Bank Liquidity Price and Banking Market Competition

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Abstract

Two salient features of the banking sector are its heavy reliance on short-term funding and the existence of imperfect competition in banking markets. This paper investigates how competition in the bank funding market generates real impact by affecting the determination of short-term liquidity prices for banks. Exploiting the exogenous variation in banking market competition resulting from the U.S. banking deregulation in 80s and early 90s, this paper documents two novel facts about the real outcome implications of banking market competition. First, while banks' loan making generally tends to be less local than deposit taking, a more competitive banking market enlarges this geographic mismatch between banks' activities on two sides of their balance sheets. Furthermore, this effect is more pronounced for banks that are financed with higher shares of uninsured deposits or transaction deposits, as well as for loans made to labor-intensive industries. Second, examination of the lending dynamics of banks hit by the 1986 oil price shock reveals a mixed effect of banking market competition on economic stability. A more competitive banking market provides better hedging against idiosyncratic shocks for lightly hit areas, but it can lead to a severe freeze-up in bank lending in heavily hit areas where the shocks are more systemic. Evidence suggests that these real effects of banking market competition are generated through it impacts on how supply/demand shocks on bank short-term funding transmit to banks' short-term (retail/wholesale) liquidity prices.

Keywords: Bank short-term funding, Banking market competition, Lending distance, Economic stability.

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1. Introduction

Two salient features of the banking sector in an economy are its heavy reliance on short-term funding as the provider of liquidity insurance (Diamond and Dybvig (1983), Diamond and Rajan (2001)) and the existence of imperfect competition in banking markets (Acharya et al. (2012), Schnabl et al. (2017)). Much research has shown that changes in banks' short-term liquidity condition can have a profound impact on the real economy by affecting banks' credit supply decisions, and that imperfect competition exists in both the wholesale and retail markets of bank short-term funding. However, little is known about how perfect/imperfect competition in banking markets can affect real economic outcomes through its impact on the determination of banks' short-term funding cost. This paper sets the goal to empirically answer this question.

Exploiting the exogenous variation in banking market competition that resulted from the US banking deregulation during the 80s and early 90s, this paper documents two novel facts about the real outcome implications of banking market competition.[1] First, while banks' loan making generally tend to be less local than deposit taking, variations in banking market competition can significantly affect the degree of this geographic mismatch between banks activities on two sides of their balance sheets. Second, an examination of the lending dynamics of banks hit by the 1986 oil price shock reveals a mixed effect of banking market competition on the economy's resilience to unexpected shocks. I show that these real effects of banking market competition are generated through its impact on how supply/demand shocks on bank short-term funding are transmitted to banks' short-term (retail/wholesale) liquidity prices. Let us now elaborate.

The largest chunk of banks' liability is deposits, which are liquid and often redeemable on demand. As shown in Figure 1, over 80% of U.S. banks' liabilities are in the form of bank deposits. Such a heavy reliance on liquid deposit financing implies a natural sensitivity to variations in short-term liquidity conditions for the banking sector. My analysis starts from the following simple fact: banks are concerned about their short-term liquidity raising cost; thus, banking market competition can affect banks' real activities through its impact on the determination of short-term liquidity prices.

[1]The banking market deregulation during this episode and considered in this paper is the deregulation of bank funding markets. More details of the banking deregulation are discussed in Section 2.

The first novel fact I document, that the geographic mismatch between banking activities is acutely influenced by banking market competition, hinges on how a particular form of supply-side shock transmits into short-term liquidity prices. The credit extend by banks to their borrowers will circulate in the economic system, in which process it creates fresh supply of deposits to the banking sector.[2] Using detailed loan-level observations from SBA small business loan dataset, I empirically document a quantitatively significant "deposit creation" effect of bank loans. That is, an increase in credit flow to an area generates a positive shock to the supply of short-term liquidity for banks located in this area. By exploiting the intrastate deregulation of three states that happened in early 90s, I explore how the level of banking market competition would affect the transmission of this positive supply shock to banks' liquidity raising cost.[3]

While a positive supply shock on banks' short-term liquidity generally implies a lowered price at which banks can raise liquidity, the exact transmission and the reduction in the liquidity price hinge on competition in banking markets. In a highly competitive environment, an increased supply of short-term liquidity in a local area is unlikely to produce much reduction in the liquidity price for local banks. This is because a competitive banking market allows banks from nearby areas to easily come in and bid for liquidity once the price of short-term liquidity in a local area becomes low. Symmetrically, under the competitive market setting, banks are able to capture (at least) some benefits of the lowered liquidity price from credit that flows to nearby areas.

Empirically, I show that before the intrastate deregulation, a 10% expansion in the credit received by adjacent area businesses was only associated with a 0.2% decrease in a bank's average wholesale funding costs, while the number becomes 3.75% after the deregulation. Relatedly, a 10% expansion in credit inflow from outside the region to local businesses was associated with 2.5% decrease in local banks' wholesale funding costs before intrastate deregulation, but predicted no significant changes in local banks' wholesale funding cost after deregulation. The same patterns are also consistently observed for changes in retail liquidity prices.

[2]This idea of "loans create deposits" can be related to a canonical view of bank money creation that loans will immediately create a matching deposits. The stand we take in this paper is that loans will create deposits, but in an indirect way through enlarging the supply of short-term funding for the banking sector.

[3]These three states are Iowa, Arkansas and Minnesota, all of which deregulated their bank funding markets in 1994, 1994 and 1993. We focus on these three states because the SBA small business loan dataset starts from 1990.

These results, which show how banking market competition can affect the transmission of such a positive supply shock on bank short-term funding to bank liquidity price, have some natural implications for banks' real activities. In particular, the geographic scope of banks' activities on both sides of their balance sheets is likely to be distorted by the liquidity price transmission outcomes. In a segmented banking market, when banks make loans to firms in the same local area, they reap the benefit of the "deposit creation" effect of loans and enjoy a lowered prices of short-term liquidity subsequently. However, when they extend loans to businesses outside the local area, loan-making banks are unlikely to gain much from the enlarged supply of short-term liquidity that these loans create. Therefore, when banking markets are segmented such that the ability of banks to raise deposits from outside areas is limited, banks will tend to concentrate on making loans in their local area.

Empirically, I show that banks in the three states (Iowa, Arkansas, and Minnesota) that deregulated the banking sector during early 90s significantly widened their average geographic lending distance immediately after the intrastate deregulation. For instance, prior to deregulation, only about 10% on average of Iowa banks' small business lending portfolio was allocated to distant borrowers outside their network structure. After the intrastate deregulation initiated in 1994, the average distant portfolio started to rise significantly; indeed, by 1997, Iowa banks were allocating about 20% of their small business loans to distant borrowers outside of their branching networks.[4] I also run a couple of placebo tests, which show that this enlarged geographic mismatch between banking activities that accompanied banking market deregulation was more pronounced for banks that had a higher sensitivity to short-term liquidity prices and for loans made to labor intensive industries.

The second novel fact documented by this paper is that banking market competition has a mixed effect on economic stability, and this is related to the role played by banking market competition in the transmission of demand-side shocks to short-term liquidity prices. Such demand-side shocks could be driven by a sudden increase in the withdrawal of deposits, an increased draw down in the credit commitment by borrowing firms, or an increased rate of delay or default in the loan payment. I consider the following specific scenario under which the banking sector experiences a spike in its demand for short-term funding. The 1986 oil price bust unexpectedly hit the U.S. oil industry as well as the banking sector that makes loans to it. When the

[4]The borrower being outside the branching networks of the loan-making bank means that there is no branch of the loan-making bank located in the same county in which the borrower is located in. See detailed discussion in Section 3.2.

shock hit, firms in the oil industry suffered a sudden decrease in their profits and cash flow. Many of these firms thus have to delay or even default on their loan payments. The resulting spikes in the short-term overdue ratio for banks that made loans to these oil firms effectively implies an enlarged demand for short-term liquidity for these banks, which had to meet their obligations on the liability side.

An increased demand for short-term liquidity from the banking sector generally implies a higher price of liquidity, but the exact transmission to liquidity prices would depend on the competitiveness of banking markets and the relative scale of the shock. Depending on the geographic distribution of oil-related businesses, the scale of the demand shock on short-term bank liquidity induced by the oil price bust can vary substantially across regions. In areas where oil-related businesses are concentrated, the fraction of banks that experienced an increased demand for short-term liquidity is likely to be high in these areas. In areas that have fewer oil firms, the fraction of troubled banks is likely to be low.

Let us consider first an area that is lightly hit by the shock, in which only a small fraction of the local banks are in need of an increased amount of short-term liquidity. In such an area, for banks hit by the demand shock on short-term liquidity, the wholesale liquidity from the inter-bank market is likely to be a non-trivial source of liquidity to accommodate their increased demand for short-term funding. When banking markets are competitive, the wholesale liquidity traded in the inter-bank market can be purchased at a price close to the marginal cost. This is so because competitive banking markets can effectively improve the threat points for liquidity-needy banks when they bargain with banks surplus in liquidity. In contrast, when banking markets are segmented, banks that face liquidity stress can be severely extracted in their inter-bank trading due to their limited outside option and end up incurring a substantially higher wholesale funding cost. Empirically, I estimate an reduction of 64 basis points in wholesale liquidity rate increase for shocked banks in lightly hit areas, if they are in states that have deregulated the banking sector.

In heavily hit areas, the story is totally different. Here the retail prices of short-term bank liquidity deserve more attention because the wholesale liquidity market becomes silent once an aggregate liquidity shortage kicks in. The competitive banking market now becomes undesirable. This is so because it allows banks to easily steal retail liquidity from other areas by simply offering a slightly more attractive rate than the rates offered by local banks in those areas. As a consequence, the price of short-term liquidity in the retail market gets bid up, to a point where no banks have incentive to steal liquidity from others' local areas. In this way, the whole system can become trapped in a high interest rate equilibrium, in which all banks are forced to pay an inefficiently high price for short-term liquidity. Empirically, I estimate an extra 213 basis points increase in retail liquidity raising cost for shocked banks in heavily hit areas, if they are in states that have deregulated the banking sector.

These patterns on how an increased demand for liquidity from the banking sector transmits to the prices of short-term liquidity implies a mixed effect of banking market competition on the economy's resilience to negative shocks. To test this prediction, I conduct a diff-in-diff analysis on the lending dynamics of banks hit by the 1986 oil price shock. My findings show that in lightly hit areas where the shock is relatively idiosyncratic, a more competitive banking market could increase the economy's resilience to the shock and maintain a relatively stable level of corporate lending from the banking sector. In contrast, in heavily hit areas where the shock was systemic, more competitive banking markets turn out to be counter-productive and could aggravate the economy's response to the shock, as reflected in a larger contraction in the level of corporate lending from the banking sector.

Related Literature The first strand of literature this paper is closely related with is an extensive literature on banks' heavy reliance on short-term funding, in performing their role as the liquidity provider in the economy. Diamond and Dybvig (1983) and Diamond and Rajan (2001) recognize the benefits and necessity for banks to finance themselves with short-term debt, as well as point out the potential risks associated with doing so. Kashyap et al. (2002) made the argument that commercial banks' deposit-taking and loan-making are actually unified by a more primitive function of banks that differentiate banks from other savings institutions, which is the provision of liquidity on demands. Importantly, they argue that loan-making and deposit-taking generate synergies within a bank so long as the liquidity shocks on depositors and firms are not perfectly correlated. Their findings provide evidences suggesting short-term liquidity concerns can affect banks' activities on their asset side. Gatev and Strahan (2006) provides supporting evidence for this view through examining the funding inflow conditions when there is market-wide liquidity dry-up in the CP market. Acharya and Mora (2015) provides evidence that systemic shocks to banks' liquidity and deposit funding negatively impair banks' role as liquidity providers in an economy and thus dampen loan making.

The second strand of literature this paper is closely related with is a large body of research studying how banking deregulation or in general banking market competition affect real economic outcomes. The most representative set of works include Schnabl et al. (2017), Rice and Strahan (2010), Black and Strahan (2002), Jayaratne and Strahan (1996), Huang (2015), Chava et al. (2013), Karceski et al. (2005), Cetorelli and Gambera (2001), Cetorelli and Strahan (2006), Berger et al. (1998). The contribution of our paper to this strand of literature is that our paper provides a novel angle through which changes in bank funding market competition could affect real outcome– through its impact on determination of short-term liquidity prices.

The third strand of literature the paper relates to is the work investigating dynamics of bank lending distances and the factors affecting the lending distances. Recent representative works include Granja et al. (2019), Nguyen (2019), Presbitero et al. (2014), Degryse and Ongena (2005), Beck et al. (2010), etc. Our paper is the first to document the fact that increases in banking market competition will induce banks to lend to distant borrowers and enlarging the geographic mismatches their activities on the two sides of balance sheets.

This paper is also related to works studying how banks' short-term liquidity raising cost spikes affect real economic outcomes, primarily through impacting their lending behavior. This strand of works include Correa et al. (2016), Khwaja and Mian (2008), Schnabl (2012).

The rest of the paper is organized as follows. In Section 2, I introduce the institutional background and the natural experiment setting for this empirical study. Section 3 describe the data source and measurement construction for key variables in our empirical analysis. Section 4 lays out the framework for our empirical tests, from which hypotheses to be test are drawn. Section 5 investigates how banking market competition can affect the transmission of a particular supply-side shock to the short-term liquidity prices, as well as its implication on the geographic scope of banking activities. Section 6 examines the role played by banking market competition in the transmission of demand-side shocks to the short-term liquidity prices, and what it implies for the relation between banking market competition and economic stability. Section 7 concludes.

2. Institutional Background and Natural Experimental Setting

2.1. Institutional Background

In order to causally investigate how changes in banking market structure affect the determination of banks' short-term liquidity price determination through supply and demand side factors, it is important that we could have an experimental setting where we are able to compare whether the same (group) of banks' short-term liquidity price determination has ever changed when the local banking market structure changed. Static cross-sectional correlations between short-term liquidity price determination and measures of local banking market structure are limited in explaining power due to the presence of reverse causality issues: banks operating in high competitiveness local banking market could have fundamentally different compared with those operating in low competitiveness local banking market, thus making the cross-sectional analysis unable to generate meaningful results.

The historical episode throughout which we conduct empirical analysis is the U.S. banking sector deregulation that spanned from late 1970s to the middle of 1990s following the pass of Depository Institutions Deregulation and Monetary Control Act by Congress. One of the major chapters of this phenomenal wave of banking deregulation was the intrastate deregulation, under which restrictions on banks' branching operations within the state was lifted.[5]

In 1970s, legislatures of most states in the U.S. restricted intrastate bank expansions (Gatev and Strahan (2006)). Starting from late 1970s, states started to lift the within-state restrictions on local banks' branch openings.[6]

There are two important features of intrastate-deregulation that makes it an ideal laboratory for studying our research question. The first feature is the nature of intrastate deregulation transformed local banks' retail deposit market segmentation.

[5]There are two main chapters of banking deregulation during this episode, the first is the intrastate deregulation, which is featured with removals of within-state branching restrictions; while the second is the interstate banking deregulation, which is featured with allowance of cross-state branch acquisition under reciprocal agreement. For the purpose of our paper, the intrastate deregulation is the relevant deregulation instruments for the purpose of identifying increased competitiveness in local deposit market, since various previous research has demonstrated that the intra-state deregulation had more significant effect on local banking market structure (Amel and Liang (1992), Jayaratne and Strahan (1996)).

[6]In 1970, only 12 states allowed unrestricted statewide branching. Between late 1970s and 1994, however, 38 states deregulated their restrictions on branching.

The most important step of intrastate banking deregulation was to allow banks to expand their branches within states through mergers and acquisitions. This act permitted banks to convert offices of subsidiary banks (existing or acquired) into branches of a *single* bank. Before the implementation of this act, deposit markets were very segmented. Banks were only allowed to take deposits within one piece of geographical region. Even if a bank could have several branches across adjacent counties, a depositor of one branch in county A would not have access to her deposit through another branch of the same bank in county B.[7] The second prominent feature of the intrastate deregulation was that the whole process was a lasting process that occurred across states at different times throughout the early-1980s to mid-1990s episode in a piecemeal manner. For instance, Alabama launched the intrastate deregulation through vertical integration in 1981, while Arkansas didn't went through the intrastate deregulation until 1994. Since the goal of our paper is to explore how differences in local banking market competitiveness change the supply and demand side factor′ impact on local banks' short-term liquidity price, the slow-moving chronicle feature of deregulation across states is crucial. Because it gives us environment whenever a potential factor that will impact local banks' liquidity price took place, there are both states with more competitive banking sectors and those without.

2.2. *Experimental Set-up*

In this paper, I utilize two experimental settings under the backdrop of intrastate banking sector deregulation. The first setting is a the post-1991 episode for three late intrastate deregulation states, for which we will utilize the combination of deregulation with local liquidity supply shock to study how lending distance change when local banking market competitiveness changed; the second setting is the 1986 oil-price shock episode, which could be interpreted as a negative liquidity demand side shock, where we study how banks' short-term funding price determination changed when the local banking market competitiveness changed.

There were three states that went through intrastate banking deregulation after 1990. They are Arkansas in 1994, Iowa in 1994 and Minnesota in 1993. The starting year of SBA small business loan data is 1991. The overlap between the three

[7] The empirical verification of this increased deposit-market competition in the true sense is that the HHI in (state-level) local banking markets decreased though the country-level total banking market become more concentrated (Black and Strahan (2002)). Deregulation increased *deposit* market competition competition at the level of the local banking market.

late intrastate deregulation states and the availability of local small business lending database allows us to compare how does changes in banking sector competitiveness transform the impact of credit supply shock on local banks' short-term liquidity price determination *within* region pre-deregulation and post-deregulation.

On the credit demand side shocks, I utilize the 1986 oil-price shock which caused sudden and dramatic shrink in oil companies' revenues in the upcoming years, and thus unable to repay their credit lines on time. This shock from the credit demand side posed serious liquidity concerns to banks who lent heavily to oil companies ex-ante. Importantly, the shock-affected banks are located in different states where some of them already finished intrastate banking deregulation while others not. Holding other factors unchanged, this gives us exogenous variation on local banking market competitiveness when they went through a liquidity shock from credit demand side. Moreover, depending on the ex-ante loan exposure to oil companies and local banks' geographic proximity to oil companies, some local regions are *systemically* affected by oil shocks, these are primarily oil states including Texas, Arkansas, Louisiana, Oklahoma and New Mexico; in other states, the oil price shock only idiosyncratically hit the local banks' liquidity conditions. Further, within the five systemically hit states, Texas, Louisiana and Oklahoma went through intrastate deregulation when the oil price shock was still on-going.[8] This gives us perfect opportunity to study how local banking sector competitiveness increase interact with systemic liquidity shock from credit supply side. The details of this episode is done in Section 6.

3. Data and Main Variable Construction

3.1. Small Business Loan Data

I obtain the data on local small business loans from Small Business Administration (SBA), which contains a list of all SBA-guaranteed loans under the 7(a) program from 1991 to 2010, for the focus of our work, we utilize the sub-sample of the SBA loans from 1991 to 2000. The data-set contains information about borrowing firm and lending banks' identity, address, zip code, city and state of both the borrowing small business and the lending bank, status of the loans, (whether it's performing or default), types of the loans, initial interest rate, approval date, industry categorization of

[8] All of the three went through intrastate deregulation in 1988, while the oil-price plummet happened in the end of 1986, and continued all the way till 1989.

the borrower (NAICS), maturity of the loans, etc. Following Brown and Earle (2017), I exclude cancelled loans from the analysis because the cancellation may be at the initiative of the borrower. For the SBA dataset, using the University of Chicago Geographic Information Service (GIS), we geocode the geographic coordinates of approximately 1 million borrowers and their lenders. We are unable to locate the geographic coordinates of approximately 0.6% of the SBA borrowers in the dataset and we discard those observations. I compute the distance between borrowers and lenders in the dataset as the geodetic distance between the reported addresses of borrowers and respective lenders in the SBA dataset. The summary statistics of the SBA loan data is provided in Table 1.

In Table 2, I provide the county-level summary statistics of SBA loans that is utilized in Section 4.1. I construct the sample by using the SBA loan data set from 1991-2000. SBA loans are aggregated to the county level. I include counties that has at least 5 records of SBA loans in each year, and we restrict counties to those with at least 5 consecutive years of observations. Imposing these restrictions results us in a total of 1905 counties from the year 1991-2000, with an annual average number of small business loans to be 55 and average annual total SBA loan amount to be $9370k.

3.2. *Bank Branch and Lending Distance*

An important component of our empirical analysis is the locations of banks branches in local geographic areas. I obtain information on geographic characteristics of all branches of commercial banks from the Summary of Deposits database (SOD) provided by FDIC. There are two parts of the database, the first part contains the relevant information starting from 1994, which is directly available for download from the FDIC's webpage;[9] the second part the data before 1994, which is extracted from the digitized copies of the *Databook – Operating Banks and Branches* that's available from Hathitrust online library. This dataset contains information on the geographical coordinates (in particular the county where the bank branch is located in) and deposits of each branch of a given bank in the United States. I complement the SOD dataset by assigning latitudes and longitudes to each branch address whenever geographic coordinate data are missing. For each bank, I take out the counties where it has branches in, and get the information of the latitudes and longitudes of the geo-

[9] https://www.fdic.gov/regulations/resources/call/sod.html

graphic centroids that county.[10] In this way, I am able to form the entire branching network structure of a given bank b (we denote this network as Ω_b). The SBA small business lending dataset contains information on the small businesses' and the corresponding lending bank's location at the zip-code level.[11] In this way, I am able to calculate the geodetic distance between the borrowing small business and the lending bank, based on the banks' branching network structure we obtained from the SOD dataset. Following Granja et al. (2019), we define $D_{b,i}$ the length of the shortest curve between bank b's branching network and borrower firm i's location.[12] Thus for each bank in a given year t and a given bank b with branching network Ω_b, we can calculate its weighted average lending distance to small businesses:

$$L_{b,t} = \sum_i \frac{l_{b,i,t}}{\sum_i l_{b,i,t}} D_{b,i,t}$$

Getting ready this distance variable prepares us for the analysis on the effect of local banking sector deregulation on the banks' lending distance changes for the three states that went through intra-state deregulation in the early 1990s. The three late deregulated states are AR, MN and IA. The summary statistics of the late deregulated states' small business lending characteristics and lending distances are provided in Table 1.

3.3. *Bank balance sheet data*

The bank balance sheet data is from U.S. Call Reports provided by the Federal Reserve Bank of Chicago. I use data from 1982 to 2000. The data contains quarterly data on the income statements and balance sheets of all U.S. commercial banks. Table 3 shows the summary statistics of banks' balance sheet items. Panel (A) shows the summary statistics of banks located in non-oil states, and Panel (B) shows the summary statistics of banks in the five oil states: TX, NM, LA, OK, and AR.[13] In the summary statistics, we show the bank size in the natural log of banks' total assets in

[10]The longitude and latitude of county centroids are available here: https://en.wikipedia.org/wiki/User:Michael_J/County_table.

[11]The latitude and longitude of the all the U.S. zip-codes are provided here: https://public.opendatasoft.com/explore/dataset/us-zip-code-latitude-and-longitude/table/.

[12]Mathematically, $D_{b,i} = \min_{br \in \Omega_b} \{d_{b(br),i}\}$

[13]In our sample of oil-state banks, we have excluded those banks that failed or merged into other banks during the 1986 oil-price shocks. A bank is defined as failed or merged into others if it disappeared from the Call Report since 1986.

thousands of dollars, the decomposition of banks' loans, the banks' liability structure, and the banks' funding costs (wholesale and retail). As can be seen through comparing Panel (A) and Panel (B), all of the important summary statistics are very similar between the oil and non-oil state banks.

Another spectrum of our empirical analysis compares banks in the three-digit zipcode areas that were systemically hit by the oil-price shock and those that were idiosyncratically hit by the oil-price shock.

3.4. *Measuring banks' liquidity raising cost*

Since we are interested in investigating how local banking market structure affects local banks' short-term liquidity funding cost determination, it is crucial that I have good proxy of banks' short-term funding rate. I construct the implied retail and wholesale funding rate using information from Call Report following Acharya et al. (2012). In particular, I take the interest expenses on deposits and wholesale funding and then divided by the total stock of deposits and wholesale liabilities.

$$\text{Retail rate} = \frac{\text{Interest expense on deposits}}{\text{Deposits}}$$

$$\text{Wholesale rate} = \frac{\text{Interest expense on Fed funds purchased and securities sold under agreements to repurchase}}{\text{Fed funds purchased and securities sold under agreements to repurchase}}$$

where "Interest expense on deposits" is RIAD4170, "Interest expense on Fed funds purchased and securities sold under agreements to repurchase" is RIAD4180, availability of both of these two sequences of variables start from the first quarter of 1983. "Deposits" is RCON2200, which is the total stock of domestic deposits; "Fed funds purchased and securities sold under agreements to repurchase" is RCFD3353, which is the quarterly average of wholesale liabilities.

Figure 2 shows the evolution of (weighted average) commercial banks' retail funding rate and wholesale funding rate over 1976-2013.

4. Framework of Empirical Tests

In this section, I lay out the framework of the empirical tests of the paper. The goal of the paper is to investigate how banking market competition generates real impact on banking activities, through affecting the determination of bank short-term funding prices. In organizing the empirical tests, we examine how the level of banking market competition affects the transmission of supply-side and demand-side shocks on bank short-term funding to bank liquidity prices respectively.

4.1. Supply-side shocks and Implications

Changes in the supply of bank short-term funding can affect the price of bank liquidity. In this part, we discuss how a particular form of liquidity supply shock transmits to the price of bank short-term liquidity, as well as the role played by banking market competition in this process. Based on these intuitions, we further discuss how the geographic mismatch in banking activities is likely to be affected by banking market competition.

A) **A supply-side shock: Loans create deposits**

Borrowers do not borrow to sit idle with the money. Instead, the credit received by a borrower–be it a firm or a household, will be circulating in the economy. Whoever receives this credit in the subsequent transactions triggered by the outlay of the initial borrower will have a demand to find a safe store to place this credit. Such a demand for safe store to place this credit effectively generates a fresh supply of short-term liquidity for the banking sector in this economy.

In this way, corporate loans extended to firms located in an area will generate an enlarged supply of short-term liquidity for banks residing in this area. Following this logic, a sudden increase in the credit flow to an area could be viewed as a positive supply shock on the short-term liquidity to banks in this area, which is likely to affect the price of liquidity for these banks.

B) **Transmission to liquidity prices and banking market competition**

A positive shock on the supply of bank short-term liquidity generally implies a reduced price at which banks can raise liquidity. However, the exact transmission and the reduction in liquidity price hinge on the competition in banking markets.

In a highly competitive environment, an increased supply of short-term liquidity in a local area is likely to translate little into reduction in liquidity price for local banks. This is because a competitive banking market allows banks from nearby areas to come in and bid for liquidity once the price of short-term liquidity in a local area becomes low. Symmetrically, under the competitive market setting, banks are able to capture some benefits of lowered liquidity price from credit flowing to nearby areas. These intuitions hold consistently for both short-term liquidity in both retail markets and wholesale markets.

As a comparison, in an environment of highly segmented banking market, the impact of increased credit flow on liquidity price for local banks is likely to be different. Following a sudden increase of credit flow received by firms in a local area, banks in this area are likely to be able to enjoy a significantly lowered price of short-term liquidity. This is because local banks are protected by the segmented banking market, which prohibits banks from nearby areas to come inside and hence allows local banks to reap most of the benefits from enlarged supply of short-term liquidity. Symmetrically, while segmented banking markets enables banks to better enjoy the lowered liquidity price after positive supply shock to their local areas, it also makes harder for banks to gain benefits from enlarged supply of short-term liquidity in nearby areas.

C) **Implication: Geographic mismatch between banking activities**

The above discussions on how banking market competition may affect the transmission of such a positive supply shock on bank short-term funding to bank liquidity price have some natural implications on banks' real activities. In particular, the geographic scope of banks' activities on both sides of their balance sheets is likely to be distorted by the liquidity price transmission outcomes.

Being the major provider of credit in the economy, banks' activities on their asset side play a critical role in generating real economic growth. As an important aspect of banks' lending behavior, the geographic scope of bank lending has been examined by a large body of literature. While it has been well documented that banks' loan making are less geographically local than their deposit taking, how this geographic mismatch between banking activities is related to banking market competition has not been fully understood.

Our analysis about how banking market competition affects the liquidity price transmission of supply-side shock has a clear implication on the geographic mismatch between banking activities. That is, more competitive banking markets are likely to enlarge the geographic mismatch between banks' deposit taking and loan making. To be more precise, when banking markets become more competitive, banks are likely to increase their lending distances.

This prediction is easy to understand. Under a segmented banking market, by making loans to firms in the same local area, banks are able to reap the benefit of the "deposit creation" effect of loans and enjoy a lowered prices of short-term liquidity subsequently. However, for loans extended to firms outside the local area, the loan-making banks are unlikely to be able to gain the enlarged supply of short-term liquidity created by these loans. Therefore, when banking markets are segmented such that banks' ability to raise deposits from outside areas is limited, banks tend to concentrate in their local area in making loans. This pattern would be pronounced for banks care much about their short-term liquidity condition.

Conversely, with a highly competitive banking market, there would be little point for banks to focus on local lending for liquidity perspective. Loans made to local firms and hence fresh supply of short-term liquidity generated in the local areas are unlikely to translate much into lowered liquidity price for the loan-making banks. Despite the weak protection of locally generated supply of short-term liquidity, competitive banking markets allow banks to gain at least some benefits from loans extended to borrowers from outside areas. Therefore in such cases, banks are unlikely to focus on lending to local borrowers for liquidity considerations.

4.2. Demand-side shocks and Implications

The second part of the empirical analysis examines how demand-side shocks on banks' short-term funding transmit to real outcomes and the role played by banking market competition in the process. In particular, we study scenarios in which banks are faced with liquidity stress, featuring an increased demand for short-term liquidity from the banking sector.

A) **A demand-side shock: The 1986 oil price bust**

The 1986 oil price bust unexpectedly hit the U.S. oil industry as well as the banking sector that makes loans to it. Upon the shock hit, firms in oil industry experienced sudden decrease in their profits and cash flow. Many of these firms thus have to delay or even default on their loan payments. The resulting spikes in the short-term overdue ratio for banks that made loans to these oil firms effectively enlarged the demand for short-term liquidity for these banks– to meet their obligations on the liability side.

As such, the oil price bust which took place in early 1986 and last for more than one year effectively creates a demand-side shock on short-term funding to the U.S. banking sector. Depending on the area's risk loading on oil industry, for instance, the number of oil-related firms in the area, the shock is a systemic one for some areas while more of an idiosyncratic one for others. In what follows, it becomes clear that the scale of the shock is a key parameter in assessing the affect of banking market competition on economic stability.

B) **Transmission to liquidity prices and banking market competition**

While the distinction between retail and wholesale liquidity stays silent in the above analysis of supply-side shocks transmission, it makes a critical difference in our analysis of the demand-side shock.

For a lightly hit area where the shock is idiosyncratic, banks hit by the shock will actively engage in inter-bank trading to borrow wholesale liquidity from those surplus in liquidity. For these lightly hit areas, the functioning of the wholesale liquidity market and the pricing of wholesale liquidity are crucial determinants of the economy's resilience to the shock. As a sharp comparison, for heavily hit areas where the shock is more systemic, the inter-bank market becomes less relevant as there is a system-wise shortage of liquidity in these areas. In such cases, conditions in the retail liquidity markets and the pricing of retail liquidity are more relevant determinants for the economy's resilience to the shock.

An increased demand for short-term liquidity from the banking sector generally implies a higher price of liquidity, but the size depends on how competitive the banking markets are. Let's consider first an area that is lightly hit by the shock. In such an area banks in need of short-term liquidity are likely to rely on wholesale market to accommodate their increased demand for short-term funding. When banking markets are competitive, wholesale liquidity is likely to be traded at a price close to the marginal cost. This is because competitive banking markets effectively improves the threat points of liquidity-needy banks in their bargaining with banks surplus in liquidity. On the contrary, in a setting of segmented banking markets, liquidity-surplus banks are able to extract rents from inter-bank trading and charge positive mark-ups in the wholesale liquidity lent to banks in need of liquidity.

For heavily hit areas, the story is totally different. In these areas the retail prices of short-term bank liquidity are what should be paid more attention to as the wholesale liquidity market becomes silent once an aggregate liquidity shortage kicks in. Competitive banking market now becomes undesirable– it allows banks to bid up prices of retail markets in an effort to raise enough liquidity to meet their demand. As a consequence, the whole system could be trapped in a high interest rate equilibrium, in which all banks are forced to pay an inefficiently high price for short-term liquidity. On the other hand, segmented banking market can resolve this problem– all banks are perfectly disciplined in their liquidity raising behavior and thus no bank would be concerned that the retail liquidity price in their local area gets bid up too high.

C) **Implication: Mixed effect on economic stability of banking market competition**

Banking sector's ability to weather stress on their short-term liquidity is critical in determining an economy's resilience to negative shocks. Our analysis above on how banking market competition affects the transmission of increased demand for short-term liquidity to bank liquidity prices suggests a potentially mixed role played by banking market competition in affecting the stability of real economy.

For lightly hit areas, competitive banking market enables banks in need of liquidity to borrow wholesale liquidity from those surplus in liquidity at reasonably low prices. Through this way, these banks hit by the demand shock on short-term liquidity do not have to cut their illiquid lending much. However, for lightly hit areas where banking markets are segmented, banks facing an increased demand (or concern of) short-term liquidity will have to respond by cutting illiquid lending significantly, as the price of liquidity they can borrow from the wholesale markets is likely to be high. In sum, for lightly hit areas where the shock is relatively idiosyncratic, a more competitive banking market can increase the economy's resilience to the shock and maintain a relatively stable level of corporate lending from the banking sector.

For heavily hit areas, competitive banking market now becomes counter-productive– it makes the local economy trapped into a high interest rate equilibrium in which all bank need to pay an inefficiently high price for short-term liquidity in the retail market. As a result, banks hit by the shock have to cut their illiquid lending substantially and the economy experiences a severe freeze-up in economic activities. On the other hand, segmentation in banking markets turns out to be valuable for these heavily hit areas– it allows each of the hit banks to raise short-term liquidity from their local retail market at reasonably low prices. To sum up, for heavily hit areas where the shock is systemic, a more segmented banking market can increase the economy's resilience to the shock and maintain a relatively stable level of corporate lending from the banking sector.

5. Geographic Mismatch between Banking Activities and Banking Market Competition

In this section, I start my analysis by illustrating a particular form of supply shock on bank short-term liquidity – that *loans create deposits*. I then investigate how this supply shock on bank short-term funding translates into prices of bank short-term liquidity and the role played by banking market competition in this process. Based on these results, we document a novel finding about the geographic scope of banking activities – that more competitive banking markets enlarges the geographic mismatch between between deposit taking and loan making. Evidences are provided suggesting that this pattern is driven by the impact of banking market competition on the determination of bank short-term liquidity prices.

5.1. *A Supply Shock on Bank Short-term Liquidity: Loans Create Deposits*

Loans made by one bank can generate fresh supply of short-term liquidity for the banking sector as those who receive the credit would have a demand for a safe store to place these credit. In this part, we empirically document this "deposit creation" effect of loan making, through examining loan-level data and bank balance-sheet data that contains detailed information on geographic locations. In what follows, I start by documenting empirically that positive credit supply shock to a local economy is indeed positively correlated with local banks' deposit growth.

A) **Baseline results**

To explore the effect of credit growth on local banks' deposit growth, we collapse banks' balance sheet data and the SBA small business loan data to county level. In order to establish the "deposit creation" effect of loan making, we need to deal with an important reverse causality, which is the fact that an increase in local credit could be instead driven by the increase in local banks' deposit. To get around this reverse causality issue, instead of using the credit received by local small businesses from local banks, I utilize credit received by local small businesses from banks outside of the county where the business is located in. I then investigate whether increases in credit inflow from banks *outside* of a county is associated with deposit growth of local banks *inside* the county. We write down the following regression specification:

$$\Delta\text{Deposit}^{\text{local}}_{i,z,t} = \alpha_{i,z} + \mu_t + \beta\Delta\text{Loan}^{\text{outside}}_{z,t} + \epsilon_{z,t} \quad (1)$$

where i indexes bank, z indexes a county, t indexes year, $\Delta\text{Deposits}^{local}_{i,z,t}$ is defined as $Ln(\text{Deposit})_{i,z,t} - Ln(\text{Deposit}_{i,z,t-1})$ which is the log differences in the total deposits of bank i in county z between year t and year $t-1$, and $\Delta\text{Loan}^{\text{outside}}_{z,t}$ is log of the sum of total local small business lending that was lent by banks located outside of the county during the year-quarter t. Higher values of $\Delta\text{Loan}^{\text{outside}}_{z,t}$ means higher volume of credit received by local businesses from lenders outside of the local area itself during the year-quarter. To get rid of time-invariant bank-specific factors and county-level characteristics that might interfere with the correlation between local credit growth and local branch-level deposit growth, we add bank fixed effects and county fixed effects. Year fixed effects, county-year fixed effects and state-year fixed effects are also taken into consideration. We further include a set of bank-level control variables to control for bank-level time-varying factors. The baseline control variables include the share of commercial and industrial loans in total loans outstanding, the share of real estate loans in total loans outstanding, and the lagged log of the banks' total asset to control for the bank's size. Table 4 presents the regression results of the above specification.

The main coefficient of interest is β. In column (1) of Table 4's Panel (A), I run the baseline specification with only bank-level fixed effects, county-level fixed effects and time fixed effects, I find that a 10% expansion of loans from other banks outside of the local area is associated with an average of 5% increase in local banks deposit increase. In column (2) of Table 4, I add bank-level controls to control for time-varying bank-level characteristics, in column (3) I add county-time fixed effects, and in column (4) I add state-time fixed effects. Gradually adding control variables and fixed effects do not alter our results qualitatively or quantitatively. This tells us that expansion in banks' loan making (proxied by higher volume of credit inflow into the county from banks outside the county) predicts deposit growth in the local county.

B) **Placebo tests**

To get a stronger interpretation of the effect of local credit expansion on local banks' deposit growth, I conduct a couple of placebo test. In Panel (B) of Table 4, we show the regression results following the baseline structure in equation equation (1), but instead of using the one-period lagged loan expansion from outside-county banks to local businesses, as well as the two period lagged loan expansion, $\Delta\text{Loan}_{z,t-1}^{\text{outside}}$ and $\Delta\text{Loan}_{z,t-2}^{\text{outside}}$ respectively, and I find that while the one-period lagged loan expansion towards local businesses from distant banks is still strongly predicting the deposit growth in local banks' balance sheet, as can be seen from the column (1) of Table 4, 10% expansion in local credit from outside one period earlier is associated with 4.6% increase in local bank deposit; the two-period lagged local expansion from outside banks display much weaker magnitude in the correlation coefficient, this can be seen from column (2) of Table 4, 10% expansion in local business credit 2-year ago only predict 1% increase in local bank deposits. Importantly, I run the same specification but for credit expansion from outside banks one-period and two-period ahead of the current period t, I find only slightly positive and non-statistically significant coefficient estimates associated with $\Delta\text{Loan}^{\text{outside}}_{z,t+1}$ and $\Delta\text{Loan}^{\text{outside}}_{z,t+2}$. The sharp comparison between the lagged or lead credit inflows into a given county in explaining local banks' deposit growth indicate that the observed baseline results are not driven by reverse causality or serial correlation. This strengthens the deposit creation effect of new loans.

To further sharpen these results, I run the same set of specification but differentiate between labor-intensive and non-labor intensive industry. The idea is that the higher the credit inflow towards local labor-intensive business[14], the more labor income is going to be paid off locally and thus the higher the deposit growth when these newly hired workers' income is deposited into the banks accounts locally. In particular, we write down the following regression specification

$$\begin{aligned}\Delta\text{Deposit}^{\text{local}}_{i,z,t} = \alpha_{i,z} + \mu_t + \beta_1 \Delta\text{Loan}^{\text{outside,l}}_{z,t} \\ / + \beta_2 \Delta\text{Loan}^{\text{outside,nl}}_{z,t} + \epsilon_{z,t}\end{aligned} \tag{2}$$

where the subscripts are the same as defined in 1. The difference here is that I split the total sum of new credit generated by outside banks to a local area's businesses by labor-intensive industries and non-labor-intensive industries. $\Delta\text{Loan}^{\text{outside,l}}_{z,t}$ is the total sum of loans received by local labor-intensive businesses from banks outside of the local area in period t, and $\Delta\text{Loan}^{\text{outside,nl}}_{z,t}$ is the total sum of loans received by non-labor-intensive businesses from banks outside of the county in year t.

The coefficient of interests are β_1 and β_2. Table 5 presents results on regression specification defined by 2. Column (1) and column (4) of Table 5 includes all the relevant fixed effects and bank-level control variables. It is very clear that average local bank-level deposit growth is much more strongly driven by credit inflow (from outside banks) towards labor-intensive businesses rather than non-labor intensive businesses. A 10% increase in credit inflow from banks outside of a region into a county's labor intensive businesses can lead to an average of 6.2% increase in local banks' deposit growth, but a same magnitude of outside credit extension to non-labor intensive businesses will only lead to 0.5% increase in local banks' deposits on average. Comparing this cross-industry baseline results with the results in Table 4, I find that the coefficient on credit received by local labor-intensive businesses absorbs and even outrun the coefficient on overall credit received. This highlights the fact that banks'

[14] Labor intensive and non-labor intensive industries classifications are based on the businesses' NAICS Code and https://www.bls.gov/ces/. Labor intensive industries are those with 2-digit NAICS codes: 11, 21, 31-33, 53, 72, 81, 92.

loan-making increases deposits through generating new *local* labor income that's going to be re-deposited into local banks' account. Column (2) & (4) and column (3) & (6) conduct the same set of comparisons with standard errors clustered at state and year level respectively. Robust empirical estimates are consistently observed.

5.2. *Transmission to Short-term Liquidity Prices and Banking Market Competition*

In the above subsection, I established a general fact that increase in local businesses' loan received from distant banks outside of the local region predicts local banks' deposit growth through the channel that new business lending generates higher labor income and thus more deposit. The loan-making's deposit creation effect is more strongly associated with labor-intensive businesses' credit receiving. In this part, I investigate how such a positive shock on the supply of short-term liquidity can be translated into the prices of local banks' short-term funding and how this transmission process is affected by banking market competition.

A) **Transmission to Prices of Short-term Bank Liquidity**

A major portion of commercial banks' liability are the demand deposits they raise from local households. When local businesses receive more credit and pay out more labor income, this process increases the supply of fresh deposits to the local banks. Therefore, holding other factors unchanged, this deposit-supply increase will have an impact on local banks' retail liability raising costs because the supply of deposit has increased. Meanwhile, as the retail market's supply gets ampler, it will indirectly increase the bargaining position of a bank that tries to borrow in the inter-bank market. Through the improvement in bargaining position, a bank's wholesale liquidity raising cost will also be impacted. In this part, I explore the general correlation between an increase in local deposit supply and the local banks' retail and wholesale liquidity raising costs.

Similar with the design in the above subsection, I want to get rid of reverse causality issues between local banks' liquidity position and local businesses' loan issuance condition. Therefore, instead of using total new credit received by businesses in a county, I use the total amount of new loans received by local businesses from banks outside of the county to measure credit supply shock to a county. To investigate how does increase in local new credit impact local banks' retail and wholesale liquidity raising cost, I write down the following specification:

$$\begin{aligned} \text{Ave. Retail rate}_{i,z,t}^{local} &= \alpha_{i,z} + \mu_t + \beta^{retail} \Delta \text{Loan}_{z,t}^{\text{outside}} + \epsilon_{z,t} \\ \text{Ave. Wholesale rate}_{i,z,t}^{local} &= \alpha_{i,z} + \mu_t + \beta^{wholesale} \Delta \text{Loan}_{z,t}^{\text{outside}} + \epsilon_{z,t} \end{aligned} \tag{3}$$

where the explanatory variable is the same as defined in the previous subsection, the (Ave. Retail rate$_{i,z,t}^{local}$) and (Ave. wholesale rate$_{i,z,t}^{local}$) are the quarterly average retail and wholesale funding cost of bank i located in county z during the year-quarter t. The detailed definition of these two variables are provided in section 3.4.

The main coefficients of interest are β^{retail} and $\beta^{wholesale}$. Table 6 presents the results of the above regression specification. In column (1) and column (3), I include bank-level fixed effects, county-level fixed effects, and time fixed effects as baseline results. Consistent with our conjecture, expansion in loans received by local businesses, measured as the total amount of loans provided by banks outside of the county to local firms, is significantly and negatively correlated with local banks' retail and wholesale liquidity raising costs. Specifically, a 10% increase in the total new loans received by local businesses is associated with an average of 2.4% decrease in retail deposit cost, and an average of 2.87% decrease in the local banks wholesale funding cost. The results are both qualitatively and quantitatively unchanged when we include county-year fixed effects, state-year fixed effects and bank-level controls as reported in column (3) and (4) respectively.

B) **Banking market competition and Shock transmission**

In the above subsections, I establish the fact that new credit flows into a county's local businesses increases the local deposit supply and the more ample local supply of fresh deposits tend to enable local banks to raise short-term liquidity at lower average costs on average. While more abundant supply generally implies lowered price, the exact transmission would be affected by other factors such as market competition. Suppose the local banking market is perfectly competitive, then an enlarged supply of short-term liquidity in the local area won't do much in terms of lowering local banks' deposit raising costs. This is because competitive banking markets allow banks from other areas to easily come in and compete for deposits whenever the price of short-term liquidity in a local area becomes lower.

In this subsection, I explore how variations in local banking market competition could affect the transmission of enlarged supply of short-term liquidity resulting from increased credit inflow to the price of short-term liquidity for banks in local areas.

B.1) **Specification of empirical tests**

In order to cleanly identify the effect of banking market competition on liquidity price determination, we utilize a natural experiment on the changes in local banking market competitiveness. As discussed in section 2, the natural experiment I utilize here is the banking sector deregulation that lasted from the beginning of 1980s till the middle of 1990s. In this section, I utilize the three states that went through intra-state banking deregulation in the middle of 1990s, so that there is an intersection between the states' pre/post deregulation periods and the SBA data-sets. The three states that went through intra-state banking deregulation in 1990s are Arkansas (1994), Iowa (1994) and Minnesota (1993). Specifically, we would like to investigate how local banks' average wholesale and retail funding cost change when there's impulsive credit inflow into a local region's own area and into its adjacent area, before intrastate deregulation and after intrastate deregulation.

$$\begin{aligned} \Delta \mathrm{y}_{i,z,t} &= \alpha_i + \mu_{z,t} + \beta^{adj} \times \Delta \text{Adjacent area loan}_{z,t}^{out} + \text{FE's} + \epsilon_{i,z,t} \\ \Delta \mathrm{y}_{i,z,t} &= \alpha_i + \mu_{z,t} + \beta^{local} \times \Delta \text{Local area loan}_{z,t}^{out} + \text{FE's} + \epsilon_{i,z,t} \end{aligned} \tag{4}$$

where i indexes bank, z indexes county and t indexes year[15]. ΔAdjacent area $\text{loan}_{z,t}^{out}$ is the natural log of credit flow to the adjacent county areas of bank i's located county z, and ΔLocal area $\text{loan}_{z,t}^{out}$ is the natural log of credit flow to the bank i's own county area z. Both credit inflow measures are calculated using the lending from banks outside of the respective region. The dependent variable $\Delta \mathrm{y}_{i,z,t}$ on the left-hand side are either the year-to-year change in average wholesale funding cost or retail funding cost of bank i located in the three-digit zip-code area in year t. To figure out how change in local banking market competitiveness could affect the impact of credit supply on local banks' average retail and wholesale funding cost, I run the above set of regressions both before intrastate deregulation and after intrastate deregulation according to the exact year where bank i's location state finished intrastate banking deregulation.

The coefficients of interests are β^{adj} and β^{local}, and especially the comparison within between $\beta^{adj}_{\text{before deregulation}}$ versus $\beta^{adj}_{\text{after deregulation}}$ and $\beta^{local}_{\text{before deregulation}}$ versus $\beta^{adj}_{\text{local deregulation}}$. Table 7 and Table 8 presents the results of the above regression specification. Panel (A) of Table 7 and Table 8 shows the results comparing how bank-level wholesale funding cost's response towards adjacent area's businesses have changed post the

[15] Since we focus our examination to three late intrastate deregulation states, I switch our basic unit of observation to bank-year level.

intrastate banking deregulation; and Panel (B) of Table 7 and Table 8 presents the paralleling comparison for average retail liquidity funding costs Column (1) and (3) of the two tables include basic fixed effects at bank level, county level and state level, while column (2) and (4) of Table 7 and Table 8 include all relevant fixed effects.

B.2) **Estimation results**

Through comparing the column (2) and column (4) of Table 7 Panel (A), we can see that before intrastate banking deregulation, positive credit expansion to the banks' adjacent area businesses was only weakly negatively correlated with a bank's average wholesale funding cost during, a 10% expansion in the credit received by adjacent area businesses is only associated with a 0.2% decrease in a bank's annual wholesale funding costs; but after the intrastate banking deregulation, a same 10% expansion in the credit received by adjacent area businesses is associated with 3.75% decrease in a bank's annual wholesale funding costs. The difference is both quantitatively and statistically significant.

This sharp comparison in the above coefficient estimates is consistent with our discussion in section 4.1(B). Before intrastate deregulation, banking markets are highly segmented as banks are limited to conduct deposit taking only within its own local geographic area. Therefore an increase in the supply of short-term liquidity in adjacent area won't do much in improving banks' bargaining position in their wholesale liquidity trading. As such, the transmission of increased supply of short-term liquidity in adjacent area into lowered wholesale price would be minimal before the intrastate deregulation. However, things will completely change after the prohibition of intrastate deposit competition gets lifted. Free of geographical deposit-taking restrictions, whenever adjacent area see a credit supply or better growth potential of deposit supply, that means a bank can freely dip into that deposit pool, the possibility of doing this improves a bank's bargaining position (regardless of whether in equilibrium the bank really dipped into the adjacent deposit market), and lead to a decrease in its average wholesale funding costs.

In Panel (B) of Table 7, I report the estimation results on how a local bank's average wholesale funding cost interact with credit expansion from outside to local businesses, before and after the intrastate banking deregulation. Contrary to the patterns about credit expansion to adjacent area businesses, before deregulation, higher volume of credit inflow from outside the area to local businesses was associated with a decrease in local banks' average wholesale funding costs, a 10% expansion in credit inflow from outside the region to local businesses was associated with 2.5% decrease in local banks' wholesale funding costs; however, after the intrastate banking deregulation, higher credit inflow into the local businesses does not predict significant decrease in local banks' wholesale funding costs.

The reasoning beneath Panel (B) of results is in line with that in Panel (A). Before the intrastate deregulation, when banks from outside the local area could not easily enter the local deposit market, increases in credit received by local businesses and the so generated supply of short-term liquidity in the local area can substantially benefit local banks residing in this area. In particular, a well-protected access to local deposit supply can effectively improve banks' threat point of bargaining in their wholesale liquidity trading and hence materializes into a lowered wholesale short-term funding cost. After the intrastate deregulation however, when other banks from outside the local region can freely dip into local deposit market, the access to newly increased local deposits is no longer well protected. Thus the impact of positive local credit supply no longer result in non-trivial decrease in average wholesale liquidity funding cost for local banks. The comparison can be easily seen from column (2) and (4) of Panel (B).

Paralleling the analysis on wholesale liquidity raising cost, I study how banks retail liquidity raising cost interacts with credit supply to local and adjacent areas, before and after intrastate banking deregulation. The results of this part are shown in Table 8. Comparing column (2) and column (4) of Panel (A), I find that both before and after the intrastate banking deregulation, positive credit supply towards a bank's adjacent regions doesn't have a significant impact on the retail liquidity raising price of a local bank, both the magnitude and statistical significance of the coefficient are low. However, through comparing column (2) and column (4) of Panel (B), it is clear that before deregulation, positive credit inflow into a bank's geographic area is associated with a significant decrease in local banks' retail liquidity funding cost, specifically, 10% expansion in the credit inflow volume towards local business will lead to 2.38% decrease in local banks' retail liquidity funding costs. The reasoning is that before deregulation, other banks outside of a local geographic region could not dip into local deposit market. When local businesses received higher volume of loans, expand their business and write off more wage bills to their employees, local deposit supply will increase, allowing local banks to raise retail liquidity at lower costs. However, when banks from other locations can freely enter the local deposit market, the local banks deposit market privilege tend to be diluted by the competition from distant banks. Post the deregulation a 10% expansion in lending towards local businesses from the outside lenders is associated with 0.3% increase in the retail funding rate, and the estimation is statistically insignificant.

5.3. Bank Lending Distances before and after Intrastate Deregulation

Up until now, I have mainly focused on how changes in local banking market structure affect liquidity raising costs on the wholesale and retail liquidity market through credit supply shocks to local businesses. When local deposit market gets more competitive, banks' short-term liquidity prices become less sensitive to local credit supply shocks but start to respond to credit supply changes in adjacent areas. These results hold true for both retail and wholesale liquidity.

A natural implication from these patterns then is: how would bank lending distance respond to changes in banking market competition? In this subsection, I provide answer to this question through examining changes in geographic distance of bank lending before and after the intrastate banking deregulation.

A) **Measuring bank lending distance**

The experimental environment of conducting this lending distance change analysis is the same as in the previous section, where we have three late intrastate deregulation states (Iowa, Arkansas, and Minnesota) and the availability of transaction-level small business loans from SBA. The methodology I utilize follows Granja et al. (2019).

In particular, I take each bank's geographic location information in the call report data, and merge with SBA loan dataset over years. The combination of these two datasets gives us location of lending banks and the locations of their all their lending in a given year. In order to measure the distance of lending of a given bank, I geocode the respective locations of the borrowing business and the lending bank, getting their latitudes and longitudes, and calculate the distance between the two geographic coordinates. This gives us a continuous measurement of the distance of a business loan.

One important issue in terms of this measurement is that it is likely that after the intrastate deregulation, banks start to expand their branching network to other geographic units and thus the actual distance between a borrowing small local business and a lender is shorter than the calculated version using the SBA datset. As has been discussed in the variable construction section, I deal with this problem by coding out the geographical coordinates of all branches of a given bank *over time*, and calculate the *shortest* distance between the loan receiver's location and the lending bank's branches. This gives us a good measurement in the sense of taking into consideration the time-varying changes of any specific bank's branching network. This refinement of the measure allows us to robustly get how expanded did a bank's shortest lending distance become after the intrastate deregulation compared with before.

B) **Baseline results**

Figure 3 to Figure 5 visualize the change in local banks' lending distances in the three late deregulated states before and after the intrastate deregulation. In Figure 3, we display how banks' average ratio of portfolio allocating to borrowing businesses outside of their branching network has evolved during the episode of intrastate deregulation. In panel (a) of Figure 3, I show that before deregulation, an average of around 10% of Iowa banks' small business lending portfolio was allocated to distant borrowers outside of their network structure; after the intrastate deregulation initiated in 1994, the average distant portfolio started to rise significantly, by the time of 1997, Iowa banks allocated around 20% of their small business loans to distant borrowers outside of their branching network. Similar pattern holds for Arkansas and Minnesota, though differences exist among states in the pre-deregulation trend.

In panel (b) of Figure 3, I plot the lending distance patterns of banks in other regions of the economy during the same period, and find no significant expansion patterns. This suggests that intrastate deregulation was indeed the driver of this change distant portfolio allocation. In Figure 4 and Figure 5, I conduct the similar exercises. In particular, Figure 4 shows the weighted average of banks' lending distances in miles (weighted by the total small business loan amount) for banks located in the three late deregulated states. In Figure 5, I show the median of banks' lending distances in miles of banks in late deregulated states. Using these two alternative measures of bank lending distances, we find consistent results suggesting that banks in these three states significantly increases the geographic scope of their activities on the asset side immediately after the implementation of intrastate deregulation. Both exercises are compared with banks in other regions of economy that didn't gone through intrastate deregulation during the same episode. The fact that other states do not witness such increases in bank lending distance around the same periods reinforces our argument that more competitive banking market is a major driving force between the enlarged geographic mismatch between banking activities.

These changes in geographic distance of banks lending before and after the banking market deregulation can be easily related to our findings on short-term liquidity price in previous subsections. As documented in section 5.1, the "deposit creation" effect of loans made to local businesses can enlarge the supply of short-term liquidity in local areas. Before the intrastate deregulation, banks are not able to directly touch other geographic areas' deposit pool except borrow from banks in those areas. Symmetrically, banks from other areas are also not able to come in and steal away the local deposits. As a result, for any banks, if they make lending outside their own geographic area, the deposit created by loans they extend is unlikely to do much benefit for them. However, the fresh supply of deposits generated in local area by their loans extended to local businesses can substantially lower future liquidity price for these banks, as outside banks cannot easily come in and steal them away. Therefore, banks won't have too much incentive to lend outside of their own geographic area before the intrastate banking deregulation, given their concerns of liquidity issues.

After the intrastate deregulation however, any local lending will no longer going to local banks' account since banks from other geographic units can freely enter and compete for the newly created liquidity with attractive prices. Conversely, lending to business in nearby areas now can provide (at least) some benefit to the loan-making banks. That being said, banks' incentive to confine their lending to local businesses is likely to be weakened. Following this line of reasoning, the hypothesis that I can test is after the intrastate deregulation, banks from specific geographic units are likely to extend their lending to businesses located in more distant geographic units.

5.4. Placebo Tests on Bank Lending Distance Variations

To further strengthen these findings, I conduct a couple of placebo tests. The goal of this subsection is to provide empirical evidences that allows us to claim the variations in bank lending distance documented above is indeed driven by the short-term funding price channel.

A) **Placebo test I: labor-intensive loans v.s. non labor-intensive loans**

First, I consider the *within-bank* changes in lending distances to firms from industries with different labor intensity. The intuition is as follows, before the intra-state deregulation, all banks could only get the deposit from their local geographic units, knowing this, they will be more willing to lend to firms that operates and hire labor in local areas. The localness of lending should be more profound to businesses that are labor-intensive because these businesses that could generate more local deposit supply. As a result, I expect that on average the small business lending to firms in labor-intensive industries should have shorter lender-borrower distance, and should be more likely to be in the same county as the lender. Indeed, for the three late-deregulated states, average small business lending distance to labor-intensive businesses was 5.53 miles before intrastate deregulation; while the average distance to non-labor-intensive businesses was 15.76 miles, a triple of the labor-intensive distance.[16] Furthermore, because the labor-intensive business loans are more geographically constrained compared with non-labor-intensive loans, we should expect to see that the labor-intensive small business loans are more responsive toward the intrastate deregulation. To verify this reasoning, we run the following regression specification:

$$y_{b,l,t} \quad = \quad \alpha_b + \beta_1 1[\text{Post deregulation}]_t + \beta_2 1[\text{Post deregulation}]_t \times 1[\text{Labor-intensive}]_{l,b,t} + \epsilon_{b,l,t}$$

where b indexes bank, l indexes a small business loan, and t indexes year. The dependent variable is either the natural log of lending distances (in miles), or a dummy variable that equals to 1 if the credit-receiving small business is located in a county that's within the bank b's branching network. The main explanatory variables are 1[Post deregulation] and its interaction with 1[Labor-intensive] and 1[Non-labor-intensive].

Table 9 displays the results of the regression analysis under this specification. Post the deregulation, average within-bank lending distance increased by 3.5 miles, and importantly, the expanded lending distance seemed to be mostly attributed to lending towards labor-intensive industries. In particular, the average lending distance towards labor-intensive businesses expanded by 5.8 miles; while the lending distance towards non-labor-intensive businesses expanded by only 2.7 miles on average.

Similarly, if we consider the the likelihood that a bank lend towards businesses outside of their branching network, I find that post the intra-state deregulation, the average within-bank likelihood that a loan is directing towards a within-network small business decreased by 16.4%. However, it is the loans towards labor-intensive businesses that the likelihood witnessed more significant decrease: post the deregulation, likelihood of labor-intensive lending towards within-network businesses decreased by a significant 18.2%. The non-labor-intensive businesses lending also became more likely to be out of branching network, but not as significant compared with the before-deregulation trend: post the deregulation, the likelihood of lending towards within-network non-labor intensive businesses decreased by only 7.6%.

B) **Placebo test II: banks' deposit structure**

[16] Post deregulation however, the average labor-intensive distance went up to 11.21 miles, and the average non-labor-intensive distances went up to 16.44 miles.

The second set of placebo test that I run is from the angle of banks' reliance on short-term funding. Similar with the reasoning in the business labor-intensity exercise, in this part I investigate which types of banks are more likely to expand lending distances post the deregulation. If the increased local banking market competition alters bank lending behavior through transforming the underlying determination of short-term liquidity prices, then it must be banks who are more sensitive to short-term liquidity shocks that will respond more drastically in altering their lending behavior. In this regard, I conduct the following regression specification:

$$y_{b,l,t} = \alpha_b + \beta_1 1[\text{Post deregulation}]_t + \beta_2 1[\text{Post deregulation}]_t \times S_b + \epsilon_{b,l,t}$$

where b indexes bank, l indexes loan, and t indexes year. S_b is a bank-level measure of the bank's short-term liability funding reliance.

In this part of exercise, I utilize two variables to measure banks' reliance on short-term funding need, the first variable is the ratio of transaction deposits over time deposits (the ratio between item RCON2215 and (RCON6648+RCON2604)); and the second variable is the ratio of uninsured time deposits over time deposits (the ratio between item RCON2604 and (RCON6648+RCON2604)). Both these two variables captures banks' sensitivity to short-term liquidity prices– the higher these two variables, the more banks care about the price at which they can raise short-term liquidity. I calculate each bank's reliance on the short-term liquidity funding and tag a bank as having high reliance on short-term liquidity funding if the bank's S_b is above the top 25-the percentile in the relevant sample of analysis. In the static cross-sectional and over-all sample analysis, the S_b measures are calculated using the bank's entire history of observations; in the diff-in-diff part of analysis for banks in the late-deregulated states, the S_b measures are calculated using the banks' balance sheet between 1982-1992.

Table 10 presents the overall-sample bank-loan correlation between the bank's short-term liquidity funding needs and the average outcome of its lending distances. In the first two columns, we find that banks that are more reliant on short-term liquidity funding are more likely to grant a loan to firms within their branching network; in column (3) and (4), and compared with the other banks, average lending distances are 4.8 miles shorter.

Table 11 presents the diff-in-diff analysis on banks in the late-deregulated states. In this setting, I am able to trace how within-bank lending distances have evolved post the intra-state deregulation compared with before the deregulation. In the first part of the table, I show that post the deregulation, average likelihood of an outside-network loan being made by the banks increases by 11.7%, and this transformation tend to be most significant and primarily driven by banks with high short-run liquidity funding needs pre-deregulation, as can be read from column (3) and (4) of the first part of the table, controlling for the interaction between 1[Post deregulation] and the indicator that the bank is of high short-run liquidity funding reliance, I find the coefficient β_2 on the interaction absorbs the magnitude of β_1. Similar with pattern shown for the likelihood of lending outside branching network, in the second part of the table, I show that within-bank average lending distance increased significantly after the intra-state deregulation, and the change was primarily driven by banks with high short-term funding need.

6. Economic Stability and Banking Market Competition

In Section 5, I examined how changes in banking market competition may affect how enlarged supply of bank short-term funding be transmitted to banks' retail and wholesale liquidity raising costs, as well as its implication on the geographic scope of banking activities. In this section, I look at the other side of price determination–how the demand-side shocks on bank short-term funding transmit to the prices of bank liquidity and the role played by banking market competition in the process. The analysis of the demand-side shock transmission is perhaps more important, since banking sector's resilience to unexpected negative shocks is a critical determinant of the real economic stability.

To make clean identification on how changes in banking market competition may impact the determination of banks' short-term liquidity raising costs, I utilize a natural experiment setting that combines staggered intrastate banking deregulation across states during the 1980s and the 1986 oil price bust. The oil-price shock event provide the ideal setting for the purpose of our study for clean identification purpose. The reasons are as follows. First, the occurrence of this oil price bust was mainly due to supply side factors (in middle East countries) that were unexpected and orthogonal to the U.S. banking deregulation. Second, banks that were exogenously hit by the event in terms of their liquidity conditions were also located in states that were at different status of intrastate banking deregulation. Third, due to nature of the shock that is from one specific industry, there exist substantial variations across geographic units in turns of the scale of the shock that local banking sector is suffering. These special features of the episode allows us to draw a full picture of how different levels in banking market competition would transform the determination of banks' short-term liquidity raising costs when the liquidity condition suddenly turns tight; and what happens to this transformation when such a demand shock is a systemic one versus the case where it is an idiosyncratic one.

6.1. *The 1986 Oil Price Bust*

In this subsection, I provide some details on the 1986 oil price bust and explain how the US banking sector was affected. Specifically, I show evidences suggesting that the occurrence of the shock was unlikely to be correlated with the process of banking deregulation; moreover, I show that banks around U.S. were hit by the shock in their liquidity conditions and that they were located across a wide range of areas covering both deregulated and underegulated states.

Throughout the year of 1986, the price of crude oil went through a dramatic drop. As shown in Figure 6, crude oil price slumped from 30.8 dollars per barrel to 12.8 dollars per barrel. The cause of the sudden oil price drop was that in late 1985, Saudi Arabia unilaterally engineered a substantial reduction in the price of oil by increasing its daily production of crude from two million to four million barrels.[17] The sudden drop in oil price due to external reasons suddenly lead to huge revenue loss of U.S. oil-related companies and drove them into serious negative liquidity conditions to repay their short-term debt. This is reflected in Figure 7. Before the after the oil-price hit, oil-related companies' net income slumped from arount 0 to -0.3; while, their current ratio went down drastically from 5 to less than 4.[18]

The oil companies' sudden revenue losses quickly translated into negative liquidity shocks on related banks who had non-trivial portion of their loan portfolio in energy loans. In the left-hand side panel of Figure 7, we calculate the banks' NPL dynamics during the episode by comparing banks located in the energy states and

[17] Saudi Arabia was the largest oil-reserve economy and Saudi Arabia increased output and drove oil prices lower to force other OPEC members to adhere to agreed-upon production quotas (Gately (1986)).

[18] Mac McGee, marketing director of the Cactus Drilling Company, one of the largest drillers in West Texas, observed in early 1986 that everybody geared up and borrowed. The banks can't afford to carry companies very long. If things dont pick up some, it's going to be a real tragedy. The situation, however, only worsened. The changing times were tellingly reflected in the prevailing bumper stickers. Oil-patch workers bumper stickers had read "$85 (a barrel) in 85". In contrast, a slogan displayed in late 1986 read "Chapter 11 in 87".

those located elsewhere. It is clear that those banks whose loan portfolio were more likely to be from oil companies (proxied by the fact that they are geographically closer to oil firms) witnessed a sharp increase in their NPL from around 2% to nearly 4.5%, though their pre-shock NPL is at a very comparable level with banks that were not so much exposed to the shock elsewhere in the country. Indeed, the shock happened so unexpectedly and to such a severe extent that it drove exposed banks into severe liquidity situations. It appeared that bankers had limited things they could do to protect their liquidity issues from the unexpected and precipitous decline in oil prices that occurred in 1986. Frank Anderson, an analyst with Weber, Hall, Sale & Associates in Dallas, expressed the following opinion:

> ”At $18 a barrel, you’ll start seeing a little squirming... If oil prices come down gradually, the banks have a number of things they can do to their energy credits, like add more collateral or restructure the loans. They have a lot more flexibility. But if the price drops suddenly to $15 a barrel, they will have no time to react.”[19]

The most extreme reflection of this oil-price induced bank liquidity shock is the bank failures in some of the traditional energy states, notably the state of Taxes. From 1986 through 1989, 387 Texas commercial banks failed, including 9 of the state’s 10 largest bank holding companies. In 1988, 175 Texas banks failed with assets of $47.3 billion, 25 percent of the state’s 1987 year-end banking assets. All in all, in this section I established the fact that the 1986 oil price shocks inflicted severe negative short-term funding shocks to banks that were exposed to oil company loans beforehand.

6.2. *Defining Shocked Banks and Shock Scale across Geographic Areas*

In the last section, I established that the 1986 oil-price shock was driven by external factors unrelated to the banking deregulation in U.S.throughout 80s, and that this oil price shock presents serious liquidity issues to banking sector due to increases in delayed or failed loan repayments by borrowers in oil-related businesses. In this section, I provide a clear definition on how liquidity-shocked banks are empirically specified.Based on our identification of banks facing increased demand for short-term liquidity, I further describe the empirical specification of the shock scale for each geographic units at 3-digit zip-code level.

[19] Lisabeth Weiner and Richard Ringer, Falling Oil Prices Could Bleed Portfolios of Energy Banks, American Banker (January 22, 1986), 2.

A) **Identifying Shocked Banks**

The oil-price shock led to serious liquidity issues at banks who have outstanding loans extended to firms in oil industry, reflected by a sharp spike in the ratio of delayed or defaulted loan payment. Following this logic, I identify banks facing increase demand for short-term liquidity by examining the short-term overdue ratio of each bank. Banks observed to experience a sharp increase in their short-term overdue ratio would have an enlarged demand for short-term liquidity to respect their liability side obligation. Empirically, I use changes in the "within 3-month overdue ratio" to proxy for each banks' demand for short-term liquidity.[20]

More specifically, I identify a banks as being facing an increased demand for short-term liquidity after the oil shock if and only if its post-shock level of "within 3-month overdue ratio" increased by more than 30% compared with its own pre-shock level. Mathematically, this definition goes as follows:

$$\frac{Ave.\text{within 3-month overdue}_{86-87}}{Ave.\text{within 3-month overdue}_{85}} - 1 > 0.3$$

Banks satisfying the above condition are empirically identified as the ones that receive a shock on their short-term liquidity demand, so as to accommodate the routine outflow of deposits.

B) **Measuring Scale of the Shock**

Given our empirical specification that identifies banks receiving a demand shock on short-term liquidity, I can further measure the scale of this demand shock for the local banking sector in each geographic area. Our specification of the geographic unit for the empirical analysis is at 3-digit zip-code level.[21] For our following analysis of how banking market competition may affect economic stability, I distinguish the demand shocks on short-term liquidity into idiosyncratic shocks and systemic shocks, for the banking sector in each geographic units.

[20]Mathematically, the "within 3-month overdue ratio" for each bank is calculated by RCFD1403-RCFD1407, where RCFD1403 is the "TOTAL LOANS AND LEASE FINANCE RECEIVABLES: NONACCRUAL" and RCFD1407 is "TOTAL LOANS AND LEASE FINANCING RECEIVABLES: PAST DUE 90 DAYS OR MORE AND STILL ACCRUING".

[21]In Figure 12, I plot the flow expense in wholesale liquidity for banks hit by the demand shock on short-term liquidity. The distinction between systemically hit area versus idiosyncratically hit area is under the 3-digit zip-code specification. As illustrated in the figure, the hit banks substantially increase their flow expense on wholesale liquidity if located in an idiosyncratic area, whereas decrease their wholesale funding expense if located in a systemically hit area. These results suggest that specifying the geographic unit at 3-digit zip-code level is empirically appropriate. I discuss this issue in more details in Section 6.3.

Empirically, I specify the banking sector of an 3-digit zip-code area as being hit by a systemic demand shock on short-term liquidity, if and only if more than 35% of the local banks in this area satisfy our above specification of a shocked bank. In other words, the shock on demand for short-term funding is a systemic one if a large share of the local banks are experiencing an increase in their short-term overdue ratio. On the contrary, if only a few banks in a 3-digit zip-code are shocked by the oil price bust as defined above, then the demand shock on short-term liquidity is an idiosyncratic one for the local banking sector in this area.

The graphical visualization of the distribution of the 3-digit zip-code areas is displayed in Figure 8. The darker blue shaded three-digit zip-code areas are those that are defined receiving systemic liquidity shocks in the local banking market, and the orange dots are the locations of oil and gas companies. The locations of these companies are constructed from Compustat for firms in the 2-digit SIC code 13. The message comes clear from the figure that systemically hit geographic areas were pretty diversely located all over the economy. In particular, each states had some 3-digit zip-code areas that were significantly more severely hit than others. This is crucial because the diverse locations across both deregulated and underegulated states allows us to really investigate the effect of having a more competitive local banking sector on short-term liquidity costs determination when the scope of the shocks is different. Also, these systemically hit areas' locations also tend to be very correlated with the distribution of firms in energy industry, which validates that the measurement is a good mapping between oil companies and the banks whose short-term liquidity conditions were severely affected.

6.3. *Empirical Specifications and Results*

In this subsection, I elaborate the specifications of our empirical tests and discuss the empirical findings.

A) **State level analysis**

As a beginning point of this section, I start with documenting the C&I lending dynamics of banks that receive a demand shock due to the oil price bust. These banks are identified with the methodology specified in section 6.2. In particular, we group states into systemically hit states and idiosyncratitcally shocked states. Systemic shocked states include Oklahoma, Louisiana, New Mexico, California, North

Dakota, Wyoming, Arkansas, Utah and Alaska.[22] Idiosyncratic shock states include all other states that contains at least one 3-digit zip code are that is defined as exposed to shocks in section 6.2.

Figure 9 displays the weighted average of these shocked banks' C&I lending amount in both the systemically shocked states and those in the idiosyncratically shocked states, standardized using the banks' C& I lending in year 1985 as base year. In the left-hand side panel of Figure 9, we compare the C&I lending of banks in systemically shocked sates that were already deregulated and the systemically shocked states that were underegulated in 1986. The red line represents the deregulated states and the dark blue line represents the underegulated states. Before the oil-price shock in 1986, banks in deregulated and underegulated states that were systemically hit by oil price shock ex-post see no difference in their C&I lending trend; however, after being hit by the oil-price plunge, banks in deregulated states witnessed a more significant contraction in their C&I lending (an average decrease of about 20% during 1986-1987) compared with in those underegulated states (an average decrease of less than 10%).

Interestingly, on the right-hand side panel, I show the same pair of comparison for the idiosyncratically shocked states. Contrary to the pattern shown in the systemically shocked states however, banks in deregulated states didn't see significant contraction in their C& I lending since the onset of oil-price shock; rather, banks in states that hadn't gone through intrastate deregulation saw a heavier contraction in their C&I lending.

B) **3-digit zip-code level analysis: bank lending dynamics**

To tighten the statistical significance of this pattern, we estimate the following regression specification, the difference is here is that instead of looking at the average trend of C&I lending at state level, we look at the average trend of local banks' C&I lending at 3-digit zip-code unites level:

$$y_{b,z,q}^{\text{Deregu./Underegu.}} = \alpha_i + \gamma_{z,q} + \sum_{t=1982, t\neq 1985}^{t=1990} \beta_t 1[\text{Year=t}] + \beta_3 \mathbf{X} + FEs + \epsilon_{b,z,q} \tag{5}$$

where $y_{b,z,q}$ is the natural log of bank b's C& I lending who's located in the 3-digit zip-code area z in year q. I take into consideration bank-level time-invariant factors by including bank control, I also include zip-area and time fixed effects, and bank's

[22] I do not include Texas in our analysis as Texas's concentration on oil industry is much higher than any other states. So I exclude Texas in my cross-state analysis to ensure that states in the analysis are comparable with each other.

time-varying control variables including the natural log of total assets, the banks' agricultural loan share and real estate loan share in total loans outstanding.

The coefficient estimates and the 95% confidence intervals are plotted in Figure 10. The time 0 is taken to be year 1985. The coefficient plots at the 3-digit zip-code level are consistent with the patterns in the state level weighted averages: more competitive local banking market seems to have exacerbated the contraction in C&I lending when local banking sector were systemically hit in their liquidity; on the other hand, if the local banking sector were only idiosyncratically hit by the shock in their liquidity conditions, banks in the less competitive banking market seem to be contracting their C&I lending after the liquidity shock.

Table 12 shows the average different treatment effects of being located in a deregulated banking market as opposed to a underegulated one when the liquidity shock comes:

$$y_{b,z,q} = \alpha_i + \gamma_{z,q} + \beta_1 1[\text{Post}] + \beta_2 1[\text{Deregulated}] \times 1[\text{Post}] + \beta_3 \mathbf{X} + FEs + \epsilon_{b,z,q}$$

where 1[Post] is a dummy variable that switches to 1 from 1986. 1[Deregulated] is equal to 1 if the state the bank is located deregulated no later than 1987. The panel covers all banks that were in operation from 1982 to 1990.

The different bank lending behavior in response to the sudden liquidity shock when banks were located in deregulated and deregulated geographic units is a reflection of the fact that banking market competitiveness does have a differential real impact when there's short-term liquidity shocks. If the pre-shock bank and local level variables were comparable across banks located in early and late deregulated geographic areas, it must be that differences in local banking market structure has differentially affected the determination of short-term liquidity funding costs among the local banks.

C) **3-digit zip-code level analysis: short-term liquidity price responses**

In the following part of this section, I investigate how shocked banks' wholesale and retail funding costs had evolved differently post the liquidity shock when banks are located in geographic units that had gone through intrastate banking deregulation compared with those that had not yet.

I start this part of analysis by investigating how banks' retail and wholesale interest flow expenses evolved if they were located in geographical areas that went through liquidity shocks of different scale. Similar with the specification we run for the investigation on banks' C& I lending behavior, I write down the following regression specification and plot the coefficient estimates for banks in different treatment control groups:

$$
\begin{aligned}
\mathrm{E}_{b,z,q} = \alpha_i + \gamma_{z,q} + \sum_{t=1982, t\neq 1985}^{t=1990} \beta_t 1[\text{Deregulated}] \times 1[\text{Year=t}] \\
+ \mu 1[\text{Deregulated}] + \beta_3 \mathbf{X} + FEs + \epsilon_{b,z,q}
\end{aligned}
$$

where $E_{b,z,q}$ is either the natural log of wholesale interest expenses or retail interest expenses of bank b in the 3-digit zip-code area z in year q.

Figure 11 and Figure 12 graphically show the dynamics of local banks' wholesale and retail interest expenses before and after the oil-price shock. By comparing the patterns in Figure 11 and Figure 12, we can see a clear comparison among how banks meet their short-term liquidity needs when they were hit by the oil-price shock. In areas systemically hit by the oil-price shock, banks tended to have increased their retail interest expenses while decreased their wholesale interest expenses. On the other hand, for banks in local geographic units that are not systemically hit, these banks tend to substantially increase their wholesale interest expenses. This comparison suggests when banks in a local area were all experiencing increased demand for short-term liquidity, the local wholesale funding market is unlikely to be where banks in this area raise short-term liquidity from. Instead, shocked banks in this area are likely to rely more on local retail funding market, which explains why the retail interest expenses went up higher in systemically hit regions than in idiosyncratically hit regions.

This interpretation can also be alternatively confirmed from a different angle, as shown by the regression analysis in Table 15. In this table, we regress a bank's net wholesale asset holding on net wholesale liability of other banks that were located in the same 3-digit zip-code area and on the net wholesale liability of banks that were located in other three-digit zip-code areas in the same state. The regression covers all banks in operation from 1980-1990 and covers the years spanning from 1980-1990. We find that during the 1980s, a banks' wholesale liability moves closely with local banks' wholesale asset holding, indicating a non-trivial part of banks' wholesale trading are done locally.

I then move on to investigate the dynamics of wholesale and retail funding rate of shocked banks in systemically hit areas and idiosyncratically hit areas respectively.

Importantly, we examine the role played by banking market competition in the determination of these short-term bank funding rates. We write down the following regression specification:

$$Y_{b,z,q} = \alpha_i + \gamma_{z,q} + \beta_1 1[\text{Post}] + \beta_2 1[\text{Deregulated}] \times 1[\text{Post}] + \beta_3 \mathbf{X} + FEs + \epsilon_{b,z,q} \quad (6)$$

where $Y_{b,z,q}$ is either the retail funding rate or wholesale funding rate (as defined in section 3.4) of bank b in 3-digit zip-code are z in year q. 1[Post] is a dummy variable that switches to 1 from 1986. 1[Deregulated] is equal to 1 if the state the bank is located deregulated no later than 1987.

In Table 13 displays the results of changes in retail funding rate comparing pre and post oil shock, as well as how they interact with the status of intrastate deregulation. I find that after the oil price shock, shocked banks' average retail funding rate increased significantly both in systemically hit 3-digit zip-code areas (an average increase of 220 basis points) and in idiosyncratically 3-digit zip-code areas (an average increase of 36 basis points). More importantly, for the 3-digit zip-code areas that had been systemically hit, the retail funding rate increase was more substantial in those areas located in a state that has deregulated its banking sector. In particular, these systemically shocked and deregulated areas see an extra 213 basis point increase in the retail rate post oil price shock. For the idiosyncratically hit areas, on the contrary, 3-digit zip-code areas with more competitive local banking market didn't witness significantly higher increase in their retail rate.

Similarly I conduct the same set of analysis for the treatment effect of deregulation on the transmission of the liquidity demand shock to changes in shocked banks' wholesale funding rate. The results are reported in Table 14. It can be seen clearly that post the oil price bust, shocked banks located in both systemically hit and idiosyncratically hit areas saw a significant increase in their wholesale short-term funding rates. Specifically, wholesale funding rate for the shocked banks in idiosyncratic areas on average increases by 121 basis points and 128 bps for banks systemically hit areas. More importantly, while the status of deregulated or not does not affect wholesale funding cost for shocked banks in systemically hit areas, it has an economically impact on the wholesale funding cost for those in idiosyncratically hit area. In particular, for the shocked banks in idiosyncratic hit 3-digit zip-code area, the increase in its wholesale funding cost will be lowered by 64 basis points if the state has deregulated its banking sector.

These results are consistent with the empirical predictions based on our discussions in Section 4.2 (C). In a systemically hit area where many banks facing increased demand for short-term liquidity, local wholesale funding market is unlikely to be the main source from which shocked banks raise liquidity. Instead, conditions in local retail funding market will be critical in determining the resilience of these shocked banks. Under this circumstance, more competitive banking market can trigger fierce competition for retail liquidity and may trap the local banking sector in a high interest equilibrium in which all shocked banks are paying a substantially higher prices for short-term liquidity raised from local retail market. As a consequence, these shocked banks would have to severely cut their credit supply in such a competitive environment.

On the contrary, for shocked banks in the idiosyncratically hit 3-digit zip code areas, things will be a complete turn-around, as reflected in the significant negative coefficient on the interaction term between 1[Post] and 1[Deregulated]. This is because for shocked banks in a idiosyncratically hit area, wholesale funding market is nontrivial source of liquidity raising. For such an area in deregulated states, local banks are shocked in their liquidity demand could easily compete with each other on getting new deposits in adjacent or even more distant area. This off-equilibrium status strictly improves hit banks' bargaining position when they borrow from local peers, thus bringing down their wholesale rate relative to a bank in similar idiosyncratically liquidity-hit position but located in a geographic location that's "border-closed".

Using an alternative way to visualize our findings above, I run the following dynamic diff-in-diff to capture the heterogeneous treatment effect of oil shock with heterogeneity coming from whether the bank is located in a deregulated or underegulated geographic unit.

$$y_{b,z,q}^{\text{Deregu./Underegu.}} = \alpha_i + \gamma_{z,q} + \sum_{t=1982, t\neq 1985}^{t=1990} \beta_t 1[\text{Year=t}] + \beta_3 \mathbf{X} + FEs + \epsilon_{b,z,t}$$

where $y_{b,z,q}^{\text{Deregu./Underegu.}}$ is bank b's retail rate or wholesale rate in 3-digit zip-code area z in year q. Figure 13 and Figure 14 show the dynamics of short-term liquidity cost and the deregulation status under systemically and idiosyncratically hit local areas.

7. Conclusion

In this paper, I investigate how competition in bank funding market generates real impact through affecting the determination of short-term liquidity prices for banks. In particular, I examine how different levels in banking market competition can affect the transmissions of supply/demand side shocks on bank short-term funding to bank liquidity prices. Exploiting the exogenous variations in banking market competition resulting from the US banking deregulation in 80s and early 90s, this paper documents two novel facts about the real outcome implications of banking market competition.

First, while banks loan making in general tend to be less local than deposit taking, more competitive banking market enlarges this geographic mismatch between banks activities on two sides of their balance sheets. This effect of banking market competition on the geographic scope of banking activities is more pronounced for banks with high sensitivity to short-term liquidity prices and loans made to borrowers in labor-intensive industries. Evidences are provided suggesting that a main driving force behind this result is the impact of banking market competition on the transmission of a particular supply shock to the prices of short-term bank funding.

Second, examination of the lending dynamics of banks hit by the 1986 oil price shock reveals a mixed effect of banking market competition on economy's resilience to unexpected shocks. More competitive banking market provides better hedging against idiosyncratic shocks for lightly hit areas, but may lead to more severe freeze-up in bank lending for heavily hit areas where the shocks are more systemic. Evidences show that such a mixed effect on economic stability is largely due to the role banking market competition plays in the transmission of demand-side shocks to the prices of short-term bank liquidity.

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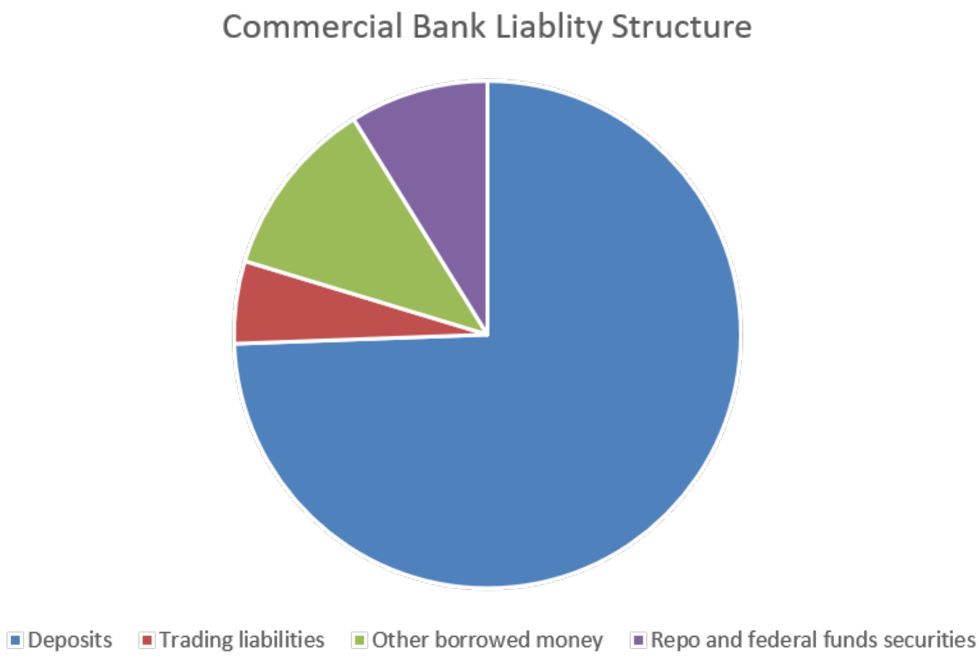
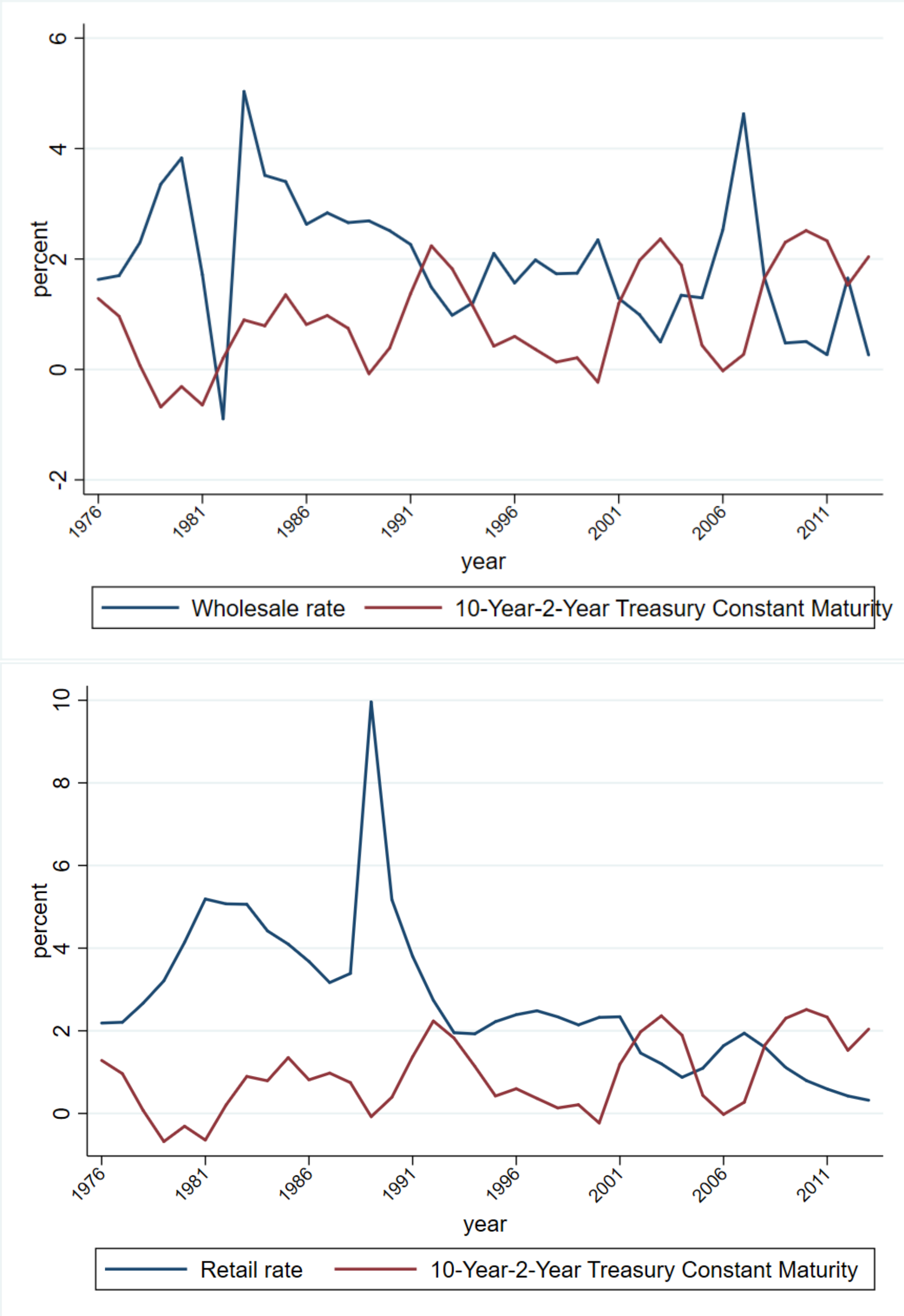
Appendix A. An Appendix

Fig. 1. Banking Sectors' Liability Structure



This figure displays (weighted average by size) liability structure of U.S. commercial banks using bank balance sheet data from Call Report 1976-2013.

Fig. 2. Banks' wholesale and retail funding cost



This figure displays the dynamics of commercial banks' implied wholesale and retail funding rate from 1976-2013 based on the definition provided in Section 3.4 as well as the evolution of the spread between 10-Year Treasury Constant Maturity (BC10YEAR) and 2-Year. The Treasury bond data used in calculating interest rate spreads is obtained directly from the Treasury Constant Maturity (BC2YEAR) from U.S. Treasury Department.

Table 1. Small Business Lending Characteristics and Lending Distances: 1991-2000

Panel A: Overall states

	N	Mean	Sd.	p(25)	p(50)	p(75)
Loan amount	329115	156456.84	171468.15	44704.00	88920.00	199500.00
Maturity (months)	329115	122.70	83.15	60.00	84.00	180.00
1[Charge-off]	329115	0.10	0.30	0.00	0.00	0.00
Distance	329115	481.14	583.07	35.27	233.02	743.37

Panel B: Late-deregulated states

	N	Mean	Sd.	p(25)	p(50)	p(75)
Loan amount	26928	121362.44	139286.70	37716.00	72000.00	144137.50
Maturity (months)	26928	107.58	63.35	60.00	84.00	144.00
1[Charge-off]	26928	0.11	0.31	0.00	0.00	0.00
Distance	26928	106.09	193.83	5.98	24.28	122.93

I(Charge-Off) is a dummy variable that takes the value of one if the loan was charged-off. SBA Loan Interest Rate is the initial interest rate on the SBA loan. SBA Loan Amount is the initial principal amount of the SBA loan. SBA Loan Maturity is the initial maturity in the number of months.

Table 2. Small Business Lending Characteristics at county level: 1991-2000

	Mean	Sd.	p(25)	p(50)	p(75)
No. of SBA loans	54.07	88.57	16.00	44.00	69.00
Total loan amount	9370229.29	25221205.24	994400.00	4671800.00	7721612.00
Total loan amount^{out}	3482322.18	39823341.14	298232.00	3028734.00	4721612.00
% to labor intensive	33.48%	17.09%	23.16%	31.21%	40.56%
No. of counties	1905				

The table shows the summary statistics SBA loans aggregated at the county level. No. of loans is the total number of SBA loans issued by small businesses located in the county in a given year. Total loan amount is the sum of the total loan amount at aggregated at the county level in a given year. And the % to labor intensive is the % of total loan amount that's lent to small businesses that belongs to labor intensive industries. Labor intensive industries are those small businesses with 2-digit NAICS codes: 11, 21, 31-33, 53, 72, 81, 92.

Table 3. Bank Balance sheet Summary Statistics: 1982-2000

Panel A: Non-oil states					
	Mean	Sd.	p(25)	p(50)	p(75)
Asset size (Ln.)	11.71	1.53	10.68	11.49	12.44
Deposits/Total liabilities	0.92	0.12	0.91	0.95	0.97
Time deposits/Deposits	0.47	0.14	0.38	0.47	0.56
Uninsured deposits/Deposits	0.11	0.11	0.05	0.08	0.14
Demand deposit/Deposits	0.16	0.10	0.11	0.14	0.20
Real estate loan/Total loan	0.45	0.19	0.32	0.45	0.58
Agricultural loan/Total loan	0.08	0.14	0.00	0.01	0.08
C& I loan share/Total loan	0.22	0.14	0.12	0.20	0.29
Retail funding costs	0.03	0.16	0.02	0.03	0.04
Wholesale funding costs	0.02	0.42	0.01	0.01	0.02
Wholesale liability/Total liabilities	0.05	0.08	0.01	0.03	0.06
Panel B: Oil states					
	Mean	Sd.	p(25)	p(50)	p(75)
Asset size (Ln.)	11.54	1.06	10.79	11.52	12.25
Deposits/Total liabilities	0.94	0.09	0.93	0.96	0.98
Time deposits/Deposits	0.50	0.12	0.42	0.50	0.57
Uninsured deposits/Deposits	0.16	0.08	0.09	0.14	0.20
Demand deposit/Deposits	0.16	0.08	0.12	0.15	0.19
Real estate loan/Total loan	0.46	0.17	0.33	0.46	0.58
Agricultural loan/Total loan	0.06	0.11	0.00	0.02	0.07
C& I loan share/Total loan	0.24	0.14	0.14	0.22	0.32
Retail funding costs	0.03	0.54	0.02	0.12	0.04
Wholesale funding costs	0.02	0.10	0.01	0.01	0.02
Wholesale liability/Total liabilities	0.04	0.06	0.01	0.02	0.04

The table shows the summary statistics of banks' balance sheet variables for all commercial banks in operation from 1980-1990. The balance sheet variables are constructed from Call Report 1982-2000. Panel B contains all banks in oil states including Texas, New Mexico, Oklahoma, Louisiana, Arkansas, Alaska, Utah, North Dakota, California, and Wyoming. Panel A includes all other non-oil states.

Table 4. Local Credit Growth and Local Banks' Deposit Growth

Panel A: Baseline Results

	$\Delta\text{Deposit}^{local}_{z,t}$			
	(1)	(2)	(3)	(4)
$\Delta\text{Loan}^{out}_{z,t}$	0.513***	0.441***	0.335***	0.341***
	(0.0524)	(0.0425)	(0.0943)	(0.0940)
Observations	160650	159673	159523	159497
R^2	0.123	0.169	0.182	0.190
Bank FE	✓	✓	✓	✓
County FE	✓	✓	✓	✓
Quarter FE	✓	✓	✓	✓
County-year FE	N	N	✓	✓
State-year FE	N	N	N	✓
Controls	N	✓	✓	✓

Panel B: Placebo Tests

	$\Delta\text{Deposit}^{local}_{z,t}$			
	(1)	(2)	(3)	(4)
$\Delta\text{Loan}^{out}_{z,t-1}$	0.462***			
	(0.0615)			
$\Delta\text{Loan}^{out}_{z,t-2}$		0.103***		
		(0.00805)		
$\Delta\text{Loan}^{out}_{z,t+1}$			0.0263	
			(0.0773)	
$\Delta\text{Loan}^{out}_{z,t+2}$				0.0192
				(0.0708)
Observations	163276	157859	150282	141706
R^2	0.200	0.183	0.199	0.203
Bank FE	✓	✓	✓	✓
County FE	✓	✓	✓	✓
Quarter FE	✓	✓	✓	✓
County-year FE	✓	✓	✓	✓
State-year FE	✓	✓	✓	✓
Controls	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

This table presents the regression results of equations (1):

$$\Delta\text{Deposit}^{\text{local}}_{i,z,t} = \alpha_{i,z} + \mu_t + \beta\Delta\text{Loan}^{\text{outside}}_{z,t} + \epsilon_{z,t}$$

The table presents regression showing the correlation between local credit growth and deposit growth at local bank level. The dependent variable of both Panel (A) and Panel (B) is the the log differences in the total deposits of bank i in area z between year t and year t−1. The right-hand side variable in Panel (A) is log of the sum of total local small business lending that was lent by banks located outside of the local area during the year-quarter t. The right-hand side variables in Panel (B) are conceptually the same as in Panel (A) but taken the lag or lead for one or two period. Standard errors are clustered at the state level.

Table 5. Local Credit Growth and Local Banks' Deposit Growth

	$\Delta \text{Deposit}_{z,t}^{local}$					
	(1)	(2)	(3)	(4)	(5)	(6)
ΔL-I sector credit_t^{out}	0.616***	0.613***	0.613***			
	(0.0847)	(0.0660)	(0.0631)			
ΔNon L-I sector credit_t^{out}				0.0539	0.0539	0.0539
				(0.0538)	(0.0525)	(0.0604)
Observations	150910	150910	150910	150910	150910	150910
R^2	0.156	0.161	0.161	0.144	0.152	0.152
Bank FE	✓	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓	✓
Quarter FE	✓	✓	✓	✓	✓	✓
County-year FE	✓	✓	✓	✓	✓	✓
State-year FE	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓
Clusters		State	Year		State	Year

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

This table presents the regression results of equations (2):

$$\Delta \text{Deposit}_{i,z,t}^{\text{local}} = \alpha_{i,z} + \mu_t + \beta_1 \Delta \text{Loan}_{z,t}^{\text{outside,l}} / + \beta_2 \Delta \text{Loan}_{z,t}^{\text{outside,nl}} + \epsilon_{z,t}$$

The table presents regression showing the correlation between local labor-intensive/non-labor-intensive firms' credit growth and deposit growth at local bank level. The dependent variable is the the log differences in the total deposits of bank i in area z between year t and year t1. The independent variable for column (1)-(3) is the total sum of loans received by local labor-intensive businesses from banks outside of the local area one period earlier, and independent variable for column (4)-(6) is the total sum of loans received by non-labor-intensive businesses from banks outside of the local region one period earlier. Standard errors are clustered at state level for column (2) and (5) and are clustered at year level for column (3) and (6).

Table 6. Local Credit Growth and Local Banks' Liquidity Raising Cost

	Δ Retail rate		Δ Wholesale rate	
	(1)	(2)	(3)	(4)
ΔLocal credit$_t^{out}$	-0.244***	-0.269***	-0.287***	-0.272***
	(0.0382)	(0.0311)	(0.0415)	(0.0470)
Observations	170765	166425	55970	54869
R^2	0.342	0.379	0.420	0.428
Bank FE	✓	✓	✓	✓
County FE	✓	✓	✓	✓
Quarter FE	✓	✓	✓	✓
County-year FE	N	✓	N	✓
State-year FE	N	✓	N	✓
Controls	N	✓	N	✓

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

This table presents the regression results of equations (3):

$$\text{Ave. Retail rate}_{i,z,t}^{local} = \alpha_{i,z} + \mu_t + \beta^{retail}\Delta\text{Loan}_{z,t}^{\text{outside}} + \epsilon_{z,t}$$
$$\text{Ave. Wholesale rate}_{i,z,t}^{local} = \alpha_{i,z} + \mu_t + \beta^{wholesale}\Delta\text{Loan}_{z,t}^{\text{outside}} + \epsilon_{z,t}$$

The table presents regression showing the correlation between local credit growth and retail/wholesale funding cost at the bank level. The dependent variable of column (1) and (2) is the implied retail rate at the bank level and the dependent variable of column (3) and (4) is the implied wholesale rate at the bank level. The concrete definitions for implied retail rate and implied wholesale rate are provided in Section 3.4. The independent variable is the log of the sum of total local small business lending that was lent by banks located outside of the local area during the year-quarter t.

Table 7. Local and Adjacent area credit growth, wholesale funding cost: before and after deregulation

Panel A: Adjacent area credit expansion

	Wholesale funding rate			
	Before deregulation		After deregulation	
	(1)	(2)	(3)	(4)
ΔAdjacent area loans^{out}	-0.0229	-0.0309	-0.375***	-0.389***
	(0.0409)	(0.0507)	(0.0811)	(0.0103)
Observations	9796	9631	12833	12579
R^2	0.093	0.095	0.098	0.109
Bank FE	✓	✓	✓	✓
County-year FE	N	✓	N	✓
Bank-year FE	✓	✓	✓	✓

Panel B: Local credit expansion

	Wholesale funding rate			
	Before deregulation		After deregulation	
	(1)	(2)	(3)	(4)
ΔLocal area loans^{out}	-0.252**	-0.283***	0.0154	0.0263
	(0.0487)	(0.0527)	(0.0244)	(0.0355)
Observations	9795	9630	12822	12567
R^2	0.108	0.223	0.113	0.259
Bank FE	✓	✓	✓	✓
County year FE	N	✓	N	✓
Bank year FE	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

This table presents the regression results of the following equations:

$$\Delta y_{i,z,t} = \alpha_i + \mu_{z,t} + \beta^{adj} \times \Delta\text{Adjacent area loan}^{out}_{z,t} + \text{FE's} + \epsilon_{i,z,t}$$
$$\Delta y_{i,z,t} = \alpha_i + \mu_{z,t} + \beta^{local} \times \Delta\text{Local area loan}^{out}_{z,t} + \text{FE's} + \epsilon_{i,z,t}$$

The table presents regression showing the correlation wholesale funding rate changes and the flow of credit to adjacent area businesses at bank-year level. The regression covers bank from the three late-deregulated states MN, AR and IA. The dependent variable is the year-to-year change in average wholesale funding rate of bank i located in the three-digit zip-code area z in year t. The independent variable of Panel (A) is ΔAdjacent area loan$^{out}_{z,t}$, which is the natural log of credit flow to the adjacent county areas of bank i's located area z in year t. The independent variable of Panel (B) is ΔLocal area loan$^{out}_{z,t}$, which is the natural log of credit flow to the bank i's own county area z in year t.

Table 8. Local and Adjacent area credit growth, retail funding cost: before and after deregulation

Panel A: Adjacent area credit expansion

	Retail funding rate			
	Before deregulation		After Deregulation	
	(1)	(2)	(3)	(4)
ΔAdjacent area loans^{out}	0.00177	0.00220	-0.00619	-0.00823
	(0.00471)	(0.00502)	(0.00468)	(0.00668)
Observations	6285	6285	12514	12514
R^2	0.013	0.018	0.011	0.011
Bank FE	✓	✓	✓	✓
County year FE	N	✓	N	✓
Bank year FE	✓	✓	✓	✓

Panel B: Local credit expansion

	Retail funding rate			
	Before Deregulation		Post Deregulation	
	(1)	(2)	(3)	(4)
ΔLocal area loans^{out}	-0.238**	-0.292***	0.0324	0.0363
	(0.0433)	(0.0427)	(0.0446)	(0.0582)
Observations	9795	9630	12822	12567
R^2	0.085	0.248	0.109	0.221
Bank FE	✓	✓	✓	✓
County year FE	N	✓	N	✓
Bank year FE	✓	✓	✓	✓

Standard errors in parentheses

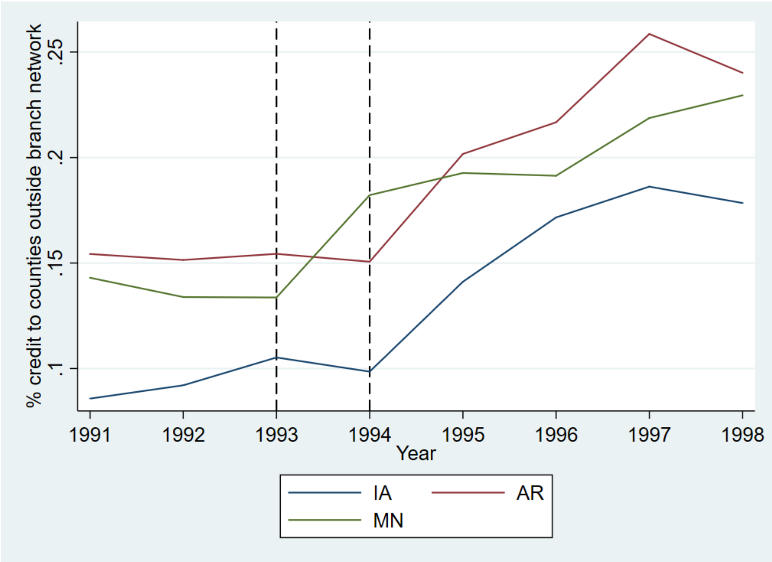
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

This table presents the regression results of the following equations:

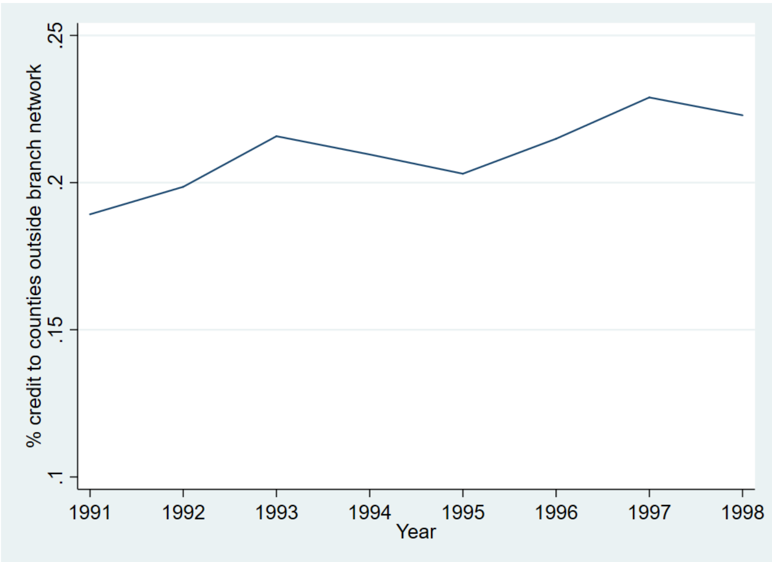
$$\Delta y_{i,z,t} = \alpha_i + \mu_{z,t} + \beta^{adj} \times \Delta\text{Adjacent area loan}^{out}_{z,t} + \text{FE's} + \epsilon_{i,z,t}$$
$$\Delta y_{i,z,t} = \alpha_i + \mu_{z,t} + \beta^{local} \times \Delta\text{Local area loan}^{out}_{z,t} + \text{FE's} + \epsilon_{i,z,t}$$

The table presents regression showing the correlation retail funding rate changes and the flow of credit to adjacent area businesses at bank-year level. The regression covers bank from the three late-deregulated states MN, AR and IA. The dependent variable is the year-to-year change in average retail funding rate of bank i located in the county area z in year t. The independent variable of Panel (A) is ΔAdjacent area loan$^{out}_{z,t}$, which is the natural log of credit flow to the adjacent county areas of bank i's located area z in year t. The independent variable of Panel (B) is ΔLocal area loan$^{out}_{z,t}$, which is the natural log of credit flow to the bank i's own county area z in year t.

Fig. 3. Banks' lending portfolio towards businesses outside of branching network: late-deregulated states and other sates



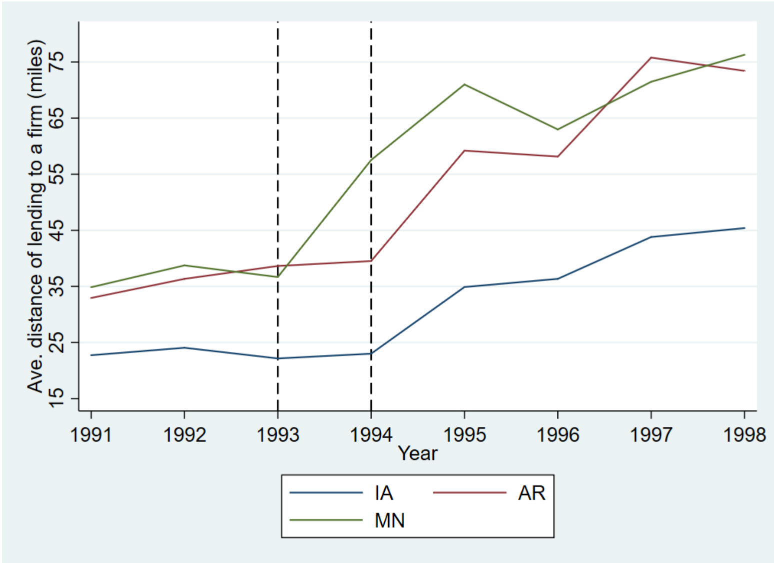
(a) Banks' lending distance change around deregulation in deregulated states



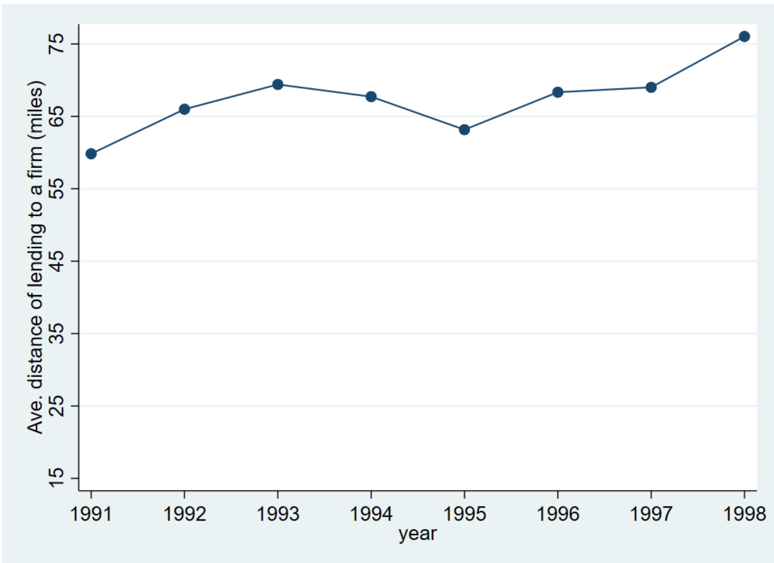
(b) Banks' lending distance in other states during the same episode

Notes: This figure shows the average of banks' portfolio to borrowing small businesses located outside of their branching network. Panel (a) shows the evolution of out-of-network portfolio of banks in late-deregulated states and panel (b) shows the evolution of out-of-network portfolio of banks in all the other states during the same episode.

Fig. 4. Banks' lending distance in deregulated states and other states (weighted average)



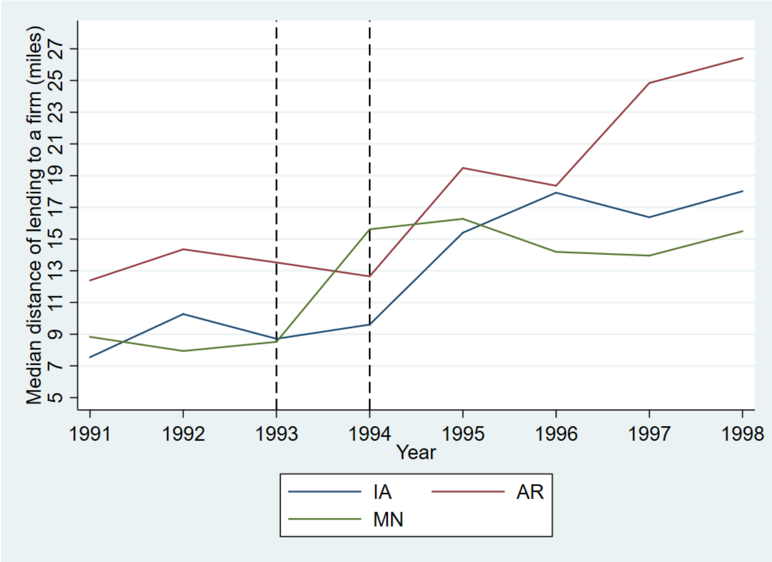
(a) Banks' lending distance change around deregulation in deregulated states



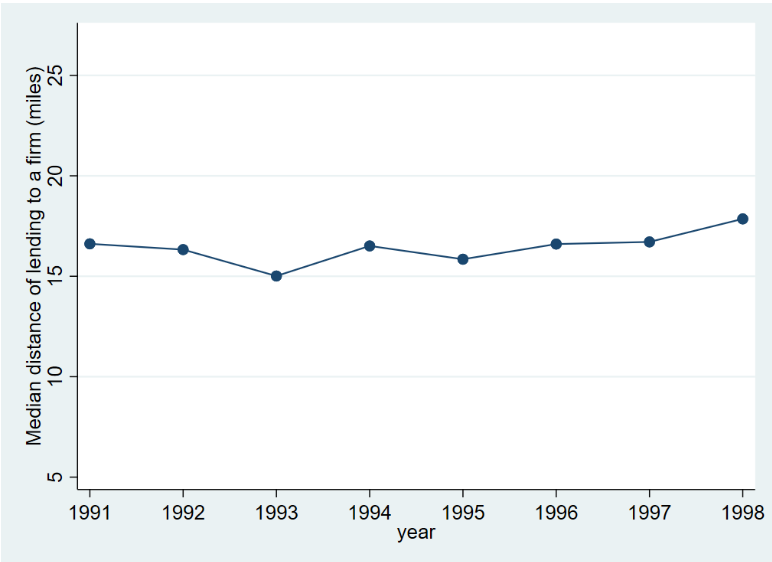
(b) Banks' lending distance in other states during the same episode

Notes: This figure shows the average of banks' lending distance, weighted by the lending amount and banks' size. Panel (a) shows the evolution of weighted average of lending distances of banks in late-deregulated states and panel (b) shows the evolution of weighted average of lending distances of banks in all the other states during the same episode.

Fig. 5. Banks' lending distance in deregulated states and other states (median)



(a) Banks' lending distance change around deregulation in deregulated states



(b) Banks' lending distance in other states during the same episode

Notes: This figure shows the median of banks' average lending distances. Panel (a) shows the evolution of median of banks' lending distances (weighted by each loan's total amount) in late-deregulated states and panel (b) shows the evolution of the evolution of median of banks' lending distances (weighted by each loan's total amount) in all the other states during the same episode.

Table 9. Bank Lending Distance and Labor Intensity of Borrowers

	Ln(Distance)		1[Within network]	
	(1)	(2)	(3)	(4)
1[Deregulation]	1.252***		-0.164*	
	(0.266)		(0.111)	
1[Deregulation]×1[Labor-intensive]		1.752***		-0.182**
		(0.127)		(0.0592)
1[Deregulation]×1[Non-labor-intensive]		0.966		-0.0763
		(0.722)		(0.0556)
Observations	21928	21928	21928	21928
R^2	0.082	0.099	0.079	0.097
Bank FE	Y	Y	Y	Y
State FE	Y	Y	Y	Y
County FE	Y	Y	Y	Y

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: This table presents the bank-loan level regression on banks' small business loan distances for banks in the late deregulated states. The regression covers all banks in late-deregulated states during the episode of 1990-1996. The left-hand side variable in columns (1) and (2) are both the natural log of the shortest lending distance between a credit-receiving small business and the lending banks' branching network. The dependent variable in column (3) and (4) is the dummy variable that equals to 1 if the credit-receiving firm is from counties that are within lending banks' branching network after the deregulation. Labor intensive industries are those small businesses with 2-digit NAICS codes: 11, 21, 31-33, 53, 72, 81, 92.

Table 10. Bank Short-term Liquidity Reliance and Lending Distance

	1[Within network]		Ln(Distance)	
	(1)	(2)	(3)	(4)
High $\frac{\text{Transactiol deposits}}{\text{Time deposits}}$	0.112***		-0.762**	
	(0.0231)			
High $\frac{\text{Uninsured deposits}}{\text{Deposits}}$		0.136***		-0.828***
		(0.0297)		(0.187)
Observations	321982	321982	321982	321982
R^2	0.117	0.109	0.108	0.105
Bank FE	Y	Y	Y	Y
State FE	Y	Y	Y	Y
County FE	Y	Y	Y	Y

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: This table presents bank-loan level cross-sectional regression about banks' small business loan distances on the banks' reliance reliance on short-term liquidity funding. The regression covers all banks during the episode of 1990-2000. The dependent variable in column (1) and (2) is the dummy variable that equals to 1 if the credit-receiving firm is from counties that are within lending banks' branching network. The left-hand side variable in columns (3) and (4) is the natural log of the shortest lending distance between a credit-receiving small business and the lending banks' branching network. High Transaction deposits/time deposits an indicator variable that equals to 1 if the bank's average over-time transaction deposit/time deposit ratio is above 25-th percentile among all banks in the sample; and High Uninsured deposits/Deposits is an indicator variable that equals to 1 if the bank's average over-time Uninsured deposits/Deposits is above 25-th percentile among all banks in the sample.

Table 11. Responses of Bank Lending Portfolio to Distant Areas

Panel A:	1[Outside network]		
	(1)	(2)	(3)
1[Post Deregulation]	0.117***	0.0463***	0.0622***
	(0.00237)	(0.00702)	(0.0105)
1[Post Deregulation]×High$\frac{\text{Transaction deposits}}{\text{Time deposits}}$		0.102***	
		(0.00232)	
1[Post Deregulation]×High$\frac{\text{Uninsured deposits}}{\text{Deposits}}$			0.133**
			(0.0438)
Observations	21928	21928	21928
R^2	0.011	0.012	0.016
Bank FE	Y	Y	Y
State FE	Y	Y	Y
County FE	Y	Y	Y

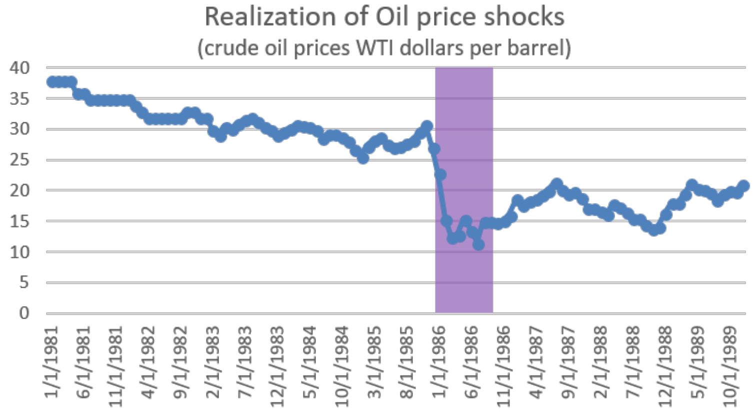
Panel B:	Ln(Distance)		
	(1)	(2)	(3)
1[Post deregulation]	0.691***	0.0882***	0.0729**
	(0.121)	(0.0236)	(0.0212)
1[Post deregulation]×High$\frac{\text{Transaction deposits}}{\text{Time deposits}}$		0.599***	
		(0.0611)	
1[Post Deregulation]×High$\frac{\text{Uninsured deposits}}{\text{Deposits}}$			0.565***
			(0.0642)
Observations	21928	21928	21928
R^2	0.012	0.013	0.013
Bank FE	Y	Y	Y
State FE	Y	Y	Y
County FE	Y	Y	Y

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

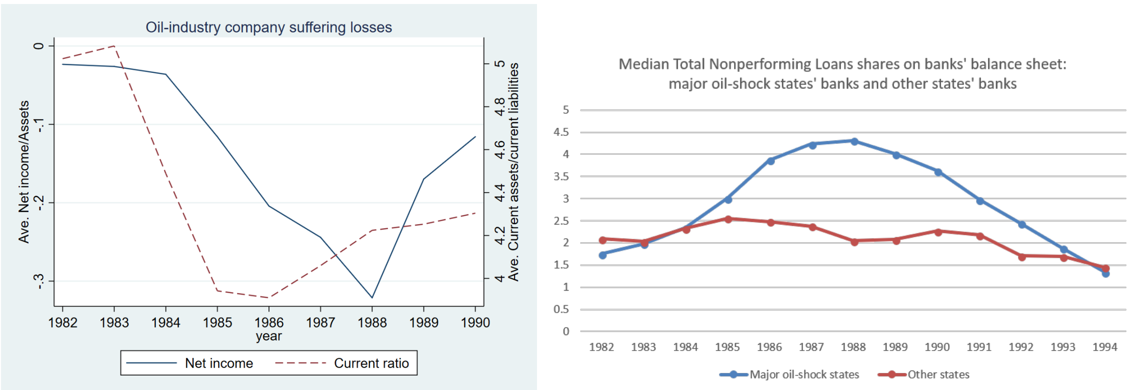
Notes: This table presents the bank-loan level regression on banks' small business loan distances for banks in the late deregulated states. The regression covers all banks in late-deregulated states during the episode of 1990-1996. The left-hand side variable in Panel (A) is the dummy variable that equals to 1 if the credit-receiving firm is from counties that are outside of the lending banks' branching network after the deregulation. The dependent variable in Panel (B) is the natural log of the shortest lending distance between a credit-receiving small business and the lending banks' branching network. High Transaction deposits/time deposits an indicator variable that equals to 1 if the bank's average over-time transaction deposit/time deposit ratio is above 25-th percentile among all banks in the sample; and High Uninsured deposits/Deposits is an indicator variable that equals to 1 if the bank's average over-time Uninsured deposits/Deposits is above 25-th percentile among all banks in the sample.

Fig. 6. 1986 oil price shock



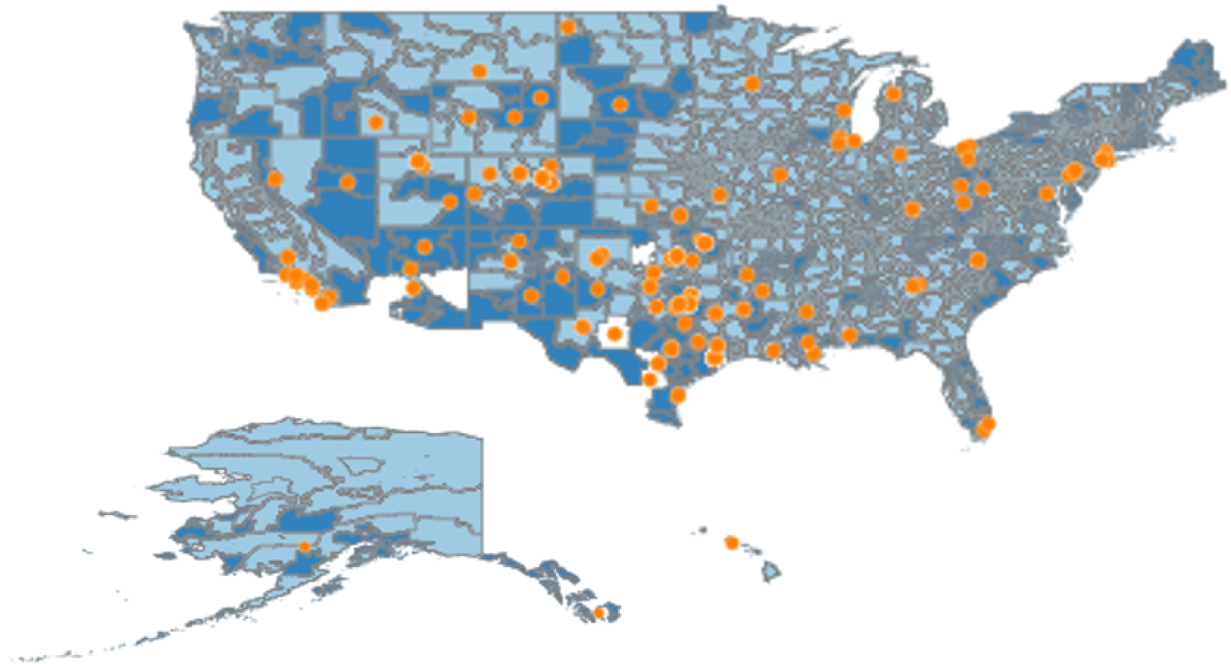
The figure shows the oil price dynamics retrieved from FRED's West Texas Intermediate oil price series.

Fig. 7. U.S. oil company losses after the oil price glut 1986 and Banks' NPL dynamics



The figure shows the oil firms' losses after the 1986 oil price glut. The blue line shows the weighted average of Net Income/Assets of all firms with SIC code 1311 in Compustat (Annual) on the left-axis; on the right-axis is the dynamics of weighted average of current ratio of firms during this period. Current ratio is calculated as current assets/current liabilities. On the right panel we show the average NPL of banks in oil-states and those in other states in U.S.. NPL the total non-performing loans scaled by total loans outstanding. Total nonperforming loans equals the Total Loans and Lease Finance Receivables, Nonaccrual (call report RCFD1403). Total loans equals Total Loans and Leases, Net of Unearned Income call item RCFD2122. Oil states including Texas, New Mexico, Oklahoma, Louisiana, Arkansas, Alaska, Utah, North Dakota, California, and Wyoming

Fig. 8. Distribution of hit geographic units



The figure shows the distribution of the hit 3-digit zip-code geographic units defined in section 6.2, and the distribution of oil companies. The figure in darker blue shows the 3-digit zip code areas that are defined as being systemically exposed to the oil-price shocks. A bank is defined as being hit by the oil-price shock if $\frac{\textit{Ave}.\text{within 3-month overdue}_{86-87}}{\textit{Ave}.\text{within 3-month overdue}_{85}} - 1 > 0.3$, the average is the within-bank average across year-quarters. And a 3-digit zip-code is defined as being systemically hit by the shock if more than 35% of the local banks were hit by the oil-price shock. The orange dots shows the location of oil companies in 1985. Locations of oil companies are constructed from Compustat with two-digit SIC code 13.

Table 12. Treatment effects of oil-price shock on bank lending in deregulated and non-deregulated states

	C&L Loans			
	Systemic		Idiosyncratic	
	(1)	(2)	(3)	(4)
1[Post]	0.154***	-0.160***	-0.0945***	-0.114***
	(0.0243)	(0.0227)	(0.0203)	(0.0294)
1[Post]×1[Deregulated]	-0.0336***	-0.0155***	0.0467***	0.0159***
	(0.00979)	(0.00814)	(0.00638)	(0.00388)
Observations	46940	46940	161172	161172
R^2	0.939	0.958	0.949	0.960
Bank FE	✓	✓	✓	✓
3-zip FE	✓	✓	✓	✓
Quarter FE	✓	✓	✓	✓
State FE	✓	✓	✓	✓
Controls	N	✓	N	✓

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

$$y_{b,z,q} \quad = \quad \alpha_i + \gamma_{z,q} + \beta_1 1[\text{Post}] + \beta_2 1[\text{Deregulated}] \times 1[\text{Post}] + \beta_3 \mathbf{X} + FEs + \epsilon_{b,z,q}$$

b refers to bank, z refers to 3-digit zip code area, t refers to year-quarter, $y_{b,z,t}$ is ln(C& I loans) of bank b in 3-digit zip z in year-quarter t. The panel covers all banks in operation from 1982-1990. 1[Post] switch on to 1 from 1986. 1[Deregulated] is equal to 1 if the state the bank is located deregulated no later than 1987. Controls are bank-level controls including log of assets, agricultural loan share and real estate loan share.

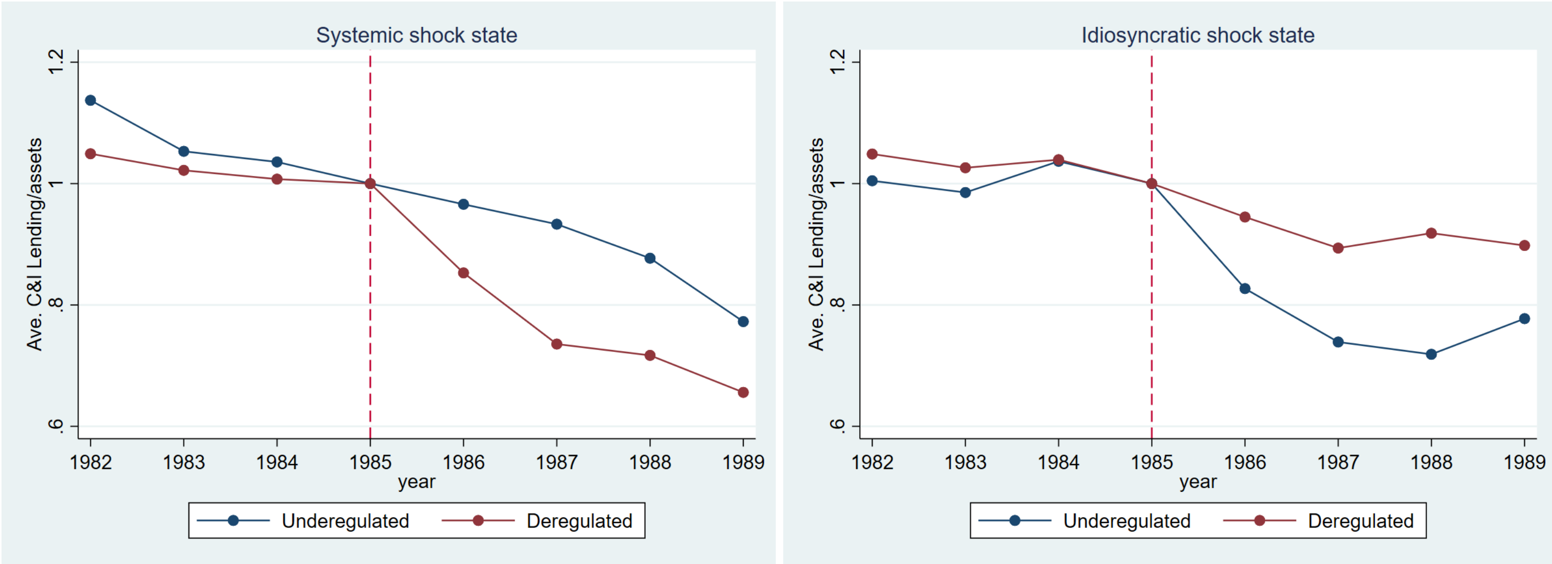


Fig. 9. C& I lending dynamics of banks in deregulated and underegulated states

Notes: The figure plots the dynamics of average bank C& I lending dynamics of banks in Oil states and Non-Oil states. Each dot represents the weighted average of C&I lending of banks in the states. Systemic shock states include Oklahoma, Louisiana, New Mexico, California, North Dakota, Wyoming, Arkansas, Utah and Alaska; Idiosyncratic shock states include all other states that contains at least one three-digit zip code are that is defined as exposed to shocks.

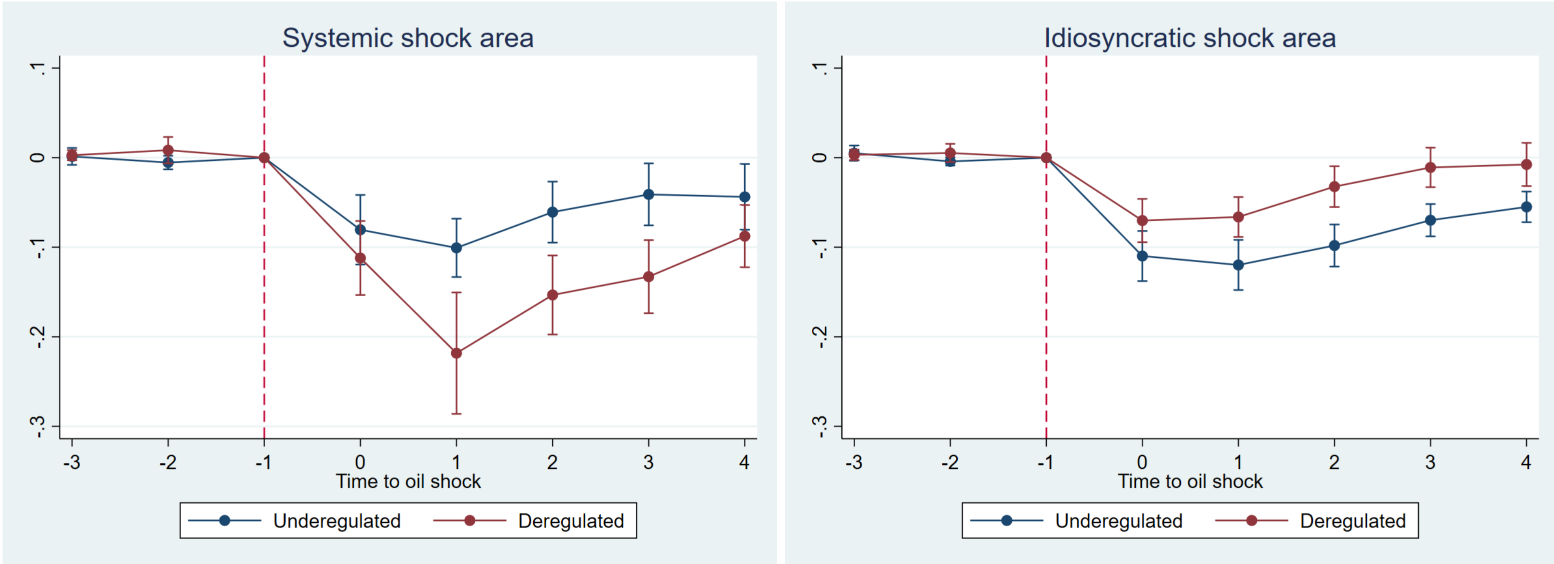
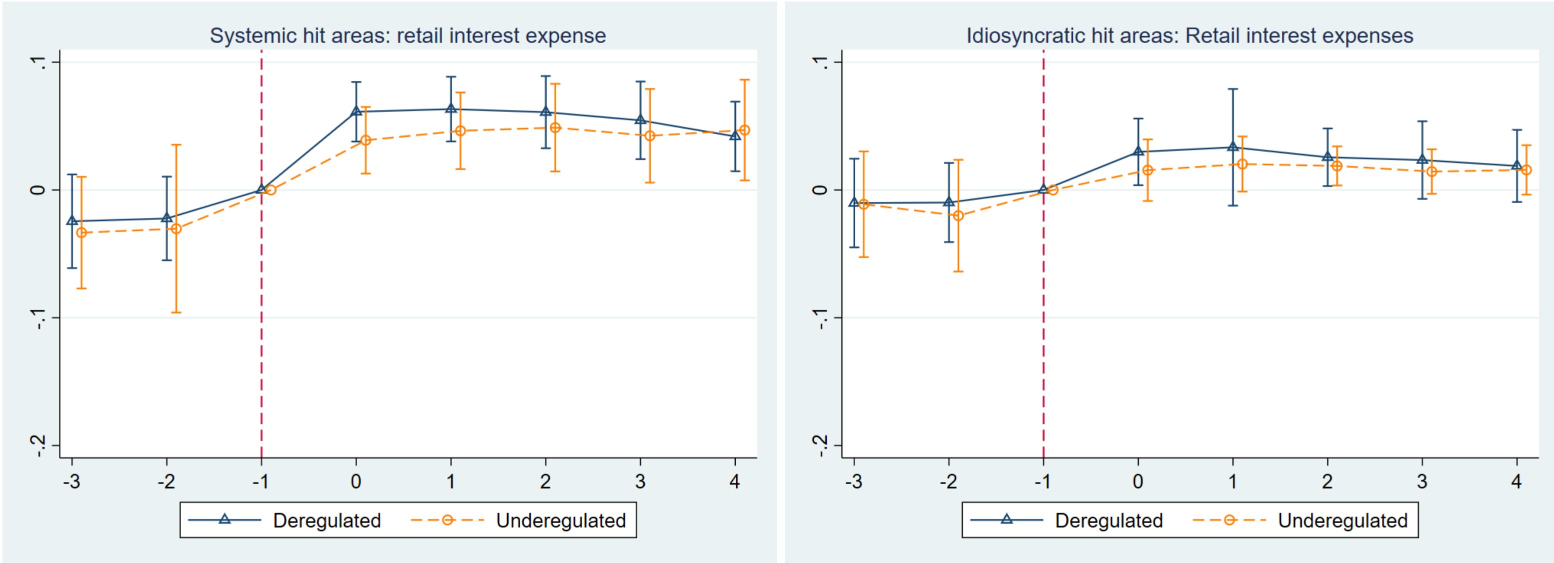


Fig. 10. C& I lending dynamics of banks in deregulated and underegulated states

$$
\begin{aligned}
y_{b,z,q} &= \alpha_i + \gamma_{z,q} + \sum_{t=1982, t\neq 1985}^{t=1990} \beta_t 1[\text{Deregulated}] \times 1[\text{Year=t}] + \mu 1[\text{Deregulated}] + \beta_3 \mathbf{X} + FEs + \epsilon_{b,z,q} \\
y_{b,z,q}^{\text{Deregu./Underegu.}} &= \alpha_i + \gamma_{z,q} + \sum_{t=1982, t\neq 1985}^{t=1990} \beta_t 1[\text{Year=t}] + \beta_3 \mathbf{X} + FEs + \epsilon_{b,z,t}
\end{aligned}
$$

Notes: The regression includes three-digit zip area, bank and state fixed effects and standard errors are clustered at state level. Control variables include log of banks' assets, agricultural loan share and real estate loan share. To make the above figure, the second equation is run and coefficients are plotted separately.

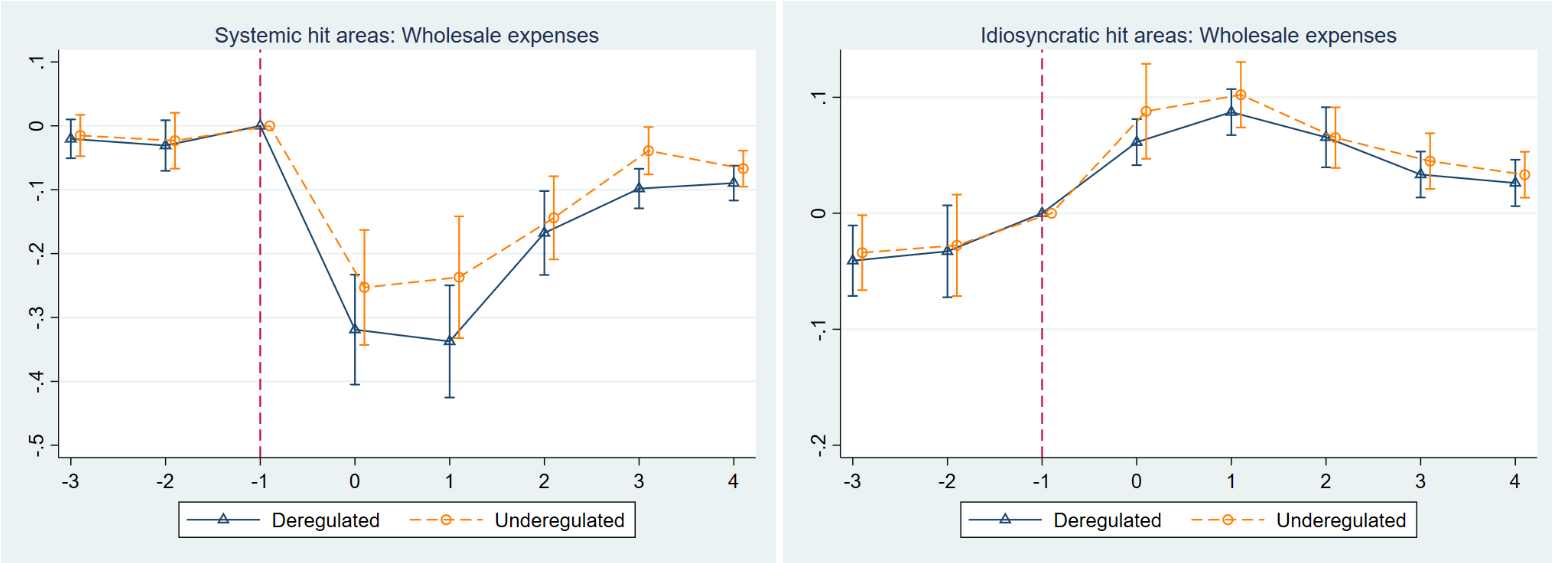
Fig. 11. Retail funding costs changes of banks in deregulated and underegulated states



$$\text{Ln(Retail int. expense)}_{b,z,q} = \alpha_i + \gamma_{z,q} + \sum_{t=1982, t\neq 1985}^{t=1990} \beta_t 1[\text{Deregulated}] \times 1[\text{Year=t}]$$
$$+\mu 1[\text{Deregulated}] + \beta_3 \mathbf{X} + FEs + \epsilon_{b,z,q}$$

Notes: The figure plots the dynamics of exposed banks' retail interest expenses by whether the bank is located in a systemically hit or idiosyncratically hit three-digit zip code area. Bank's time-varying control variables including the natural log of total assets, the banks' agricultural loan share and real estate loan share in total loans outstanding

Fig. 12. Retail funding costs changes of banks in deregulated and underegulated states



$$
\begin{aligned}
\text{Ln(wholesale int. expense)}_{b,z,q} &= \alpha_i + \gamma_{z,q} + \sum_{t=1982, t\neq 1985}^{t=1990} \beta_t 1[\text{Deregulated}] \times 1[\text{Year=t}] \\
&+ \mu 1[\text{Deregulated}] + \beta_3 \mathbf{X} + FEs + \epsilon_{b,z,q}
\end{aligned}
$$

Notes: The figure plots the dynamics of exposed banks' wholesale interest expenses by whether the bank is located in a systemically hit or idiosyncratically hit three-digit zip code area. Bank's time-varying control variables including the natural log of total assets, the banks' agricultural loan share and real estate loan share in total loans outstanding

Table 13. Treatment effects of oil-price shock on banks' retail funding costs in deregulated and non-deregulated states

	Retail funding rate			
	Systemic		Idiosyncratic	
	(1)	(2)	(3)	(4)
1[Post]	0.0131***	0.0221***	0.00364***	0.00358**
	(0.00416)	(0.00469)	(0.00101)	(0.00112)
1[Post]×1[Deregulated]	0.0172***	0.0213***	0.00394	0.00382
	(0.00398)	(0.00471)	(0.0106)	(0.00548)
Observations	46214	46202	60365	60167
R^2	0.182	0.194	0.185	0.209
Bank FE	✓	✓	✓	✓
3-digit zip FE	✓	✓	✓	✓
Quarter FE	✓	✓	✓	✓
Controls	N	✓	N	✓

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

$$\text{Retail rate}_{b,z,q} \quad = \quad \alpha_i + \gamma_{z,q} + \beta_1 1[\text{Post}] + \beta_2 1[\text{Deregulated}] \times 1[\text{Post}] + \beta_3 \mathbf{X} + FEs + \epsilon_{b,z,q}$$

Notes: b refers to bank, z refers to 3-digit zip code area, t refers to year-quarter, retail rate$_{b,z,t}$ is $\frac{\text{Interest expense on deposits}}{\text{Ave. quarterly deposits}}$ of bank b in 3-digit zip z in year-quarter t. The panel covers all banks in operation from 1982-1990 (bankrupted banks are excluded). 1[Post] switch on to 1 from 1986. 1[Deregulated] is equal to 1 if the state the bank is located deregulated no later than 1987. Controls are bank-level controls including log of assets, agricultural loan share and real estate loan share.

Table 14. Treatment effects of oil-price shock on banks' wholesale funding costs in deregulated and non-deregulated states

	Wholesale funding rate			
	Systemic		Idiosyncratic	
	(1)	(2)	(3)	(4)
1[Post]	0.0138***	0.0128***	0.0129***	0.0121***
	(0.00311)	(0.00321)	(0.00322)	(0.00256)
1[Post]×1[Deregulated]	-0.00126	-0.00108	-0.00577**	-0.00639***
	(0.00218)	(0.00262)	(0.00119)	(0.00125)
Observations	18273	17917	60685	59781
R^2	0.199	0.276	0.172	0.193
Bank FE	✓	✓	✓	✓
3-digit zip FE	✓	✓	✓	✓
Quarter FE	✓	✓	✓	✓
Controls	N	✓	N	✓

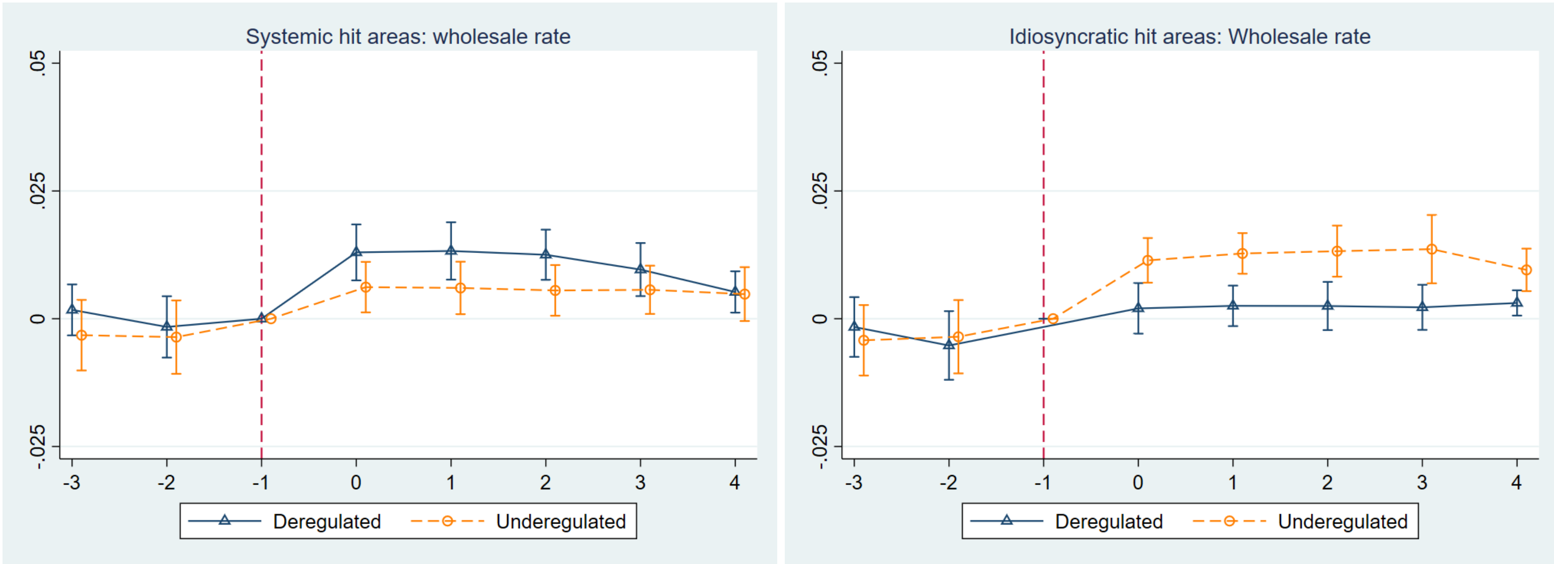
Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

$$\text{Wholesale rate}_{b,z,q} = \quad \alpha_i + \gamma_{z,q} + \beta_1 1[\text{Post}] + \beta_2 1[\text{Deregulated}] \times 1[\text{Post}] + \beta_3 \mathbf{X} + FEs + \epsilon_{b,z,q}$$

Notes: b refers to bank, z refers to 3-digit zip code area, t refers to year-quarter, wholesale rate$_{b,z,t}$ is $\frac{\text{Interest expense on federal funds and repo liabilities (RIAD4180)}}{\text{Ave. quarterly federal funds and repo liabilities (RCFD3353)}}$ of bank b in 3-digit zip z in year-quarter t. The panel covers all banks in operation from 1982-1990 (bankrupted banks are excluded). 1[Post] switch on to 1 from 1986. 1[Deregulated] is equal to 1 if the state the bank is located deregulated no later than 1987. Controls are bank-level controls including log of assets, agricultural loan share and real estate loan share

Fig. 13. Wholesale funding costs changes of banks in deregulated and underegulated states

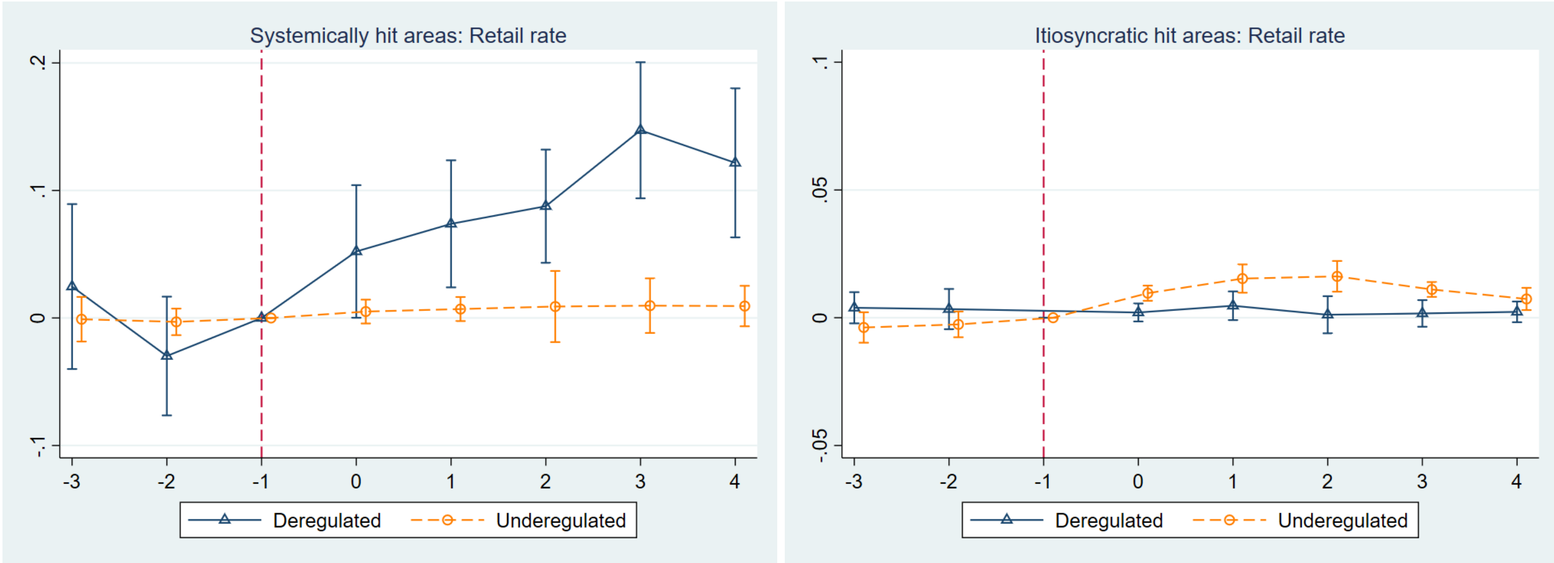


$$y_{b,z,q} = \alpha_i + \gamma_{z,q} + \sum_{t=1982, t \neq 1985}^{t=1990} \beta_t 1[\text{Deregulated}] \times 1[\text{Year=t}] + \mu 1[\text{Deregulated}] + \beta_3 \mathbf{X} + FEs + \epsilon_{b,z,q}$$

$$y_{b,z,q}^{\text{Deregu./Underegu.}} = \alpha_i + \gamma_{z,q} + \sum_{t=1982, t \neq 1985}^{t=1990} \beta_t 1[\text{Year=t}] + \beta_3 \mathbf{X} + FEs + \epsilon_{b,z,t}$$

Notes: The regression includes three-digit zip area, bank and state fixed effects and standard errors are clustered at state level. Control variables include log of banks' assets, agricultural loan share and real estate loan share. To make the above figure, the second equation is run and coefficients are plotted separately.

Fig. 14. Retail funding costs changes of banks in deregulated and underegulated states



$$\text{Retail rate}_{b,z,q} \quad = \quad \alpha_i + \gamma_{z,q} + \beta_1 1[\text{Post}] + \beta_2 1[\text{Deregulated}] \times 1[\text{Post}] + \beta_3 \mathbf{X} + FEs + \epsilon_{b,z,q}$$

Notes: b refers to bank, z refers to 3-digit zip code area, t refers to year-quarter, retail rate$_{b,z,t}$ is $\frac{\text{Interest expense on deposits}}{\text{Ave. quarterly deposits}}$ of bank b in 3-digit zip z in year-quarter t. The panel covers all banks in operation from 1982-1990 (bankrupted banks are excluded). 1[Post] switch on to 1 from 1986. 1[Deregulated] is equal to 1 if the state the bank is located deregulated no later than 1987. Bank-level controls including log of assets, agricultural loan share and real estate loan share.

Table 15. Wholesale liability issuance by local banks from adjacent and distant banks

	Δ Net Wholesale assets	
	(1)	(2)
	Same area	Other area
ΔNet wholesale Liabilities	0.121***	0.0232
	(0.0283)	(0.0332)
Observations	82492	25623
R^2	0.113	0.121
Bank FE	✓	✓
3-digit zip FE	✓	✓
3-digit zip-year FE	✓	✓
State FE	✓	✓
State-year FE	✓	✓

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

$$\Delta\text{Net wholesale assets}_{i,z,t} = \alpha_z + \Delta\text{Net wholesale liabilities}^{\text{Same/Other}}_{z/-z,t} + FE's + \epsilon_{c,t}$$

Notes: the above regression is specified at the bank and 3-digit zip-code level and standard errors are clustered at three-digit zip-year level. The left-hand side variable is the bank-level average net wholesale assets over a year for a bank in a specific 3-digit zip-code area z. The right-hand side variable 3-digit zip-code average of banks' net wholesale liabilities, the 3-digit zip-code on the right-hand side is either the area sharing the same area with the bank in the dependent variable or a different 3-digit zip code area in the same state with the bank in the dependent variable. The regression covers all banks inoperation from 1980-1990 and covers the years spanning from 1980-1990.

Table 16. Variable Definition and Source

Variable	**Source and definition**
Total Assets	Call report RCFD2170
Deposits	Call report RCON2200: Total Domestic Deposits
Uninsured Deposits	Call report RCON2604 before 2009Q4 and RCONJ474 after that: Uninsured deposits are deposits greater than $100k until 12/31/2009 and greater than $250k after that.
Transaction deposits	Call report RCON2215: Total Transaction accounts.
Time deposits	Call report (RCON2604+RCON6648): Sum of total time deposits accounts more than $100,000 and time deposits accounts less than $100,000.
Total loans	Call report RCFD1400+RCFD2165 before 1984 and RCFD1400 after 1984: Total Loans and Leases.
Wholesale Liability	Call report RCFD2800 before 2002Q1 and (RCFDB993+RCFDB995) after 2002Q1: Fed funds purchased and securities sold under agreements to repurchase.
Wholesale Assets	Call report RCFD2800 before 2002Q1 and (RCFDB993+RCFDB995) after 2002Q1: Fed funds purchased and securities sold under agreements to repurchase.
Interest expense on wholesale funding	Call report RIAD4180: Interest expense on Fed funds purchased and securities sold under agreements to repurchase.
Interest expense on retail funding	Call report RIAD4170: Interest Expenses on Deposits
C& I Loans	Call report RCFD1350 before 2002Q1 and RCFDB987+RCFDB989 after 2002Q1: Fed funds sold and securities purchased under agreements to resell.
Real Estate Loans	Call report RCFD1410.
Agricultural Loans	Call report RCFD1590.
Short-term overdue	Call report RCFD1403-RCFD1407: total past due loans minus the past due loans over 3 months.