCs with new horizontal wells.[17]

Banks source their deposits from different areas. This is reflected in the proportion of deposits held at different branches of the same bank. The fracking areas can be an important source of deposits for some banks, while for others the branches in these areas are primarily lending outlets. I measure bank exposure to the liquidity shock with the weighted average of new wells across the network. The weights used are the share of bank deposits collected at each branch in the previous year. Formally:

$$Exp_t^i = \sum_{b \in B_{i,t}} DepShare_{i,t-1}^b \times NewWells_{HUC,t} \tag{2}$$

$B_{i,t}$ is the set of bank branches of bank i in year t. $DepShare_{i,t-1}^b$ is the share of total bank deposits collected at branch b during the previous year. New $\text{Wells}_{HUC,t}$ is the number of new horizontal wells in Hydrological Unit HUC. The weights in this measure also eliminate from the sample branches which did not exist or were owned by a different bank in the previous year. Table 2 lists the medians for the bank-level averages for well exposure, deposit growth,

[17] I confirm that the owners are just as likely to inhabit the areas where fracking is being done by comparing some key census statistics for zip codes within fracking areas to zip codes outside of these areas. This information is provided in Table A1 in the online appendix.

cost of deposits, and small business origination growth for each year in the sample. The average exposure across all years for small banks is 3.65 while the median is 0.8. There are a total of 305 bank×year observations of exposed small banks. For big banks the average is 1.3 and the median is 0.15. There are 410 bank×year observations of exposed big banks.

It is worth noticing that small banks with positive exposure experience higher growth in deposits and loan origination and lower interest expense compared to small unexposed banks, during most of the sample years. This is in line with my assumption that the exposure to new wells is a proxy for a deposit shock. This is, however, not true for the big banks.

The identification strategy for the effect of a real estate boom is closely linked to the model presented in Section 3. In parallel with the setup for the deposit shocks, the real estate shocks, κ_{ij}, can be set to one at locations with relatively high appreciation, and set to zero everywhere else. This effectively defines booming zones where every bank is exposed to real estate shocks. I identify these zones with residential appreciation in the top 90^{th} percentile for the US. Alternatively, I use the residential appreciation at the median branch of each bank to capture the exposure to real estate booms. The first measure is area specific, while the second measure is bank specific.

The first parametrization of exposure to real estate booms uses the fraction of branches located inside areas with appreciation in the top decile for the US:

$$Exp_t^i = \frac{1}{TotBr_{i,t}} \sum_{b \in B_i^t, t} I_b(Boom_{c,t})$$

$TotBr_{i,t}$ and B_i^t are, respectively the total number of branches of bank i, in year t, and the set of all branches. $Boom_{c,t}$ takes the value of 1 if the quarterly growth rate of HPI of county c is in the top decile for the year t. $I_b(Boom_{c,t})$ takes a value of 1 if the branch b of bank i is located in a county with a boom. Table 3 lists the bank averages for real estate exposure, deposit growth, cost of deposits, and small business origination growth for each year in the sample. The average exposure for an exposed small (big) bank is 70% (38%). In all but one year, small banks with positive exposure experience both higher loan origination growth and higher deposit growth, compared to small unexposed banks. Similar pattern is observed for the big banks.

The second parametrization of exposure to real estate booms uses the median residential appreciation at distinct branches of the network. Here there are two dimension of variation in appreciation: 1) across different banks; 2) within a given bank. Banks with higher median appreciation should be more exposed to changes in the return of real estate loans. Within banks, returns are not likely to be uniform across the network with above-median branches likely exposed to higher returns than the rest. I assume that these branches are directly affected by shocks to the return of real estate loans. It is likely that the return to small business lending also increases at these branches due to a positive local correlation between the shocks to the returns. In this case I can only identify the combined effect of the increase in the return of both loans on lending. As discussed in the section 3, this effect is consistently estimated only at the branches with appreciation equal to or less than the median for the network. Therefore, I remove branches with above median appreciation when I estimate the effect on small business lending.

4.2 Effect of Shocks on the Balance Sheet

The effect of shock exposure on bank balance sheet is estimated with the following equation:

$$\triangle \ln \mathrm{Y}_t^i = \alpha_3 \left(\mathrm{Small}^i \times Exp_t^i\right) + \alpha_4 \left(\mathrm{Big}^i \times Exp_t^i\right) + \beta_2 X_t^i + \phi_i + \sigma_t + \epsilon_{b,t}^i \tag{3}$$

In the case of fracking Y_t^i is two measures of deposits and interest expense and in the case of RE booms Y_t^i is C&I loans and loans secured by real estate. Information for deposits at each bank branch allows me to examine cash deposits close to new wells by estimating:

$$\triangle \ln \mathrm{Dep}_{b,t}^i = \alpha_1 \left(\mathrm{Small}^i \times \mathrm{NewWells}_{HUC,t}\right) + \alpha_2 \left(\mathrm{Big}^i \times \mathrm{NewWells}_{HUC,t}\right) + \beta_1 X_t^i + \sigma_t + \epsilon_{b,t}^i \tag{4}$$

where $\text{Dep}_{b,t}^{i}$ is the level of deposits at branch b of bank i and $\text{NewWells}_{HUC,t}$ is the number of new wells in the proximity of the branch. X_t^i includes bank-level controls.[18] ϕ_i and σ_t are bank fixed effects and year fixed effects. All of the idiosyncratic errors are assumed to be correlated within a given bank and are clustered at the bank level.

The results from the estimation of equations (3) and (4) are presented in Table 4. The branch-level regression for fracking exposure suggests that new wells boost local liquidity. The effect is significant and similar in magnitude for banks with small and big networks, which is consistent with local land owners who do not have a preference for one type of branch over another. Branches located within areas with two new wells experience 10bps faster deposit growth relative to branches with no new wells in the proximity. The coefficient of exposure in the second column of Table 4 is positive and significant only for small banks. It appears that the additional deposits at the branch level do not have a significant impact at the balance sheet level of the big banks. For small banks, an average exposure of 2 new wells is associated with 0.5% faster total deposit growth and 45% faster growth in large deposits relative to banks with no exposure. The evidence from the growth in large deposits is particularly compelling since one expects that fracking payments lead to large deposits. This increase in deposit growth translates into a decrease in interest expense by close to 10bps.[19] Big banks are not affected. The cumulative increase of deposits over the entire period for all exposed small banks is approximately \$2.6 billion.[20] This is a substantial increase relative to the \$25 billion deposits held by these institutions.

The effect of exposure to residential booms, captured by the fraction of branches in the top decile, is explored columns (5)-(7) of Table 4. The coefficient estimates for *C&D* loans are statistically significant and positive for both bank categories. Adding the off-balance-sheet commitments for these loans (column (6)) further increases the size of the coefficients

[18]Control variables include the lags of Log of Assets, Deposits/Assets, C&I Loans/Assets, Mortgage Loans/Assets, Unused Loan Commitments / Assets, and the change in the number of branches.

[19]Interest expense is in percentage units. I use the change in the interest expense rather than the level because the interest expense is extremely persistent.

[20]This estimate uses the coefficient from the second column of Table 4, bank exposure, and the starting stock deposits for each year.

implying that banks increased their exposure to real estate beyond what is evident from examining just the balance sheet activity. A small (big) bank with an average level of exposure of 70% (38%) increases actual construction and development loans plus unused commitments as a fraction of total assets by 0.5% (0.9%) relative to banks with no exposure. The results for all loans secured by real estate including the unused commitments (column (7)) imply that small banks did not just increase their concentration in $C\&D$ loans – a small banks with average exposure invested 0.7% more of its assets in real estate. The implied aggregate increases in construction loans for exposed banks over the entire sample is approximately $0.3 (3.1) billion for small (big) banks.[21] Annually, these increases represent close to 1% of the total stock of C&D loans.

Bank networks may not have branches within the top decile areas but may still be located within areas with significant appreciation which allows them to invest in profitable construction projects. Using appreciation at the median branch accommodates this continuous distribution of residential appreciation. The results in columns (8)-(10) of Table 4 suggest that the appreciation at the median branch of bank networks captures the variation in the incentive to invest in construction projects. In particular, coefficient estimates form regression (9) confirm that for both groups of intermediaries increases in network exposure to residential appreciation is associated with higher concentration in C&D loans. A small (big) bank with a 1% higher median appreciation has a 0.6% (0.4%) higher concentration in C&D (including commitments) loans. This evidence implies that even banks outside of the top decile areas take advantage of the booming house market and increase their investments in real estate. The implied aggregate increases in construction loans for exposed banks over the entire sample for small (big) banks is $2 (4.6) billion. Annually, these increases represent close to 1.5% of the total construction and development loans extended by small banks and close to 0.8% of the total credit by big banks.

[21] The implied increase uses coefficient estimates from Table 4, actual bank exposure, and stock of loans at the beginning of each year.

4.3 Effect of Shocks on Small Business Lending

In the next step I examine whether banks exposure to the two shocks leads to changes in small business lending by estimating:

$$\triangle \ln SBL^{i}_{b,t} = \alpha_1 \left(\text{Small}^{i} \times Exp^{i}_{t}\right) + \alpha_2 \left(\text{Big}^{i} \times Exp^{i}_{t}\right) + \beta X^{i}_{t} + \phi_i + \eta_{c,t} + \epsilon^{i}_{b,t} \tag{5}$$

$SBL^{i}_{b,t}$ is the small business originations by branch b of bank i in year t. Exp^{i}_{t} is allowed to have a different effect across banks with less and more than 30 branches. $\eta_{c,t}$ is a county-year fixed effect. In all samples I exclude branches located within areas under the immediate effect of each shock.[22]

The parameters of interest are α_1 and α_2. Positive estimates in the case of fracking imply that new wells allow for increases in lending outside of the energy booms. Under the assumption that exposure to fracking delivers additional liquidity to the affected banks, positive estimates are evidence that these intermediaries expand lending to small businesses only when deposits increase. In other words, the affected banks are dependent on internal sources of funding. Negative α's for the case of residential booms imply that banks finance their increased concentration in C&D loans by reducing credit to businesses away from the residential booms.[23] The inclusion of the county-year fixed effect implies that α_1 and α_2 are identified by comparing the loan originations by banks of varying exposure in the same county-year.[24] Therefore, the identification of this effect is not driven by differences in overall economic conditions in different counties – the county-year fixed effects already accommodate these differences.

[22]For fracking I exclude branches in areas with new horizontal wells as well as places with existing horizontal and directional wells. Excluding areas with wells is warranted under the concern that demand shocks are correlated with active drilling. For residential boom I exclude all branches within areas with appreciation above the 90^{th} percentile or areas where any of the existing banks faces residential appreciation above its respective median. I further exclude from the sample, bank networks for which less than 15% of branches are above median since for these banks the capital allocation within the network is not well defined.

[23]Under the assumption that real estate booms increase the return of both real estate and small business loans locally, the set of α's will capture the combined effect of higher loan origination in the part of the network which is excluded form the sample.

[24]This is the case because the effect of exposure in a location where all banks have the same exposure (or no exposure) cannot be distinguished from the county-year fixed effect.

Since the level of loan originations is likely branch-specific I use the growth of loan originations, rather than the level as it implicitly removes a branch fixed effect in the levels of loan originations.[25] Finally, to control for the fact that some banks may refinance more than others or provide loans with longer maturity, I also include a bank fixed effect in the main equation.

All samples exclude branches with direct exposure. This may not be sufficient to achieve identification for two reasons. First, the shock can be correlated with demand shocks in the nearby areas. For the case of fracking new wells may require an additional supporting infrastructure in nearby areas. Any increases in lending in these areas cannot, therefore, be attributed solely to changes in the bank credit supply. For the case of residential booms the surround areas can experience higher construction demand or general redevelopment if these booms lead to gentrification. Second, in the case of fracking the landowners may deposit their checks at branches just outside of the fracking areas. This implies that differences in the lending of treated and untreated banks will not capture differences in the available liquidity. Both of these concerns imply that I should exclude additional branches located near the energy booms. I provide additional coefficient estimates using only branches located at least 24 mi, 30 mi, 50 mi, and 100 mi away from any fracking wells.[26]

The results from the estimation of equation (5) can be found in Table 5. Column (1) excludes all branches within areas with active wells in the current and previous year. While the effect of exposure for small banks is positive, it is marginally significant. The coefficient increases and becomes significant at 5% when I exclude from the sample branches within 24 miles of fracking areas (column (2)). Further excluding branches within 30, 50, and 100 miles leads to a stable and similar coefficient across the estimations. All of the estimates for small banks imply that increased liquidity has a substantial effect on the banks' lending activity. After controlling for local variation in demand at the county level, I find that a branch of

[25] The branch fixed effect in the levels of originations also controls for the persistence of loans that are rolled over each year.

[26] I have done this analysis using degrees as a measure of distance. In the paper, I report the approximate distance in miles.

a small bank with 2 new wells increases origination growth of small business loans by 9% relative to a branch of a bank with no branches in fracking areas. The county-year fixed effects are crucial for identification in this estimation. Fracking can invigorate local demand for small business loans. As long as this leads to a county-wide increase, this effect will be controlled for with the fixed effects. My results, therefore, imply that even in counties that experience an overall increase in credit demand due to the energy booms, the banks with a liquidity shock increase their credit supply more relative to the banks with no liquidity shocks. The effect of exposure for big banks is not significant for any of the samples. This is consistent with the fact that these banks did not experience a liquidity shock from presence in fracking areas.

There seems to be a smaller difference between the lending of exposed versus unexposed banks at branches close to fracking areas. As previously discussed this is a result of a combination of spatially correlated demand shocks originating from the fracking areas and liquidity shocks experienced by banks located strictly outside the energy booms. Comparing lending activity at longer distances, the effect of the liquidity shock stabilizes in size and remains significant. This is due to the fact that in more distant credit markets exposed banks are compared to other banks that are much less likely to be related to general energy booms.

Over the entire sample the implied increase in originations by small banks is $5 billion. The average annual originations for locations within 200 miles of the energy booms are close to $33 billion, making the identified credit-supply increase substantial. Interestingly, almost the entire increase in the stock of deposits was invested in new originations between 2001 and 2005. While this estimate is higher than what is estimated by Plosser (2014), it is not necessarily comparable since it uses the deposit increases only from the drilling of new wells.

Figure 2 plots the α_1 coefficient from equation (5) with the 95% confidence bands for samples that sequentially exclude branches within the indicated distance. The figure also includes the distribution of the branches of small banks by distance from the fracking areas.

The coefficient plot indicates that liquidity has a big impact on lending within the band between 30 to 60 miles outside of fracking areas. Still, the impact is significant when I use only variation form branches beyond 100 miles. Beyond 130 miles, the effect of liquidity converges to zero. This is likely due to the fact that there are not too many branches of small banks beyond this distance.

The credit-supply effect is identified by comparing competing branches in different credit markets. To confirm that this comparison is justified and to make sure that the small banks exposed to fracking are not fundamentally different, I compare some key statistics from the balance sheet of exposed and unexposed banks. I also compare performance across the two bank categories by examining key components of the ROE.[27] The information for the two relevant categories of small banks – with no exposure, located within 100 miles of fracking and with positive exposure – is listed in Table A2 in the online appendix. Treated banks have a higher concentration in commercial and consumer lending and a lower concentration in loans secured by real estate and in securities. They fund their investments with a higher fraction of deposits and lower borrowing. The two groups have similar profitability, with the exposed banks earning slightly more non-interest income. The health of the portfolio is also similar. Overall, the information does not suggest that the treated banks are fundamentally different.

The results from the estimation of equation (5) for exposure to residential booms are given in columns (6)–(13) of Table 5. The first set of results use the fraction of branches in areas with residential appreciation in the top decile for the U.S. while the second set uses residential appreciation at the median branch of a bank network to capture exposure to booms. The sample in (6) excludes only branches in the top decile and sample (7)–(10) exclude branches within 24 to 100 miles from a residential boom. The effect of exposure to residential booms is negative and significant for both small and big bank networks. This is consistent with the fact that both bank categories increased their exposure to loans related to construction and

[27] Here I follow the modified Dupont analysis introduced by MacDonald and Koch (2014)

development. It is expected that bigger banks will face a lower marginal cost of borrowing from the interbank market and will be able to expand lending to land developers without decreasing small business loans compared to smaller banks. This expectation is borne out by the data – the coefficient for big banks is half the size of the small bank coefficient for most of the estimates. For both bank types, the effect increases once the branches close to residential booms are eliminated. There can be two explanations for this: 1) positive demand shocks affect areas close but outside the booming areas; 2) close to the booms branches of different banks are impacted similarly despite differences in the measure of exposure.[28]

To quantify the results let us focus on a branch more than 30 miles away from the residential boom. A small bank with 70% exposure will decrease loan origination growth by 78% relative to a branch of a bank with no exposure. The difference in origination drops to 23% if we consider all branches outside the booms. Focusing on big banks, a 38% difference in exposure leads to a 23% difference in loan origination growth if we only consider branches that are at least 30 miles away. If we consider all branches the difference drops to 14% and is marginally significant.

The results indicate that geographical concentration in areas with surging residential prices allows banks to take a relatively bigger positions in C&D investments. These are financed not through an increase in leverage but through a substitution away from small business credit in markets outside residential booms. This pattern is consistent across the two bank categories. The implied aggregate decrease in small business originations by small banks is approximately \$0.4 billion while for big banks the decrease is \$3.5 billion. These numbers represent respectively 25% and 9% of the aggregate originations by the exposed banks outside of residential booms. The reduction in small business credit is significantly higher than the increase in C&D loans. This suggests that the credit reduction is used

[28]There is an additional reason that the effect of exposure can have either sign in locations close to the boom. On one hand small business lending in a location with increasing housing prices should decrease because small businesses will rely on financing through home equity lines. Adelino et al (2013) document this mechanism. On the other hand small business loans should increase due to a demand boom that results from increases in household wealth as housing prices increase.

to finance other types of bank investments, possibly small business loans in the areas of residential booms. In other words, an overall increase in the demand for bank capital in the booming areas can explain the negative credit supply shift that banks impose on small businesses.

The contraction in credit can be traced to more than 100 miles away. Figure 3 plots the geographical extent of the credit reduction. Small banks contract credit predominantly within 30 to 100 miles away from the booming area. This periphery practically contains all of their branches outside. For big banks, the contraction in credit is more pronounced at branches beyond 100 miles. The combined effect for both bank types suggests that there was an overall reduction in credit to small businesses – at closer distance credit was reduced by small banks, while at bigger distances this was done by big banks.

In order to make sure that banks with a foothold in booming areas are not fundamentally different I compare balance sheet and performance measures for small banks with and without exposure to residential booms in Table A3 in the online appendix. Small banks with positive exposure are relatively bigger than other small banks within 100 miles of the residential booms. Both groups hold the same fraction of real estate loans, with the exposed banks holding a higher fraction of commercial and consumer loans. Unexposed banks hold a higher fraction of their assets in liquid investments. The difference in the loan mix makes exposed banks more profitable, partially due to the higher asset utilization (aTA/aTE) and partially due to the slightly higher leverage. The portfolio health of both groups is very similar. The overall differences between the two groups are consistent with the increases in the profitability of investments available to banks with higher geographical concentration in areas with residential booms.

The last three columns in Table 5 explore the alternative proxy for real estate booms. The sample in column (11) excludes branches above the median; (12) excludes branches above the median and in areas in the top 95^{th} percentile; (13) excludes branches above the median and in areas in the top 90^{th} percentile. The evidence across all estimations suggests that an increase in the median appreciation for small banks leads to a decrease in lending growth at the part of the network with lower appreciation. The effect of median appreciation is marginally significant for big banks but has the same direction. Focusing on counties where the residential appreciation is below the median for each bank, a small bank in the top quartile of exposure (2.6%) decreases origination growth by 13%-16% relative to competitors in the first quartile of exposure (1%). The advantageous geographical locations of some banks allows them to increase their profitability by investing in construction lending, which is offset on the balance sheet by a decrease in credit to small businesses in counties where the residential market experiences relatively slower appreciations. Notice that this effect is not driven by county-level differences across the U.S. – the county-year fixed effects accommodate this variation. The results indicate that within a county with a lower residential appreciation, banks with exposure to "hotter" markets decrease local credit to businesses at a higher rate.

The implied aggregate decrease in credit to businesses in counties with below median appreciation is \$2.1 billion for small and \$4.4 billion for big banks (at an annual basis). These contractions are significant since they represent close to 20% of total originations in these market by small banks and close to 10% of total originations for big banks. Similarly to the case of the top decile areas, the credit reduction is bigger than the increase in C&D loans, implying that banks substitute between small business lending at below median branches and a combination of C&D loans and other types of lending in areas with higher residential appreciation.

Comparing performance and asset composition of small banks above and below 1.4% (the median) of appreciation at the median branch (Table A4 in the online appendix) we see that higher exposure to residential appreciation is related to a higher concentration in loans secured by real estate and lower concentration in commercial and consumer lending. This is consistent with the increased incentive for investing in real estate when banks have a geographical advantage. Also consistent with the interpretation that real estate booms increase the profitability of real estate loans, higher median appreciation is associated with higher bank profitability. This is driven by higher asset utilization and slightly higher leverage. The health of the portfolio across the two groups is similar.

The results, taken together, are consistent with the argument that small banks extend more loans related to real estate when parts of their networks experience rapid residential appreciation. This leads to a decease in capital allocated for small business credit at branches where real estate prices are not growing as fast relative to the bank median. The shift is tantamount to a negative lending-supply shock for small businesses in areas which do not experience abrupt price appreciation of residential real estate. The results are consistent with evidence provided by Loutskina and Strahan (2015), who show that banks increase the growth rate of mortgage originations at the counties of their network where prices are higher. Chakraborty et al (2014) show that banks with exposure to real estate appreciations increase the real estate loans in their portfolios. My findings are also consistent with the evidence from the literature on the lending channel of monetary policy where smalls banks (as defined by assets (Kashyap and Stein (2000)) or by BHC affiliation (Campello (2002), Schnabl (2012)) are unable to alleviate funding shocks and decrease the supply of credit. Here banks face a higher return when investing in loans secured by residential real estate. They fund these loans by decreasing small business lending at locations that are not subject to real estate booms.

The identification rests on the important assumption that banks do not expand their networks in a strategic way. In particular, I assume that banks that face an increase in the marginal return of small business loans outside of fracking areas do not enter fracking areas in order to finance the increase loan demand. Evidence in Plosser (2014) and Gilje et al (2014) suggests that banks did not chase funds within fracking counties. In the robustness section I show that the results are not sensitive to the dropping from the sample of recently acquired/new branches in fracking areas.

5 Small Business Lending and Real Activity

The results so far do not imply that business credit markets are segmented. They indicate that bank credit may be limited by the overall funding available to the financial institutions. The availability of funding can impact the credit terms that banks can offer to small businesses and can induce businesses to switch banks. The observed changes in credit presented in the previous section are consistent with a weaker form of local segmentation – businesses are free to borrow from any local bank. Importantly, if there is also evidence that real activity is affected this will point to a stronger form of segmentation where businesses expand (are forced to contract) activity depending on the funding available at their local bank. This section investigates whether credit supply shifts impacted real activity measured by establishment growth.

5.1 Methodology

Studying the independent effect of credit on real activity is challenging – one is likely to observe both increases in credit and establishment growth not only because increased credit allows for economic expansion, but also because increases in business activity are associated with higher demand for credit.

While the amount of lending in a given geographical area is clearly endogenous with respect to the level of economic activity, one can argue that bank exposure to deposit growth or residential appreciation in other, disconnected, markets is not. In other words, it is unlikely that a small business, far from an energy boom, is more likely to be established when the bank in the proximity has more physical branches in an area with new fracking wells.[29] This allows me to investigate the link between the supply-driven changes in lending, proxied by bank exposure to the shocks, and establishment growth.

[29] A business within an industry that is directly related to mining is likely to be established in response to new fracking wells, even if the business is not in direct proximity to the energy boom. I exclude industries that are directly impacted by the shocks that I consider in the paper in order to avoid this source of endogeneity.

I measure *borrower* exposure to banks subject to shocks as:

$$AreaExp_{zip,t} = \frac{1}{\text{TotalBanks}_{zip,t}} \sum_{\text{BankSet}_{zip,t}} BankExposure_{i,t} \tag{6}$$

where $BankSet_{zip,t}$ and $\text{TotalBanks}_{zip,t}$ are, respectively, the set of distinct banks providing credit at a given zip code, and their total number. $BankExposure_{i,t}$ is defined as Exp_t^i in the previous section with the exception of appreciation at the median branch. In that case $AreaExp_{zip,t}$ is the fraction of below-median branches providing credit to a zip code.

Area exposure can be measured separately for small and for big banks. The top part of Figure 4 shows small bank area exposure for a sample year. The areas closest to energy booms have higher exposure, yet there is significant variation in exposure away from the booms. The plot for the real estate shock (not shown here) exhibits a similar pattern. In each of the cases, having areas with no exposure close to areas with exposure will be important for the identification of the effect of the balance sheet shocks.

The impact of credit supply shifts on establishment growth is estimated with:

$$\triangle \ln Est_{zip,t}^{ind} = \alpha_1 AreaExpSmall_{zip,t} + \alpha_2 AreaExpBig_{zip,t} + \delta_{ind,state,t} + \theta_{zip,ind} + \varepsilon_{ind,zip,t} \tag{7}$$

$\triangle \ln Est_{zip,t}^{ind}$ is the log difference of the number of total establishments of industry *ind* in area *zip* during year t. Industries are defined at the 2-digit NAICS level and exclude mining, construction, finance, and real estate (and insurance).[30] $AreaExpSmall_{zip,t}$ and $AreaExpBig_{zip,t}$ are defined as in (6), using only small or only big banks. $\delta_{ind,state,t}$ is an industry-state-year fixed effect which absorbs time-varying demand shocks at the industry level in each state. $\theta_{zip,ind}$ is a location-industry fixed effect which allows for differences in the permanent industry endowments at the zip code. Some of the difference in exposure can be explained by the level of urbanization of zip codes. The location-specific controls accommodate this source of variation. The identification of the area exposure effect is achieved by

[30] These industry are possibly affected directly by the shocks considered here.

comparing establishment growth for the same industry within the same state but at different zip codes. In all estimations I restrict the sample to the zip codes outside of the source of the shocks. I further exclude zip codes at increasing distance from the shocks in order to gauge whether there is an overlap between the credit supply shocks and the variation in establishment growth.

The coefficients of interest in this specification are the set of α's. Positive coefficients in the case of the energy booms imply that locations where credit was provided by banks with new fracking wells, grow faster than locations where credit is provided by the rest of the banks. Negative coefficients in the case of real estate booms imply that location where credit was reduced by banks investing in real estate loans grow slower than locations where this decrease was smaller.

5.2 Results

The results from the estimation of specification (7) is provided in Table 6. The set of samples considered closely follow those used in the previous section. Starting with areas that likely received increased access to liquidity we see that the coefficient for area exposure to small banks is statistically significant and positive for all but the first samples (columns (1)–(5)). The point estimate is higher when more zip codes are excluded but the standard error increases as well. A zip code which is serviced by a bank with two new wells and is more than 30 miles from a fracking area experiences 0.5% faster establishment growth relative to a zip code where credit is provided by a bank with no new wells. This effect goes up to almost 1% if we consider the results form estimation (5). The impact of the positive credit supply shock is substantial given that the average (median) zip code establishment growth is 0.8% (0%). The change in the coefficient for small banks is consistent with the pattern of lending. At branches close to fracking there was not a significant difference in lending between exposed and unexposed banks. This was due to the fact that unexposed banks close to fracking also received a positive liquidity shock. This can explain why close to fracking zip codes with low exposure experience similar establishment growth as zip codes with high exposure – all of these zip codes likely experience credit inflow.

The implied aggregate change in establishments due to the increase in the credit supply is approximately 50,000 between 2001 and 2007.[31] This accounts for 13% of the aggregate change in the number of U.S. establishments during the period, which was approximately 380,000. These estimates suggest that a $105 thousand increase in small business originations is associated with the creation of a new establishment. At the zip code level, a 1% increase in small business origination growth is associated with a 5bps increase establishment growth.

The zip codes where bank exposure lead to establishment growth are closely matched with the areas where branches increased lending as shown in Table 5. This match can be further confirmed with the coefficient plot in the bottom part of Figure 4. Zip codes, more than 100 miles away, experienced faster establishment growth when they received credit from branches of banks exposed to fracking.

I have compared zip codes where credit was provided by small banks with and without exposure to fracking. Table A5 in the online appendix shows that zip codes without exposure have higher agricultural, construction, and transportation shares of establishments, while those with exposure have more FIRE, and professional services establishments. This is consistent with the fact that zip codes with exposure are more urban, have a higher income, population, and education levels. This comparison underscores the importance of controlling for differences in the endowments across locations in the main regression. Even though the results are not driven by these fixed differences, it appears that the increase in lending and in establishments occurred mostly in areas with urban characteristics.

Focusing on area exposure to residential booms in the top decile we see that the credit contraction by small banks has a significant negative impact on establishment growth. Columns (6)–(10) show that the effect is statistically significant and has a similar value across all of the samples. A zip code where credit was provided by banks with 70% of branches in

[31] This estimate uses the small bank exposure coefficient of 0.00239.

booms experiences 0.9% slower establishment growth relative to a zip code with credit from banks with no branches in booms. This difference in *bank* exposure at individual banks lead to a 78% decrease in lending growth. The implied aggregate decrease in the number of establishments at zip codes where credit was provided by small banks with branches in the top decile is approximately 13,000 between 2001 and 2005. This represents 4.4% of the total new establishments added during the same period. The total decrease in originations for this period is $2.2 billion, implying that a $170 thousand decrease in small business lending is associated with the closure of an establishment.

The effect of credit contraction by big banks does not have a significant effect on establishment growth. The contraction was likely substituted away by businesses from alternative sources. This is consistent with the idea that borrowers form bigger banks rely on transactions-based lending and are less constrained in terms of alternative sources of credit. Notice from Figure 3 that big banks reduced credit at branches more than 100 miles from residential booms. At such a distance, there is no evidence that small banks also contracted credit. It is, therefore, likely that businesses substituted the credit reduction from big banks with credit from small banks.

The bottom part of Figure 4 plots the effect of exposure to small banks as different zip codes are eliminated from the sample. The reduction in real activity matches well the contraction in credit by small banks. As expected, the effect goes to zero as branches at larger distances are eliminated. While small bank networks have a limited geographic span, they can still generate negative effects on real activity beyond 100 miles from areas with booms.

Table A6 available in the online appendix compares the characteristics of zip codes across exposure to banks with branches in the top decile. Similarly to the case of fracking, zip codes where credit is provided by small banks with exposure to residential booms are more urban. They have a higher share of professional and health care services establishments, higher population, and income. While urban areas with high levels of income and eduction are the hubs of innovation and business start-ups, being located in these areas is not sufficient. The availability of business credit appears to be critical for growth in real activity.

The results for the alternative specification of residential booms, columns (11)–(14), show that borrowing from below median branches of small banks has a statistically significant, negative effect on establishment growth. The magnitude of the effect decreases when zip codes with high residential appreciation or zip codes in the proximity are excluded from the sample. A zip code located within 50 miles of an area in the top decile borrowing only from below-median branches will experience 0.34% slower establishment growth relative to a zip code which borrows only from above-median branches. The implied aggregate decrease in the number of establishments explained by the fraction of below-median branches is approximately 37,000 between 2001 and 2005.[32] This represents 11.5% of the total new establishments added during the same period. The total decrease in originations by small banks at branches that were below the median is $10.6 billion. This implies that a $283 thousand decrease in small business lending is associated with the closure of an establishment. Table A7 available in the online appendix confirms that zip codes serviced by banks with high and low exposure are very similar. This suggests that the locations with lower fraction of below median branches are not fundamentally different. The major difference is that banks lowered their loan concentration in the first group and increased their concentration in the second.

The results in this section taken together with the changes in credit supply point to a strong segmentation in the market for small business lending. The fact that real activity increases as banks channel additional liquidity to places more than 100 miles away does not showcase the importance of these intermediaries. It shows that businesses in these areas were not able to expand using funds from other banks and are forced to wait for funding opportunities from their local banker. Similarly, in the case of exposure to residential booms businesses that are forced to lower their activity lose funding because lending to them is not

[32]The estimate uses the coefficient from regression (2), -0.00277.

as profitable as lending to construction at other offices of the bank. While this is optimal from the bank's perspective it is not obvious whether other distant banks may not find it optimal to lend to this business. Since credit and activity fall the evidence suggests that businesses were not able to access other sources of credit.

6 Robustness and Extensions

This section extends the results for small business lending by exploring the extensive margin. In addition, I examine whether the effects of each of the shocks is robust to: using an asset-based definition of bank size; controlling for both shocks at the same time; excluding new branches; controlling for the headquarter effect or home bias; controlling for the average distance between a branch and the borrowers.

Asset-based Bank Groups The group of small banks used in the paper closely overlaps with institutions with less than $1.1 billion in assets. Table 7 provides some key regression results based on the asset-based definition. The coefficient estimates are close to those in the main section.

The Extensive Margin The information provided in the CRA filings allows me to infer the total number of loans at bank branches. The results from the extensive margin are hard to interpret – when banks increase the amount of credit to existing customers, they have discretion over whether they report this as one origination or two separate originations. For this reason, it is hard to distinguish if the bank is serving new customers and refinancing less or whether the bank is just refinancing more loans. Most importantly, finding that a coefficient is not statistically different form zero does not imply that no loans to new businesses are made. The results are reported in Table 8. The first estimation presents the impact of new wells on the growth rate in the number of originations, excluding from the sample branches within 30 miles of fracking activity. While the coefficient for small banks is positive, the effect is not statistically significant. The second set of results focuses on the fraction of branches in areas with residential booms (top 90^{th} percentile of appreciation). The coefficient for small banks is statistically significant and negative. This indicates lower origination activity for banks with higher exposure to residential booms. The effect is not significant for bigger banks. The last set of results focuses on the effect of real estate appreciation at the median branch. The coefficients for both bank categories are negative but not significant.

Controlling for Both Shocks The identification in the paper assumes that the two shocks are not related since they are located in different areas. Furthermore, given that small banks were mostly affected, one need not worry about the spillovers between the two shocks due to the limited span of their networks. I test this assumption by focusing on the period between 2001 and 2005, the overlap between the two shocks, and estimating the lending equation with both measures of exposure. The estimates are presented in Table 9. The first estimation only uses exposure to new wells, while the second uses only the fraction of branches within areas in the top decile. The sample in both estimations is identical. In the last regression, I include both measures simultaneously. Coefficients are almost identical in each of the estimations.

Network Selection, Headquarter Effect, and Distance to the Branch The main results related to fracking assume that banks do not deliberately open new branches within areas with new fracking wells in order to capture additional liquidity. Over the period between 2001 and 2007 there is indeed a significant number of branch acquisitions and construction of new branches. 168 (647) of the 819 (4,038) branches of small (big) banks that have been in proximity to new fracking wells have either been acquired or established. To explore the sensitivity of the main results to the changes in the branch network I exclude these branches from the sample when calculating bank exposure. The results based on branches farther than 50 miles from fracking are listed in the first column of Table 10. The coefficient for small banks does not change. This is an indication of the fact that most of the branch acquisitions involved institutions which already had an exposure to fracking.

Results by Keeton (2009) and Presbitero et al (2014) suggest that bank headquarters are treated differently, either because of home bias or due to informational problems. I explore the sensitivity of my results to this by examining whether the effects of the shocks are different at the headquarter branch. This is done by interacting each of the measures of exposure to a particular shock with an indicator for whether the branch is also the main bank branch. The results are listed in Table 10. In the case of fracking, there is some evidence that lending is expanded at non-headquarter branches while the main branch does not experience much of a change. In the case of branches in top decile, it seems that the headquarter reduces lending more than the rest of the branches. The fracking result can be explained by the fact that most of the investment opportunities are at the non-headquarter branches. The real-estate result can be due to the fact that the expansion of lending to construction and development done at the headquarter.

The literature on borrower distance and small business lending argues that relationship lending is conducted at close proximity to the borrowers (Degryse and Ongena (2005)). Therefore, branches that serve more distant businesses provide credit to less opaque firms. In order to see whether the baseline results are sensitive to the type of firms each branch is serving (as proxied by average distance to the firm), I control for the average distance between the branch and the lending locations. In particular, I interact average distance between the branch and the firms that it serves with the measure of exposure to each of the shocks. Notice that the average distance could alternatively capture branches that lend in rural areas where firms are more geographically dispersed. The results are listed in Table 10. The coefficients for the impact of exposure are mostly unaffected. In the case of appreciation at the median branch, exposed banks reduce lending primarily at branches that serve more distant customers.

7 Conclusion

This study investigates the extent of access to funding available to small businesses in distinct credit markets. I show that banks exposed to shocks in one market experience changes in their ability to lend and impose credit supply shocks in the rest of their markets, affecting the real activity of borrowers. Smaller banks are key in this process. Their balance sheet is affected by exposure to energy booms and to real estate booms. This exposure is transmitted to businesses via increased and decreased credit, respectively. The fact that real activity increases following the positive credit supply shock shows that businesses in areas with increased credit were not able to expand earlier using funds from other banks and were forced to wait for funding opportunities from their local banker. Similarly, decreased activity following credit contraction shows that businesses in areas with reduced credit were forced to lower their activity unable to substitute funding lost to more profitable construction projects elsewhere. While this is optimal from the perspective of the financial intermediary it is likely inefficient since a more distant bank may find it optimal to fund the business but is not able to. These results strongly indicate that the credit market for small business lending provided by smaller banks is segmented i.e. small businesses are not able to access credit from non-local small banks.

Tables and Figures

Table 1: Summary Statistics for Intermediaries Reporting Small Business Loans

Banks with less than 30 branches										
Year	N	ln Assets	Deposits/Assets	Interest Expense/Deposits	Securities/Assets	Tier1 Capital/Assets	C&I/Assets	Mortgages/Assets	Net Income/Assets	Unused Commit/Assets
2001	1,222	13.029	0.788	0.009	0.218	0.088	0.097	0.250	0.007	0.217
2002	1,308	13.048	0.788	0.006	0.228	0.088	0.094	0.230	0.007	0.171
2003	1,436	13.082	0.788	0.004	0.234	0.089	0.092	0.217	0.007	0.192
2004	1,369	13.131	0.787	0.004	0.229	0.090	0.096	0.204	0.007	0.237
2005	668	13.547	0.770	0.005	0.236	0.089	0.091	0.211	0.007	0.297
2006	614	13.639	0.774	0.007	0.219	0.091	0.093	0.208	0.007	0.220
2007	581	13.711	0.760	0.008	0.186	0.097	0.102	0.205	0.006	0.300
Banks with more than 30 branches										
Year	N	ln Assets	Deposits/Assets	Interest Expense/Deposits	Securities/Assets	Tier1 Capital/Assets	C&I/Assets	Mortgages/Assets	Net Income/Assets	Unused Commit/Assets
2001	238	15.368	0.727	0.008	0.209	0.074	0.114	0.231	0.007	0.202
2002	256	15.497	0.726	0.005	0.226	0.075	0.108	0.223	0.008	0.202
2003	255	15.501	0.728	0.003	0.231	0.075	0.101	0.226	0.007	0.199
2004	238	15.545	0.728	0.003	0.231	0.077	0.102	0.235	0.007	0.207
2005	242	15.608	0.730	0.004	0.213	0.077	0.102	0.237	0.008	0.222
2006	238	15.663	0.734	0.006	0.195	0.079	0.103	0.227	0.007	0.248
2007	245	15.629	0.734	0.007	0.179	0.080	0.108	0.218	0.006	0.234

Notes: The table reports medians for the bank controls for each of the years in the sample. Interest expense is reported at the quarterly level.

Table 2: Summary Statistics for Banks Exposed to Fracking

Banks with less than 30 branches										
	No Exposure					*Positive Exposure*				
	N	New Wells	$\triangle \ln SBL$	$\triangle \ln Dep$	Interest Expense/Deposits	N	New Wells	$\triangle \ln SBL$	$\triangle \ln Dep$	Interest Expense/Deposits
2001	1,015	0.000	0.248	0.081	0.96%	37	0.893	0.217	0.139	0.82%
2002	1,058	0.000	0.058	0.072	0.57%	36	0.395	0.024	0.076	0.52%
2003	1,101	0.000	0.085	0.082	0.41%	43	1.136	0.122	0.067	0.36%
2004	1,120	0.000	0.011	0.055	0.33%	84	0.953	0.047	0.049	0.29%
2005	588	0.000	0.030	0.074	0.44%	32	0.346	0.074	0.076	0.43%
2006	525	0.000	0.007	0.080	0.66%	19	1.682	0.025	0.092	0.67%
2007	445	0.000	0.018	0.048	0.83%	54	0.642	0.012	0.051	0.76%
Banks with more than 30 branches										
	No Exposure					*Positive Exposure*				
	N	New Wells	$\triangle \ln SBL$	$\triangle \ln Dep$	Interest Expense/Deposits	N	New Wells	$\triangle \ln SBL$	$\triangle \ln Dep$	Interest Expense/Deposits
2001	168	0.000	0.227	0.085	0.85%	52	0.064	0.413	0.061	0.84%
2002	198	0.000	0.063	0.077	0.50%	42	0.069	0.068	0.042	0.49%
2003	209	0.000	0.047	0.089	0.36%	37	0.229	0.082	0.089	0.34%
2004	175	0.000	0.021	0.066	0.30%	59	0.140	0.053	0.056	0.26%
2005	181	0.000	0.045	0.092	0.41%	54	0.133	0.036	0.087	0.39%
2006	163	0.000	0.044	0.076	0.61%	69	0.436	0.006	0.093	0.60%
2007	137	0.000	0.033	0.049	0.75%	97	0.321	-0.036	0.038	0.73%

Notes: The table lists averages for bank exposure to fracking, growth in originations, growth in deposits, and interest expense, across small and big banks, and across exposed and unexposed banks.

Table 3: Summary Statistics – Top Decile of Residential Real Estate Appreciation

	Banks with less than 30 branches						*Banks with more than 30 branches*					
	No Exposure			*Positive Exposure*			*No Exposure*			*Positive Exposure*		
	Exp	$\triangle \ln SBL$	$\triangle \ln Dep$	*Exp*	$\triangle \ln SBL$	$\triangle \ln Dep$	*Exp*	$\triangle \ln SBL$	$\triangle \ln Dep$	*Exp*	$\triangle \ln SBL$	$\triangle \ln Dep$
2001	0	0.212	0.143	0.733	0.227	0.139	0	0.112	0.106	0.417	0.221	0.094
2002	0	0.005	0.120	0.752	0.023	0.130	0	0.036	0.084	0.489	0.067	0.097
2003	0	0.058	0.131	0.691	0.073	0.160	0	0.030	0.095	0.337	0.065	0.087
2004	0	-0.027	0.082	0.661	-0.024	0.194	0	-0.066	0.077	0.368	-0.016	0.097
2005	0	0.009	0.129	0.623	-0.092	0.236	0	-0.021	0.101	0.310	-0.008	0.141

Notes: The table lists averages for exposure to real estate boom, the average small business origination growth, and the average deposit growth across banks with no exposure and banks with positive exposure, and across size. Exposure here is defined as the fraction of branches in the areas where average quarterly appreciation of residential real estate is in the top decile for the U.S..

Table 4: Effect of New fracking Wells and Real Estate Booms on Balance Sheet Variables

Dependent Variable	△ ln Branch Deposits (1)	△ ln Bank Deposits (2)	△ ln Bank \$100K+ Dep (3)	△ Interest Expense (4)	C&D (5)	C&D* (6)	RE (7)	C&D (8)	C&D* (9)	RE (10)
New Wells in Proximity × Small	0.000487**									
	(0.000238)									
New Wells in Proximity × Big	0.000395***									
	(0.000130)									
Avg. New Wells × Small		0.00225***	0.223**	-0.0386**						
		(0.000871)	(0.102)	(0.0155)						
Avg. New Wells × Big		-0.00154	-0.0245	-0.0296						
		(0.00211)	(0.191)	(0.0425)						
Frac in Top 90^{th} × Small					0.00477**	0.00676**	0.0103**			
					(0.00186)	(0.00302)	(0.00519)			
Frac in Top 90^{th} × Big					0.0166***	0.0236***	0.00506			
					(0.00533)	(0.00660)	(0.0123)			
Appr at Med Branch × Small								0.351***	0.574***	0.462**
								(0.0997)	(0.144)	(0.198)
Appr at Med Branch × Big								0.309*	0.412**	0.130
								(0.172)	(0.207)	(0.298)
Observations	310,206	7,490	7,177	7,490	5,550	5,550	5,550	5,500	5,500	5,500
R-squared	0.007	0.546	0.427	0.405	0.939	0.943	0.945	0.939	0.944	0.946
Bank FE	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Clustered SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: *** p<0.01, ** p<0.05, * p<0.1. The table provides coefficient estimates for the impact of bank exposure on, respectively, branch-level deposit growth, bank-level total deposit growth, bank-level \$100K+ deposit growth, change in interest expense, construction and development loans as a fraction of assets, construction and development loans + unused commitments as a fraction of assets (C&D*), and loans secured by real estate + unused commitments as a fraction of assets (RE). Interest expense is in percentage units and is at an annual basis. Controls included in the estimation but not reported include: ln Assets_{t-1}, $\text{Deposits/Assets}_{t-1}$, $\text{Securities/Assets}_{t-1}$, $\text{C\&I/Assets}_{t-1}$, $\text{Mortgages/Assets}_{t-1}$, Unused Loan $\text{Commitments/Assets}_{t-1}$, △ TotalBranches × Small Bank, △ TotalBranches × Big Bank, $\triangle I$(Small Bank). Each of the controls is the quarterly average from the previous year. Sample covers 2001 to 2007.

Table 5: Effects of Local Shocks on Small Business Lending

Dependent Variable	△ ln Small Business Lending												
Excluded Branches	Frack Area (1)	Frack +24mi (2)	Frack +30mi (3)	Frack +50mi (4)	Frack +100mi (5)	90^{th} Areas (6)	90^{th} +24mi (7)	90^{th} +30mi (8)	90^{th} +50mi (9)	90^{th} +100mi (10)	>Med Appr (11)	>Med & 95^{th} (12)	>Med & 90^{th} (13)
Avg. New Wells × Small	0.0191*	0.0256**	0.0450***	0.0406**	0.0414**								
	(0.0107)	(0.0120)	(0.0157)	(0.0180)	(0.0206)								
Avg. New Wells × Big	-0.00181	0.00153	0.00187	0.00270	0.0119								
	(0.00631)	(0.00496)	(0.00509)	(0.00545)	(0.0124)								
Frac in Top 90^{th} × Small						-0.335**	-0.659**	-1.111***	-1.267***	-1.322**			
						(0.169)	(0.296)	(0.311)	(0.452)	(0.596)			
Frac in Top 90^{th} × Big						-0.369*	-0.587**	-0.599**	-0.645*	-0.785**			
						(0.201)	(0.291)	(0.304)	(0.346)	(0.369)			
Appr at Med Branch × Small											-8.703**	-9.741**	-8.182**
											(3.548)	(3.817)	(4.068)
Appr at Med Branch × Big											-4.651*	-4.810*	-4.709*
											(2.615)	(2.634)	(2.637)
Observations	263,105	239,519	230,845	210,678	169,632	177,429	165,300	161,574	154,177	143,735	88,974	87,717	85,669
R-squared	0.178	0.178	0.177	0.175	0.174	0.204	0.211	0.212	0.215	0.216	0.259	0.258	0.259
County x Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Clustered SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: *** p<0.01, ** p<0.05, * p<0.1. The table provides coefficient estimates for the impact of new fracking wells on the growth in originations of small business loans at different branches of the bank network. Each of the regressions excludes branches in areas with horizontal or directional wells as well as areas with drilling activity in the previous year. The first regression excludes branches within areas with fracking activity (as defined by Hydrological Unit Codes). Regressions (2) to (5) exclude branches within the corresponding distance from the boundary of an area with fracking activity. Controls included in the estimation but not reported include: ln Assets_{t-1}, $\text{Deposits/Assets}_{t-1}$, Cost of Deposits_{t-1}, $\text{Securities/Assets}_{t-1}$, Tier1 $\text{Capital/Assets}_{t-1}$, $\text{C\&I/Assets}_{t-1}$, $\text{Mortgages/Assets}_{t-1}$, Net $\text{Income/Assets}_{t-1}$, Unused Loan $\text{Commitments/Assets}_{t-1}$, Is Part of Multi-BHC?, Is Part of Single-BHC?, △ TotalBranches × Small Bank, △ TotalBranches × Big Bank, $\triangle I$(Small Bank). Each of the samples covers the period form 2001 up to 2007.

Table 6: Real Effects of Credit Supply Shifts

Dependent Variable	$\triangle$ ln Total Establishments in Zip Code													
Excluded Zip Codes	Frack Area	Frack +24mi	Frack +30mi	Frack +50mi	Frack +100mi	90^{th} Areas	90^{th} +24mi	90^{th} +30mi	90^{th} +50mi	90^{th} +100mi	None	90^{th}	90^{th} +50mi	90^{th} +100mi
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Area Frack Exp, Small	0.000908*	0.00231***	0.00239***	0.00327**	0.00460**									
	(0.000502)	(0.000716)	(0.000813)	(0.00156)	(0.00219)									
Area Frack Exp, Big	-0.000305	-9.27e-05	5.79e-05	-0.000192	-0.000225									
	(0.000411)	(0.000430)	(0.000448)	(0.000601)	(0.00179)									
Area Exp 90^{th}, Small						-0.0167***	-0.0131**	-0.0127**	-0.0162**	-0.0155**				
						(0.00548)	(0.00611)	(0.00640)	(0.00704)	(0.00751)				
Area Exp 90^{th}, Big						-0.00422	-0.00859	-0.00748	-0.00600	-0.00676				
						(0.0121)	(0.0128)	(0.0129)	(0.0132)	(0.0141)				
Area Frac >Med, Small											-0.00340***	-0.00277**	-0.00286**	-0.00263*
											(0.00125)	(0.00132)	(0.00137)	(0.00141)
Area Frac >Med, Big											-0.000251	-0.000219	-0.000617	-0.000792
											(0.00151)	(0.00151)	(0.00161)	(0.00169)
Observations	1,198,465	1,095,673	1,059,251	968,891	759,595	959,198	912,749	898,049	863,821	802,821	1,108,536	943,633	829,916	771,159
R-squared	0.188	0.192	0.193	0.197	0.208	0.210	0.211	0.211	0.213	0.218	0.208	0.216	0.220	0.224
Zip x Ind FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State x Ind x Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State x Ind Clust SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: *** p<0.01, ** p<0.05, * p<0.1. The table provides coefficient estimates for the impact of zip code exposure to banks with branches in fracking areas. Each of the regressions excludes zip codes in areas with horizontal or directional wells as well as areas with drilling activity in the previous year. The first regression excludes zip code within areas with fracking activity (as defined by Hydrological Unit Codes). Regressions (2) to (5) exclude zip codes within the corresponding distance from the boundary of an area with fracking activity. Each of the samples covers the period form 2001 up to 2007.

Table 7: Small Business Lending: Asset-based Bank Groups

Dependent Variables	$\triangle$ ln Small Business Lending		
	No Branches 30mi to Fracking	No Branches 30mi to Top 90^{th}	No Branches Above Median
Avg. New Wells $\times$ (Assets$\leq$ \$1.1 billion)	0.0619***		
	(0.0199)		
Avg. New Wells $\times$ (Assets> \$1.1 billion)	0.00227		
	(0.00498)		
Fraction of Branches in Top 90^{th} $\times$ (Assets$\leq$ \$1.1 billion)		-1.707***	
		(0.449)	
Fraction of Branches in Top 90^{th} $\times$ (Assets> \$1.1 billion)		-0.672**	
		(0.304)	
Appreciation at Median Branch $\times$ (Assets$\leq$ \$1.1 billion)			-9.166***
			(3.463)
Appreciation at Median Branch $\times$ (Assets> \$1.1 billion)			-4.943*
			(2.646)
Observations	230,845	156,166	87,717
R-squared	0.177	0.217	0.258
County x Year FE	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes
Bank Clustered SE	Yes	Yes	Yes

Notes: *** p<0.01, ** p<0.05, * p<0.1. The table provides coefficient estimates for the impact of each of the shocks on the originations. Bank groups are defined based on asset sizes. For variable definitions and sample restrictions refer to the notes for the baseline results. Controls included in the estimation but not reported include: ln Assets_{t-1}, $\text{Deposits/Assets}_{t-1}$, Cost of Deposits_{t-1}, $\text{Securities/Assets}_{t-1}$, Tier1 $\text{Capital/Assets}_{t-1}$, $\text{C\&I/Assets}_{t-1}$, $\text{Mortgages/Assets}_{t-1}$, Net $\text{Income/Assets}_{t-1}$, Unused Loan $\text{Commitments/Assets}_{t-1}$, Is Part of Multi-BHC?, Is Part of Single-BHC?, $\triangle$ TotalBranches $\times$ Small Bank, $\triangle$ TotalBranches $\times$ Big Bank, $\triangle I$(Small Bank).

Table 8: The Extensive Margin of Small Business Lending

Dependent Variables	△ ln Number of Small Business Originations		
	No Branches 30mi to Fracking	No Branches 30mi to Top 90^{th}	No Branches Above Median
Avg. New Wells × Small Bank	0.00315		
	(0.0247)		
Avg. New Wells × Big Bank	-0.00132		
	(0.00804)		
Fraction of Branches in Top 90^{th} × Small Bank		-0.888***	
		(0.324)	
Fraction of Branches in Top 90^{th} × Big Bank		-0.639	
		(0.549)	
Appreciation at Median Branch × Small Bank			-7.255
			(4.426)
Appreciation at Median Branch × Big Bank			-2.590
			(3.572)
Observations	230,845	161,574	88,974
R-squared	0.213	0.264	0.320
County x Year FE	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes
Bank Clustered SE	Yes	Yes	Yes

Notes: *** p<0.01, ** p<0.05, * p<0.1. The table provides coefficient estimates for the impact of each of the shocks on the number of originations. For variable definitions and sample restrictions refer to the notes for the baseline results. Controls included in the estimation but not reported include: ln Assets_{t-1}, Deposits/Assets_{t-1}, Cost of Deposits_{t-1}, Securities/Assets_{t-1}, Tier1 Capital/Assets_{t-1}, C&I/Assets_{t-1}, Mortgages/Assets_{t-1}, Net Income/Assets_{t-1}, Unused Loan Commitments/Assets_{t-1}, Is Part of Multi-BHC?, Is Part of Single-BHC?, △ TotalBranches × Small Bank, △ TotalBranches × Big Bank, $\triangle I$(Small Bank).

Table 9: Interactions between Fracking and Residential Booms

Dependent Variables	△ ln Small Business Lending		
	No Branches in Fracking or 90^{th}	No Branches in Fracking or 90^{th}	No Branches in Fracking or 90^{th}
	(1)	(2)	(3)
Avg. New Wells × Small Bank	0.0433**		0.0436**
	(0.0201)		(0.0197)
Avg. New Wells × Big Bank	0.0204		0.0206
	(0.0204)		(0.0207)
Fraction of Branches in Top 90^{th} × Small Bank		-0.332*	-0.337*
		(0.178)	(0.178)
Fraction of Branches in Top 90^{th} × Big Bank		-0.360*	-0.360*
		(0.193)	(0.191)
Observations	132,576	132,585	132,576
R-squared	0.210	0.210	0.210
County x Year FE	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes
Bank Clustered SE	Yes	Yes	Yes

Notes: *** p<0.01, ** p<0.05, * p<0.1. The table provides coefficient estimates for the impact of fracking controlling for fraction of branches in areas with residential appreciation in the top decile. The sample covers 2001 to 2005. It excludes branches close to fracking and branches in areas with residential booms. Controls included in the estimation but not reported include: ln Assets_{t-1}, Deposits/Assets_{t-1}, Cost of Deposits_{t-1}, Securities/Assets_{t-1}, Tier1 Capital/Assets_{t-1}, C&I/Assets_{t-1}, Mortgages/Assets_{t-1}, Net Income/Assets_{t-1}, Unused Loan Commitments/Assets_{t-1}, Is Part of Multi-BHC?, Is Part of Single-BHC?, △ TotalBranches × Small Bank, △ TotalBranches × Big Bank, $\triangle I$(Small Bank).

Table 10: Network Selection, Headquarter Effect, Distance to Borrower

Dependent Variables	△ ln Small Business Lending						
	Old Branches	Headquarter Effect			Distance to Borrower		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Avg. New Wells × Small Bank	0.0431**	0.0466***			0.0348*		
	(0.0186)	(0.0158)			(0.0204)		
Avg. New Wells × Big Bank	0.00261	0.00188			0.000837		
	(0.00543)	(0.00510)			(0.00505)		
Fraction of Branches in Top 90^{th} × Small Bank			-1.055***			-1.022**	
			(0.317)			(0.431)	
Fraction of Branches in Top 90^{th} × Big Bank			-0.599**			-0.425*	
			(0.305)			(0.245)	
Appreciation at Median Branch × Small Bank				-8.515**			-6.311*
				(3.430)			(3.439)
Appreciation at Median Branch × Big Bank				-4.054			-2.451
				(2.523)			(2.598)
Avg. New Wells × Small Bank × Is HQ?		-0.0510*					
		(0.0308)					
Avg. New Wells × Big Bank × Is HQ?		-0.00165					
		(0.0109)					
Fraction of Branches in Top 90^{th} × Small Bank × Is HQ?			-0.917**				
			(0.431)				
Fraction of Branches in Top 90^{th} × Big Bank × Is HQ?			0.0476				
			(0.252)				
Appreciation at Median Branch × Small Bank × Is HQ?				1.081			
				(1.341)			
Appreciation at Median Branch × Big Bank × Is HQ?				-0.107			
				(1.731)			
Avg. New Wells × Small Bank × ln(1+Dist)					0.0305		
					(0.0260)		
Avg. New Wells × Big Bank × ln(1+Dist)					0.00803		
					(0.0259)		
Fraction of Branches in Top 90^{th} × Small Bank × ln(1+Dist)						-0.315	
						(0.868)	
Fraction of Branches in Top 90^{th} × Big Bank × ln(1+Dist)						-0.682	
						(0.506)	
Appreciation at Median Branch × Small Bank × ln(1+Dist)							-9.921***
							(2.993)
Appreciation at Median Branch × Big Bank × ln(1+Dist)							-9.536***
							(3.187)
Observations	210,644	230,845	161,574	92,435	230,845	161,574	92,435
R-squared	0.175	0.177	0.213	0.257	0.177	0.213	0.259
County x Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Clustered SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: *** p<0.01, ** p<0.05, * p<0.1. The table provides coefficient estimates for specifications that extend the baseline models. Specifications (1) and (4) allow the main effects to differ at the headquarter and according to the distance to between the branch and the borrower, for the case of fracking. Estimations (2) and (5), and (3) and (6) do this for the case of fraction of branches in the top decile and appreciation at the median branch.

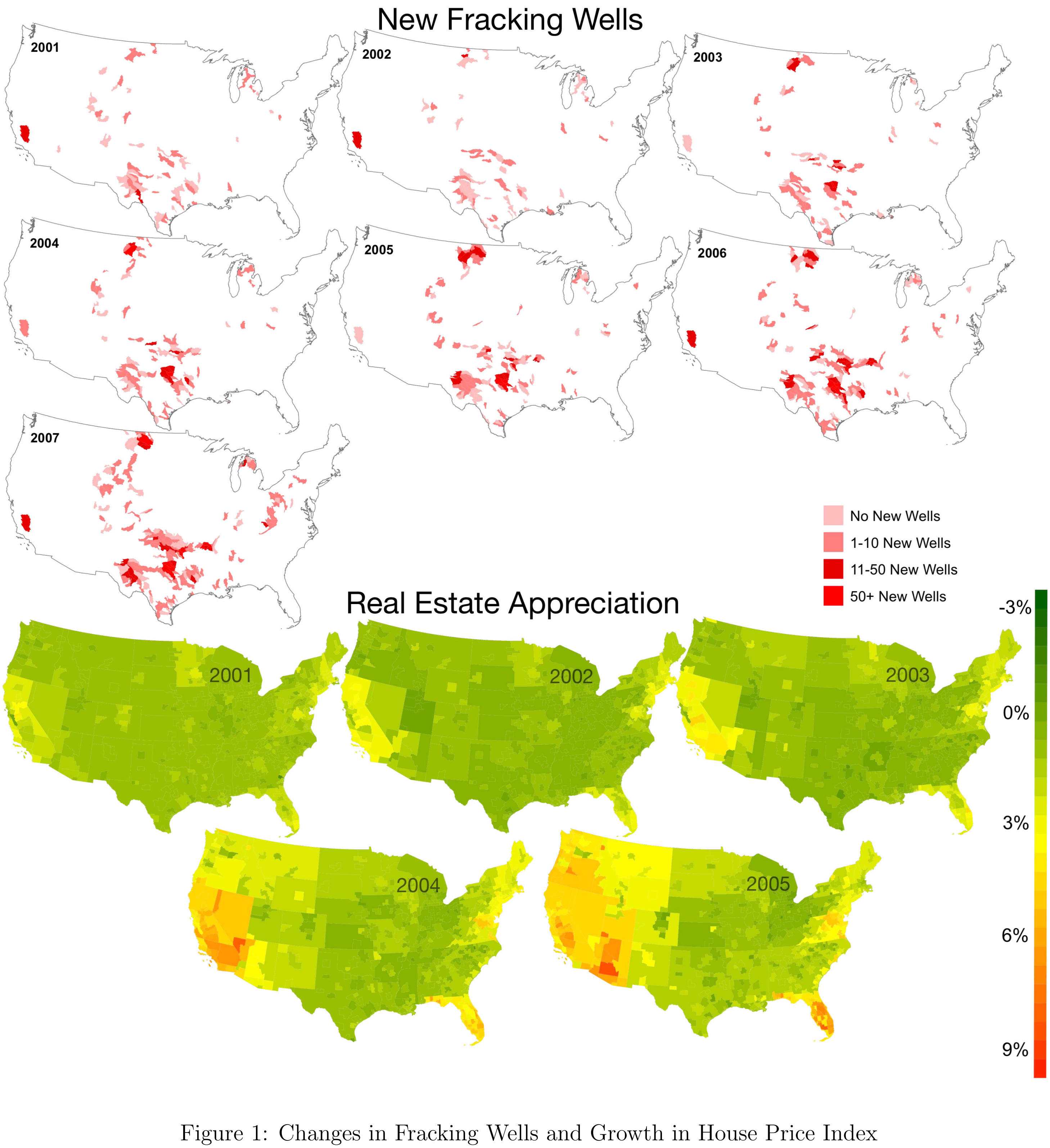

Figure 1: Changes in Fracking Wells and Growth in House Price Index

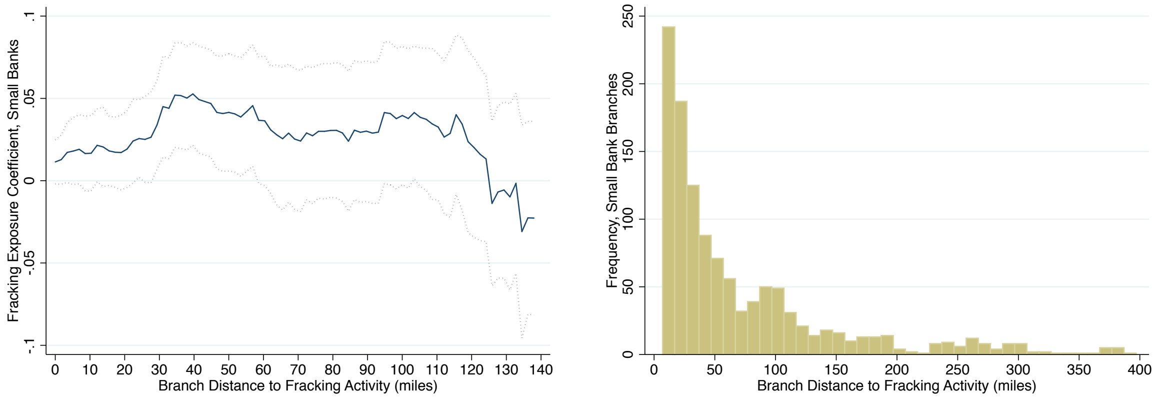

Figure 2: Coefficient Plot of Exposure to Fracking and Branch Distribution, Small Banks

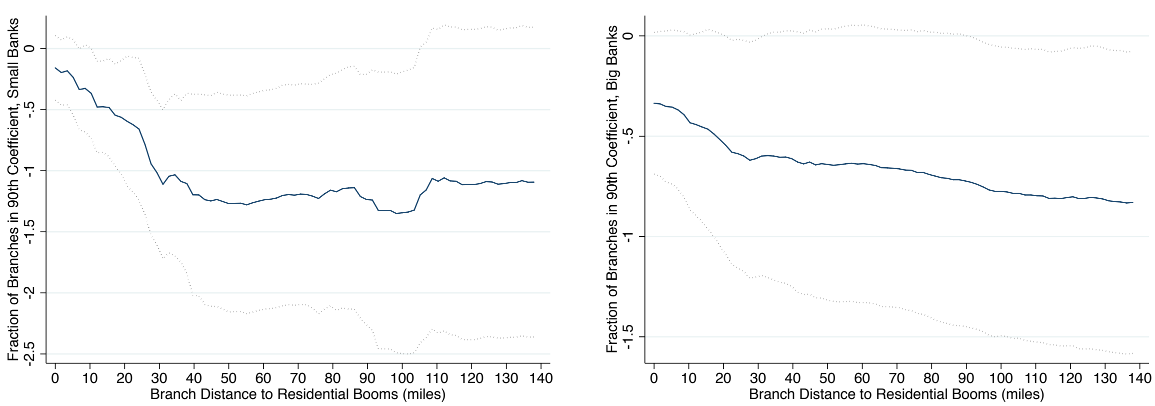

Figure 3: Coefficient Plot of the Effect of Fraction of Branches in Areas with Residential Booms

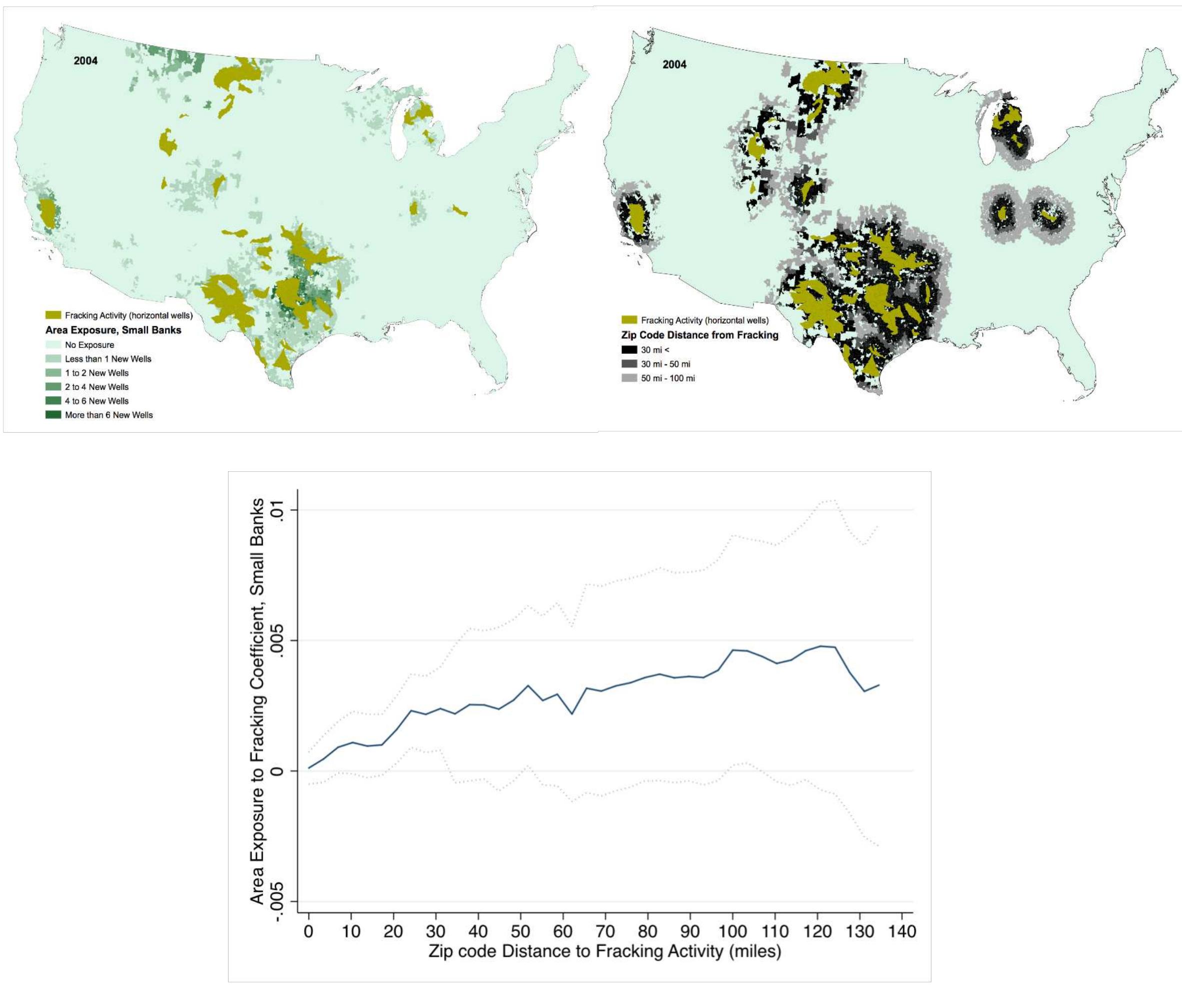

Figure 4: Area Exposure to Small Banks with Branches in Fracking Areas, 2004

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Appendix (for online publication only)

A1 - Data Appendix

CRA Census Tract Lending

Each bank that falls under the CRA reporting criteria is required to submit to the Federal Financial Institutions Examination Council (FFIEC) detailed information on each of the new small business loans it has originated between January 1st and December 31st of each year. A small business loan is defined as either a commercial and industrial (C&I) loan or a loan secured by nonresidential real estate with amount of less than $1 million. The bank is to disclose for each loan the location of the borrower (census tract) and the amount of the loan that has been extended. This detailed information is processed by the FFIEC and after extensive review for accuracy is released to the public. To preserve the privacy of the customers of each bank the public information aggregates the total gross originations into three categories – less than $100,000, between $100,000 and $250,000, and between $250,000 and $1,000,000. Only the totals within each category are reported. Additionally, the bank reports total originations to firms with revenue below $1,000,000. This study uses all of the small business loan originations by adding the total amounts originated in each of the subcategories listed above. The geographical information is aggregated to the county level where separate totals are reported for the metropolitan and the non-metropolitan area of the county (if applicable). Within the MSA-county and the nonMSA-county areas further distinction is made between the origination amounts extended across different income level areas (based on the census tract income level). Since each bank is required to report the census tracts and the income level at each census tract where at least one new loan was extended I am able to decrease the level of aggregation in the public disclosures. This information allows me to eliminate the census tracts where no loans are originated. The total origination amounts for a given MSA-county or nonMSA-county across different income levels are distributed equally to all of the census tracts according to the particular income level. If there's only one census tract with a particular income level within the county area this census tract gets the precise amount of originations.

Branch Locations

The second source of data for this paper comes from the Summary of Deposits information maintained by the Federal Deposit Insurance Corporation (FDIC). FDIC provides a list of addresses of all active physical branches of all commercial banks and thrifts that are in operation in a given year. For example, the 2000 file includes 85,493 branches of all banks in operation[33]. Of the 85,493 locations about 86% have the precise branch GPS coordinates while the remaining 14% only list an address. The branches with missing coordinates were geo-coded separately for each year based on the US address[34]. Consequently, each of the bank branches in operation for the period between 2000 and 2009 was associated with a particular GPS-coordinate location[35].

[33] This number excludes ATM locations.

[34] This was done with the geo-coding service SmartyStreets.

[35] Some of the addresses are not very accurate and this is reflected in the precision of the GPS coordinates.

Matching Bank Networks Over the Sample Period

The final step in the creation of the dataset has to do with the associations of bank networks over time. It is customary in this literature to use a method called force-merging that will account for mergers and acquisitions of banks over the years. This method merges the balance sheet of two or more banks in the year before the merger occurs and thus maintain the relative size of the assets and liabilities between the two years. This paper deviates from this practice. In what is described above, I have assumed that a given client of a bank receives a loan from the closest super-branch of that bank. To use the force-merging method I will have to assume that the client of a bank can choose to go to a super-branch of the actual bank that has extended the loan *or* to a super-branch of the bank that merges with the first bank in the following period. This is obviously inconsistent. The method that this paper uses instead is to match the spatial distribution of a bank network at two different points in time. The nodes of a network of a bank in one year are matched with only those nodes that exist in the following year in the same location and belong to the same bank. The dataset, therefore, only includes observations for networks that report under the CRA for at least two consecutive years and at least one node of the network is in the same location between the two years.

Aggregation of Census Tracts to ZIP Code Areas

The CRA information is provided at the census tract level while the CBP information on the number of establishments is provided at the USPS ZIP code level. The census tracts are slightly smaller than the ZIP areas so I aggregate the CRA information to the ZIP code level. To do this I overlay the ZIP areas over the census tracts and compute the percentage of the area of each ZIP area that is comprised of each census tract that overlaps with the ZIP area. Average exposure is converted from the census tract level to the ZIP level using percentage of total area as a weight.

A2 - Model

Each bank, i, has multiple branches, indexed by j. Assuming that each bank has one branch per credit market, j can also refer to the credit market where the branch is located. The total number of branches if i are N_i. I assume that the bank is a monopolist and at each branch, ij, it can:

- Lend to one small business an amount of L_{ij} with a marginal return $r_j^L + r_i^L - \alpha_L L_{ij}$,
- Lend to one land developer an amount of K_{ij} with a marginal return $r_j^K + r_i^K - \alpha_K K_{ij}$,
- Collect up to D_{ij} in deposits at no cost.

The marginal returns to each of the loans has a local component, indexed by j, and a bank component, indexed by i. The bank can also borrow funds from the inter-bank market of amount B_i at a marginal cost of $\alpha_B^i B_i$.

There are two periods, t and $t+1$. After period t the bank experiences three different branch-specific shocks to:

- The return of the business loan such that the return becomes $r_j^L + r_i^L - \alpha_L L_{ij} + \eta_{ij}$,
- The return of the real estate loan such that the return becomes $r_j^K + r_i^K - \alpha_K K_{ij} + \kappa_{ij}$,
- The deposits such that the branch can collect $D_{ij} + \delta_{ij}$.

In the first period the bank chooses L_{ij}^t and K_{ij}^t at each branch to maximize profits subject to its budget constraint:

$$\max_{\{L_{ij}^t\},\{K_{ij}^t\}} \Pi_i^t = \sum_j L_{ij}^t R_{ij}^L(L_{ij}^t) + K_{ij}^t R_{ij}^K(K_{ij}^t) - B_i^t R_i^B(B_i^t) \tag{8}$$

$$\text{s.t.} \sum_j L_{ij}^t + \sum_j K_{ij}^t = \sum_j D_{ij}^t + B_i^t \tag{9}$$

where $R_{ij}^L(L_{ij}^t)$, $R_{ij}^K(K_{ij}^t)$ is the interest charged on the two loans and $R_i^B(B_i^t)$ is the interest paid on external borrowing. There are two sets of FOCs for each loan type. They require that at the optimal allocation the return to each loan at each branch is equalized to the marginal cost of bank borrowing. Plugging in the budget constrain in the FOCs, I get:

$$\alpha_L L_{ij}^t + \alpha_B^i \sum_j L_{ij}^t + \alpha_B^i \sum_j K_{ij}^t = r_j^L + r_i^L + \alpha_B^i \sum_j D_{ij}^t \tag{10}$$

$$\alpha_K L_{ij}^t + \alpha_B^i \sum_j K_{ij}^t + \alpha_B^i \sum_j L_{ij}^t = r_j^K + r_i^K + \alpha_B^i \sum_j D_{ij}^t \tag{11}$$

To solve for the optimal allocation, I express the conditions in matrix, using block-matrix notation:

$$\begin{bmatrix} G & \alpha_B^i J_{N_i} J_{N_i}' \\ \alpha_B^i J_{N_i} J_{N_i}' & \tilde{G} \end{bmatrix} \begin{bmatrix} L_i^t \\ K_i^t \end{bmatrix} = \begin{bmatrix} R_j^L \\ R_j^K \end{bmatrix} + \begin{bmatrix} r_i^L J_{N_i} \\ r_i^K J_{N_i} \end{bmatrix} + \begin{bmatrix} (\alpha_B^i \sum_j D_{ij}^t) J_{N_i} \\ (\alpha_B^i \sum_j D_{ij}^t) J_{N_i} \end{bmatrix} \tag{12}$$

where L_i^t and K_i^t are $(N_i \times 1)$ vectors that include the respective lending at each branch. R_j^L and R_j^K similarly are $(N_i \times 1)$ vectors which include the location component of the marginal return. J_{N_i} is a $(N_i \times 1)$ vector of ones. Finally, G and $\tilde{G}$ are $(N_i \times N_i)$ symmetric matrices with α_B^I entries off the main diagonal. G has $(\alpha_L + \alpha_B^i)$ on the main diagonal and $\tilde{G}$ has $(\alpha_K + \alpha_B^i)$.

To solution for L_i^t and K_i^t is:

$$\begin{bmatrix} L_i^t \\ K_i^t \end{bmatrix} = \begin{bmatrix} G & \alpha_B^i J J' \\ \alpha_B^i J J' & \tilde{G} \end{bmatrix}^{-1} \left(\begin{bmatrix} R_j^L \\ R_j^K \end{bmatrix} + \begin{bmatrix} r_i^L J \\ r_i^K J \end{bmatrix} + \begin{bmatrix} (\alpha_B^i \sum_j D_{ij}^t) J \\ (\alpha_B^i \sum_j D_{ij}^t) J \end{bmatrix} \right) \tag{13}$$

where I have abbreviated J_{N_i} with J. This expression fully characterizes the optimal lending at each of the branches during period t. At the end of period t, the bank observes the shocks to the return of each of the loans and the deposits and maximizes profits by allocating funds to each of the loan types. I get:

$$\begin{bmatrix} L_i^{t+1} \\ K_i^{t+1} \end{bmatrix} = \begin{bmatrix} G & \alpha_B^i JJ' \\ \alpha_B^i JJ' & \tilde{G} \end{bmatrix}^{-1} \left(\begin{bmatrix} R_j^L \\ R_j^K \end{bmatrix} + \begin{bmatrix} \eta \\ \kappa \end{bmatrix} + \begin{bmatrix} r_i^L J \\ r_i^K J \end{bmatrix} + \begin{bmatrix} (\alpha_B^i \sum_j D_{ij}^t + \delta_{ij})J \\ (\alpha_B^i \sum_j D_{ij}^t + \delta_{ij})J \end{bmatrix} \right) \tag{14}$$

where η and κ are $(N_i \times 1)$ vectors that include the branch-specific shocks to the marginal return to both loans and δ_{ij} are the shocks to the deposits. Taking the difference, I get:

$$\begin{bmatrix} \triangle L_i \\ \triangle K_i \end{bmatrix} = \begin{bmatrix} G & \alpha_B^i JJ' \\ \alpha_B^i JJ' & \tilde{G} \end{bmatrix}^{-1} \left(\begin{bmatrix} \eta \\ \kappa \end{bmatrix} + \begin{bmatrix} (\alpha_B^i \sum_j \delta_{ij})J \\ (\alpha_B^i \sum_j \delta_{ij})J \end{bmatrix} \right) \tag{15}$$

To find an expression for small business lending, L_{ij}^t, at each branch, I need to invert the block matrix on the left hand side. I do this by using the formula for an inverse of a block matrix:

$$\begin{bmatrix} G & \alpha_B^i JJ' \\ \alpha_B^i JJ' & \tilde{G} \end{bmatrix}^{-1} = \begin{bmatrix} (G - (\alpha_B^i)^2 JJ' \tilde{G}^{-1} JJ')^{-1} & -\alpha_B G^{-1} JJ' (\tilde{G} - (\alpha_B^i)^2 JJ' G^{-1} JJ')^{-1} \\ -\alpha_B \tilde{G}^{-1} JJ' (G - (\alpha_B^i)^2 JJ' \tilde{G}^{-1} JJ')^{-1} & (\tilde{G} - (\alpha_B^i)^2 JJ' G^{-1} JJ')^{-1} \end{bmatrix}$$

I focus only on the matrices in the first row since I am interested in characterizing the optimal small business lending at each branch.

I use extensively the guess and verify method for finding the inverse of matrices that have one term on the main diagonal and a different term off the diagonal. In particular, I make a guess that the inverse takes the same form – one term on the main diagonal and one term off the diagonal – and use the restrictions from $GG^{-1} = I$ to find what the two terms in the inverse are. Using this method, one can show that G^{-1} is a symmetric matrix with $\left(\frac{1}{\alpha_L} - \frac{\alpha_B^i}{\alpha_L(\alpha_L + N_i \alpha_B^i)}\right)$ on the main diagonal and $\left(-\frac{\alpha_B^i}{\alpha_L(\alpha_L + N_i \alpha_B^i)}\right)$ off the main diagonal. Similarly, $\tilde{G}^{-1}$ is a symmetric matrix with $\left(\frac{1}{\alpha_K} - \frac{\alpha_B^i}{\alpha_K(\alpha_K + N_i \alpha_B^i)}\right)$ on the main diagonal and $\left(-\frac{\alpha_B^i}{\alpha_K(\alpha_K + N_i \alpha_B^i)}\right)$ off the main diagonal. I use the expressions for G^{-1} and $\tilde{G}^{-1}$ and the guess and verify method to find that:

$$(G - (\alpha_B^i)^2 JJ' \tilde{G}^{-1} JJ')^{-1} = (a - b) I_{N_i} + bJJ' \tag{16}$$

$$-\alpha_B G^{-1} JJ' (\tilde{G} - (\alpha_B^i)^2 JJ' G^{-1} JJ')^{-1} = \tilde{a} JJ' \tag{17}$$

where:

$$a = \frac{1}{\alpha_L} \left(\frac{N_i \alpha_K \alpha_B^i + N_i \alpha_L \alpha_B^i + \alpha_K(\alpha_L - \alpha_B^i)}{N_i \alpha_K \alpha_B^i + N_i \alpha_L \alpha_B^i + \alpha_K \alpha_L} \right) \tag{18}$$

$$b = -\frac{\alpha_K \alpha_B^i}{\alpha_L (N_i \alpha_K \alpha_B^i + N_i \alpha_L \alpha_B^i + \alpha_K \alpha_L)} \tag{19}$$

$$\tilde{a} = -\frac{\alpha_B^i}{(N_i \alpha_K \alpha_B^i + N_i \alpha_L \alpha_B^i + \alpha_K \alpha_L)} \tag{20}$$

I order to make the solution more tractable, I assume that $\alpha_B^i = \gamma / N_i$. This allows me to express each of the three parameters as:

$$a = \frac{1}{\alpha_L} \frac{\gamma\alpha_K + \gamma\alpha_L + \alpha_K(\alpha_L - \gamma/N_i)}{\phi} \tag{21}$$

$$b = -\frac{1}{N_i} \frac{\gamma\alpha_K}{\phi} \tag{22}$$

$$\tilde{a} = -\frac{1}{N_i} \frac{\gamma}{\phi} \tag{23}$$

where $\gamma\alpha_K + \gamma\alpha_L + \alpha_K\alpha_L = \phi$. The first parameter is positive while the last two are negative. Finally, I can use the parameters to provide the explicit solution for $\triangle L_{ij}$:

$$\triangle L_{ij} = a\eta_{ij} - \frac{\gamma\alpha_K}{\phi} \frac{1}{N_i} \sum_{\bar{j}} \eta_{ij} - \frac{\gamma}{\phi} \frac{1}{N_i} \sum_{j} \kappa_{ij} + \frac{\gamma}{\alpha_L} \frac{\gamma\alpha_L + \alpha_K\alpha_L}{\phi} \frac{1}{N_i} \sum_{j} \delta_{ij} \tag{24}$$

where $\bar{j}$ refers to the set of branches outside of j. Re-writing we get:

$$\triangle L_{ij} = a\eta_{ij} - b_1 \frac{1}{N_i} \sum_{\bar{j}} \eta_{ij} - b_2 \frac{1}{N_i} \sum_{j} \kappa_{ij} + b_3 \frac{1}{N_i} \sum_{j} \delta_{ij} \tag{25}$$

where:

$$a = \frac{1}{\alpha_L} \frac{\gamma\alpha_K + \gamma\alpha_L + \alpha_K(\alpha_L - \gamma/N_i)}{\phi} \tag{26}$$

$$b_1 = \frac{\gamma\alpha_K}{\phi} \tag{27}$$

$$b_2 = \frac{\gamma}{\phi} \tag{28}$$

$$b_3 = \frac{\gamma}{\alpha_L} \frac{\gamma\alpha_L + \alpha_K\alpha_L}{\phi} \tag{29}$$

A-3: Robustness Tables and Figures

Table A1: Census Statistics for Fracking and Non-Fracking Zip Codes

	Zip Codes Inside Fracking			Zip Codes Outside Fracking		
	N	Mean	Std. Dev.	N	Mean	Std. Dev.
Population	9695	10323.03	(12392.93)	153177	11686.24	(14123.91)
Median Age	9695	36.62965	(5.139222)	153177	37.481	(5.233941)
Median Income	9695	35234.14	(12451.33)	153177	41664.27	(16368.72)
Income Per Capita	9695	17153.05	(6010.743)	153177	20159.59	(8704.774)
Poverty Percentage	9694	17.90%	(10.65%)	152943	14.07%	(10.77%)
Urban	9694	39.01%	(41.69%)	153073	45.08%	(43.64%)
Fraction with Bachelor's Degree	9694	9.86%	(6.78%)	153031	11.96%	(7.77%)

Notes: The table lists the summary statistics for key characteristics for two categories of zip codes: those within areas where fracking occurs and those outside. The information is from the 2000 U.S. Census.

Table A2: Small Bank Comparison: Fracking vs Non-fracking exposure

	No Exposure, within 100mi			Positive Exposure		
	N	Mean	Std. Dev.	N	Mean	Std. Dev.
Average Total Assets (aTA)	1764	777975	(1585136)	310	995670	(1951839)
RE Loans / aTA	1764	0.4701	(0.1796)	310	0.4391	(0.1627)
Commercial Loans / aTA	1764	0.0917	(0.0871)	310	0.1098	(0.0804)
Consumer Loans / aTA	1764	0.0542	(0.0763)	310	0.0621	(0.0725)
Total Loans / aTA	1764	0.6330	(0.1798)	310	0.6390	(0.1693)
Loan Loss Allowance / aTA	1764	0.0086	(0.0050)	310	0.0080	(0.0034)
Total Investments / aTA	1764	0.2889	(0.1789)	310	0.2757	(0.1694)
Other Real Estate / aTA	1764	0.0014	(0.0027)	310	0.0014	(0.0033)
Total Deposits / aTA	1764	0.7944	(0.1123)	310	0.8036	(0.1063)
FHLB Advances / aTA	1764	0.0671	(0.0871)	310	0.0573	(0.0838)
Common and Pref Stock / aTA	1764	0.0959	(0.0389)	310	0.0949	(0.0243)
ROE	1764	0.1394	(0.0977)	310	0.1380	(0.0745)
ROA	1764	0.0124	(0.0092)	310	0.0126	(0.0071)
aTA / aTE	1764	11.3271	(2.6917)	310	11.0927	(2.2635)
Total Operating Income / aTA	1764	0.0712	(0.0241)	310	0.0732	(0.0209)
Profit Margin	1760	0.1873	(0.2002)	307	0.1857	(0.0756)
Operating Expense / aTA	1764	0.0537	(0.0202)	310	0.0562	(0.0205)
Interest Expense / aTA	1764	0.0215	(0.0091)	310	0.0200	(0.0090)
Non-interest Expense / aTA	1764	0.0294	(0.0143)	310	0.0337	(0.0179)
Provision for Loan Loss / aTA	1764	0.0028	(0.0061)	310	0.0025	(0.0032)
Non-interest Income / aTA	1764	0.0117	(0.0182)	310	0.0145	(0.0185)
Interest Spread Earned	1764	0.0384	(0.0131)	310	0.0392	(0.0088)
Loan Charge-offs / Total Loans	1764	0.0043	(0.0080)	310	0.0040	(0.0051)
90+ Past Dues Loans / Total Loans	1764	0.0019	(0.0039)	310	0.0013	(0.0016)
Non-accruing Loans / Total Loans	1764	0.0073	(0.0089)	310	0.0064	(0.0070)

Notes: The table lists asset composition and performance statistics for small banks with no exposure to fracking which are located within 100 miles of fracking areas and for small banks with positive exposure. Information is calculated from Call Reports.

Table A3: Small Bank Comparison: Fraction in Top Decile

	No Exposure			No Exposure, within 100mi			Positive Exposure		
	N	Mean	Std. Dev.	N	Mean	Std. Dev.	N	Mean	Std. Dev.
Average Total Assets (aTA)	3651	623196	(564411)	551	663599	(625700)	317	1290240	(1136938)
RE Loans / aTA	3651	0.4952	(0.1547)	551	0.5095	(0.1508)	317	0.5082	(0.1874)
Commercial Loans / aTA	3651	0.0933	(0.0732)	551	0.0817	(0.0810)	317	0.0972	(0.0752)
Consumer Loans / aTA	3651	0.0554	(0.0685)	551	0.0434	(0.0560)	317	0.0430	(0.0660)
Total Loans / aTA	3651	0.6643	(0.1497)	551	0.6478	(0.1376)	317	0.6674	(0.1584)
Loan Loss Allowance / aTA	3651	0.0086	(0.0037)	551	0.0087	(0.0037)	317	0.0088	(0.0040)
Total Investments / aTA	3651	0.2580	(0.1473)	551	0.2721	(0.1336)	317	0.2588	(0.1562)
Other Real Estate / aTA	3651	0.0013	(0.0027)	551	0.0006	(0.0018)	317	0.0008	(0.0017)
Total Deposits / aTA	3651	0.7909	(0.1003)	551	0.7797	(0.1108)	317	0.7734	(0.1033)
FHLB Advances / aTA	3651	0.0698	(0.0802)	551	0.0762	(0.0800)	317	0.0745	(0.0844)
Common and Pref Stock / aTA	3651	0.0951	(0.0269)	551	0.0965	(0.0284)	317	0.0944	(0.0285)
ROE	3650	0.1363	(0.0664)	551	0.1241	(0.0673)	317	0.1337	(0.0614)
ROA	3651	0.0123	(0.0057)	551	0.0114	(0.0067)	317	0.0120	(0.0052)
aTA / aTE	3650	11.1854	(2.4113)	551	11.0966	(2.5272)	317	11.3610	(2.6480)
Total Operating Income / aTA	3651	0.0692	(0.0178)	551	0.0682	(0.0159)	317	0.0703	(0.0165)
Profit Margin	3650	0.1826	(0.1499)	551	0.1694	(0.0612)	317	0.1799	(0.0696)
Operating Expense / aTA	3651	0.0518	(0.0157)	551	0.0513	(0.0127)	317	0.0523	(0.0160)
Interest Expense / aTA	3651	0.0207	(0.0089)	551	0.0216	(0.0095)	317	0.0207	(0.0100)
Non-interest Expense / aTA	3651	0.0288	(0.0127)	551	0.0279	(0.0093)	317	0.0298	(0.0138)
Provision for Loan Loss / aTA	3651	0.0023	(0.0031)	551	0.0018	(0.0028)	317	0.0018	(0.0026)
Non-interest Income / aTA	3651	0.0107	(0.0141)	551	0.0091	(0.0120)	317	0.0111	(0.0133)
Interest Spread Earned	3650	0.0387	(0.0081)	551	0.0389	(0.0074)	317	0.0389	(0.0089)
Loan Charge-offs / Total Loans	3654	0.0031	(0.0041)	553	0.0025	(0.0040)	317	0.0025	(0.0032)
90+ Past Dues Loans / Total Loans	3654	0.0016	(0.0026)	553	0.0011	(0.0020)	317	0.0011	(0.0019)
Non-accruing Loans / Total Loans	3654	0.0058	(0.0058)	553	0.0045	(0.0042)	317	0.0054	(0.0050)

Notes: The table lists asset composition and performance statistics for small banks with no exposure to top decile, with no exposure to top decile and within 100 miles of top decile areas, and with positive exposure. Information is from Call Reports.

Table A4: Small Bank Comparison: Median Appreciation

	Median Appreciation $\leq 1.4\%$			Median Appreciation $> 1.4\%$		
	N	Mean	Std. Dev.	N	Mean	Std. Dev.
Average Total Assets (aTA)	762	659819	(572621)	746	945033	(877517)
RE Loans / aTA	762	0.4957	(0.1402)	746	0.5252	(0.1688)
Commercial Loans / aTA	762	0.0996	(0.0672)	746	0.0888	(0.0678)
Consumer Loans / aTA	762	0.0593	(0.0515)	746	0.0475	(0.0659)
Total Loans / aTA	762	0.6792	(0.1254)	746	0.6824	(0.1386)
Loan Loss Allowance / aTA	762	0.0087	(0.0034)	746	0.0088	(0.0039)
Total Investments / aTA	762	0.2382	(0.1249)	746	0.2396	(0.1343)
Other Real Estate / aTA	762	0.0019	(0.0029)	746	0.0010	(0.0021)
Total Deposits / aTA	762	0.7841	(0.0919)	746	0.7792	(0.0979)
FHLB Advances / aTA	762	0.0821	(0.0832)	746	0.0806	(0.0865)
Common and Pref Stock / aTA	762	0.0943	(0.0229)	746	0.0940	(0.0267)
ROE	762	0.1293	(0.0612)	746	0.1334	(0.0659)
ROA	762	0.0117	(0.0051)	746	0.0121	(0.0066)
aTA / aTE	762	11.1510	(2.2262)	746	11.2998	(2.3240)
Total Operating Income / aTA	762	0.0723	(0.0137)	746	0.0698	(0.0189)
Profit Margin	762	0.1766	(0.2918)	746	0.1763	(0.0649)
Operating Expense / aTA	762	0.0561	(0.0128)	746	0.0518	(0.0157)
Interest Expense / aTA	762	0.0224	(0.0089)	746	0.0198	(0.0093)
Non-interest Expense / aTA	762	0.0309	(0.0097)	746	0.0301	(0.0132)
Provision for Loan Loss / aTA	762	0.0028	(0.0029)	746	0.0019	(0.0029)
Non-interest Income / aTA	762	0.0119	(0.0083)	746	0.0114	(0.0154)
Interest Spread Earned	762	0.0396	(0.0081)	746	0.0398	(0.0084)
Loan Charge-offs / Total Loans	762	0.0041	(0.0043)	746	0.0025	(0.0043)
90+ Past Dues Loans / Total Loans	762	0.0020	(0.0029)	746	0.0012	(0.0021)
Non-accruing Loans / Total Loans	762	0.0075	(0.0059)	746	0.0053	(0.0053)

Notes: The table lists asset composition and performance statistics for small banks with median appreciation $\leq 1.4\%$ and with median appreciation $> 1.4\%$. Information is from Call Reports.

Table A5: Zip Codes Statistics: Exposure to Small Banks Exposed to Fracking

	Zip Exposure to Small=0			Zip Exposure to Small>0		
	N	Mean	Std. Dev.	N	Mean	Std. Dev.
Share Agriculture, Forestry, Hunting	6206	2%	(5%)	2758	1%	(5%)
Share Mining	6206	1%	(4%)	2758	1%	(3%)
Share Utilities	6206	1%	(3%)	2758	1%	(3%)
Share Construction	6206	15%	(10%)	2758	12%	(8%)
Share Manufacturing	6206	6%	(5%)	2758	6%	(5%)
Share Wholesale Trade	6206	6%	(5%)	2758	6%	(5%)
Share Retail Trade	6206	16%	(7%)	2758	15%	(6%)
Share Transportation and Warehousing	6206	5%	(6%)	2758	4%	(4%)
Share Information	6206	2%	(2%)	2758	2%	(2%)
Share Finance and Insurance	6206	5%	(4%)	2758	6%	(3%)
Share Real Estate Rental and Leasing	6206	4%	(4%)	2758	5%	(3%)
Share Professional, Scientific, and Technical Services	6206	8%	(6%)	2758	9%	(7%)
Share Management of Companies	6206	1%	(1%)	2758	1%	(1%)
Share Administrative	6206	5%	(4%)	2758	5%	(3%)
Share Educational Services	6206	1%	(2%)	2758	1%	(1%)
Share Health Care and Social Assistance	6206	9%	(6%)	2758	9%	(6%)
Share Arts, Entertainment, and Recreation	6206	2%	(3%)	2758	2%	(3%)
Share Accommodation and Food Services	6206	9%	(6%)	2758	9%	(6%)
Share Other Services	6206	12%	(6%)	2758	11%	(5%)
Share Public Administration	6206	0%	(1%)	2758	0%	(1%)
Population	6141	13209	(15516)	2724	18546	(17580)
Median Age	6141	37	(5)	2724	35	(6)
Median Income	6141	40173	(14568)	2724	43146	(16166)
Income Per Capita	6141	18734	(6909)	2724	20241	(7953)
Poverty Percentage	6140	15%	(10%)	2724	15%	(11%)
Urban	6140	46%	(43%)	2724	63%	(41%)
Fraction with Bachelor's Degree	6140	11%	(7%)	2724	13%	(8%)

Notes: The table lists shares of establishments by industry and key population statistics for two categories of zip codes: those serviced by small banks with positive fracking exposure and those serviced by small banks with no exposure and within 100 miles. The population information is from the 2000 U.S. Census and the industrial composition is from the County Business Patterns.

Table A6: Zip Codes Statistics: Exposure to Small Banks with Branches in the Top Decile

	Zip Exposure to Small=0			Zip Exposure to Small>0		
	N	Mean	Std. Dev.	N	Mean	Std. Dev.
Share Agriculture, Forestry, Hunting	3743	3%	(6%)	11150	2%	(4%)
Share Mining	3743	1%	(3%)	11150	1%	(2%)
Share Utilities	3743	1%	(3%)	11150	1%	(2%)
Share Construction	3743	17%	(11%)	11150	15%	(10%)
Share Manufacturing	3743	6%	(7%)	11150	5%	(5%)
Share Wholesale Trade	3743	6%	(5%)	11150	5%	(4%)
Share Retail Trade	3743	16%	(8%)	11150	15%	(7%)
Share Transportation and Warehousing	3743	6%	(6%)	11150	5%	(6%)
Share Information	3743	2%	(3%)	11150	2%	(2%)
Share Finance and Insurance	3743	5%	(4%)	11150	5%	(3%)
Share Real Estate Rental and Leasing	3743	4%	(4%)	11150	4%	(3%)
Share Professional, Scientific, and Technical Services	3743	8%	(6%)	11150	9%	(6%)
Share Management of Companies	3743	1%	(1%)	11150	1%	(1%)
Share Administrative	3743	6%	(5%)	11150	6%	(4%)
Share Educational Services	3743	1%	(3%)	11150	1%	(2%)
Share Health Care and Social Assistance	3743	8%	(6%)	11150	9%	(6%)
Share Arts, Entertainment, and Recreation	3743	3%	(4%)	11150	2%	(3%)
Share Accommodation and Food Services	3743	9%	(8%)	11150	9%	(6%)
Share Other Services	3743	12%	(7%)	11150	12%	(6%)
Share Public Administration	3743	0%	(1%)	11150	0%	(1%)
Population	3605	8518	(11043)	10915	14599	(16095)
Median Age	3605	38	(6)	10915	38	(5)
Median Income	3605	40526	(15804)	10915	45508	(18412)
Income Per Capita	3605	19656	(8021)	10915	22296	(10344)
Poverty Percentage	3595	15%	(11%)	10894	13%	(10%)
Urban	3600	36%	(41%)	10906	56%	(43%)
Fraction with Bachelor's Degree	3600	11%	(7%)	10902	14%	(8%)

Notes: The table lists shares of establishments by industry and key population statistics for two categories of zip codes: those serviced by small banks with positive exposure to top deciles and those serviced by small banks with no exposure and within 100 miles. The population information is from the 2000 U.S. Census and the industrial composition is from the County Business Patterns.

Table A7: Zip Codes Statistics: Exposure to Small Banks with Below-median Branches

	<50% of Branches Below Median			>50% of Branches Below Median		
	N	Mean	Std. Dev.	N	Mean	Std. Dev.
Share Agriculture, Forestry, Hunting	72578	2%	(5%)	31633	2%	(4%)
Share Mining	72578	1%	(3%)	31633	1%	(4%)
Share Utilities	72578	1%	(3%)	31633	1%	(3%)
Share Construction	72578	15%	(10%)	31633	14%	(9%)
Share Manufacturing	72578	6%	(6%)	31633	6%	(5%)
Share Wholesale Trade	72578	6%	(6%)	31633	6%	(6%)
Share Retail Trade	72578	16%	(8%)	31633	16%	(7%)
Share Transportation and Warehousing	72578	5%	(6%)	31633	5%	(6%)
Share Information	72578	2%	(2%)	31633	2%	(2%)
Share Finance and Insurance	72578	5%	(4%)	31633	5%	(4%)
Share Real Estate Rental and Leasing	72578	4%	(3%)	31633	4%	(3%)
Share Professional, Scientific, and Technical Services	72578	8%	(6%)	31633	8%	(6%)
Share Management of Companies	72578	1%	(1%)	31633	1%	(1%)
Share Administrative	72578	5%	(4%)	31633	5%	(4%)
Share Educational Services	72578	1%	(2%)	31633	1%	(2%)
Share Health Care and Social Assistance	72578	8%	(6%)	31633	8%	(6%)
Share Arts, Entertainment, and Recreation	72578	2%	(3%)	31633	2%	(3%)
Share Accommodation and Food Services	72578	9%	(6%)	31633	9%	(6%)
Share Other Services	72578	12%	(6%)	31633	12%	(6%)
Share Public Administration	72578	0%	(1%)	31633	0%	(1%)
Population	71337	12333	(14404)	31176	12750	(14640)
Median Age	71337	37	(5)	31176	37	(5)
Median Income	71337	42664	(17164)	31176	40783	(15082)
Income Per Capita	71337	20623	(9137)	31176	19815	(8088)
Poverty Percentage	71200	14%	(11%)	31144	14%	(11%)
Urban	71270	48%	(44%)	31162	47%	(43%)
Fraction with Bachelor's Degree	71247	12%	(8%)	31154	12%	(8%)

Notes: The table lists shares of establishments by industry and key population statistics for two categories of zip codes: those serviced by less than 50% below-median branches of small banks and those serviced by more than 50%. The population information is from the 2000 U.S. Census and the industrial composition is from the County Business Patterns.