EXPORTING LIQUIDITY:

BRANCH BANKING AND FINANCIAL INTEGRATION*

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ABSTRACT

Using exogenous liquidity windfalls from oil and natural gas shale discoveries, we demonstrate that bank branch networks help integrate U.S. lending markets. Banks exposed to shale booms enjoy liquidity inflows, thereby increasing their capacity to originate and hold new loans. Exposed banks increase mortgage lending in non-boom counties, but only where they have branches and only for hard-to-securitize mortgages. Our findings suggest that contracting frictions limit the ability of arm's length finance to integrate credit markets fully. Branch networks continue to play an important role in financial integration, despite the development of securitization markets.

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I. INTRODUCTION

Over the past thirty years the banking system in the U.S. has gone through a significant transformation, relying more on capital markets and direct finance in funding loans and less on local bank deposits. The U.S. mortgage market has been at the forefront of this transformation, with 52% of loans in 2011 financed by securitization markets, up from 12% in 1980.[1] Moreover, improvements in information technology have facilitated bank lending well outside of branch-based geographical domains (Petersen and Rajan, 2002). These changes have allowed capital to flow across the U.S. economy and thus integrate local credit markets. The greater role of external capital markets in facilitating access to credit should have diminished the value of bank branch networks for lending. Yet over the same period the extent and density of bank offices and branches has continued to grow, from 63,200 (about 5 per bank) in 1990 to 89,800 (about 14 per bank) in 2012.[2]

In this paper, we show that branch networks still play an important role in integrating local credit markets. Using a unique positive exogenous shock to bank liquidity stemming from oil and gas "fracking" booms, we document that bank liquidity inflows increase mortgage lending in areas not experiencing the booms. Lending increases *only* in markets where banks have a branch presence. The effect is most pronounced for loan types that are subject to more contracting frictions, and therefore are harder to fund from external markets (e.g., through securitization). Moreover, banks exposed to shale-booms expand overall lending, as opposed to merely taking lending business away from other banks operating in similar markets. Combined, the results provide evidence that branch networks allow lenders to mitigate contracting frictions,

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[1] These statistics refer to the whole mortgage market, including mortgages for home purchase, home equity lines, as well as mortgage re-financings.

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

and thus play an important role in integrating information intensive segments of credit markets where arm's length financing is limited.

To identify how funds flow across markets, we exploit a unique bank liquidity shock stemming from "fracking" booms – the unexpected technological breakthrough that made vast amounts of shale oil and gas deposits economically profitable to develop. Oil and gas companies pay significant mineral royalty payments to landowners to develop shale resources. This wealth windfall results in increased deposit supply for banks with branches in shale-boom counties (Gilje, 2011 and Plosser, 2011). It also allows local landowners to pay down outstanding debt, further amplifying banks' liquidity windfalls.

Armed with this exogenous shock, we evaluate whether banks export liquidity by focusing on mortgage originations *outside* of shale-boom counties. Exploring mortgage lending has three advantages. First, these loans have a clear geographical dimension pinned down by the property location, which is not possible for other types of loans. Second, studying lending outside shale boom counties alleviates concerns that shale discoveries drive credit demand. Third, the rich dataset allows us to saturate models with county*year fixed effects, thus removing confounding demand effects. Conceptually, our analysis compares mortgage growth rates in the same county-year for two otherwise similar banks, one with branches in a shale-boom county (and thus exposed to a positive liquidity shock) and the other without exposure.

Why might local liquidity shocks affect credit? The traditional banking literature argues that two frictions are necessary for a liquidity shock to propagate. First, banks must face (liability-side) frictions in accessing external financing that preclude them from undertaking all profitable investment opportunities. In our setting, this friction stems from small and regional banks having limited access to external debt and equity markets and drawing most of their funds from insured (and potentially subsidized) deposits. These regional banks are at the center of our analysis, as they benefit most from the fracking wealth windfalls.[3] We show that shale booms lead to a simultaneous increase in quantity and decline in cost of deposits at banks with branches in the shale-boom counties. The lower financing costs thus allow them to expand their investments in either loans or marketable securities.

For the shock to stimulate new lending, a second (asset-side) friction between banks and borrowers is required: some new lending made by banks with liquidity inflows must be ones that other banks would not choose to originate. Thus, for new lending to be stimulated, we need banks to have access to a set of borrowers over which they have a cost advantage relative to competing banks. A bank's physical branch footprint provides such an advantage, as geographical proximity lowers the cost of information production and allows better loan monitoring (e.g., Berger et al., 2005). Thus, banks would expand new credit in markets where they possess local information or a borrower relationship advantage.

Our results indicate that banks export newly found liquidity to other markets. An average bank exposed to the boom grows its mortgage originations 7% faster relative to a similar non-exposed bank. This effect is large relative to average mortgage origination growth rates (11%). Furthermore, consistent with the notion that bank branches mitigate contracting frictions, mortgage lending increases *only* in outlying (non-boom) counties where exposed banks have branches. Lending does not increase in areas where exposed banks have no local knowledge and thus have no informational advantage over other sources of financing (e.g. securitization). To further solidify this notion, we document that liquidity windfalls expand lending more in loan

[3] Our experiment is not likely to matter for very large banks, in part because such banks have relatively easy access to the interbank market, meaning that the marginal cost of funds is unlikely to be affected by a small shock to the deposit base. In fact, when we exclude the largest banks from our tests the coefficients of interest do not change (see Table 5).

types subject to greater contracting frictions, which are less likely to be securitized, such as home equity lines (sold or securitized 4.5% of the time) and home-purchase mortgage (sold or securitized 46% of the time), as opposed to mortgage re-financings (sold or securitized 65% of the time). Overall, our evidence suggests that bank branches integrate segments of lending markets that arm's-length finance cannot.

Our core results leave the question of efficiency in allocation of newly found liquidity unanswered. Perhaps exposed banks waste the proceeds of the shale booms on pet projects (<NPV), as in Jensen (1986). One might even argue that such pet projects are most likely to be located near a bank's branches. We find no evidence supporting this agency problem. Loan delinquencies and charge-offs of banks exposed to shale booms fall rather than rise after the exposure to the boom, with varying degrees of statistical significance that depend on the ex-post horizon and model specification.

Our findings contribute to several strands of the literature. First, the results extend research on the financial integration of U.S. markets and help explain why large benefits followed deregulation.[4] Two mechanisms, potentially working in parallel, can explain why the removal of restrictions on banks' ability to expand across geographical markets improved economic outcomes: tougher competition and improved capital mobility. There is abundant evidence that increases in competition post-deregulation led to more efficient banking (Stiroh and Strahan, 2003), lowered the cost of capital for non-financial firms (Rice and Strahan, 2010)

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[4] The intrastate branching deregulation led to faster growth of the state economies (Jayaratne and Strahan (1996)) and lower growth volatility (Morgan, Rime and Strahan (2004)). Such deregulation came with better quality lending (Jayaratne and Strahan, 1996), more entrepreneurship and a greater share of small establishments (Black and Strahan 2002; Cetorelli and Strahan, 2006, Kerr and Nanda, 2009), lower income inequality, less labor-market discrimination and weaker labor unions (Black and Strahan, 2001; Beck et al., 2010; Levkov, 2012). That said, Loutskina and Strahan (forthcoming) provide evidence from the recent housing boom that financial integration helped fuel local housing and economic booms, thus raising local volatility.

and contributed to better allocation of resources (Jayaratne and Strahan, 1996). There is much less direct evidence, however, about deregulation's effect on capital mobility. In this paper, we show that branch networks contribute to capital flows across local credit markets. Thus, the increasing scope and density of bank branch networks made possible by deregulation potentially increased the efficiency of capital allocation by allowing savings in one area to finance investment in other areas.

Second, extant research evaluates whether close proximity between borrowers and lenders lowers the cost of information production and monitoring. Breakthroughs in information technology allowed for larger distances between borrowers and lenders (Petersen and Rajan, 2002). However, local lenders still extend more credit to riskier borrowers than distant lenders: loan rates tend to decline with the distance between borrower and lender (Degryse and Ongena, 2005; Agrawal and Hauswald, 2010); more opaque (smaller) borrowers tend to establish enduring relationships with their local (small) banks; and larger, more transparent firms tend to borrow from larger (not so local) financial intermediaries (e.g., Berger et al., 2005). In mortgage finance, locally concentrated lenders focus on soft information intensive segments of the mortgage market (Loutskina and Strahan, 2011) and have an advantage in screening and monitoring riskier borrowers (Cortes, 2011). We contribute to this literature by documenting that even in the most developed, integrated, and technologically advanced lending market − the U.S. mortgage market − local finance is hard to substitute. Branch networks, and by extension local knowledge, remain important for segments of the credit markets subject to contracting frictions.

Third, our paper offers a micro-economic approach to testing the bank lending channel.[5] Most of the existing studies exploit a common bank liquidity shock engineered by a central bank. These shocks naturally correlate strongly with credit demand and business cycle conditions, creating identification challenges. Some studies address these challenges by exploiting cross-sectional differences in bank on-balance-sheet lending responses to aggregate liquidity shocks (e.g., Gertler and Gilchrist, 1994, Kashyap et al., 1994, Kashyap, Stein, 2000, Campello, 2002 and Loutskina, 2011). Other more recent studies use natural experiments, where external shocks from abroad propagate into domestic credit markets through cross-border ownership of banks (e.g., Peek and Rosengren, 1997, Schnabl, 2012, Cetorelli and Goldberg, 2012). Our study is closest to those evaluating how local liquidity shocks from bank failures, government interventions or bank runs affect lending supply (Ashcraft, 2006, Khwaja and Mian, 2008, Paravisini, 2008, Iyer and Peydro, 2011). Unlike much of the earlier literature, however, we isolate the supply effects by exploiting data with precise information on the location of both lender and borrower location.

In the remainder of the paper, Section II describes briefly the shale booms and their effects on local banks. Section III contains a simple conceptual framework to motivate our tests. Section IV describes our data, and Section V reports empirical methods and results. Section VI contains a brief conclusion.

II. SHALE BOOMS

In 2003, a surprise technological breakthrough combined horizontal drilling with hydraulic fracturing ("fracking") and enabled development of natural gas shale. The subsequent

[5] See the theoretical arguments in, e.g., Bernanke and Blinder (1988), Holmstrom and Tirole (1997), and Stein (1998).

development of shale led to a new energy resource equivalent to 42 years of U.S. motor gasoline consumption. As recently as the late 1990s, shale gas was not thought to be economically viable, and represented less than 1% of U.S. natural gas production. The development of the Barnett Shale near Fort Worth, TX in 2003 changed industry notions on the viability of natural gas shale.

The Barnett Shale was initially drilled by Mitchell Energy in the early 1980s (Yergin, 2011). Rather than encountering the highly porous rock of a conventional formation, however, Mitchell encountered natural gas shale. While shale holds vast amounts of natural gas, it is highly non-porous and traps the gas in the rock. After 20 years of experimentation, in the early 2000s Mitchell Energy found that hydraulic fracturing ("fracking") could break apart shale and free natural gas for collection at the surface. This breakthrough combined with horizontal drilling and higher natural gas prices made large new reserves from shale economically profitable to develop.

The size of this energy resource and the low risk of unproductive wells ("dry-holes") have led to a land grab for mineral leases. Before commencing any drilling operations, oil and gas firms must negotiate leases with mineral owners. Typically these contracts are comprised of a large upfront "bonus" payment, paid whether the well is productive or not, plus a royalty percentage based on the value of the gas produced over time. The resulting wealth windfalls led to large increases in local bank deposits. In an interview with the Houston Chronicle (2012), H.B. "Trip" Ruckman III, president of a bank in the Eagle Ford shale, stated "We have had depositors come in with more than a million dollars at a whack." This statement is consistent with reports of leasing terms. For example, an individual who owns one square mile of land (640 acres) and leases out his minerals at $10,000/acre would receive an upfront one-time payment of $6.4 million plus a monthly payment equal to 25% of the value of all the gas produced on his lease.

Two previous studies have tested how the shale booms affected banks and bank lending, as well local real outcomes. Plosser (2011) studies the impact on banks, finding that exposure to shale booms comes with increased bank lending as well as holdings of securities. These results are consistent with the idea that bank financing costs fall with the advent of shale booms. Gilje (2011) studies outcomes for non-financial firms within shale-boom counties themselves, finding that financially dependent industries grow relative to less dependent ones; he argues that greater credit supply within the booming areas stimulated investment. Neither study, however, explores the implications of the shale booms for outlying markets connected via branch networks, as ours does.

The shale-boom windfalls represent an exogenous liquidity shock relative to the underlying characteristics of the affected communities for a number of reasons. First, the economic viability of shale wells was determined by larger macroeconomic forces, such as demand for natural gas and natural gas prices (Lake, Martin, Ramsey, and Titman, 2012), and therefore was unrelated to the local economic conditions (health, education, demographics, etc.).

Second, the technological breakthroughs, horizontal drilling and hydraulic fracturing, were unexpected, and the viability of these technologies in different geographies was uncertain. It was extremely challenging even for oil and gas companies to predict how many wells an area might need to develop recoverable resources. Highlighting the fast pace and unpredictable nature of these discoveries, in 2008, *five* years after the technology was discovered, the Haynesville Shale area in Louisiana experienced an increase in lease bonus payments from a few hundred dollars an acre to $10,000 to $30,000 an acre within a one-year time period (reported by the New Orleans' Times-Picayune, 2008).

Combined, these facts suggest that it was unlikely that banks could strategically alter branch structures to gain greater exposure to shale liquidity windfalls. Thus, bank windfalls from shale discoveries are an attractive setting to study how liquidity is exported across branch networks in the U.S.

III. Conceptual Framework

We evaluate the anatomy of the financial integration of the U.S. mortgage markets through the prism of the lending channel, where shocks to bank financing costs affect their lending. In the frictionless world of Modigliani and Miller, the cost or availability of firm financing should have no effect on investment. Yet the corporate finance literature argues, for example, that cash-flow shocks raise investment by alleviating frictions of raising funds in external markets. Similarly, the bank lending channel needs frictions so that liquidity shocks propagate and affect investment. These frictions originate on both the liability and asset sides of bank balance sheets. To illustrate these ideas, below we offer a simple conceptual framework to motivate our empirical tests.

Liability-Side Response to Shale-Booms

Banks face frictions in tapping external capital markets that sometimes make external finance expensive or even unavailable, limiting their ability to finance all positive NPV projects. Existing literature argues that smaller banks face significantly greater frictions than larger ones in accessing external sources of finance such as the interbank market or the bond market. Thus, small banks respond more, for example, to central bank policy shocks (Kashyap and Stein, 2000;

Jayaratne and Morgan, 2000; Campello, 2002). Constrained banks face an upward sloping supply of funds that tops out at the rather high external borrowing rate (illustrated in Figure 1A). In contrast, very large, publicly owned banks (e.g. Bank of America) would have much better and cheaper access to external finance, so their cost of funds would flatten quickly and at a lower level (Figure 1B). The marginal cost of funds for such very large banks might be pinned down by the interbank borrowing rate (e.g. the Federal Funds rate).

Deposit windfalls and loan repayments stemming from shale booms reduce the marginal cost of funds for banks with substantial business in booming areas, illustrated in Figure 1. Since location provides convenience to nearby depositors (Pilloff and Rhoades, 2002) and borrowers (Berger et al., 2005), banks with branches in the booming counties have an advantage in harvesting local landowners' wealth windfalls. These banks' cost of funds would fall with the advent of liquidity shocks generated by additional deposit inflows (which we document below) and/or loan prepayments (which are not observable because loan balances combine old and new loans).

Asset-Side Response

A mere shift in banks' cost of funding is not sufficient to affect lending. Banks with low cost funds may simply take business away from competing banks with higher cost funds, or they may expand their holdings of marketable securities. For lending to change, we need each bank to serve a portion of borrowers over which it possesses better information (i.e. lower screening and monitoring costs) than potential competitors. With access to a pool of such borrowers, each bank will face a declining marginal return on lending. These returns will bottom out and flatten once the marginal investment becomes a marketable security (or, in this context, a mortgage that could potentially be made by any other lender, which itself would be securitizable).

With some degree of market power over a set of borrowers, the decline in funding costs from shale booms allows banks to originate and hold previously unprofitable loans. As presented in Figure 1A, the bank thus will increase the amount lent (moving from point A to point B) when funding costs fall. Banks facing relatively weak loan demand would expand their holdings of marketable securities rather than loans (Figure 1C). Loan-market power plausibly stems from informational advantages in screening and monitoring, which each bank uniquely possess based on local knowledge from close proximity to borrowers (Degryse and Ongena, 2005; Loutskina and Strahan, 2011). Moreover, mortgage credit availability for low-income borrowers increases with bank branch presence, and both interest rates and defaults are lower (Ergungor, 2010; Ergungor and Moulton, forthcoming).

We recognize that this simple framework, taken literally, would imply that banks holding marketable securities during the pre-boom period would not respond to the liquidity inflows. But a more realistic framework would account for the idea that holding loans and taking deposits exposes banks to liquidity risk; managing such risk requires banks to hold marketable securities and cash (Kashyap, Rajan and Stein, 2002). In fact, Plosser (2011) shows that banks exposed to shale booms increase both loans *and* securities.

Empirical Implications

This simple conceptual framework helps guide our empirical approach. First, we compare lending responses in areas where banks plausibly have access to local knowledge – markets where they have a branch presence – with responses in markets where they lend but have no physical presence. In markets with branches, banks will face declining marginal returns on new loan originations and also be forced to use internal funds rather than capital markets to fund those loans. This follows directly because the information frictions that motivate lending market power also create a barrier to securitization. Second, we segregate the mortgage origination rates by the information sensitivity of the loan itself; information-sensitive loans (e.g. subordinated second-lien mortgages) ought to respond more than less-information sensitive loans (e.g. senior first-lien mortgages). Third, the response of loan originations ought to be stronger in markets with more unsatisfied demand (compare Figures 1A and 1C). Thus, we separate our data by local credit demand measured by lagged mortgage approval rates.

Our simple framework also suggests that large banks with access to public debt and equity markets ought to respond less to liquidity inflows compared to small and regional banks (compare Figures 1A and 1B). That said, we have little power in our empirical setting to test this implication. Large banks not only have capital market access, they also have very extensive branch networks. Our natural experiment – exposure to shale booms – is simply too small to affect their liquidity in an empirically meaningful way for them. Bank of America, for example, owned 6038 branches, 182 of which are located in shale-boom counties as of 2010 (~3%). In contrast, the typical exposed bank in our sample has about 50% of its branches in a shale-boom county.

Our tests are close to investment-cash flow studies in the corporate finance literature, which imply that cash-flow shocks raise investment by alleviating the need to raise funds in external markets. This literature began by exploring correlations between cash-flow shocks and investment for different types of firms (Fazzari, Hubbard and Petersen, 1988). Subsequent challenges to this approach emerged, however, because cash flow innovations may be correlated with investment opportunities or because financial constraints may be measured with error (e.g. Kaplan and Zingales, 1997; Alti, 2003). Our setting avoids these identification problems because we can test how liquidity shocks affect lending in areas that are not the source of the shock. Moreover, unlike studies of non-financial companies, investment by banks can be separated into that which must be financed internally (mortgages over which the lender possesses an information advantage) vs. investments that can be financed externally (mortgages that are easily securitized).

IV. Data and Sample Selection

Our sample is based on lending activity in the seven states with major shale discoveries between 2003 and 2010: Arkansas, Louisiana, North Dakota, Oklahoma, Pennsylvania, Texas and West Virginia. As Figure 2 shows, each state contains a large number of counties that experienced shale booms as well as a large number of non-boom counties. Across the seven states, 124 counties experienced booms and 515 did not. Our sample, built at the bank-county-year level, includes all banks making housing-related loans (home purchase mortgages, mortgages for re-financing, and home equity loans) in any of these seven states. We consider all lenders irrespective of their branch locations (i.e., including loans originated without brick and mortar presence in a county) or exposure to the booms. We drop all non-bank lenders because most fund mortgage lending with securitization and are, thus, only affected by changes in the aggregate supply of funds from the securitization market. The sample begins in 2000 (three years before the first shale boom), and ends in 2010.

Using the *Summary of Deposits* from the Federal Insurance Deposit Corporation (FDIC), we determine the number of branches and amount of deposits held by each bank in each county-year in the seven states.[6] These data allow us to build two alternative measures of exposure to the shale-boom shocks. The first – *Share of Branches in Boom Counties* – equals the fraction of

[6] http://www2.fdic.gov/sod/.

branches owned by each bank that are located in a shale-boom county. The measure ranges from zero (for banks without branches in boom counties, or for banks with branches in boom counties during the years prior to a boom's onset) to one (for banks with all of their branches in boom counties after the onset of the booms). This variable equals zero for all bank-years prior to 2003, the year of the first shale investment. After 2003, the variable increases within bank over time as more counties experience booms.

Our second measure accounts for both the distribution of branches across counties as well as the size of the shale investments. This measure – *Growth in Shale Well Exposure* – equals the weighted exposure to the growth in the number of shale wells, where the fraction of a bank's branches in each county serves as weights. This measure is harder to interpret than the *Share of Branches in Boom Counties* because it need not vary between zero and one, but it accounts for differences in the relative size and growth of the booms.

Our models focus on the effect of exposure to the shale boom on mortgage credit growth, but we include other bank characteristics as control variables, each measured from the end of the prior year. These variables include the following: Log of $Assets_{t-1}$; Deposits/$Assets_{t-1}$; Cost of $Deposits_{t-1}$ (=interest expenses on deposits / total deposits); Liquid Assets / $Assets_{t-1}$; Capital / $Assets_{t-1}$ (=Tier 1 capital/ assets); C&I Loans / $Asset_{t-1}$; Mortgage Loans / $Assets_{t-1}$; Net Income / $Assets_{t-1}$; Loan Commitments / $Assets_{t-1}$; and, Letters of Credits /$Assets_{t-1}$. Data for bank control variables come from year-end Call Reports. We merge Call Report and HMDA following Loutskina and Strahan (2009).

Table 1 reports summary statistics for our two measures of banks' exposure to the shale well boom - *Share of Branches in Boom Counties* and *Growth in Shale Well Exposure* (Panel A), as well as the lagged bank characteristics (Panel B), separated by whether or not the bank has any exposure to a shale-boom county. Table 1 shows that exposed banks tend to be larger than non-exposed banks and that their deposits grow faster and have lower cost, consistent with the notion that exposure to the shale boom leads to increases in deposit supply. The marked difference in asset size (log of assets) is a potential concern in our models because large banks differ in many ways from smaller ones, so we will report robustness tests in which we filter out larger banks.

To measure mortgage activity, we utilize the detailed data on mortgage applications collected annually under the *Home Mortgage Disclosure Act* (HMDA). Whether a lender is covered depends on its size, the extent of its activity in a Central Business Statistical Area (CBSA), and the weight of residential mortgage lending in its portfolio.[7] The HMDA data include loan size, whether or not a loan was approved, as well as some information on borrower characteristics. Using HMDA data, we measure mortgage origination growth by bank-county-year. HMDA reports both the identity of the lender as well as the location of the property down to the census-tract level. These are the only comprehensive data on lending by US banks that allow researchers to locate borrowers geographically. In principle we would also like to test for similar effects on other kinds of loans (especially loans to small businesses), but micro data at loan level are not available outside of housing. HMDA also contains information on the purpose of the loan (mortgage purchase loans, home-equity loans, and mortgage re-financings) and whether the lender expects to sell or securitize the loan within one year of origination. We use

[7]Any depository institution with a home office or branch in a CBSA must report HMDA data if it has made a home purchase loan on a one-to-four unit dwelling or has refinanced a home purchase loan and if it has assets above $30 million. Any non-depository institution with at least ten percent of its loan portfolio composed of home purchase loans must also report HMDA data if it has assets exceeding $10 million. Consequently, HMDA data does not capture lending activity of small or rural originators. U.S. Census shows that about 83 percent of the population lived in metropolitan areas over our sample period and hence the bulk of residential mortgage lending activity is likely to be reported under the HMDA.

these data to test whether loans easier to finance in securitization markets respond less to the local liquidity inflows that follow shale booms.

Table 1 reports summary statistics for mortgage growth rates, defined as the difference in the log of mortgage originations, at both bank-year (Panel C) and bank-county-year (Panel D) levels. For purposes of simple comparisons, we focus mainly on the summary statistics at the bank-year level, since our main variables of interest vary *only* at that level; in our regressions, we absorb variation across county-years with fixed effects. For the average exposed bank, mortgages grow 11.7% per year, compared to 11.2% for non-exposed banks. This difference is larger for retained mortgage growth, which averages 9.1% per year for exposed banks, compared to 7.7% for non-exposed banks. These raw differences could be attributed to both the deposit windfalls as well as to economic growth of the boom counties. We isolate these two effects in our regressions. Note that the standard deviation in the mortgage growth rates is very high relative to the mean, but much of this variation reflects time-series fluctuations stemming from changes in interest rates (which alter re-financing rates drastically) as well as variation around the housing boom (2004-2006) and bust (2006-2010) periods, which our data straddle.

HMDA also offers some borrower characteristics, which we use to build the following control variables for all loans originated at the bank-county-year level: borrower and area income, loan size-to-borrower-income ratio, percent women applicants, percent minority applicants, and percent minority population in the area of loan applications. In all of our models we control for the contemporaneous means of each of these borrower attributes across all loan applications in a given bank-county-year.

V. METHODS AND RESULTS

Shale-Booms as a Positive Liquidity Shock

We first establish that banks exposed to shale-booms experience liquidity inflows. Such inflows occur both because local mineral rights owners expand the local supply of deposits by putting funds into local bank branches (which is directly observable), and because they pay back outstanding loans (which is not).

To establish the first channel – that bank deposit supply increases with shale-boom exposure – we report regressions of both deposit quantity (deposit growth) and price (interest expense on deposits / deposits), as follows:

$$Deposit\ Growth_{i,t} = \gamma_1 Bank\ Boom\ Exposure_{i,t} + Control\ Variables + \varepsilon_{i,t}, \quad \textbf{(1a)}$$

$$Interest\ Expense\ /\ Deposits_{i,t} = \gamma_2 Bank\ Boom\ Exposure_{i,t} + Control\ Variables + \varepsilon_{i,t}, \quad \textbf{(1b)}$$

where the unit of analysis varies by bank *i* / year *t*. If shale-booms increase deposit supply, then we expect $\gamma_1 > 0$ and $\gamma_2 < 0$. We include lags of bank characteristics as control variables, as well as bank and year fixed effects. Standard errors are clustered by bank.

As shown in Table 2, deposit quantity increases and its price falls with bank shale exposure, consistent with a positive supply shock. (These changes are consistent with those illustrated in Figure 1.) To understand magnitudes, consider comparing a bank with average exposure to shale (*Share of Branches in Boom Counties* = 0.45) to one with no exposure. According to our estimates, exposed banks would experience deposit growth about 2.5 percentage points faster (column 1: 0.45*0.0567) and the interest expense on deposits would fall by about 7 basis points (column 3: 0.45*-0.0015). These magnitudes line up well with the differences in means between exposed and non-exposed banks in Table 1.

Table 2 also reports similar regressions for the bank capital/asset ratio and the return on assets (ROA = net income/lagged assets). These results suggest the neither bank equity capital nor ROA differ between exposed v. unexposed banks ex ante. Thus, other than bank size, the two sets of banks appear comparable along some key observable characteristics.

Baseline Result

To evaluate how liquidity windfalls affect mortgage lending, we estimate a three-dimensional panel regression of the growth in mortgage originations in non-shale counties on each bank's shale-boom exposure, as follows:

$$\textit{Mortgage Growth}_{i,j,t} = \alpha_{j,t} + \beta \textit{ Bank Boom Exposure}_{i,t} + \textit{Borrower \& Lender Controls} + \varepsilon_{i,j,t}\,, \quad \textbf{(2)}$$

where *i* indexes lenders, *j* indexes counties, and *t* indexes years. With this panel structure we can absorb county*year effects ($\alpha_{j,t}$), thus removing time-varying, county-level demand-side shocks related to business cycles, industry composition, housing demand, etc. To further separate supply shocks from potentially confounding demand shocks, we include in our sample *only* counties that *did not* experience a shale boom during the 2000-2010 period. As in Table 2, we use two alternative measures of a bank's exposure to the shale booms: *Share of Branches in Boom Counties* and *Growth in Shale Well Exposure*. Unlike *Mortgage Growth*, both exposure measures do not vary across counties for a given bank-year; hence we build standard errors by clustering by bank throughout all of our results.

We use mortgage origination growth (the change in logs) as the dependent variable, rather than the log level of mortgage originations or market share. By normalizing the dependent variable by last year's lending in a respective bank-county, we account for variation in the extent of lending in a given county by a given bank.[8]

We then decompose *Mortgage Growth* into the growth in retained mortgages and the growth in sold or securitized mortgages. This decomposition not only helps validate our identification strategy, it also allows for a deeper understanding of capital supply to the mortgage market. First, it allows us to document the true on-balance-sheet sensitivity of total lending to a liquidity supply shock. Second, it allows us to evaluate whether the liquidity allows banks to retain more loans at the expense of the secondary market. Finally, our core hypothesis posits that in response to an exogenous liquidity shock banks expand soft-information intensive lending and, by extensions, banks should not invest more in hard-information lending. Thus, evaluating banks' securitized loan originations allows us to evaluate our core hypothesis.

As shown in Table 3, we find significant positive effects of exposure to shale-booms on both total mortgage growth (columns 1 & 2) and growth of retained mortgages (columns 3 & 4), but no significant effect on sold-loan growth (columns 5 & 6). For retained mortgages, a typical exposed bank (e.g. one with about 45% of its branches in a shale-boom county – recall Table 1) would grow its retained-mortgage portfolio 14 percentage points (=0.45*0.325) faster in the non-boom counties than a similar bank without exposure to the shale-boom windfalls (based on the coefficient of interest in column 3). The results are also robust to whether or not we include the bank-year lagged control variables, which collectively have little explanatory power.

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[8] In addition to the intensive margin, we explored the variation on the extensive margin, which our growth rate approach cannot address since we require positive lending in the prior year (not reported). We did not find that liquidity windfalls affect the extensive margin. This null result, we think, occurs because the liquidity shocks matter only in areas where banks have a branch presence (documented below), and banks almost always lend a non-zero amount in areas where they have branches. We have also tested whether mortgage acceptance rates vary with shale-boom exposure but find that they do not.

Do Banks Enter 'Boom' Counties to Chase Funds?

One concern may be that, after observing the advent of shale-boom discoveries in 2003, banks enter shale-boom counties (or counties with known shale reserves) to raise low-cost deposits. If such entry were motivated by the need to fund new loans, then our effects could be driven by *both* supply and demand factors, thus invalidating our identification strategy. [9]

We address this concern by testing whether banks with higher loan demand subsequently increase their exposure by entering shale-boom counties. Specifically, we evaluate what share of a bank's boom exposure is attributed to its 2002 branch distribution and whether bank-specific loan demand affects the remaining variation. The distribution of branches in 2002 could not have been motivated by demand for funds because shale booms started unexpectedly in 2003. We build the 2002-branch-network exposure proxies using only the time variation in county shale booms ($\textit{Share of 2002 Branches in Boom Counties}_{i,t}$ and $\textit{Growth in Exposure from 2002 Branches}_{i,t}$). These measures capture exposure to the boom that would have occurred if each bank had held constant its 2002 branch network. We then run the following regressions:

$$\textit{Share of Branches in Boom Counties}_{i,t} = \gamma_1 \bullet \textit{Share of 2002 Branches in Boom Counties}_{i,t} + \gamma_2 \bullet \textit{Mortgage Application Growth}_{i,t-1} + \gamma_3 \bullet \textit{Mortgage Application Growth}_{i,t-2} + \textit{Control Variables} + \varepsilon_{i,t}, \qquad \textbf{(3a)}$$

and

$$\textit{Growth in Shale Well Exposure}_{i,t} = \gamma_1 \bullet \textit{Growth in Exposure from 2002 Branches}_{i,t} + \gamma_2 \bullet \textit{Mortgage Application Growth}_{i,t-1} + \gamma_3 \bullet \textit{Mortgage Application Growth}_{i,t-2} + \textit{Control Variables} + \varepsilon_{i,t}, \qquad \textbf{(3b)}$$

[9] For example, Ben-David, Palvia and Spatt (2013) report evidence of banks increasing demand for deposits (and hence prices) locally when they face higher loan demand in out-of-state markets connected through branches.

where the unit of observation varies by bank *i* / year *t*.

If banks' exposure to the boom is solely due to the time variation in onsets of boom throughout the counties, then we expect $\gamma_1 = 1$. If banks facing higher loan demand (captured by past loan application growth) enter booming markets to access cheap deposits, then we expect $\gamma_2 > 0$ and/or $\gamma_3 > 0$. We estimate (3a) and (3b) over the 2003 to 2010 period because these are the years when the shale booms occur. The sample contains all banks that originated mortgages in at least one county in the seven states that experience shale booms.

Table 4 reports the estimates of (3a) in Panel A and (3b) in Panel B with different sets of control variables. The 2002 branch distribution explains the vast majority of subsequent exposure to the shale booms. In the simple models, R^2 exceeds 92%. Moreover, t-statistics on *Share of 2002 Branches in Boom Counties (Growth in Exposure from 2002 Branches)* never fall below 50 and the coefficient is close to one. At the same time, past loan application growth has almost no explanatory power. Even in column (2) of Panel B, where the coefficient γ_3 is statistically significant at the 10% level, the effect of past loan growth on boom exposure is economically negligible. Overall, there is no evidence that banks with high loan demand systematically enter (or purchase branches in) shale-boom counties.

Robustness Tests

The baseline results in Table 3 withstand a wide set of robustness tests, which we summarize in Table 5. First, we evaluate whether our results could be attributed to the shale-boom exposed banks systematically lending more irrespective of the boom. That is, we test whether the parallel trends assumption between 'treatment' and 'control' banks is violated. Columns (1) and (2) of Table 5 test whether banks exposed and not exposed to booms behave similarly before the booms actually occur. We create the variable *Pre-boom Indicator for*

Booming Banks, equal to one for booming banks during all years prior to an actual boom. For example, the indicator would be set equal to one during 2000-2006 for a bank that first became exposed to a shale-boom county in 2007. The indicator would be equal to zero for all years after 2006 in this example. For banks that never experience exposure, the indicator equals zero for all years. By introducing this variable, we can rule out the possibility that banks which experience booms (the treatment group) behave differently from other banks (control group) during 'normal' times. Consistent with this notion, the coefficient on this variable is never significant.

We have also estimated a model fully saturated with 'event-time' indicator variables *added* to our baseline specification. Specifically, for each bank define the first year in which it becomes exposed to any shale-boom as 'year 0', and then define indicator variables for years: -4, -3, …, +4 and $+5^+$ (all years +5 and later), with the omitted category including banks that are never exposed and exposed banks 5 years or more before the first boom. This approach allows us to test for any specification error in our base model, since the coefficients on the event-time indicators will reflect any non-zero residual variation either just before the advent of booms (if, for example, booms are anticipated), as well as any non-zero variation during a transition after booms begin. Figure 3 reports the coefficients on these event-time indicators, along with +/- 1.65 standard error bands. As the Figure shows, these coefficients never come close to achieving statistical significance and thus indicate that our baseline model is well specified.

Second, to further rule out reverse causality we include the growth of a bank's branches with the set of control variables. This approach allows us to rule out the notion that banks with strong loan demand open or purchase new branches to fund loan growth. Specifically, if banks expand their branch network in anticipation of a boom we should observe this additional explanatory variable take power away from our core variable of interest, exposure to the fracking boom. We find a positive correlation between branch growth and mortgage growth, but adding this variable has almost no impact on the coefficient of interest (columns 3 & 4).

Third, we evaluate the possibility that our results are driven by banks with branches in close proximity to shale-boom counties growing faster than other banks in the same county. If some banks' lending grows faster due to demand spill-overs from neighboring boom counties, then our results could be driven by both supply- and demand-side shocks. It is also possible that some of the additional deposits in shale-boom counties come from nearby counties due to migration into the booming areas. We evaluate the validity of these hypotheses by excluding bank-county-year observations from counties sharing a border with a boom county (columns 5 and 6). The results are similar to those reported in our baseline models in terms of both statistical and economic magnitude and further support the notion that the effects we document are supply-side driven.

Fourth, the summary statistics presented in Table 1 indicate that the exposed banks tend to be larger than those never exposed to shale booms. The disparity occurs because large banks, by the very fact that they are large, will have a greater likelihood of having at least some exposure to counties with shale-booms. Large banks, however, also have wide access to the capital markets and, during the time of crisis, government financial support, and hence might grow their lending quicker than the rest of the banking sector. To evaluate this premise, we estimate equation (3) without very large banks, defined as those in the top decile of the asset size distribution. The coefficients on both *Share of Branches in Boom Counties* and *Growth in Shale Well Exposure* increase slightly in magnitude and statistical significance when we impose this filter.

Fifth, we estimate our model after dropping bank-county-years where the mortgage growth rate is based on fewer than 15 loans during the prior year (columns (9) and (10)). This filter drops observations likely to have substantial noise in the dependent variable. Again, the results are stronger than before, both in terms of magnitudes as well as statistical significance. This indicates that our results cannot be attributed to noise in measuring the changes in banks' origination decisions.

In the sixth and final robustness test, we add bank*county fixed effects (columns (11) and (12)). Adding these effects removes the possibility that some banks may always grow faster than others within the same county. For example, some banks may simply advertise more in specific areas or have more branches in better locations, leading to persistently higher rates of mortgage growth. In fact, adding the bank*county effects increases the magnitude and statistical significance of our results.

Note that in Table 5 and hereafter, we focus on total mortgage origination, although as we have documented the effects are driven by variation in retained (as opposed to sold) mortgage growth. The core objective of this paper is to evaluate whether bank liquidity inflows affect individual banks' and ultimately overall lending supply, as opposed to exploring the shocks' effects on a bank's decision to finance lending on balance sheet or through loans sales/securitization. Loutskina and Strahan (2009) have established that the decision to hold or sell a mortgage at the margin depends on a bank's funding cost, which varies with exposure to the shale booms in the setting of this paper.

Where Do Local Shocks Matter?

As we described in Section III, increases in liquidity should only affect credit supply for loans where contracting frictions make arm's length finance difficult, either because lenders have better information than investors or because incentives for lenders to engage in sufficient monitoring would diminish if a loan were sold (e.g., Gorton and Pennacchi, 1995, Holmstrom and Tirole, 1997, Keys et al., 2010). If a lender has no information or monitoring advantage relative to any other lenders – if the lending decision depends only on public information such as borrower FICO scores and mortgage loan-to-value ratios – then we would expect changes in bank funding to have no impact on their credit supply decisions. These markets would be highly commoditized and competitive. In contrast, changes in local funding could affect credit supply in market segments where frictions require soft information production and thus erect barriers to non-local lenders or to a local lender securitizing their originations. In line with these arguments, we should see liquidity inflows being exported to markets with more contracting frictions and those where lenders have informational advantage over the other financial intermediaries.

We have already documented that a liquidity shock has no impact on banks' securitization volumes. We now further our investigation and evaluate whether banks increase lending more in market where they have a competitive advantage in local knowledge. Specifically, we evaluate whether liquidity windfalls increase lending more in counties where banks have branches, as compared to counties where they lend without a brick and mortar presence. Extant literature suggests that local lenders have an informational advantage as they tend to lend to more opaque and riskier firms. Mortgage lenders with branches near their borrowers also have an advantage in monitoring borrowers that may experience distress. Consistent with this argument we find that mortgages made by local lenders (those with a branch in the county where the property is located) are consistently securitized or sold at much lower rates than those made by non-local lenders. Figure 4 illustrates the difference is nearly 30 percentage points, on average.[10]

Consistent with our core hypothesis, we expect local lenders (those with branches in the same county as the borrower) to respond more to the liquidity windfalls than non-local lenders. To test this idea, we introduce an interaction to the models based on whether or not the bank has a branch located near the borrower:

$$\textit{Mortgage Growth}_{i,j,t} = \alpha_{j,t} + \beta_1 \textit{Local Lender}_{i,j,t} + \beta_2 \textit{Bank Boom Exposure}_{i,t} + \\ + \beta_3 \textit{Local Lender}_{i,j,t} * \textit{Bank Boom Exposure}_{i,t} + \textit{Borrower, Lender Controls} + \varepsilon_{i,j,t} \qquad \textbf{(4)}$$

In equation (4), $\textit{Local Lender}_{i,j,t}$ equals one if a lender i has at least one branch in county j in year t and zero otherwise. The coefficient β_3 can be interpreted as the relative difference in the effect of having a local branch versus providing the financing at arm's length. Columns (1) and (2) of Table 6 report results using all lenders, and includes the interaction term to identify β_3. Columns (3) and (4) report the model without the interaction term, including just the local-lender sample of bank-county-years.

We find mortgage growth increases for banks exposed to shale-boom windfalls, but *only* for local banks - those with branches in the same county as the property being financed. The interaction term is positive and significant (columns 1 and 2), and the overall impact on local banks is itself significant (columns 3 and 4). The direct effect of the windfall, however, is not significant (columns 1 and 2), meaning that lending in counties where exposed banks do not have branches does not change. Comparing the typical local bank with exposure (*Share of Branches*

[10] A natural way to sort our data would be based on whether or not Fannie or Freddie will provide credit guarantees, such as comparing jumbo and non-jumbo mortgages. Unfortunately, the markets we study have low real estate prices so that the vast majority of loans fall into the non-jumbo category. Figure 4 also shows a slight increase in sold loans after the financial crisis. This may seem surprising but again reflects the fact that most of the loans in these seven states where conventional ones that could be sold to one of the GSEs.

in Boom Counties = 0.45, recall Table 1) to a local bank without exposure (*Share of Branches in Boom Counties* = 0), mortgage lending would grow 13 percentage points faster (=0.45*0.29, based on column 3) at the exposed bank. There is no evidence that lenders exposed to the shale-boom windfalls would supply more credit to geographies where they do not have branches (i.e. neither the direct effect of *Share of Branches in Boom Counties* nor *Growth in Shale Well Exposure* is significantly different from zero). Table 6 thus establishes that local windfalls stimulate lending only in markets connected through bank branching networks.[11]

Next, we evaluate the effect of the windfalls by mortgage type. Contracting frictions should be most pronounced for home-equity loans (because these are often subordinated), and least for mortgage re-financing (because borrowers have an established payment history), with home purchase originations being between these two extremes. Consistent with this notion, securitization rates are lowest among home-equity loans (4.5%), highest among mortgage refinancing loans (65%), with mortgages for home purchase in the middle (46%).

To test this, we incorporate loan type by estimating Equation (4) separately for home equity loans, mortgages for home purchase, and mortgages for refinancing.[12] Table 7 reports only the coefficients of interest, but the specification includes the same set of borrower and lender controls and county*year fixed effects as the previous sets of results. Consistent with the earlier analysis, only local lenders respond to the liquidity windfalls. Moreover, their response is evident only among loans that are hard to securitize (and subject to more contracting frictions):

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[11] We have also estimated our model using *Share of 2002 Branches in Boom Counties* as an instrument for actual *Share of Branches in Boom Counties* to validate that our results are not due to endogenous entry decisions by banks into booming counties. These IV estimates are not statistically significantly different from the OLS estimated reported below. For example, the coefficient from the IV estimator equals 0.31, compared to the OLS estimate of 0.29 (Table 6, column 3).

[12] Samples differ across the three columns in Table 7 because we model the growth rate in lending, so a bank-county only appears if there are non-zero originations in two consecutive years.

mortgages for home purchase and home equity loans, but not mortgages for re-financing. In these specifications, the effects of the windfall are largest for the home-equity segment, intermediate for mortgages for home purchase, and zero for the re-financing segment.

In unreported tests, we have evaluated whether the effect of the liquidity windfalls shifts systematically during the 2008 Financial Crisis. We find no significant changes. This may seem surprising because securitization of subprime and jumbo mortgages was dramatically curtailed by the crisis, suggesting that availability of local funds ought to have become more important post crisis. But banks in our sample operate in areas with relatively low-cost housing where Fannie and Freddie dominate, as opposed to high-priced markets on the coasts. The GSEs also substantially increased their role in providing financial subsidies during and after the crisis. Moreover, the housing boom/bust cycle and expansion of sub-prime credit was much less pronounced in these states compared to regions like Southern California or Florida.

Is New Mortgage Lending a Free-Cash-Flow Agency Problem?

Our results suggest that portions of the mortgage market where arm's length finance is limited by information frictions respond positively to local liquidity shocks. This increase, however, could reflect lender agency problems (Jensen, 1986) whereby unexpected cash inflows lead managers to over-invest in value-destroying loans (i.e. marginal loans have NPV<0). The agency explanation is hard to rule out fully because we are not able to follow loan outcomes at the bank-county-year level, thus precluding our preferred identification strategy. [13] We can, however, measure outcomes for retained loans at the overall bank-year level based on data from

[13] Loan-level data on delinquencies and foreclosures is available, but assessing which investor actually bears losses is not. For example, when loans that have been securitized (or loans where originators have purchased credit protection from one of the GSEs) go bad, losses may not affect the originating lender, or such losses may be shared with other investors.

Call Reports. If agency problems are driving the increase in lending, then lenders ought to have higher loan losses after being exposed to shale booms.

Table 8 reports regressions of the fraction of mortgage loans that were charged off or are delinquent (90 days+ past due or non-accruing) in year *t+1* as a fraction of mortgage balances on bank balance sheets in year *t*, as a function of shale-boom exposure. Similar to Table 2, we include the same set of lagged bank characteristics, along with bank and year fixed effects. The results provide no support for the agency-based explanation. In fact, we find that loan performance is better at banks with exposure to the shale booms.[14]

Table 9 further undermines the validity of the agency story underlying our results by presenting evidence that the new credit is allocated rationally by lenders. First, we test whether inflows affect mortgage growth most in those markets with the highest un-served credit demand, as suggested by our simple conceptual framework (recall Figure 1A). To measure un-served credit demand, we follow Mian and Sufi (2009), who argue that the advent of subprime credit had its greatest impact on neighborhoods with unmet demand for mortgage credit, based on the mean mortgage approval rate in the area at the beginning of their sample. Their analysis suggests that such areas experienced stronger growth in credit and housing prices, and then larger crashes after 2006. We apply their strategy to our setting by inter-acting our measure of external windfalls with the average mortgage approval rate (based on HMDA data) from all mortgage applications made during the prior bank-county-year.

Second, we test whether financial constraints alter how banks react to the liquidity windfalls. We introduce an interaction between our measures of exposure with the lag of the

[14] In the set of unreported robustness tests we confirm that banks exposed to the boom continue to have lower mortgage delinquency and defaults two and three years after exposure to the boom.

bank capital-asset ratio (known in regulatory parlance as the 'leverage ratio').[15] If credit expands rationally, banks with higher capital – banks less constrained by capital – can deploy their low-cost funds to make more new loans; in contrast, more constrained banks would more quickly face binding regulatory capital constraints.

Table 9 reports these results, with each interaction term reported separately and then both together. (The direct effects of both the lagged approval rate and the lagged capital ratio are in the models but not reported.) Consistent with efficient capital flows across regions, windfalls spur lending most in areas with low mortgage approval rates, which we interpret as a proxy for un-satisfied demand for mortgage credit.[16] We find large differences in the movement of funds depending on our measure of unmet demand. For example, when demand is low (lagged approval rate = 90%), the coefficients in column 1 imply that exposed lenders (*Share of Branches in Boom Counties* = 0.45) increase their mortgage loans by 7.5 percentage points more than unexposed lenders. In contrast, when un-served credit demand in high (lagged approval = 50%), the exposed banks increase mortgages 22 percentage points faster than unexposed ones.

Lender capital constraints also affect the impact of the shocks. Capital potentially limits the extent to which a bank may deploy a given inflow from branches located in shale-boom counties because banks must operate above regulatory required minimum capital ratios. Since capital is costly to increase in the short run, especially for small and medium sized banks without access to public markets, we would expect the impact of the shock to increase with the ratio of

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[15] We find similar results if we used the bank's ratio of Tier 1 capital to risk weighted assets.

[16] In fact, the lagged approval rate is strongly correlated with mortgage growth: markets with high approval rates grow more slowly, validating the interpretation of this variable as a measure of unmet credit demand.

capital to assets.[17] Consistent with this notion, the interaction of *Share of Branches in Boom Counties* (*Growth in Shale Well Exposure*) with capital is positive and significant, both economically and statistically.

To understand magnitudes, consider first the difference in lending between exposed (*Share of Branches in Boom Counties* = 0.45) and non-exposed banks with high approval rates (=0.9, implying little un-served credit demand) and low capital (=0.07, one sigma below the mean). Our coefficients suggest that the exposed bank would grow its lending by just 2 percentage points faster than the non-exposed bank (using coefficients from column 3). Taking the other extreme, next consider the difference in lending between exposed and non-exposed banks with low approval rates (=0.5, implying substantial un-served credit demand) and high capital (=0.13, one sigma below the mean). In this case the coefficients suggest that the exposed bank would grow its lending 26 percentage points faster than the non-exposed bank. Thus, banks with high demand for credit that are able to deploy the windfalls (due to high levels of ex ante capital) grow their mortgage portfolios very substantially.

Aggregate Effects

In our core set of tests we can clearly isolate the supply side effect of bank liquidity windfalls by comparing exposed and non-exposed banks' lending in the same county-year. County-year effects fully absorb credit demand, but they also absorb any potential aggregate effect on credit supply. Our explanation for the results: banks exposed to shale-booms make new loans thus raising aggregate credit supply. It is also possible, however, that banks with access to

[17] We have also tested other possible measures of a bank's financial constraints, such as asset size or holdings of liquid assets; these are not significantly related to the size of the liquidity shock's impact on mortgage growth.

positive liquidity inflows simply out-compete banks not exposed to booms. In this case, credit would be reallocated between banks in a county but aggregate credit supply would not rise.

In our last set of tests, we attempt to discriminate between these two hypotheses by evaluating the growth in loan originations at the county level. To identify whether local bank exposure to liquidity windfalls leads to aggregate credit supply increases, we adopt a different empirical strategy that allows isolating credit supply. Specifically, we exploit fact, documented above, that shale-boom liquidity windfalls have no effect on *refinancing* loans, but do affect home purchase and home equity loans at the bank level. Yet, all three loan categories should respond to changes in local credit demand conditions similarly. So, we use county-level refinancing growth to capturer hard-to-measure variation in county-level credit demand. The mortgage refinancing growth controls for credit demand heterogeneity and obviates the need to sweep away *all* variation with county-year fixed effects. Thus, we can identify the aggregate credit-supply effect of the shale-boom exposure in a very parsimonious model. Table 10 reports the estimates of the following regression model:

$$\begin{aligned} \textit{Mortgage Growth}_{j,t} = {} & \beta_1 \textit{County Boom Exposure}_{j,t} + \\ & \beta_2 \textit{County Boom Exposure}_{j,t} * \textit{Home Equity Loans} + \\ & \beta_3 \textit{Refinancing Growth}_{j,t} + \beta_4 \textit{Refinancing Growth}_{j,t} * \textit{Home Equity Loans} + \\ & \textit{Controls} + \varepsilon_{i,j,t} \qquad \textbf{(5)} \end{aligned}$$

$\textit{County Boom Exposure}_{j,t}$ is the average measure of shale boom exposure across all banks operating in the county-year, weighted by each bank's number of branches in the county. We compute the mortgage growth rates separately for home-purchase mortgages and for home-equity loans, and allow the coefficients to vary by loan type: *Home Equity Loans* is a dummy variable equal to 1 if the dependent variable is growth in home equity loans. We include county fixed effects and two sets of year effects (one for purchase mortgages and one for home-equity loans), as well as a set of time-varying county level controls for economic conditions (contemporaneous employment growth, payroll growth and population growth). Panel A reports results using counties from all states, while Panel B only considers counties located in just the seven states with shale booms. As in our earlier tests, we do not consider counties that experienced shale booms between 2003 and 2010 to avoid bias in our results. β_1 captures the aggregate increase in credit availability in a county as a result of local bank exposure to liquidity windfalls; β_2 captures the incremental effect attributable to home equity loans.

The results (Table 10) suggest that aggregate credit supply increases with average bank exposure to the shale booms, β_1>0. This increase is similar across home purchase and home equity loans, as β_2 is not statistically significant in any of the specifications. The coefficient on exposure suggests that a one-standard deviation increase in county-level exposure (=0.07) leads to an increase in mortgage growth of about 1.5% per year (using the coefficient from column 2). The results are robust to different measures of bank boom exposure and different sample selection.

VI. CONCLUSIONS

We have provided evidence of the importance of bank branch networks in fully integrating segments of the credit market that are subject to financial contracting frictions. Shale-boom discoveries provide large and unexpected liquidity windfalls at banks with branches nearby as mineral-rights owners pay back old debt and deposit large amounts of their new wealth into local banks. Mortgage lending increases as these banks export the liquidity windfalls into outlying (non-boom) markets, but *only* when such banks have branches in *both* markets. Banks experiencing inflows do not export liquidity and lend more in areas where they have no branch presence because, we argue, without a branch presence banks cannot collect soft information about the borrowers and thus have no advantage over securitization markets.

Our results provide evidence that bank branching fosters financial integration by allowing savings collected in one locality (shale-boom counties) to finance investments in another (non-boom counties). The result is important for two reasons. First, it demonstrates the limits to arm's length financing technologies like securitization in integrating financial markets. For credit markets that require lenders to locate near borrowers to adequately understand and monitor risk, securitization is not a viable financing mechanism. Second, by allowing capital to flow more easily across local markets, deregulation of bank branching fostered a denser branch network that improved capital mobility and investment allocation efficiency.

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Figure 1A: Constrained Banks, Ex Ante Strong Loan Demand

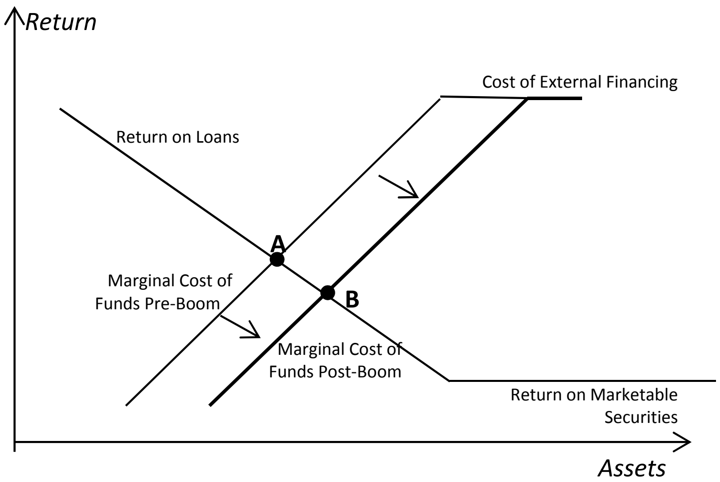


Figure 1B: Unconstrained Banks, Ex Ante Strong Loan Demand

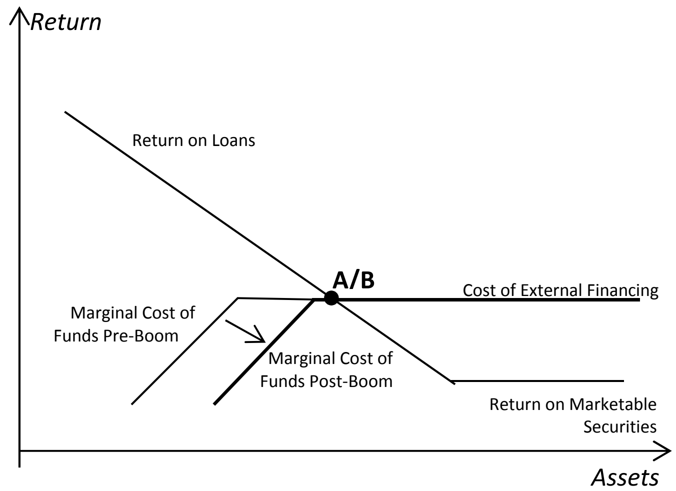


Figure 1C: Constrained Banks, Ex Ante Weak Loan Demand

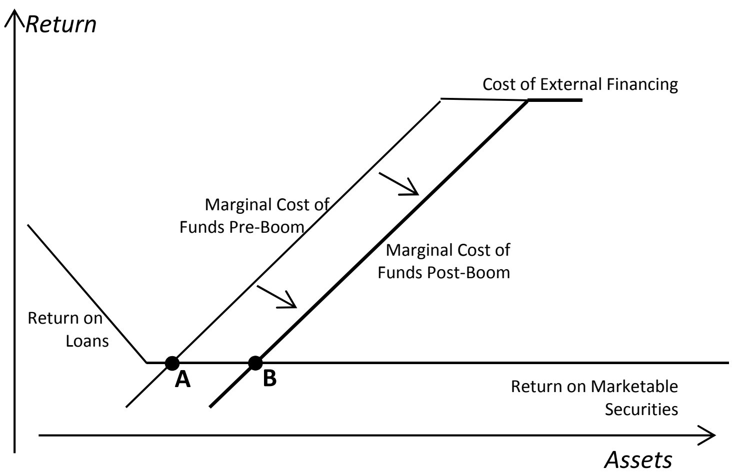


Figure 2: Location of Shale Activity

The figure maps the counties of the 7 shale boom states included in this study: AR, LA, ND, OK, PA, TX and WV. White counties are non-boom counties while shaded counties are shale boom counties as of 2010.

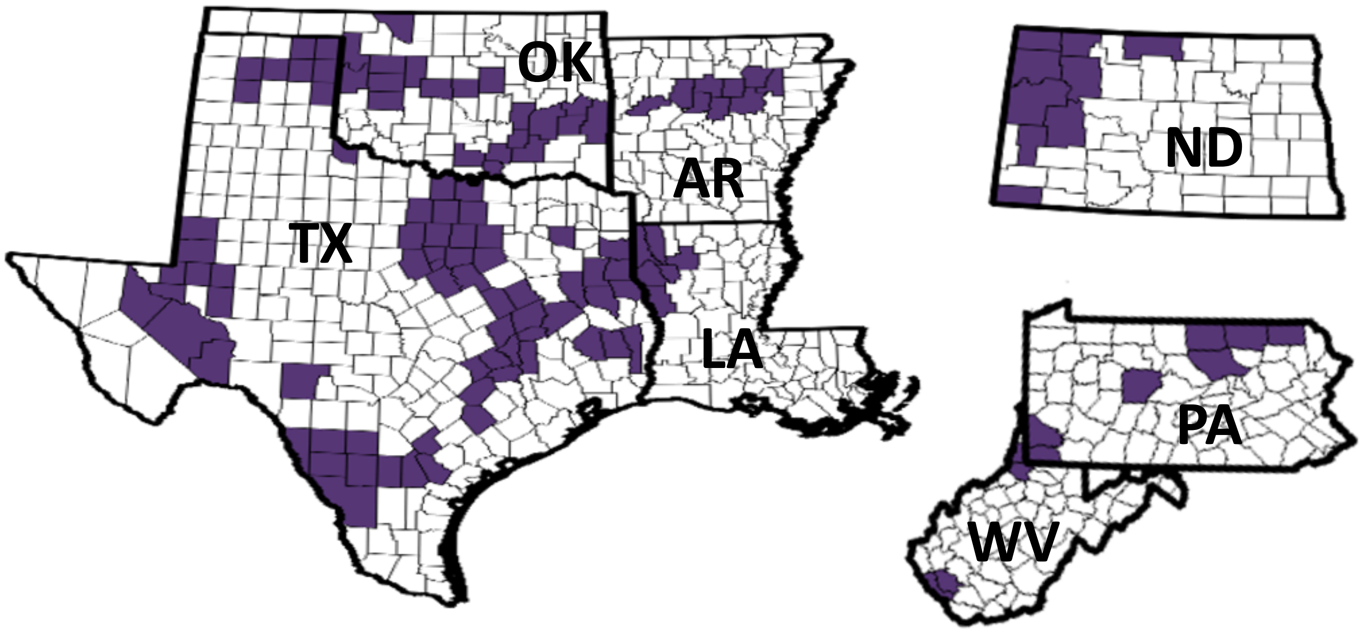
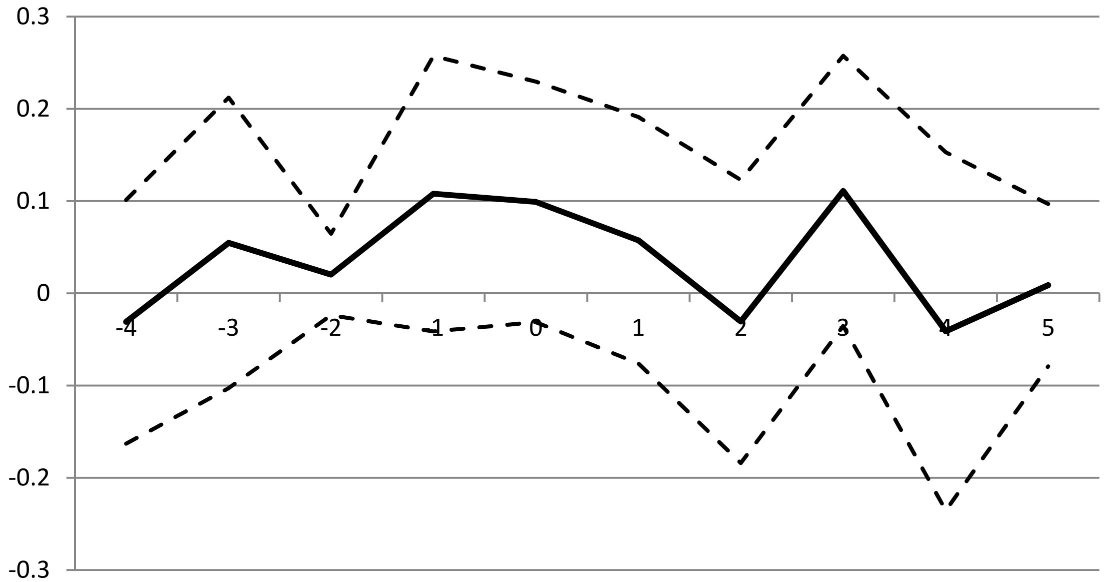


Figure 3. Event Time Indicators Relative to Base Model



This figure reports coefficients (with +/- 1.65 standard errors) on the event-time indicators from the following regression:

$$Mortgage\ Growth_{i,j,t} = \alpha_{j,t} + \beta\ Bank\ Boom\ Exposure_{i,t} + \gamma^{-4}\Gamma^{-4}_{i,t} + \gamma^{-3}\Gamma^{-3}_{i,t} + \ldots + \gamma^{+5}\Gamma^{+5}_{i,t} + Controls + \varepsilon_{i,j,t}$$

where $\Gamma^{-4} = 1$ during the year four years before bank *i* is exposed to its first shale boom; $\Gamma^{-3} = 1$ three years before, and so on. The last indicator turns on in all years from +5 on.

Figure 4: Securitization and Sold Rates, Local vs. Distant Loans

This figure plots the fraction of loans that are securitized or sold for local versus distant loans over the sample period in our study. A local loan is defined as a loan made in the same county in which a bank has a branch, while a distant loan is a loan made in a county by a lender that does not have a branch.

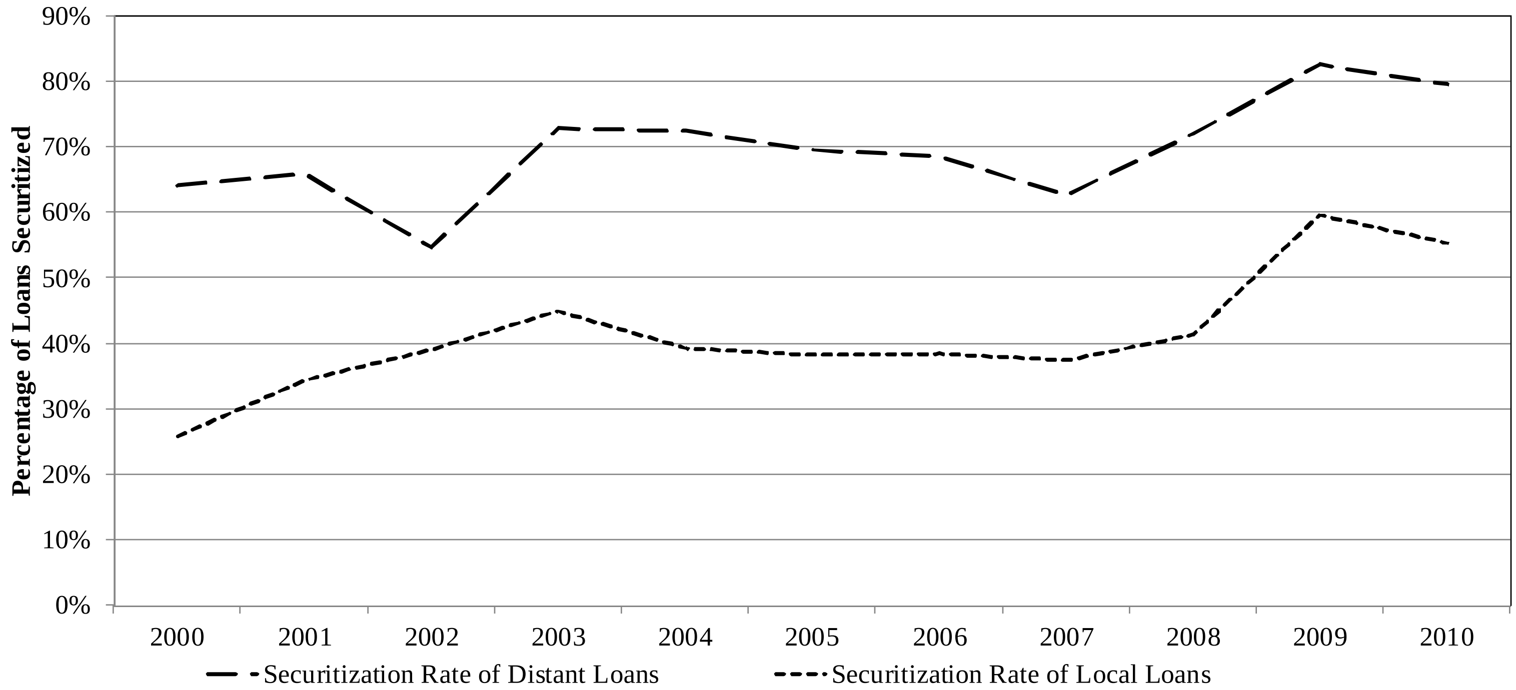


Table 1: Summary Statistics

This table reports summary statistics for banks operating in states with counties exposed to the shale boom. The unit of observation is bank-year in Panel A and Panel B, and bank-county-year in Panel C. The sample is built from the 7 states that experienced shale booms between 2000 and 2010. *Share of Branches in Boom Counties* equals the fraction of a bank's branches located in shale-boom counties (variable set to 0 before the onset of a shale boom). *Growth in Shale Well Exposure* equals the weighted exposure to the growth in the number of shale wells where the fraction of a bank's branches in boom counties serve as weights. The distribution of bank branches comes from the FDIC *Summary of Deposits*, which we use to determine whether or not a branch (or the bank that owns it) is or is not exposed to the boom. Bank characteristics come from year-end *Call Reports*. Growth in mortgage originations comes from the annual *HMDA* data.

	Non-Exposed Banks		Exposed Banks	
	Mean	Std. Deviation	Mean	Std. Deviation
Panel A: Exposure to Deposit Shock (bank-year variation)				
Share of Branches in Boom Counties	0	0	0.45	0.39
Growth in Shale Well Exposure	0	0	0.25	0.51
Number of Bank-Years	7,451		1,280	
Number of Banks	1,350		357	
Panel B: Bank Characteristics (bank-year variation)				
Deposit Growth	0.085	0.141	0.102	0.156
Log of Assets	12.451	1.390	13.428	2.090
Deposits / Assets	0.827	0.086	0.827	0.087
Cost of Deposits	0.022	0.010	0.017	0.008
Liquid Assets / Assets	0.273	0.148	0.225	0.132
Capital / Assets	0.099	0.028	0.101	0.029
C&I Loans / Asset	0.112	0.090	0.145	0.087
Mortgage Loans / Assets	0.347	0.137	0.323	0.117
Net Income / Assets	0.009	0.008	0.008	0.011
Loan Commitments / Assets	0.109	0.140	0.134	0.182
Letters of Credits / Assets	0.006	0.011	0.010	0.020
Panel C: Annual Mortgage Growth Rates (bank-year variation)				
Growth in Mortgage Originations	0.112	0.621	0.117	0.576
Growth in Retained Mortgages	0.077	0.672	0.091	0.618
Growth in Sold Mortgages	0.107	1.159	0.098	1.097
Panel C: Annual Mortgage Growth Rates (bank-county-year variation)				
Growth in Mortgage Originations	0.023	1.123	0.027	1.058
Growth in Retained Mortgages	0.013	1.200	0.017	1.159
Growth in Sold Mortgages	0.039	1.117	0.036	1.014

Table 2: Shale Boom Exposure Expands Deposit Supply

This table reports bank-year regressions of the growth in deposit and the price of deposits (interest expenses on deposits / deposits) on measures of the exposure to shale-boom counties. Controls variables are compiled based on Call Report data and measured as of the prior year end. Standard errors are clustered by bank. All regressions include bank and year fixed effects.

Dependent Variable	Deposit Growth		Price of Deposits (Interest Expense/Deposits)		Capital/Assets		Net Income/Assets	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Share of Branches in Boom Counties$_t$	0.0567***	-	-0.0015***	-	-0.00204	-	0.000479	-
	(4.03)	-	(2.66)	-	(1.08)	-	(0.61)	-
Growth in Shale Well Exposure$_t$	-	0.0264***	-	-0.0019***	-	-0.000793	-	0.000134
	-	(4.42)	-	(3.00)	-	(0.98)	-	(0.47)
Log of Assets$_{t-1}$	-0.301***	-0.301***	0.0036***	0.0036***	-0.0193***	-0.0193***	0.0039***	0.0039***
	(14.56)	(14.60)	(10.13)	(10.12)	(6.54)	(6.55)	(7.13)	(7.13)
Deposits / Assets$_{t-1}$	-1.098***	-1.098***	0.0083***	0.0083***	-0.185***	-0.185***	0.003	0.003
	(13.58)	(13.60)	(4.43)	(4.38)	(8.65)	(8.64)	(0.89)	(0.88)
Liquid Assets / Assets$_{t-1}$	-0.0674	-0.0679	-0.0027**	-0.0029**	-0.0163*	-0.0163*	-0.0004	-0.0004
	(1.38)	(1.39)	(2.21)	(2.22)	(1.72)	(1.71)	(0.20)	(0.20)
C&I Loans / Asset$_{t-1}$	0.214***	0.214***	-0.0003	-0.0003	-0.0251***	-0.0252***	0.0065**	0.0065**
	(3.56)	(3.57)	(0.21)	(0.18)	(2.81)	(2.82)	(2.50)	(2.52)
Mortgages / Asset$_{t-1}$	-0.002	-0.002	0.0034**	0.0034**	-0.0521***	-0.0521***	0.0128***	0.0128***
	(0.03)	(0.03)	(2.11)	(2.10)	(5.01)	(5.01)	(4.87)	(4.87)
Loan Commitments / Assets$_{t-1}$	0.0667	0.0665	0.0006	0.0006	0.0117	0.0117	0.0043*	0.0043*
	(0.98)	(0.98)	(0.76)	(0.74)	(1.13)	(1.13)	(1.95)	(1.95)
Letters of Credits / Assets$_{t-1}$	0.103	0.104	-0.0101	-0.0103	0.0395	0.0399	0.0192	0.019
	(0.23)	(0.24)	(1.42)	(1.44)	(0.73)	(0.74)	(1.54)	(1.53)
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	13,698	13,698	13,867	13,867	13,867	13,867	13,867	13,867
R-squared	54.8%	54.8%	89.5%	89.5%	76.3%	76.3%	63.4%	63.4%

*T-stats reported in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.*

Table 3: Effect of Liquidity Supply on Mortgage Lending

This table reports reduced form regressions of the percentage change in mortgage originations by bank-county-year on measures of the exposure to shale-boom counties. Bank-county-years are excluded if the county experienced a shale boom over the sample period. *Mortgage Growth* equals the percentage change in originations from the prior year; *Retained Growth* equals the percentage change in mortgages held on the lender's balance sheet; *Sold Growth* equals the percentage change in mortgages sold by the originator. Regressions include both lender (reported) and borrower (not reported) control variables. Lender controls are from the Call Reports from the prior year; borrower controls are the average borrower and area income, loan size-to-income ratio, percent women applicants, percent of minority applicants, and percent minority in the area for loans made during the current year (from HMDA). Standard errors are clustered by bank. All regressions also include county*year fixed effects.

Dependent Variable	Mortgage Growth		Retained Growth		Sold Growth	
	(1)	(2)	(3)	(4)	(5)	(6)
Share of Branches in Boom Counties$_t$	0.146**	-	0.325**	-	0.202	-
	(2.17)	-	(2.26)	-	(1.26)	-
Growth in Shale Well Exposure$_t$	-	0.0533**	-	0.223***	-	0.0674
	-	(1.97)	-	(2.69)	-	(1.37)
Log of Assets$_{t-1}$	-0.0121	-0.0124	-0.0096	-0.0107	-0.0217**	-0.0224**
	(1.45)	(1.49)	(1.11)	(1.27)	(2.10)	(2.15)
Deposits / Assets$_{t-1}$	(0.07)	(0.07)	(0.31)	(0.29)	0.06	0.07
	(0.41)	(0.39)	(1.40)	(1.32)	(0.31)	(0.33)
Cost of Deposits$_{t-1}$	(1.27)	(1.31)	(0.88)	(0.96)	(6.30)	(6.43)
	(0.43)	(0.44)	(0.24)	(0.27)	(1.37)	(1.39)
Liquid Assets / Assets$_{t-1}$	0.151	0.144	-0.0596	-0.0864	0.497**	0.486**
	(1.08)	(1.03)	(0.31)	(0.45)	(2.58)	(2.53)
Capital / Assets$_{t-1}$	-1.442**	-1.439**	-0.243	-0.173	-1.987***	-1.990***
	(2.20)	(2.20)	(0.39)	(0.28)	(2.92)	(2.94)
C&I Loans / Asset$_{t-1}$	0.081	0.0829	-0.0453	-0.0575	0.214	0.222
	(0.54)	(0.55)	(0.16)	(0.20)	(0.70)	(0.73)
Mortgage Loans / Assets$_{t-1}$	0.0445	0.031	-0.0104	-0.0697	0.289*	0.269
	(0.29)	(0.20)	(0.05)	(0.33)	(1.73)	(1.54)
Net Income / Assets$_{t-1}$	4.441**	4.517**	5.606*	5.764*	2.474	2.593
	(2.29)	(2.33)	(1.76)	(1.78)	(0.76)	(0.80)
Loan Commitments / Assets$_{t-1}$	0.0301	0.0292	-0.0191	-0.0222	0.0218	0.0194
	(1.32)	(1.28)	(0.51)	(0.59)	(0.57)	(0.51)
Letters of Credits / Assets$_{t-1}$	0.787	0.768	0.402	0.452	2.525**	2.497**
	(0.94)	(0.92)	(0.47)	(0.53)	(2.25)	(2.23)
Borrower Controls	Yes	Yes	Yes	Yes	Yes	Yes
County*Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank Clustered St Errors	Yes	Yes	Yes	Yes	Yes	Yes
Observations	92,144	92,144	71,034	71,034	49,427	49,427
R-squared	7.3%	7.3%	7.9%	8.0%	13.0%	13.0%

*T-stats are reported in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.*

Table 4: Determinants of Entrance and Exit Decisions and Shale Booms

This table estimates regressions of the determinants of a bank's shale boom exposure. The unit of observation is bank-year, and the dependent variable is a bank's shale boom exposure. *Exposure Based on 2002 Branch Distribution* is a bank's shale boom exposure based on holding its branch structure as of 2002. Application volume growth equals the percentage change in applications from the prior year, one and two year lags of this variable are included in the specifications. Columns (4) through (6) also include bank fixed effects, year fixed effects, and lender-specific control variables based on prior year call reports and HMDA data on mortgage applications. Application Volume Growth measures are based on HMDA. Standard errors are clustered by bank.

Panel A

Dependent Variable	Share of Branches in Boom Counties					
	(1)	(2)	(3)	(4)	(5)	(6)
Exposure Based on 2002 Branch Distribution	0.941***	0.945***	0.945***	0.912***	0.909***	0.909***
	(92.47)	(91.77)	(91.40)	(53.00)	(50.88)	(50.97)
Application Volume Growth$_{t-1}$	0.0002	-	0.0001	-0.0002	-	-0.001
	(0.34)	-	(0.02)	(0.26)	-	(0.65)
Application Volume Growth$_{t-2}$	-	0.001	0.001	-	0.001	0.001
	-	(1.64)	(1.33)	-	(1.09)	(0.71)
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes
Bank Financial Controls	-	-	-	Yes	Yes	Yes
Bank Effects	-	-	-	Yes	Yes	Yes
Observations	9,049	8,482	8,322	7,549	7,065	6,948
R-squared	92.5%	93.1%	93.2%	96.7%	96.8%	96.9%

Panel B

Dependent Variable	Growth in Shale Well Exposure					
	(1)	(2)	(3)	(4)	(5)	(6)
Exposure Based on 2002 Branch Distribution	0.961***	0.962***	0.961***	0.942***	0.941***	0.940***
	(88.87)	(87.78)	(86.94)	(57.76)	(57.30)	(57.05)
Application Volume Growth$_{t-1}$	-0.001	-	-0.001	-0.001	-	-0.002
	(0.54)	-	(0.70)	(0.57)	-	(0.95)
Application Volume Growth$_{t-2}$	-	0.0016*	0.001	-	0.002	0.001
	-	(1.83)	(1.24)	-	(1.30)	(0.61)
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes
Bank Financial Controls	-	-	-	Yes	Yes	Yes
Bank Effects	-	-	-	Yes	Yes	Yes
Observations	9,049	8,482	8,322	7,549	7,065	6,948
R-squared	93.7%	93.9%	94.0%	96.8%	97.0%	97.1%

*T-stats are reported in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.*

Table 5: Robustness Tests

This table estimates reduced form regressions of the percentage change in mortgage originations by bank-county-year using different robustness specifications. Bank-county-years are excluded if a county experienced a shale boom over the sample period. *Mortgage Growth* equals the percentage change in originations from the prior year. Regressions include both lender (not reported) and borrower (not reported) control variables. Lender controls are from the Call Reports from the prior year; borrower controls are from HMDA. Columns (1) and (2) report the analysis of parallel trends of exposed and non-exposed banks. The Pre-Boom Indicator for Booming Banks is equal to 1 for booming banks in all the years leading to the boom exposure and zero otherwise. The indicator is always equal to zero for banks that have never been exposed to the boom. Columns (3) and (4) add a control for branch growth. Columns (5) and (6) report results based on counties that do not border any of the boom counties. In columns (7) and (8) we eliminate banks with assets in the top decile of the size distribution. Columns (9) and (10) report results based on bank-county-years where lender originated at least 15 mortgages in two subsequent years. Finally, in columns (11) and (12) we incorporate bank*county fixed effects. All regressions include county-year fixed effects. Standard errors are clustered by bank.

	Dependent Variable: Mortgage Growth											
	Parallel Trend Tests		Include Branch Growth		Excluding Counties Neighboring Boom Counties		Drop Large, Nationwide Banks		Bank-County observations with at Least 15 Mortgages		Bank*County Fixed Effects	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Share of Branches in Boom Counties	0.177**	-	0.148**		0.183**	-	0.153**		0.230***	-	0.273***	-
	(2.18)	-	(2.20)		(2.17)	-	(2.24)		(3.22)	-	(5.89)	-
Growth in Shale Well Exposure	-	0.0535*		0.0566**	-	0.061***		0.0555*	-	0.0616**	-	0.110***
	-	(1.87)		(1.99)	-	(2.00)		(1.91)	-	(2.32)	-	(6.55)
Pre-Boom Indicator for Booming Banks	0.014	0.014	-	-	-	-	-	-	-	-	-	-
	(0.38)	(0.36)	-	-	-	-	-	-	-	-	-	-
Growth in Branches	-	-	0.125*	0.126*	-	-	-	-	-	-	-	-
	-	-	(1.67)	(1.67)	-	-	-	-	-	-	-	-
Borrower & Lender Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County*Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Clustered St Errors	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank*County Fixed Effects	-	-	-	-	-	-	-	-	-	-	Yes	Yes
Observations	92,144	92,144	92,144	92,144	62,189	62,189	90,926	90,926	30,365	30,365	92,144	92,144
R-squared	7.3%	7.3%	7.4%	7.4%	7.0%	7.1%	7.4%	7.4%	19.7%	19.7%	16.5%	16.5%

*T-stats are reported in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.*

Table 6: Liquidity Supply and Mortgage Lending:
The Effect of Local Lenders

This table reports reduced form regressions of the percentage change in mortgage originations by bank-county-year. Bank-county-years are excluded if the county actually a shale boom during the sample period. *Local Lenders* are those with a branch in the county (distant lenders originate mortgages without a branch in the county). *Mortgage Growth* equals the percentage change in originations from the prior year. Regressions include both lender (reported) and borrower (not reported) control variables. Lender controls are from the Call Reports from the prior year; borrower controls are the average borrower and area income, loan size-to-income ratio, percent women applicants, percent of minority applicants, and percent minority in the area for loans made during the current year (from HMDA). Standard errors are clustered by bank. All regressions also include county*year fixed effects.

Dependent Variable	Mortgage Growth			
	All Lenders		Local Lenders Only	
	(1)	(2)	(3)	(4)
Local-Lender Indicator	0.009	0.010	-	-
	(0.59)	(0.67)	-	-
Share of Branches in Boom Counties	0.116	-	0.288***	-
	(1.36)	-	(2.94)	-
Growth in Shale Well Exposure	-	0.044	-	0.131**
	-	(1.53)	-	(2.33)
Share of Branches in Boom Counties *	0.269**	-	-	-
Local-Lender Indicator	(2.53)	-	-	-
Growth in Shale Well Exposure	-	0.146**	-	-
Local-Lender Indicator	-	(2.16)	-	-
Log of Assets_{t-1}	-0.012	-0.012	0.009	0.009
	(1.44)	(1.47)	(1.08)	(1.10)
Deposits / Assets_{t-1}	-0.080	-0.076	0.411***	0.409***
	(0.46)	(0.44)	(3.97)	(3.95)
Cost of Deposits_{t-1}	-1.183	-1.217	-1.481	-1.477
	(0.40)	(0.41)	(0.27)	(0.27)
Liquid Assets / Assets_{t-1}	0.149	0.143	0.271**	0.272**
	(1.06)	(1.02)	(2.25)	(2.25)
Capital / Assets_{t-1}	-1.462**	-1.458**	-0.323	-0.320
	(2.24)	(2.23)	(0.50)	(0.49)
C&I Loans / Asset_{t-1}	0.081	0.083	0.200	0.206
	(0.54)	(0.55)	(1.25)	(1.28)
Mortgage Loans / Assets_{t-1}	0.052	0.039	0.064	0.061
	(0.34)	(0.25)	(0.40)	(0.38)
Net Income / Assets_{t-1}	4.410**	4.483**	2.013	2.075
	(2.28)	(2.31)	(0.79)	(0.81)
Loan Commitments / Assets_{t-1}	0.031	0.030	-0.106	-0.108
	(1.35)	(1.31)	(0.77)	(0.78)
Letters of Credits / Assets_{t-1}	0.801	0.778	-0.232	-0.281
	(0.95)	(0.93)	(0.33)	(0.40)
Borrower Controls	Yes	Yes	Yes	Yes
County*Year FE	Yes	Yes	Yes	Yes
Bank Clustered St Errors	Yes	Yes	Yes	Yes
Observations	92,144	92,144	22,192	22,192
R-squared	7.3%	7.3%	20.2%	20.2%

*T-stats are reported in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.*

Table 7: The effect of Liquidity Supply by Mortgage Type

This table reports reduced form regressions of the percentage change in mortgage originations by bank-county-year, broken out by mortgages for home purchase, home-equity lines, and refinancing. Bank-county-years are excluded if the county experienced a shale boom over the sample period. Regressions include both lender and borrower control variables (not reported). Lender controls are from the Call Reports from the prior year; borrower controls are the average borrower and area income, loan size-to-income ratio, percent women applicants, percent of minority applicants, and percent minority in the area for loans made during the current year (from HMDA). Standard errors are clustered by bank. All regressions also include county*year fixed effects.

Dependent Variable	*Mortgage Growth*		
	Home Purchase Mortgages	Home Equity Loans	Refinancings
	(1)	(2)	(3)
Panel A			
Local-Lender Indicator	-0.0350**	-0.0372	-0.00673
	(-2.554)	(-1.206)	(-0.338)
Share of Branches in Boom Counties	0.0626	-0.172	0.188*
	(0.89)	(-0.978)	(1.91)
Share of Branches in Boom Counties *	0.245**	0.592***	0.0642
Local-Lender Indicator	(2.44)	(2.74)	(0.50)
Borrower & Lender controls	Yes	Yes	Yes
County*Year FE	Yes	Yes	Yes
Bank Clustered St Errors	Yes	Yes	Yes
Observations	64,860	34,839	66,237
R^2	9%	16%	15%
z-statistic for: (1)==(2)		(1.457)	
z-statistic for: (2)==(3)		(2.099)	
z-statistic for: (1)==(3)		(1.106)	
Panel B			
Local-Lender indicator	-0.0348**	-0.0345	-0.00692
	(-2.564)	(-1.140)	(-0.355)
Growth in Shale Well Exposure	0.034	-0.083	0.0483
	(1.07)	(-1.533)	(1.16)
Growth in Shale Well Exposure *	0.154**	0.305***	0.0328
Local-Lender Indicator	(2.33)	(2.87)	(0.45)
Borrower & Lender controls	Yes	Yes	Yes
County*Year FE	Yes	Yes	Yes
Bank Clustered St Errors	Yes	Yes	Yes
Observations	64,860	34,839	66,237
R^2	9%	16%	15%
z-statistic for: (1)==(2)		(1.208)	
z-statistic for: (2)==(3)		(2.108)	
z-statistic for: (1)==(3)		(1.227)	

*T-stats are reported in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.*

Table 8: Do Shale Boom Exposed Banks Make Bad Loans?

This table reports bank-year regressions of mortgage charge offs and deliquencies (loans 90+ days late) relative to total mortgages on measures of the exposure to shale-boom counties. Regressions include lender controls from the Call Reports from the prior year. Standard errors are clustered by bank. All regressions also include bank and year fixed effects.

Dependent Variable	$\text{Delinquencies}_{t+1}$ / Mortgages_t		Charge-off_{t+1} / Mortgages_t	
	(1)	(2)	(1)	(2)
Share of Branches in Boom Counties_t	-0.00798**	-	-0.00324***	-
	(2.46)	-	(3.81)	-
Growth in Shale Well Exposure_t	-	-0.00313***	-	-0.000879***
	-	(3.10)	-	(2.71)
Log of Assets_{t-1}	0.00974***	0.00965***	0.00285***	0.00280***
	(5.51)	(5.43)	(4.76)	(4.65)
Deposits / Assets_{t-1}	0.01	0.01	0.00	0.00
	(0.75)	(0.79)	(0.70)	(0.74)
Liquid Assets / Assets_{t-1}	-0.0747***	-0.0745***	-0.0187*	-0.0187*
	(2.83)	(2.82)	(1.66)	(1.65)
C&I Loans / Asset_{t-1}	-0.0440***	-0.0444***	-0.0125**	-0.0127**
	(2.61)	(2.63)	(2.27)	(2.31)
Mortgage Loans / Assets_{t-1}	-0.0798***	-0.0797***	-0.0244**	-0.0245**
	(3.39)	(3.38)	(2.05)	(2.05)
Loan Commitments / Assets_{t-1}	-0.0186**	-0.0185**	-0.00862*	-0.00857*
	(2.04)	(2.05)	(1.76)	(1.76)
Letters of Credits / Assets_{t-1}	-0.0254	-0.0238	-0.0115	-0.0106
	(0.71)	(0.66)	(0.59)	(0.54)
Bank fixed effects	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes
Observations	12,999	12,999	12,659	12,659
R-squared	51.9%	51.8%	36.1%	36.1%

*T-stats are reported in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.*

Table 9: The Effect of Liquidity on Mortgage Lending:
Unserved Credit Demand and Financial Constraints

This table reports reduced form regressions of the percentage change in mortgage originations by bank-county-year. This table includes only lenders with a branch in a given county. Bank-county-years are excluded if the county actually experienced a shale boom. *Lagged Mortgage Approval Rate* equals the bank's approval rate for mortgages made from the prior county-year. *Mortgage Growth* equals the percentage change in originations from the prior year; *Lagged Bank Capital Ratio* equals the book value of capital / total assets for the lender from the prior year. Regressions include both lender and borrower (not reported) control variables. Lender controls are from the Call Reports from the prior year; borrower controls are the average borrower and area income, loan size-to-income ratio, percent women applicants, percent of minority applicants, and percent minority in the area for loans made during the current year (from HMDA). Standard errors are clustered by bank. All regressions include county*year fixed effects.

Dependent Variable	*Mortgage Growth*					
	Share of Branches in Boom County			Growth in Shale Well Exposure		
	(1)	(2)	(3)	(4)	(5)	(6)
Share of Branches in Boom Counties	0.888	-0.176	0.417	-	-	-
	(1.34)	(0.45)	(0.58)	-	-	-
Share of Branches in Boom Counties * Lagged Mortgage Approval Rate	-0.799*		-0.731**	-	-	-
	(1.68)		(2.01)	-	-	-
Share of Branches in Boom County * Lagged Bank Capital Ratio	-	3.582***	4.132*	-	-	-
	-	(2.92)	(1.85)	-	-	-
Growth in Shale Well Exposure	-	-	-	0.423	-0.104	0.155
	-	-	-	(1.17)	(0.49)	(0.46)
Growth in Shale Well Exposure Lagged Mortgage Approval Rate	-	-	-	-0.409*	-	-0.389**
	-	-	-	(1.86)	-	(1.97)
Growth in Shale Well Exposure Lagged Bank Capital Ratio	-	-	-	-	2.131**	4.61**
	-	-	-	-	(1.97)	(2.13)
Lender Controls	Yes	Yes	Yes	Yes	Yes	Yes
Borrower Controls	Yes	Yes	Yes	Yes	Yes	Yes
County*Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank Clustered St Errors	Yes	Yes	Yes	Yes	Yes	Yes
Lagged Mortgage Approval Rate & Lagged Bank Capital	Yes	Yes	Yes	Yes	Yes	Yes
Observations	22,192	22,192	22,192	22,192	22,192	22,192
R-squared	21.30%	20.20%	21.34%	21.30%	20.20%	21.35%

*T-stats are reported in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.*

Table 10: The Effect of Liquidity on Aggregate Mortgage Lending

This table reports reduced form regressions of the percentage change in county-year mortgage originations on each county's aggregate connaction via bank branch network to the shale-boom shock. For each county-year, we have two observations: growth in mortgages for home-purchase and growth in home equity loans. The regressions include county bank charcteristics averaged base on branch presence. The time-varying macro controls incllude populaiton growth, payroll growth, and employment growth. Standard errors are clustered by year.

	Panel A: Counties in All States				Panel B: Counties in 7 States with Shale Booms			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Average Share of Branches in Boom Counties$_t$	0.183***	0.210***	-	-	0.104*	0.104*	-	-
	(5.68)	(3.54)	-	-	(2.12)	(1.82)	-	-
Average Share of Branches in Boom Counties$_t$ *	-0.192	-0.191	-	-	-0.146	-0.145	-	-
Home Equity Loans Dummy	(1.80)	(1.73)	-	-	(1.06)	(1.05)	-	-
Average Growth in Shale Well Exposure$_t$	-	-	0.118***	0.139***	-	-	0.0674**	0.0758**
	-	-	(7.10)	(4.10)	-	-	(2.50)	(2.40)
Average Growth in Shale Well Exposure$_t$ *	-	-	-0.112	-0.111	-	-	-0.083	-0.082
Home Equity Loans Dummy	-	-	(1.39)	(1.33)	-	-	(1.16)	(1.10)
Growth in Mortgate Refinancing$_t$	0.158***	0.148***	0.158***	0.148***	0.0826***	0.0778***	0.0824***	0.0778***
	(8.98)	(10.57)	(8.92)	(10.47)	(3.40)	(3.40)	(3.39)	(3.40)
Growth in Mortgate Refinancing$_t$ *	0.141**	0.140**	0.141**	0.140**	0.027	0.026	0.027	0.026
Home equity Loans Dummy	(3.03)	(2.94)	(3.03)	(2.94)	(0.53)	(0.54)	(0.53)	(0.54)
Year * Loan Type FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County FE	No	Yes	No	Yes	No	Yes	No	Yes
Local Time-varying Macro Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	67,000	67,000	67,000	67,000	13,620	13,620	13,620	13,620
R-squared	22.60%	23.90%	22.60%	23.90%	14.30%	15.60%	14.30%	15.60%

*T-stats are reported in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.*