THE IMPORTANCE OF BRICK-AND-MORTAR BANK OFFICES: EVIDENCE FROM SMALL BUSINESS AND HOME MORTGAGE LENDING, 1998-2016

by

Yichen Xu

A dissertation submitted to the Faculty of the University of Delaware in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Economics

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ABSTRACT

This paper studies the effect of bank branch closures on lending in the Digital Age. Previous studies found that bank branch closings have either no effect or small negative impact on small business lending especially in the low-to-moderate income (LMI) communities. However, decisions to close bank branches are not random and are likely related to local business conditions. As a solution to this endogeneity, and building on work by Nguyen (2018), I use mergers between two large banks with no less than $10B in pre-merger assets with overlapping branching networks as a source of exogenous variation. Using instrumental variable methods, I find that branch closures significantly reduce small business lending (22% reduction in total volume) even in areas with alternative local branches. The total volume of mortgage lending is unaffected. These findings contribute to the debate about the importance of relationship lending, suggesting that physical branches will continue to play an important role mitigating informational asymmetries inherently present in small business lending.

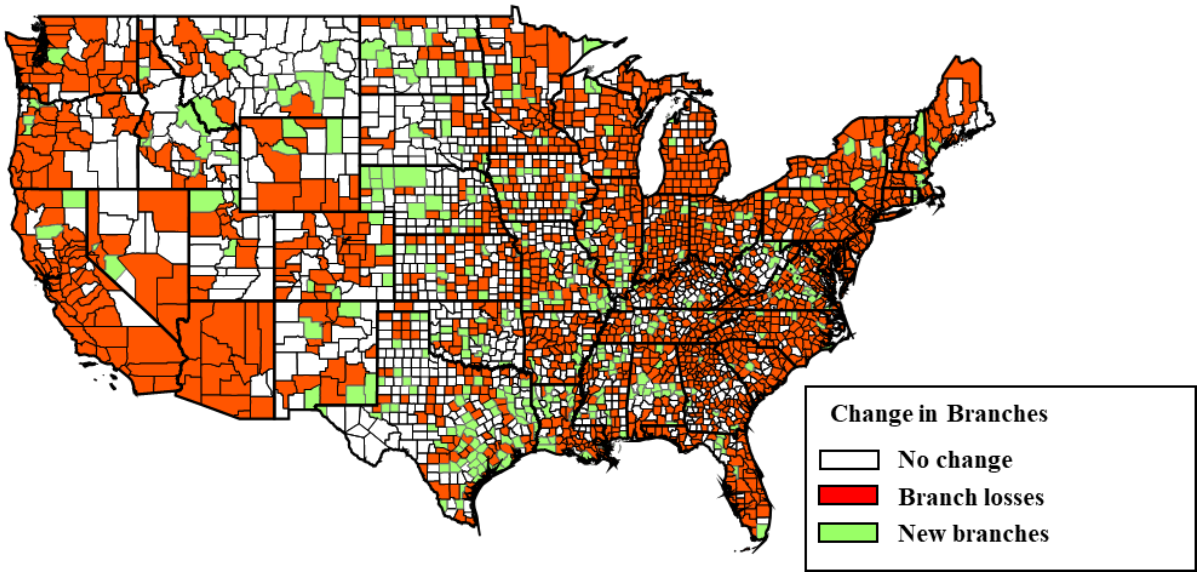
Chapter 1

INTRODUCTION

During the Great Recession, a massive loss in bank branches occurred (see Figure 1.1). According to the Federal Deposit Insurance Corporation (FDIC) Summary of Deposits (SOD), the total number of bank branches dropped by 7,689 from 2009 to 2016, which is approximately 8% of all 92,809 branches in 2008. A well developed banking network eases access to credit, which benefits the local economy by eliminating poverty and activating the labor market (Becker 2007; Peek and Rosengren 2000; Ashcraft 2005; Burgess and Pande 2005; Bruhn and Love 2014). However, the innovations in monitoring products, such as credit scoring, and the development of secondary markets eased lending from a distance (Berger 2003; Petersen and Rajan 2002). Although the traditional banking networks are still important in a banks credit allocation decisions (Gilje, Loutskina, and Strahan 2016), whether physical branches are necessary for local access to credit in the Digital Age remains unclear.

Previous studies propose two major functions for physical bank branches in local small business lending: (1) reducing informational asymmetries through relationship lending; and (2) providing geographic proximity between lenders and borrowers. The presence of physical bank branches smooths the informational friction between lenders and borrowers through relationship lending (Berger and Udell 2002; Hauswald and Marquez 2006; Petersen and Rajan 1994; Nguyen 2018; Stein 2002; Stiglitz and Weiss 1981; Ergungor 2010). By maintaining long term relationships with local firms, lenders who have offices in the neighborhoods are able to collect soft information from nearby small businesses and use the informational advantages in assessing borrower's creditworthiness and risk control (Petersen and Rajan 1994; DeYoung, Glennon, and Nigro 2008; Agarwal and Hauswald 2010). For borrowers, the visits to local branches

Figure 1.1: Branch Gain/Loss in U.S. Counties (2009-2016)



Source: FDIC SOD. "

provide them an opportunity of face-to-face interactions which are essential in building the trust between borrowers and their financial institutions. Geographic distance between lenders and borrowers, another possible obstacle to borrowing, raises costs of information collection for banks and increases the opportunity costs for borrowers to negotiate for the best offers (Brevoort and Wolken 2009).

Home mortgage lending is different from small business lending. It has more non-depository lenders, known as shadow banks, and a well developed securitization market. Most credit intermediaries lose the incentives to screen borrowers using soft information since they could easily resell their loans in the secondary market (Rajan, Seru, and Vig 2015; Keys, Mukherjee, Seru, and Vig 2010). After the financial crisis of 2007, traditional lenders tend to originate loans through their mortgage company subsidiaries to avoid heavy regulation(Demyanyk and Loutskina 2016). Although previous studies find that the physical presence of bank branches still matters in home mortgage lending (Ergungor 2010; Nguyen 2018), the mechanism behind it is not as clear.

Technology improvements change both markets in various ways. The wide use of hard information such as credit history reduces informational asymmetries and allows for long-distance small business lending (Petersen and Rajan 2002; Frame, Srinivasan, and Woosley 2001; Berger 2003). The rise of shadow banks and Fintech companies redefines the credit screening process in home mortgage lending market. These improvements in lending technologies raise the question of whether it is necessary for banks to keep brick-and-mortar offices.

To answer this question, I examine the massive closures of bank branches that took place in the past decade. While the literature provides many useful insights into the possible impact of changes in banking networks on local lending (Strahan and Weston 1996; Peek and Rosengren 1998; Berger, Saunders, Scalise, and Udell 1998; Brevoort and Wolken 2009; Ergungor 2010; Nguyen 2018), most of the studies focus on the effects of the shifts in the market structure of the banking sector or emphasize the importance of banking accessibility. This study addresses the changes of banking networks at branch level by examining the effect of the shuttering of physical branches. I find that the branch closures have a negative and prolonged effect on local small business and cause a change in market structure of home mortgage lending in the surrounding neighborhoods, even for the areas with sufficient number of alternative branches. This finding suggests that local branches still play an important role in local lending.

This paper extends the literature by examining the role of physical branches in the areas with sufficient alternative credit accessibilities. It indicates the importance of relationship lending in small business lending and suggests that the informational asymmetries exaggerate the costs of switching financial institutions for small business owners since the soft information stored in the previous borrower-lender relationships could not be properly translated into hard information which could be assessed by the potential alternative lenders. In the contrary, home mortgage lending is less hurt by branch closures. The local banks with closed branches easily maintain their market share by offering more loans through their mortgage company subsidiaries.

One major challenge in identifying the effect of branch closures on local lending is the endogeneity problem: banks tend to close branches in the areas with lower lending activities due to profitability concerns. To create an exogenous variation in branch closures, I follow Nguyen (2018) and use exposure to mergers between big banks as an instrument for branch closures.

The study starts with the reduced form analysis, which could be considered as a difference-in-differences model to study the effect of mergers on local lending. Since the mergers are between big banks, mergers are not likely to increase the complexity of bank's organization structures. The market competition is neither likely to be affected, as the study is conducted in the areas with sufficient lenders. Therefore, mergers affect local lending only through branch closures. The difference-in-differences estimator captures the reduced form relationship between branch closures and local lending.

Under the difference-in-difference specification, the difference-in-differences estimator is the comparison between the pre and post merger years as well as between the tracts exposed to merger-induced overlapping branches, which belong to both sides of the qualified mergers, and the tracts exposed to overlapping branches of other two big banks. In the following chapters, I refer to the former ones as merger-exposed tracts and the latter ones as control tracts.

I proceed with the instrumental variable approach by using exposure to "qualified" mergers, as an instrument for branch closures. Exposure to mergers could be considered as a valid instrument for branch closures when the following requirements are met: (1) mergers are not driven by local economic conditions and exposures to mergers are as good as randomly assigned; (2) eposure to mergers lead to branch closures; and (3) mergers do not have direct effect on local lending and affect local lending only through the losses of soft information in branch closures.

I expand Nguyen's work by defining the "qualified" mergers and the sample based on the geographic proximity instead of the arbitrary census boundary. This modification is to better fit the area of study, urban tracts. As the study focuses on the neighborhoods with sufficient access to banking locally, not surprisingly, most of

these neighborhoods are located in urban areas. Unlike other geographic concepts that are defined based on spatial sizes, the unit of this study, Census Tract, is the county subdivision area defined by the population size. The spatial dimension of tracts varies by the density of inhabitants. In urban areas where the population density is high, Census Tracts are often smaller than a half square mile. In these small areas, borrowers are not likely to limit their branch choices by the arbitrary tract boundaries.

Moreover, as shown in Figure 3.3, big banks tend to allocate their branches along the borders of tracts, such that the merger-induced overlapping branches, like the circled pair in the figure, are often belong to two different tracts. Therefore, I refer to the overlapping branches as the pairs of branches with geographic distance below one mile, regardless of their official census tract designation. Similarly, I define the sample based on the geographic proximity between tracts and the merger-induced overlapping branches or the overlapping branches of other big banks. Under this specifications, mergers are still independent from local characteristics and related to post-merger branch closures.

This study shows that branch closures have negative and persistent effects on small business even in the areas with sufficient number of alternative branches after merger. With exposure to branch closures, the total volume of small business originations declines by around 22% and the drop is persistent. It suggests that in the Digital Age small business lending still benefits from local relationship lending. More specifically, the hard information provided by the development of lending technology has not fully captured the borrower-related soft information collected through long term lender-borrower relationships for small business lending.

These results provide several implications for the innovation of credit scoring methods and the financial regulations. While the redlining and banking deserts issues have drawn attention from the policymakers, the branch closures in areas with sufficient access to credit are often overlooked. Branch closures break lending relationships and create difficulties in the storage and transmission of the soft information which are critical in assessing small business borrowers' creditworthiness. The losses in soft

information is hard to recover.

For home mortgage lending, the effect of branch closures is much smaller and not significant. The merging depository mortgage lenders easily maintain their market shares by originate more loans through their mortgage company subsidiaries after their local branches closed. While mortgage companies are much less regulated than the depository institutions, whether price of the credit changes is worth noting.

The paper proceeds as follows. I begin with discussing previous literature in Section 2. In Section 3, I provide the details on the identification strategy. Section 4 lists data and variable definitions. Section 5 discusses the validity of the instrument. Section 6 presents the results, and Section 7 concludes the paper.

Chapter 2

LITERATURE REVIEW

The importance of access to credit in economic outcomes is well documented by previous studies. Burgess and Pande's study shows that providing access to credit to the unbanked in rural India reduces poverty and promote local economic activities (Burgess and Pande 2005). They find that the state-led rural branch expansion increases saving and credit supply in rural areas. Therefore, rural households are able to accumulate capital and access loans for future investment. As a result, poverty is significantly reduced. Bruhn and Love(2014) provide similar evidences from a natural experiment in Mexico (Bruhn and Love 2014). They examine the business expansion of a commercial bank whose major clients are low-income households and small business owners. Their results suggest that increasing access to credit benefits local labor markets by helping small business owners stay in business and therefore contributes to poverty alleviation. Similar results are found in US market (Gilje 2012). Gilje(2012) shows that local economic outcomes are promoted by a positive local credit supply shock when the area is dominated by small, relationship-lending banks. The lack of ability to redeploy capital to other geographic areas requires small banks to allocate the extra credit supply locally. Hence, households living in the areas with existing access to these small banks receive more lending and the economic outcomes in these areas are improved.

Two of the major forms of credit supply are small business and home mortgage lending. Previous studies show that small business lending heavily relies on the lender-borrower relationships in reducing informational asymmetries by collecting soft information (Petersen and Rajan 1994; Petersen and Rajan 2002; Stiglitz and Weiss 1981). Petersen and Rajan (1994) show that lenders are able to collect information

from small businesses over time. This asymmetric information gives advantages to local lenders relative to remote lenders since local lenders have better monitoring of the local businesses. However, improvement in technology eases distant lending and leaves local lenders less advantages (Petersen and Rajan 2002).

Extensive studies have been conducted on how branching networks promote small business lending. One of the prevailing explanations is that the geographic proximity between borrowers and lenders eases soft information collection - the key to relationship lending (DeYoung, Glennon, and Nigro 2008; Agarwal and Hauswald 2010; Hauswald and Marquez 2006). Hauswald and Marquez (2006) quantify the relationship between the lender-borrower distance and small business lending. Their study shows that the increase in lender-borrower distance will weaken the quality of banks proprietary information. Therefore, distance borrowers receive higher interest rates due to their less close relationship with the lenders. De Young, Glennon, and Nigro (2008) provide evidence that collecting soft information helps lenders to control risk. Agarwal, Sumit and Hauswald (2010) find similar results: distance is associated with future success of the loan. Their results suggest that local banks use private information advantages to create adverse-selection threat to competitors on high quality, lower risk lenders. Distance between lenders and borrowers increases borrower's burden of negotiating for the best offer (Brevoort and Wolken 2009; Sussman and Zeira 1995)

The closures of bank branches and the changes in bank structures can break these lender-borrower relationships and hurt small business lending. Berger and Udell (2002) study the process of relationship lending and how it varies by bank's organizational structure. Their research shows that relationship lending smooths small business loaning by collecting soft information about the firm, its owner and local community. The soft information, mostly stored with the loan officer, is difficult to quantify and share with the banks senior management. In addition, the difficulties in transmitting the soft information are more severe in large banks with multi-level management structure. They also discover that bank mergers and acquisitions add more complexities to the organizational structure when large banks are involved. Hence, the increased

difficulties in transmitting soft information will prevent the consolidating banks from making relationship loans. As a result, small business lending are cut dramatically after the business combination (Berger and Udell 2002). Stein (2002) finds similar results: it is more difficult for larger banks to transmit soft information credibly. Therefore, post-merger branch closures usually result in losses of soft information and lead to drops in small business lending.

Unlike small business lending, the relationship between branching networks and home mortgage lending is less-researched. A major difference between home mortgage and small business lending is that the lenders of home mortgage loans are more diversified and act differently from small business lenders. Unlike small business lenders, many home mortgage loans are originated by non-depository lenders such as mortgage companies. Moreover, home mortgage lenders tend to sell their loans on the secondary markets rather than hold them (Rajan, Seru, and Vig 2015; Loutskina and Strahan 2011). Therefore, home mortgage lenders, especially non-depository lenders, show less incentives in carefully screening borrowers. Additionally, traditional banks and shadow banks face different levels of regulations (Demyanyk and Loutskina 2016). Seeking less heavy regulations, traditional banks set up mortgage company subsidiaries and originate loans through them.

However, some studies still find the importance of local branching networks in home mortgage lending. Physical presence of local branches allows face-to-face interactions between borrowers and lenders which fosters the building of trust even after the rise of Fintech companies (Merton and Thakor 2002). For lower income borrowers and borrowers with thinner credit profiles, access to physical branches allows them to borrow more easily (Ergungor 2010; Nguyen 2018). More generally, Gilje, Loutskina and Strahan (2016) show that banks with extra liquidity inflows tend to increase their mortgage lending in the areas where the banks have branching networks. It indicates that the development of secondary markets and lending technology did not fully eliminate informational frictions in mortgage lending. Local branching networks still plays an important role.

The effect of branch closures is difficult to identify due to the reciprocal relationship between branch closures and local lending. Nguyen(2018) uses post-merger consolidations as an instrument for branch closures. She assumes that mergers between two big banks are not caused by changes in local economic conditions or in local lending profitabilities. In addition, these mergers are likely lead to more closures of the overlapping branches from different sides of the merger that are located in the same census tract.

I follow Nguyen and instrument branch closures with mergers. Different from Nguyen's specification, I define the core concepts based solely on geographic proximity rather than arbitrary geographic boundaries since the sampled areas are mainly urban tracts with small spacial sizes. I compare the differences of the identification strategies in greater details in Chapter 3.

Nguyen defines all branches that are located in the same census tract as overlapping branches, regardless of the distance between these branches. This specification overlooks the situations when adjacent branches are located in different tracts. The unit of this study, Census Tract, is defined base on the population size instead of spatial dimension. The spatial size of tracts varies by the density of inhabitants. In urban tracts where the population density is high and the spatial size of the tracts is small, it is very likely for two adjacent branches to be split into two tracts. Moreover, Figure 3.3 shows that some big banks allocate their branches along the borders of tracts. It suggest that the cross-tract overlapping branches are common. Therefore, I consider overlapping branches as the branches that are no more than one mile from each other, including the cross-tract ones. The close distance between overlapping branches provide enough incentive for banks to cut a redundant branch.

Nguyen's definition for exposure to mergers is also based on the arbitrary tract boundary. She considers the exposed tracts as the ones where the overlapping branches are located. However, as mentioned above, the sampled areas are the small-size urban tracts. It is not likely that borrowers limit their branch choices by the arbitrary tract boundaries and ignore the nearby alternatives. Therefore, I consider all tracts that

are within in a distance from the overlapping branches as merger-exposed tracts. This modification takes the areas with geographic proximity to the overlapping branches into consideration. Under these modifications, mergers are still independent from local characteristics and related to post-merger branch closures.

Chapter 3

IDENTIFICATION STRATEGY

In this chapter, I outline the the identification strategy to examine the effect of branch closures on local lending. I begin with a baseline specification. I then describe the potential problems with this specification since branch closures are potentially endogenous. To address the endogeneity issue, I propose an exogenous variation in branching networks stemming from overlapping branches of merged banks.

3.1 Baseline Model and Potential Endogeneity

To observe the relationship between branch closures and local lending, I begin with the following baseline model:

$$Y_{it} = \alpha_i + \gamma_t + \beta Close_{it} + X'_{it}\delta + \epsilon_{it} \tag{3.1}$$

where Y_{it} is the outcome variable in tract i and year t - the total number or volume of home mortgages or small business loan originations; $Close_{it}$ is the number of total branch closures in tract i and year t; X_{it} controls for the tract level demographic and economic characteristics; and α_i and γ_t are the tract and year fixed effects.

One of the major challenges of this study is that banks tend to close more branches in the neighborhoods where fewer loans are originated. That is to say, the baseline model violates the exogeneity assumption and the point estimates are biased.

3.2 Mergers as An Instrument for Branch Closures

To correct the bias, I use exposure to mergers between big banks to introduce an exogenous variation in local branching networks and examine the effects of the post-merger branch closures on local lending. This study extends Nguyen (2018)'s work by

improving the design of the experiment to better fit the study of areas with sufficient branches.

I use exposure to mergers between two big banks that are quasi-randomly occurred and relevant as a plausible quasi-random experiment. I assume that exposure to mergers are exogenous: mergers between big banks are not driven by local economic conditions, and are assigned to the exposed neighborhoods instead of the control ones quasi-randomly. In addition, exposures to mergers lead to more branch closures in the surrounding neighborhoods.

In this study, I limit mergers to the ones between big banks and exclude the ones that are related to bank failures, so that local economic conditions are the cause for merger. The exposed group of each merger is defined as the tracts that are exposed to overlapping branches from both sides the merging banks, while the control tracts are exposed to overlapping branches from other two big banks. To create a homogeneous sample, the control group is selected from the remaining tracts in the same county as the merger-exposed tracts. Therefore, the merger-exposed and control tracts are similar in absence of the merger while the merger-exposed ones face higher risks of branch closures due to the merger. As a result, exposures to mergers could be considered as a quasi-random experiment.

The study is conducted using an instrumental variable approach by considering the quasi-random experiment, exposures to mergers, as an instrument for post-merger branch closures. In the following parts of this chapter, I discuss the qualified mergers, the sample selection process and the details of the model specifications.

3.2.1 Qualified Mergers

3.2.1.1 Exogeneity Condition

Not all mergers are exogenous from local economic conditions: banks merge to expand business to new markets, to extend business functions, or to save cost (Kowalik, Davig, Morris, and Regehr 2015). However, by setting restrictions on the mergers and the sample, I limit mergers to the ones that are not driven by local conditions.

Specifically, following Nguyen (2018), I limit mergers to the ones that occur between two big banks with more than $10 billion assets in the pre-merger year. In addition to Nguyen (2018), I require the mergers to be proceeded without financial assistance from the FDIC. These two restrictions limit the mergers to the exogenous ones that are not driven by local economic conditions. Unlike flood or earthquake, mergers do not randomly occur. However, for the mergers between two big banks who have branching networks nationwide, local economic conditions of a small geographic area, such as census tract, should not be the major motivation.

Mergers caused by bank failures are another type of mergers that could be related to local economic conditions. To avoid this possibility, I exclude the mergers with financial assistance from the FDIC since these mergers are usually related to bank failures or unsuccessful business operations in one or more local areas. I leave mergers that occurred during the Great Recession in the sample as long as they did not require the FDIC assistance. Different from other bank failures, the crisis mergers are not the results of the economic conditions in one location, but take place because of the national downward trend. As a robustness test, I re-examine the effects using the subsample of mergers that occur before the Great Recession and find similar results. The robustness test is presented in the Appendix A. Results for post-recession subsample is in Appendix A.

3.2.1.2 Relevancy Condition

Post-merger branch closures are not necessary in all merger-exposed areas. However, when the merged banks have overlapping branching networks, the post-merger consolidations often lead to the shuttering of branches. Therefore, I limit the merger-exposed areas to the ones where both sides have overlapping branching networks.

Consequently, the mergers should meet the following requirements: (1) are between two big banks that have more than $10 billion assets in the year before merger; (2) are proceed without financial assistance from the FDIC; and (3)are between the

acquiring and outgoing banks that have overlapping branching networks prior to the merger. I will discuss the mergers in Chapter 5.

For each qualified merger, the comparison is between the merger-exposed tracts and control tracts. In order to consider exposure to mergers as a quasi-random experiment, the sampled tracts should be homogeneous. That is to say, the control tracts are no different from the merger-exposed tracts in the absence of the merger. I define the merger-exposed tracts as the ones that are exposed to any pair of overlapping branches from both sides of a qualified merger before the merger occurs. After mergers occur, the adjacent offices from both sides of the merger turn redundant due to their geographic proximity and face higher risks of closure. The survived banks still have the options to choose the branches to close. However, the decision does not affect the exogeneity of the mergers. The geographic proximity of the overlapping branches also leaves very little difference between the closures of either branch.

To select a comparable control group, I consider the tracts that: (1) are located in the same county with the merger-exposed tracts; (2) are exposed to overlapping branches from two big banks. Therefore, the only difference between the merger-exposed and control tracts is the occurrence of mergers, which increases the chance of branch closures in the merger-exposed tracts.

3.2.2 Geographic Concepts: Definitions and Examples

Another core specification of this study lies in the definition of geographic proximity. Both the selection of overlapping branches and the sample are based on this concept. I define the geographic proximity based on the geographic distances rather than the arbitrary census boundaries.

Existing literature, such as Nguyen (2018), define overlapping branches as the pairs of branches that are located in the same Census Tract, regardless of the distance between these branches. This specification overlooks the situations when adjacent branches are located in different tracts. The unit of this study, Census Tract, is defined base on the population size instead of spatial dimension. Census Tracts are chosen as

the units of observation in this study since they are the smallest possible geographic concepts to study on - the local lending information is aggregated at tract level. Census Tracts are small county subdivision areas defined based on the population size, while the spatial dimension varies with the density of inhabitants. In urban tracts where the population density is high and the spatial size of the tracts is small, it is very likely for two adjacent branches to be split into two tracts. As summarized in Table 5.1, most tracts in this sample are located in the areas with high population density. Therefore, the geographic sizes of these census tracts are very small and are usually less than one square mile.

Moreover, Figure 3.3 shows that some big banks allocate their branches along the borders of tracts. It suggests that the cross-tract overlapping branches are common. Therefore, I define "overlapping" as a pair of branches that are within one mile of each other, regardless of whether they are located in the same Census Tracts. The close distance between overlapping branches provide enough incentive for banks to cut a redundant branch.

Nguyen's definition for exposure to mergers is also based on the arbitrary tract boundary. She considers the exposed tracts as the ones where the overlapping branches are located. However, as mentioned above, the sampled areas are the small-size urban tracts. It is not likely that borrowers limit their branch choices by the arbitrary tract boundaries and ignore the nearby alternatives.

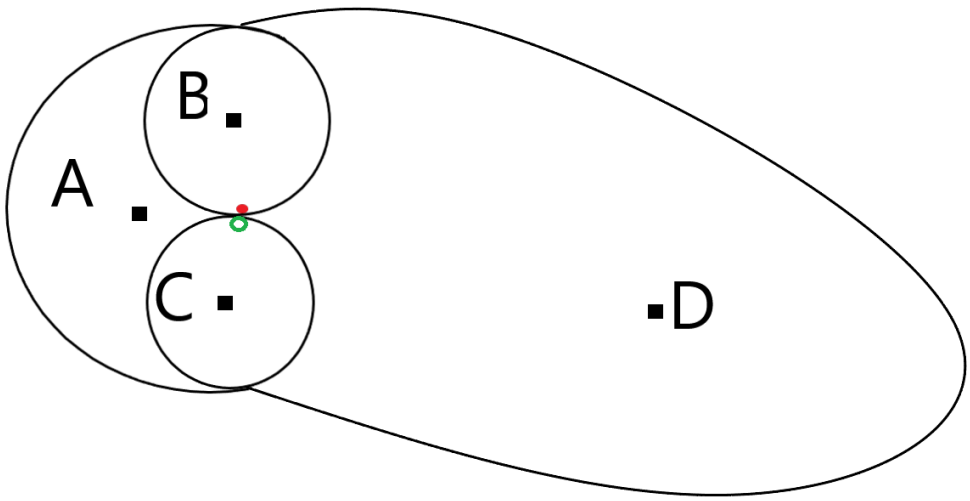
Therefore, I consider all tracts that are within in a distance from the overlapping branches as merger-exposed tracts. The selection of merger-exposed tracts is also based on geographic proximity. I define the merger-exposed group as the tracts(1) whose geographic center is within one mile from either one of the merger-induced overlapping branches; or (2) whose geographic center is within one mile from the geographic mid-point of the overlapping pair of merging branches; or (3) where either branch of the merger-induced overlapping branches is located. In other words, merger-exposed tracts are the nearby areas of the merger-induced overlapping branches.

This modification takes the areas that do not have overlapping branches within

the boundaries but with geographic proximity to the overlapping branches but into consideration. These modifications accommodate the study of urban tracts in a more realistic manner. Under these modifications, mergers are still independent from local characteristics and related to post-merger branch closures.

Figure 3.1 shows an example of how exposed tracts are selected. Suppose A, B, C and D are four neighboring tracts. The dot and circle represent a pair of cross-tract overlapping branches from both sides of a merger. All black squares represent the centroids of tracts. The centroid of tract A is within one mile from the dot and the centroid of tract D is more than one mile from the dot, the circle, and their midpoint. Thus, Tract A, B, C are exposed tracts. Tract B and C are exposed tracts since they are where one of the overlapping branches located. Based on the rules, tract A is an exposed tract and tract D is not, as its centroid is too far away from the overlapping branches and neither branch is located in it.

Figure 3.1: Example: Merger-exposed Tracts



Note: The map shows the rules of selecting merger-exposed tracts. The dot and circle represent a pair of cross-tract overlapping branches from both sides of a merger. All black squares represent the centroids of tracts. The centroid of tract A is within one mile from the dot and the centroid of tract D is more than one mile from the dot, the circle, and their midpoint. Tract A, B, C are exposed tracts.

As the study requires a homogeneous sample, I choose control groups that are similar to the exposed ones. I define the control groups as the tracts that are exposed to at least one pair of overlapping branches from other two big banks in the pre-merger year. As a result, control group is the nearby areas of the overlapping branches from two non-merging big banks.

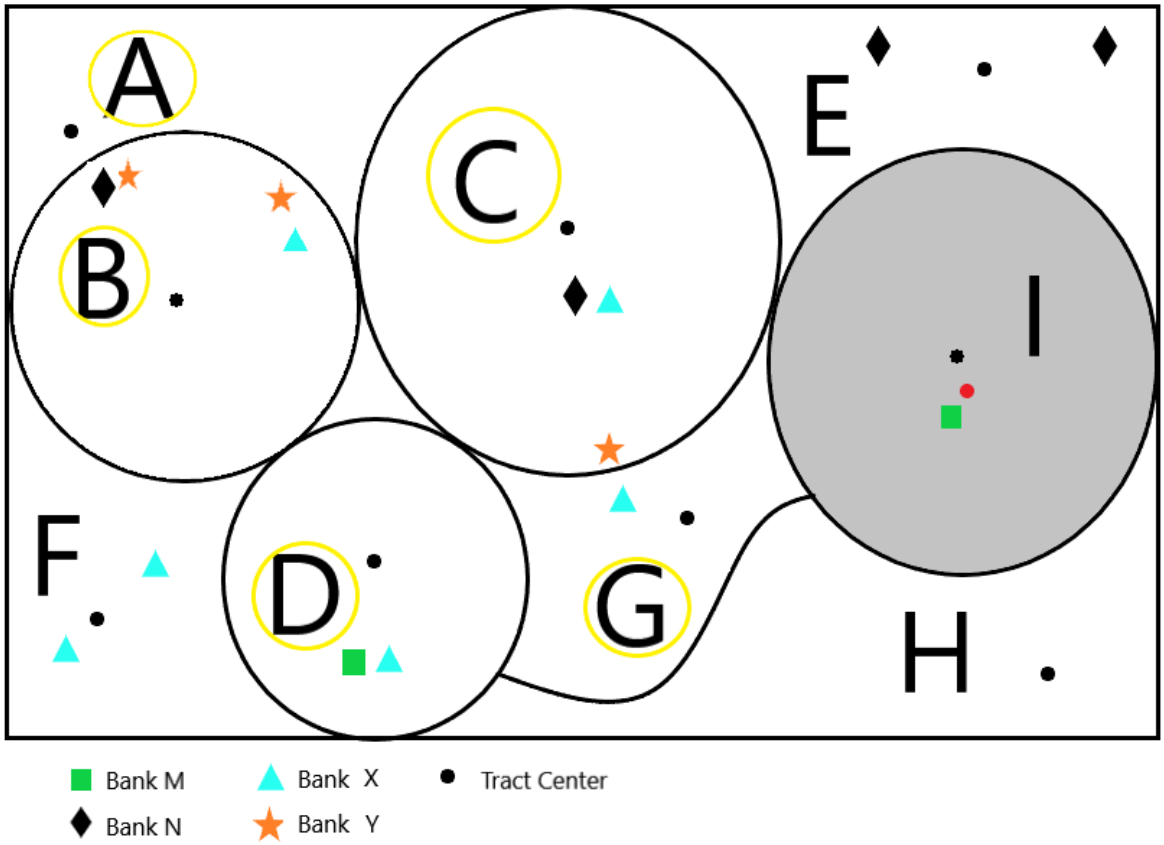
Similar to the exposed tracts, the control group is defined as the tracts(1) whose geographic center is within one mile from either one of the overlapping branches that belong to two non-merging big banks; or (2) whose geographic center is within one mile from the geographic mid-point of the overlapping branches; or (3) where either branch of the overlapping branches is located. Moreover, the control tracts of each merger are located in the same county as the exposed tracts.

Figure 3.2 shows an example of how control tracts are selected. A county has four big banks with more than $10 Billion pre-merger assets, M, N, X and Y, and nine tracts, A through I. Suppose bank M and N are the merging banks: Tract I is an exposed tract since it has a pair of overlapping branches of the merging banks M and N within its boundary. The control tracts could be any of the remaining tracts in the same county that are exposed to one or more pairs of non-merging overlapping branches which belong to M and X, M and Y, N and X, N and Y, or X and Y. In this example, Tract A, B, C, D and G are all control tracts since they satisfy the above restrictions.[1] Tract E, F,and H are excluded from the sample since they are neither exposed nor control tracts. [2]

[1] Tract B, C and D have both sides of the non-merging overlapping branches located within their boundary; Tract G has one branch of the overlapping branches within the boundary; and the centroid of Tract A is within one mile of a pair of non-merging overlapping branches.

[2] Tract E is exposed to branches from Bank N but no other branches from big bank; Tract F is exposed to branches from Bank M but no other branches from big banks; Tract H is not exposed neither has any branches from big banks.

Figure 3.2: Example: Control Tracts



Note: The map shows the rules of selecting control tracts in a county: The county has four big banks with more than $10 Billion pre-merger assets, M, N, X and Y, and nine tracts, A through I. Suppose bank M and N are the merging banks: Tract I is an exposed tract; Tract A, B, C, D and G are control tracts; and Tract E, F,and H are neither.

To apply the rules in a real world example, I present an example using Fulton County, GA and the merger between SunTrust Bank and National Bank of Commerce. Figure 3.3 shows all exposed and control tracts in this county. Both possible situations of the merger-induced overlapping branches are included: the circled area is a cross tract example; and the pair of branches in the square illustrates an example when the overlapping branches are located in the same tract. Three tracts are exposed to the circled overlapping branches: Two of them are the tracts where one of the branches are located; the other one has its centroid within one mile from the overlapping branches. One tract is exposed to the overlapping branches in the square-it is where both branches are located.

As illustrated above, the merger-exposed and control tracts should be similar to each other in absence of the merger: both are exposed to overlapping branches of two big banks and are from the same county. I describe the sample and present the results in Chapter 6.

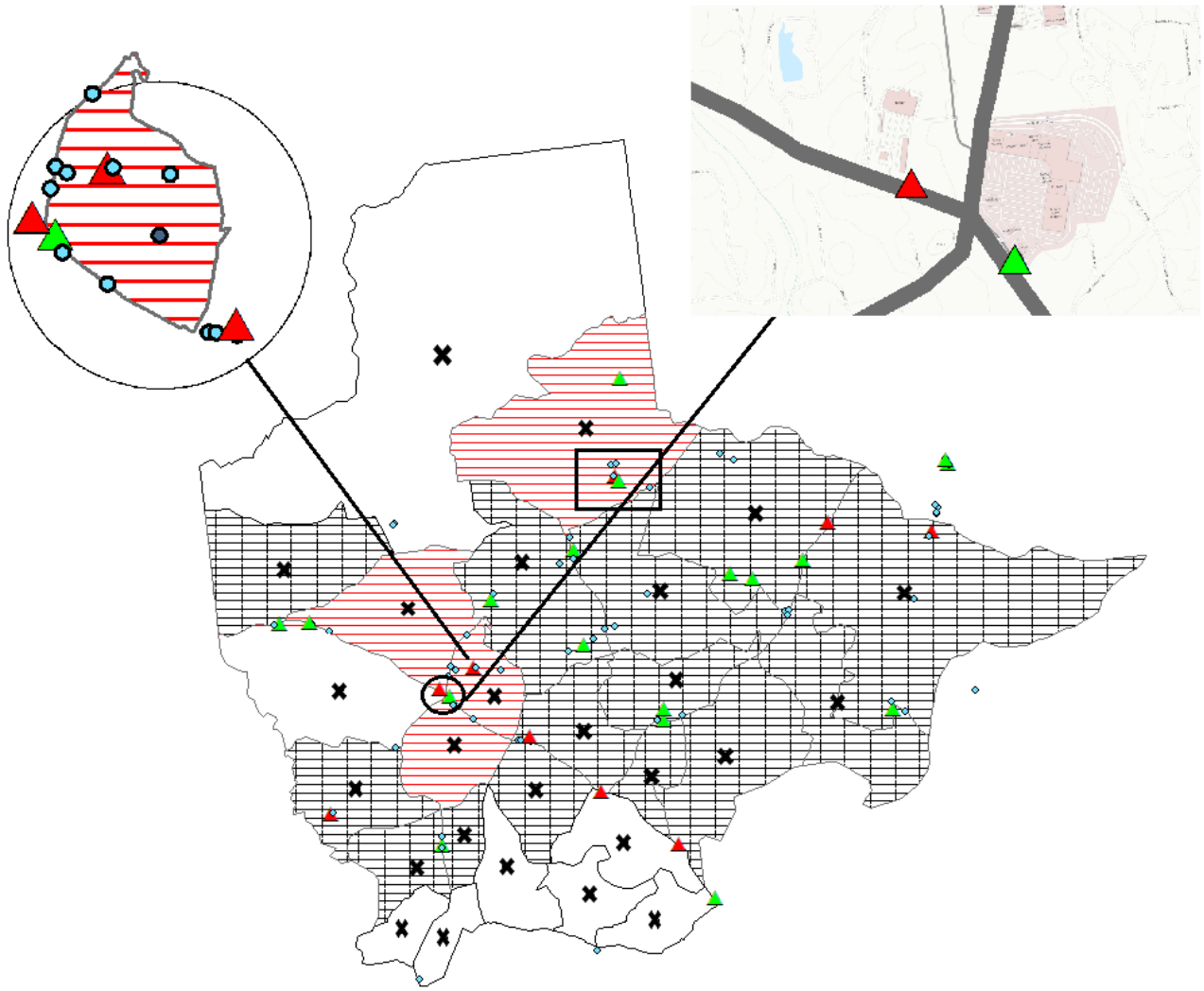
3.2.3 Empirical Strategy

Under the above specification, qualified mergers could be considered as a quasi-random experiment that causes more branch closures in the exposed tracts. As discussed above, this quasi-random experiment serves as a valid instrument for branch closures: exposures to mergers are exogenous from local economic conditions, relevant to branch closures and affect lending only through branch closures. To examine the effect of merger-induced branch closures on local lending, I conduct the study under a instrumental variable approach. The structural model of the study turns to:

$$Y_{it} = \alpha_i + \gamma_t + \beta Close_i \times Post_{it} + X'_{it}\delta_t + \epsilon_{it} \tag{3.2}$$

where the observation of analysis varies by Census Tract i and year t; Y_{it}, X_{it} controls for the tract level demographic and economic characteristics; and α_i and γ_t are the tract and year fixed effects; $Close_i$ is the indicator variable for the merger-induced branch closures, $Close_i = 1$ if any branch closed in tract i during the three years after

Figure 3.3: Example: Merger-exposed and Control Tracts - Fulton County, GA (2004)



Source: FDIC and Census. The map shows an example of merger-exposed and control tracts for the merger between SunTrust Bank and National Bank of Commerce using part of the tracts in Fulton County, GA. The zoomed map is for the circled overlapping branches, showing that the two branches are separated into difference tracts.

the merger, otherwise, 0; for home mortgage lending, $Post_{it} = 1$ if year t is within six years of the merger which tract i is exposed to, otherwise, 0; for small business lending, $Post_{it} = 1$ if year t is after the merger for tract i, otherwise, 0.

I consider merger-induced branch closures are the ones that take place within three years following the merger. The following section shows that the exposed tracts and control tracts face different chances of branch closures only in these three years. For small business lending, I consider the average effect of branch closures in all years after the merger since the even study shows that branch closures have a persistent effect on small business lending. For home mortgage lending, I capture the average effect of branch closures in the six years following the merger, as the event study plots suggest that branch closures only have effects on home mortgage lending up to six years after the merger.

Considering exposures to mergers as an instrument for post-merger branch closures, I use $Expose_i \times Post_{it}$ as an instrument for $Close_i \times Post_{it}$ and estimate the regression, where $Expose_i$ is an indicator for merger-exposed tracts; $Expose_i = 1$ if tract i has ever been exposed to the merger, otherwise, 0. The effect of merger-induced branch closures on local lending is captured by the point estimate of β.

Chapter 4

DATA

In this section, I explain the data structure of this study, describe the sample and define the key variables. This study analyzes changes in banking networks and local lending in a 18-year period ranging from 1998 to 2016. The unit of observation is Census Tract at the annual frequency. Across all tracts in the sample, 5,768 tracts fall in the merger-exposed group while 16,351 are control tracts.[1] Thus, the total sample has 22,119 Census Tracts located in 271 counties.

To analyze the role of bank branching networks on local lending, the panel includes four parts: Bank merger data, bank branch location data, local lending data and other tract level variables. In the following parts of this chapter, I discuss the sources, features, and the calculation of these variables.

4.1 Bank Mergers

Among all 3,936 mergers processed between 2002 and 2012, I focus on 24 qualified ones, that: (1) occur between two big banks that have more than $10 billion assets in the pre-merger year; (2) proceed without financial assistance from the FDIC; and (3) have overlapping branches from both banks of the merger.

Bank merger data are from the Reports of Structure Changes by Federal Deposit Insurance Corporation (FDIC). The reports document all mergers and acquisitions between banks that occurred from 1999 to 2018. I only study the mergers processed between 2002 and 2012 due to data limitation: post merger data on lending and branching networks are not available beyond 2016. As required by the above restriction, I drop all mergers that are proceeded with financial assistance from the FDIC.

[1] Appendix B provides the maps of all tracts in the sample.

I combine the pre-merger bank assets data from the Call Report by FFIEC with the merger list. Following the regulators' definition, I use $10 billion as the asset threshold for big banks for both sides of the merger.[2]

4.1.1 Mergers List

I begin with the complete merger list and then describe the summary statistics of the acquiring and outgoing banks. Table 4.1 contains the complete list of all qualified mergers and acquisitions that took place between 2002 and 2012. This list includes twenty-four qualified mergers out of all $3,936$ mergers and acquisitions that proceeded between 2002 and 2012.

[2] Consumer Financial Protection Bureau(CFPB) releases the list of depository institutions subject to their supervisory authority. They states that "We have supervisory authority over banks, thrifts, and credit unions with assets over $10 billion, as well as their affiliates."

Table 4.1: Qualified Merger List

Year*	Acquiring Institution	Outgoing Institution
2002	Bank of the West	United California Bank
2002	Firstar Bank	U.S. Bank National Association
2002	Citibank	European American Bank
2002	Michigan National Bank	Standard Federal Bank
2002	First Union National Bank	Wachovia Bank
2003	Manufacturers & Traders Trust Co.	Allfirst Bank
2003	Bank One	Amer. Nat. B&T Co. of Chicago
2005	SunTrust Bank	National Bank of Commerce
2005	Bank of America	Fleet National Bank
2005	National City Bank	The Provident Bank
2005	Regions Bank	Union Planters Bank
2005	North Fork Bank	Greenpoint Bank
2005	Chase Manhattan Bank	Bank One
2005	Wachovia Bank	SouthTrust Bank
2006	TD Bank	Hudson United Bank
2008	Bank of America	United States Trust Company
2008	The Huntington National Bank	Sky Bank
2008	TD Bank	Commerce Bank
2010	Wells Fargo Bank	Wachovia Bank
2010	Capital One	Chevy Chase Bank
2010	PNC Bank	National City Bank
2011	TD Bank	Carolina First Bank
2012	PNC Bank	RBC Bank (USA)
2012	Harris National Association	M&I Marshall & Ilsley Bank

Source: FDIC. This table lists the qualified mergers and their effective year. See Section 4 for details about the qualifications. *Year indicates the effective year of the merger.

Table 4.2 summarizes the pre-merger characteristics of the acquiring and the outgoing banks for the listed mergers. As shown in Panel A, banks from both sides of the merger have more than $10 billion assets before the business combination. The median asset size of the acquiring banks is 132 billion dollars, while the median outgoing bank holds an asset size of 32 billion dollars.[3]

Panel B examines the coverage of branching networks for the merging banks in the sample by summarizing the number of counties served. The median acquiring banks serve 185 counties and cover 10 US states, while the outgoing banks have branches in 105 counties acroaa 10 states. As expected, both sides of the mergers run businesses nationwide. The selected mergers are between big banks with widely spread networks of branches. Therefore, these mergers are less likely to be driven by local economics conditions or business expansion to one particular area.

[3] All values are measured in 2010 US dollar.

Table 4.2: Summary Statistics of Qualified Mergers

	Acquiring Institution	Outgoing Institution
	Panel A. Pre-Merger Assets (Billion 2015 Dollars)	
Median	132	32
Min	17	11
Max	1,620	626
	Panel B. Pre-Merger Total Number of Branched Counties	
Median	185	105
Min	12	7
Max	694	443
	Panel C. Pre-Merger Total Number of Branched States	
Median	10	10
Min	2	2
Max	31	45
	Panel D. Pre-Merger Total Number of Branches	
Median	1,331	543
Min	171	20
Max	5,710	3,206
	Panel E. Pre-Merger Total Number of Overlapping States	
Median	3.5	
Min	1	
Max	12	
Obs.	24	24

Source: FDIC. This table provides the summary statistics of the acquiring banks and the outgoing banks for the qualified mergers. See Section 3 for details about the qualifications.

4.2 Branching Networks

I use branch location data in defining overlapping branches as well as in selecting merger-exposed tracts and control tracts. The summary statistics of local branching networks, including the total number of bank branches, is calculated by combining branch location data and Census geographic boundaries.

Bank branch location data are from the Summary of Deposits (SOD) by FDIC. In the Summary of Deposits, FDIC provides the physical addresses of all branches. Therefore, to count the number of bank branches, I geocode all addresses and map the imputed coordinates into the Census Tract boundaries. I use the ArcGIS software and TAMU Geoservices for the geocoding process and the Tract level boundary files from IPUMS National Historical Geographic Information System for mapping. The accuracy of geocoding is summarized in Appendix C. Some of the branches are dropped from the sample during this process due to their incomplete addresses on the FDIC profile. For most years, less than 5% of branches are unmapped.

The selection of overlapping branches uses geographic coordinates of each branch derived from branch location data. The distances between bank branches and between branches and tract centers are calculated using the Haversine fomular.

Haversine formula calculates the great-circle distance, the shortest distance over the earths surface between two points as follows:

$a = sin((\phi_1 - \phi_2)/2) + cos(\phi 1) \times cos(\phi 2) \times sin^2((\lambda_1 - \lambda_2)/2)$;

$c = 2 \times arctan^2(\sqrt{a}, \sqrt{1a})$;

$distance = R \times c$;

where ϕ_1, ϕ_2 are latitudes, λ_1, λ_2 are longitudes, R is the earth's radius (mean radius = 6,371km), distance is the calculated distance between the two points.

Branch closures related information is obtained from FDIC Reports of Structure Changes. Similar to branch location data, I geocode and map all the documented addresses of closed branches to calculate the summary statistics. Appendix C summarizes the total number of annual branch closures.

4.3 Loan Originations and Lender Identification

To measure local lending activities, I use the small business lending data reported under the Community Reinvestment Act (CRA) and mortgage application data reported under the Home Mortgage Disclosure Act (HMDA). HMDA data record the loan related activities at application level, including detailed information on the lender and borrower, geographic location of the related property/business (the Census Tract of the business or property), and other loan related characteristics. In order to identify the types of mortgage lenders, I combine the HMDA reporter panel with the "HMDA lender file" which is created by Robert Avery from Federal Housing Finance Agency(FHFA).

Unlike HMDA, the publicly available CRA data are aggregated at Census Tract by year level. I am not able to separate the merging banks from other CRA lenders since the data have no lender information at tract level. Therefore, I could not perform a by lender analysis as for home mortgage lending. Both CRA and HMDA report the year of loan applications. All lending data are aggregated at Census Tract by year level.

Not all lenders are subject to HMDA and CRA reporting requirements. On average, HMDA captures about 80% of the total loan volume in the home loan market (Fishbein and Essene 2011). For loan applications that are first-lien home-purchase and refinance loans for one-to-four family dwellings, HMDA covers approximately 90 percent of all loans reported in consumer credit files (Bhutta, Laufer, and Ringo 2017).

Small business loans are mostly made by large banks or thrifts. In 2016, FDIC reports that 97 percent of small business loans (by $ volume) are made by banks and thrifts with assets of more than $1 billion. CRA reporters originate 71 percent of all small business loans outstanding (by $ volume).[4] CRA lenders, large depository institutions, account for more than 70 percent of the existing small business loans (by $ volume). As the coverage percentages are fairly stable across years, I use the loan

[4] Source: FDIC. link

originations reported to CRA and HMDA to gauge local lending activities.

For the measurements of local loan activities, I include the total number and volume of loan originations for small business and home mortgage lending. All lending related variables are aggregated at tract level. For home mortgage lending, I focus on the loans originated for home purchases on the owner-occupied one-to-four unit family dwellings. This requires both geographic and lender information to be valid. I drop about 0.1 percent of application records with missing lender or location inputs.[5] For small business lending, I study all the loans originated to small businesses.

4.4 Other Tract Level Variables

The unit of observation, Census Tracts, are defined based on the population size in a county subdivision area, while the spatial dimension of them varies with the density of inhabitants. The boundaries of Census Tracts remain stable with occasional changes only as substantial changes in population occur. I use the Census Tract level boundary files from IPUMS National Historical Geographic Information System in mapping and distance calculation. In addition, I use Census TIGER/Line maps for Census block group level boundary files. Both files are based on the U.S. decennial Census 1990, 2000, and 2010.

Most tract level demographic data are from the U.S. decennial Census 1990, 2000 and 2010. They are relatively stable across years. I convert all tract level data into Census 2000 tract equivalents using the relationship files provided by Census.

Local economic characteristics variables are updated annually: median family income information are from FFIEC Median Family Income (MFI) Report; unemployment rate data are from the Local Area Unemployment Statistics (LAUS) by the Bureau of Labor Statistics (BLS); and housing price index(HPI) data are from Federal Housing Finance Agency(FHFA). All dollar values are adjusted to 2010 U.S. dollars.

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[5] See Appendix C.

Chapter 5

TESTING INSTRUMENT VALIDITY

5.1 Exogenous Restrictions: Quasi-random Mergers

As a plausible instrument for branch closures, exposure to mergers needs to be as good as a random experiment. It means that mergers are not driven by local economic conditions and merger-exposed tracts are similar to control tracts in absence of the merger. In addition, exposures to mergers should affect local lending only through branch closures. In Section 4.1.1, I have shown the exogeneity of the mergers. I will discuss whether exposure to mergers is quasi-randomly assigned.

5.1.1 Internal Validity: Baseline Balance of the Sample

The control tracts should be no different from merger-exposed tracts in absence of the merger in both demographic and economic characteristics in the pre-merger years. To check the baseline balance of the sample, I estimate a year-by-year difference-in-differences regression and report the results in Table 5.1.

$$Y_i = \alpha + \gamma_t + \gamma_c + \beta Expose_i + \epsilon_i \tag{5.1}$$

where Y_i is the demographic/economic characteristic of tract i in the year prior to the merger; γ_t and γ_c are the year and county fixed effects; $Expose_i = 1$ if tract i has ever been a merger-exposed tract, otherwise, 0.

For each merger, the control tracts locate in the same county as their merger-exposed counterparts. The pre-merger within county differences between the two groups of tracts are captured by the estimates of β in Equation 5.1.

The estimation results are shown in Table 5.1. Column 1 shows that merger-exposed tracts are not significantly different from control tracts in either demographic

or economic aspects before the merger occurs. The exposed tracts have less residents but similar population density, slightly lower fraction of minorities, higher income and median rent, lower housing price, a little more branches and higher unemployment rates. However, all of these differences are negligible and not significantly different from zero. As a comparison, the pre-merger summary statistics of the merger-exposed and control tracts are listed in the the same table, Columns 2 and 3 respectively.

Table 5.1: Summary Statistis for Treatment and Control Tracts

	Treat-Control	Treat Mean	Control Mean
Total Population	-694.7***	4085.4	4800.9
	(74.82)		
Population Density	-310.6	18940.4	14060.3
	(1346.0)		
Minority(%)	-1.635	35.31	37.38
	(1.572)		
Tract/MSA Median Income (%)	2.843	112.6	109.1
	(3.658)		
Tract Median Income (000s)	1.627	61.48	60.41
	(1.949)		
Median Rent (000s)	0.0129	0.788	0.805
	(0.0181)		
Housing Price Index	-16.74	2286.1	2672.8
	(23.93)		
Total Number of Branches	0.205	2.591	2.446
	(0.135)		
Tract Unemployment Rate(%)	0.149	6.636	6.223
	(0.407)		
N	22,119	5,768	16,351

Note: Each line is a separate regression. All regressions control for year and county fixed effects. SE clustered at county level. ***p<0.01, **p<0.05, *p<0.1. *Source:* FFIEC and Census. All demographic variables are calculated based on Census 1990, 2000, and 2010. Median income and HPI are the values of pre-merger year. All dollar values are adjusted to 2010 U.S. dollars.

After confirming the homogeneity of the sample in demographic and economic aspects, the remaining concern is whether any pre-merger changes in the lending markets of the merger-exposed tracts cause the merger. In other words, are the lending activities or branching networks in the merger-exposed tracts changed differently than the control ones before the merger?

In Table 5.2, I compare the changing patterns in local lending markets and branching networks between both groups of tracts before the merger. I re-estimate Equation 5.1 using the pre-merger changes in branching networks, housing markets and local lending activities as dependent variables. The changes are the average annual changes in the two years prior to the merger.[1]

Column 1 shows that the merger-exposed tracts are not more nor less likely to suffer from depressed local economic conditions than their counterparts in the years prior to the mergers. The exposed group has a larger increase in small business lending, more cuts in mortgage lending and branch closures, and less growth in total number of branches, housing price and unemployment rates, but none of these differences are statistically significant.

As discussed above, the merger-exposed tracts and control tracts are similar in both demographic characteristics and economic conditions before mergers occur. Moreover, in the years before the mergers, exposed tracts do not experience more nor less changes in economic conditions. Therefore, the qualified mergers are not driven by local economic conditions in the exposed tracts.

[1] I also check if results differ for with 3 or more year averages and find similar results.

Table 5.2: Pre-Merger Trend: Treatment and Control Tracts

	Treat-Control	Control Mean
Change in Total Bank Branches(#)	-0.262	0.174
	(0.314)	
Change in Total Branch Closures(#)	-0.177	-0.0111
	(0.201)	
Change in Total SML Originations(#)	11.10	-0.117
	(8.219)	
Change in Total Mortgage Originations(#)	-2.373	-0.964
	(2.615)	
Growth in Housing Price Index(%)	-0.261	2.655
	(0.147)	
Growth in Unemployment Rate(%)	-0.285	1.546
	(0.428)	
N	5,768	16,351

Note: Each line is a separate regression. All regressions control for year and county fixed effects. SE clustered at county level. ***p<0.01, **p<0.05, *p<0.1.*Source:* FFIEC, FDIC and FHFA. All variables are the average growth rates/change over the two years before merger. "Change" variables are the annual change of the per a thousand population

5.2 Relevancy: Mergers and Branch Closures

5.2.1 Graphical Examination

A valid instrument requires that exposure to mergers lead to more branch closures in the post merger years. To observe the variations in branch networks, I estimate a year-by-year difference-in-differences model and present the results in Figure 5.1 as the event study plots.

$$Y_{it} = \alpha_i + \gamma_t + \sum_{n=-13}^{13} \beta_n (Expose_i \times Time_n) + X_{it}\delta_t + \epsilon_{6it} \tag{5.2}$$

where Y_{it} refers to the total number of branch closures from all depository institutions or the total number of closed branches from merger related banks in year t and tract i; $Time_n = 1$ if year t is the n^{th} year from the merging events, otherwise, 0; $Expose_i$ is an indicator for merger-exposed tracts; $Expose_i = 1$ if tract i has ever been exposed to the merger, otherwise, 0.

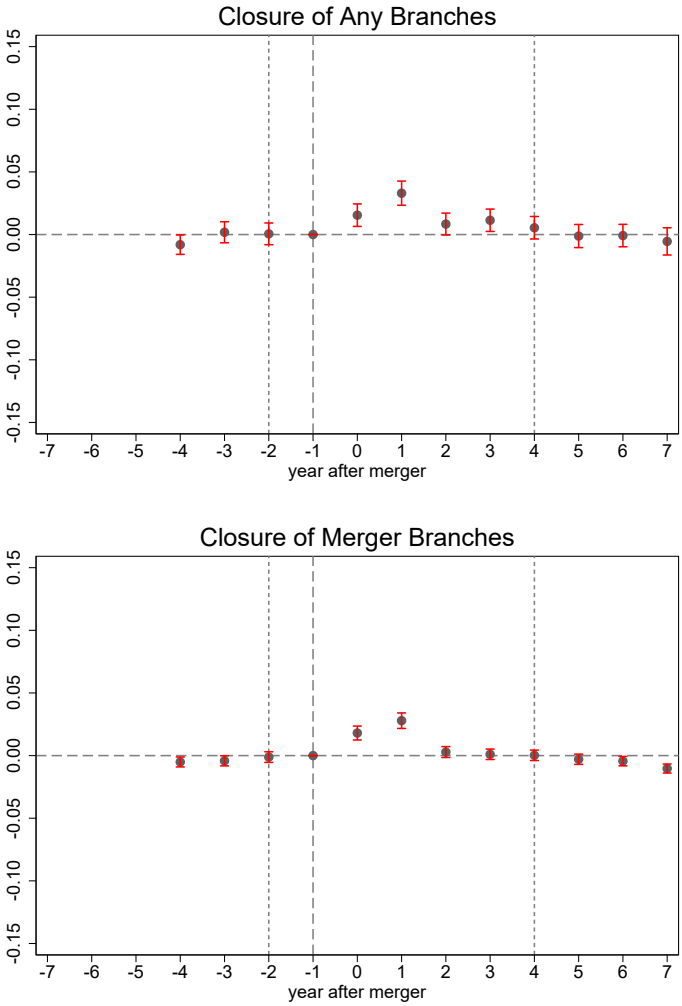
In Equation 5.2, β_ns capture the differences in overall branch closures between the merger-exposed tracts and control tracts n years from the merger. Given the assumption that both groups of tracts share same characteristics, the total number of closed branches should evolve under the same pattern across the sampled tracts before merger. Therefore, in the years prior to the mergers, β_n should not be significantly different from zero. As the mergers occur, exposed tracts are more likely to experience branch closures than their control counterparts. Hence, β_ns are expected to be positive and significant in the years following the mergers.

Figure 5.1 plots β_ns and their 95% confidence intervals from four years before the merger to seven years after the merger.[2]The upper panel describes the divergence of all branch closing trends between merger-exposed and control tracts, while the lower panel reflects the differences in the merger related closures.

Both panels follow the same pattern: Merger-exposed tracts lose similar numbers of branches as control tracts in pre-merger years and start to suffer from more closures in both overall branches and branches from merging banks as mergers become effective. Eventually, both groups go back to similar status in the fourth year after the mergers.

[2] All β_ns are comparable to the β_n of pre-merger year, β_{-1}, which is omitted from the regression. The sample is balanced from $t = -3$ to $t = 3$.

Figure 5.1: Merger exposures and Branching Network



Source: FDIC. All specifications include the full set of year fixed effects, tract fixed effects and tract level characteristics, including: population, housing price index, unemployment rate, median rent, median house value, minority fraction, median family income. All demographic variables are calculated based on Census 1990, 2000, and 2010. All median income, HPI and unemployment variables are the values in year t.

The plots provide clear evidence that exposure to mergers is positively related to the post-merger branch closures. Exposed tracts experience more branch closures relative to the control tracts in the three years following the merger and go back to normal in the long run.

5.2.2 First Stage Results

To further examine the effect of merger exposure on branch closures, I re-estimate Equation 5.2, the year-by-year first stage regression, and present the point estimates in Panel A of Table 5.3. For the years prior to the merger, being selected as merger-exposed group does not increase nor decrease the chance of facing branch closures than being selected as control group. In the year of merger, the chance of experiencing branch closures is 1.5% higher in exposed tracts. This is a 22% increase considering that only 7% of exposed tracts has branch closures in the year before merger occurs. In the following year, exposure to mergers increases the chance of branch closures by 3 percentage points.

The effect lasts for three years after merger and causes a total of 60% increase in the chance of branch closures for the exposed tracts. It shows that exposure to mergers has a positive but temporary effect on branch closures. Therefore, exposure to mergers satisfy the relevancy requirement as a valid instrument for branch closures.

Table 5.3: First-Stage Regression: Exposures to Mergers and Branch Closures

	Dependent Variable: Exposures to Branch Closures
	Year-by-Year: Exposures to Branch Closures
$\beta_{t<-5}$	0.0053
	(0.00485041)
$\beta_{t=-4}$	-0.0077
	(0.00500414)
$\beta_{t=-3}$	0.0022
	(0.00377067)
$\beta_{t=-2}$	0.0003
	(0.00492908)
$\beta_{t=0}$	0.0156***
	(0.00418213)
$\beta_{t=1}$	0.0282***
	(0.00427748)
$\beta_{t=2}$	0.006
	(0.00393819)
$\beta_{t=3}$	0.0091**
	(0.00399399)
$\beta_{t=4}$	0.0047
	(0.00407155)
$\beta_{t=5}$	-0.0018
	(0.00420255)
$\beta_{t=6}$	-0.0017
	(0.00401279)
$\beta_{t>6}$	-0.0064
	(0.0034504)
Pre-Merger Mean	0.0698
Obs	405,452

Sources: FFIEC CRA, HMDA; FHFA; FDIC; and Census. The regression include the full set of year fixed effects, tract fixed effects and controls for tract level characteristics, including: population, housing price index, unemployment rate, median rent, median house value, minority fraction, median family income. All demographic variables are calculated based on Census 1990, 2000, and 2010. All median income, HPI and unemployment variables are the values in year t. Pre-Merger Mean is the mean value of the exposed groups in the year prior to the merger. Standard errors are clustered at tract level and are in parentheses. ***p<0.01, **p<0.05, *p<0.1

5.3 Exclusive

Another concern of whether exposure to mergers could be considered as a valid instrument is whether exposure to mergers affect local lending only through the breach of lender-borrower relationship in branch closures.

Generally, mergers could affect local lending markets by reducing the competitions between lenders. However, this study focuses on the areas with sufficient access to branches where the change in market competition is minimal. Moreover, mergers may affect local lending since they increase the complexity of the bank's organization structure. It is not plausible in this study as all qualified mergers are between big banks. The organization structure is not likely to become more complex since the banks are big and have widely spread branching networks before merger occurs.

In addition, the control group consists of two types of tracts - the ones that are exposed to branches from one side of the merger and the ones without any nearby merging related branches. Accounting for almost a half of all control tracts, the former ones are exposed to the effects of mergers as well. Under this specification, the comparison between merger-exposed and control groups should have removed other merger related effects, if any were present.

Consequently, exposure to mergers could be considered as a valid instrument for branch closures.

Chapter 6

RESULTS: BRANCH CLOSURES AND LOCAL LENDING ACTIVITIES

To investigate the causal relationship between branch closures and local lending, I examine how the exogenous merger-induced branch closures affect the local lending markets in the surrounding neighborhoods. I use two measurements, the total numbers and volume of loan originations to quantify the effect of branch closures on the level of local lending: home mortgage lending and small business lending.

6.1 Graphical Examination

Assuming that exposures to mergers affect local lending only through the closures of physical branches, the relationship between exposure to mergers and local lending could be considered as the reduced form relationship between branch closures and lending. I begin to investigate this reduced form relationship by visually inspecting the changes in lending around the merger years.

To compare the year-by-year differential changes in local lending between the merger-exposed and control tracts as mergers become effective, I estimate Equation 5.2 using the total numbers and volume of loan originations as dependent variables and plot the point estimates and the 95% confidence interval of β_n in Figure 6.1 and 6.2. The dots shows the point estimates of β_n and the spike plots are the 95% confidence intervals. β_n captures the differences in total local lending in merger-exposed tracts comparing to their control counterparts in the n^{th} year after merger.

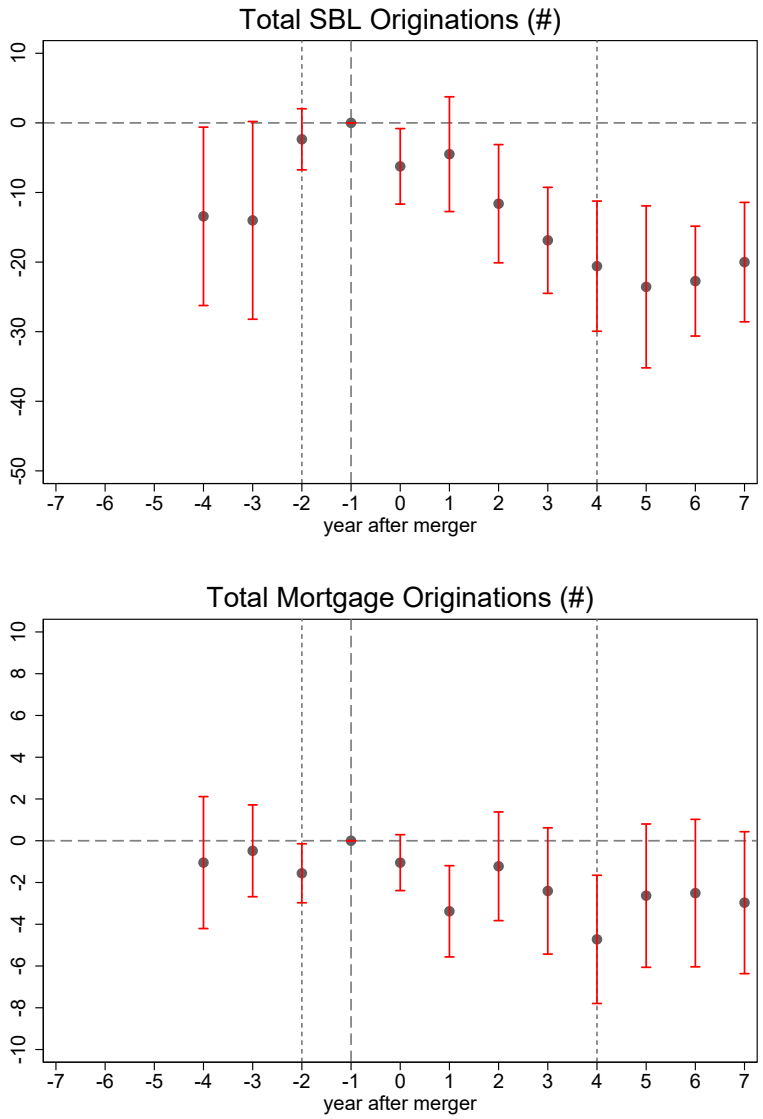
Both figures indicate a negative relationship between exposure to mergers and local lending. Figure 6.1 shows that, in the three years prior to the merger, the total number of loan originations in exposed tracts is similar to control tracts in both home

mortgage and small business markets. The upper panel shows a clear and prolonged drop in the number of small business loan originations in exposed tracts compared to control tracts. The decline starts right after the mergers take place and persists in the long run although the gap narrows after six years. The lower panel presents changes in home mortgage lending. Relative to the control tracts, total number of mortgage lending drops slightly in exposed tracts after the merger but shortly recovers.

Figure 6.2 shows similar trends in the volume of local lending. The upper panel describes a deep and long lasting decrease in small business lending in exposed tracts than in controls. The lower panel pictures a quick dip in the volume of home mortgage lending that, unlike small business lending, quickly disappears.

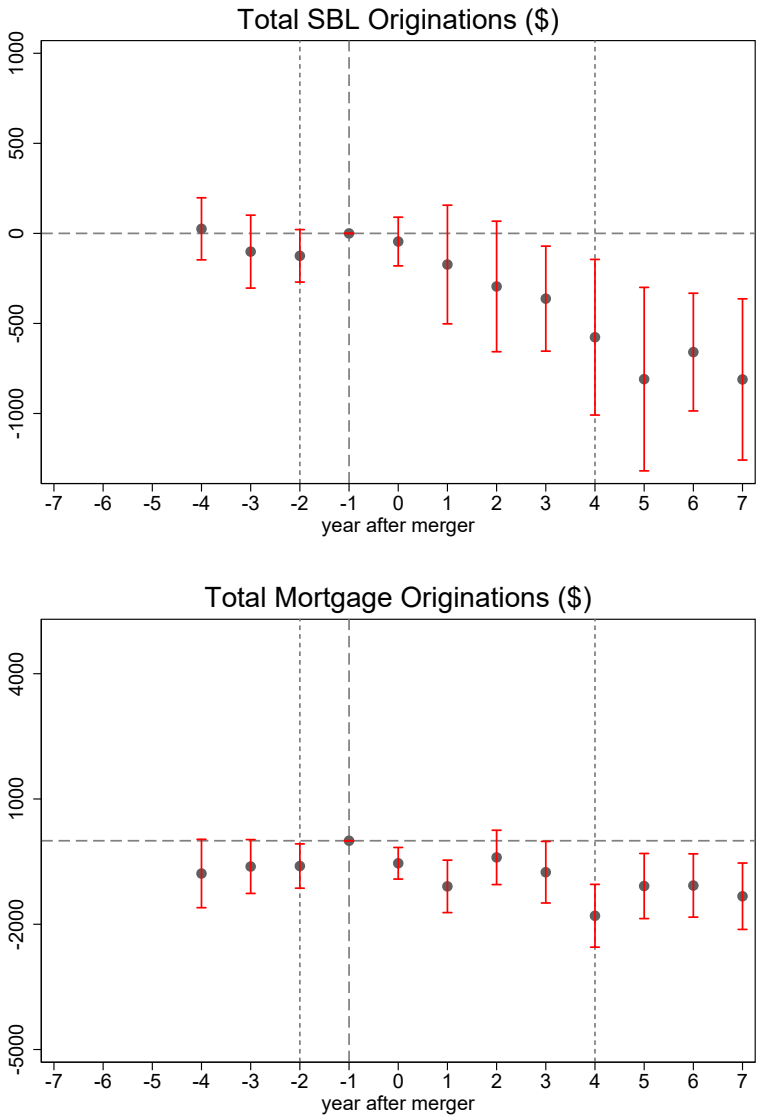
The plots suggest that merger-induced branch closures affects small business lending much more than home mortgage lending in both the number and the dollar volume of loan originations. Given the first-stage relationship shown in Figure 5.1, exposures to mergers only affect the branching networks for three years. However, the small business lending market remains affected even after the branching networks recover.

Figure 6.1: Merger and Local Lending Activities



Source: FFIEC CRA and HMDA. All specifications include the full set of year fixed effects, tract fixed effects and tract level characteristics, including: population, housing price index, unemployment rate, median rent, median house value, minority fraction, median family income. All demographic variables are calculated based on Census 1990, 2000, and 2010. All median income, HPI and unemployment variables are the values in year t. The dots shows the point estimates of β_n in Equation 5.2 and the spike plots are the 95% confidence intervals. β_n captures the differences in the level of local lending between the merger-exposed and control tracts in the n^{th} year after merger. Dependent variables are: the total number of small business (upper panel) and home mortgage (lower panel) loan originations.

Figure 6.2: Merger and Local Lending Activities



Source: FFIEC CRA and HMDA. All specifications include the full set of year fixed effects, tract fixed effects and tract level characteristics, including: population, housing price index, unemployment rate, median rent, median house value, minority fraction, median family income. All demographic variables are calculated based on Census 1990, 2000, and 2010. All median income, HPI and unemployment variables are the values in year t. The dots shows the point estimates of β_n in Equation 5.2 and the spike plots are the 95% confidence intervals. β_n captures the differences in the level of local lending in merger-exposed tracts and the control tracts in the n^{th} year after merger. Dependent variables are: the total volume of small business (upper panel) and home mortgage (lower panel) loan originations. All dollar values are in 2010 US dollars.

6.2 Regression Results

6.2.1 Reduced Form Results

As explained above, the year-by-year difference-in-differences regression captures the reduced form relationship between branch closures and local lending. Therefore, I estimate the following reduced form regression. Same as the previous section, the measurements of the level of home mortgage and small business lending are the total numbers and volume of loan originations.

$$\begin{aligned} Y_{it} = \beta_{t<=-5}(Expose_i \times Time_{t<=-5}) + \sum_{n=-4}^{6} \beta_n(Expose_i \times Time_n) \\ +\beta_{t>6}(Expose_i \times Time_{t>6}) + \alpha_i + \gamma_t + X_{it}\delta + \epsilon_{it} \end{aligned} \tag{6.1}$$

where Y_{it} refers to the total numbers and volume of loan originations in year t and tract i; $Time_n = 1$ if year t is the n^{th} year from the merging events, otherwise, 0; $Expose_i$ is an indicator for merger-exposed tracts; $Expose_i = 1$ if tract i has ever been a merger-exposed tract, otherwise, 0; X_{it} are the same variables as in Equation 3.1; α_i, γ_t are the tract and year fixed effects.

In Equation 6.1, I split the sample into three time periods: five or more years prior to the merger, from four years before mergers to six years after merger, and six and more years after merger. For the second period, β_n captures the year-by-year differences between exposed and control tracts, while for the first and third periods, $\beta_{t<=-5}$ and $\beta_{t>6}$ reports the average differences across those years. The underlying requirement of difference-in-difference regression is the satisfaction of parallel trends assumption. It means that all β in the pre-merger years should be no different from zero.

Table 6.1 reports the point estimates of all β. Column (2) and (4) show the results using the volume of home mortgage and small business lending as dependent variables. For the years long before merger, β is not significantly different from zero. It provides evidence that the merger-exposed and control tracts are similar in absence of the merger. In the four years immediately before the merger, β remains at zero for all years, suggesting that the parallel trends assumption is satisfied. As mergers become

effective, β_n turns negative and significant for both lending activities: it indicates that, comparing to control tracts, the home mortgage lending volume drops in merger-exposed tracts till the sixth year after merger; and the small business lending volume keeps declining in the long run. Colume (1) and (3) present the results when the total number originations are used to measure local lending. The results are similar to the estimates using the loan volume as a measurement of local lending.

Table 6.1: Reduced Form Regression: Exposures to Mergers and Local Lending

	Home Mortgage Lending		Small Business Lending	
	(1) Originations(#)	(2) Dollar(000s)	(3) Originations(#)	(4) Dollar(000s)
$\beta_{t<=-5}$	4.0851	388	6.8048	157
	(3.139365)	(371.16259)	(4.8754098)	(174.07638)
$\beta_{t=-4}$	-5.1754*	-1200	5.8259	-130
	(2.792763)	(1094.87404)	(3.7053605)	(175.73686)
$\beta_{t=-3}$	-0.4401	-620	-14.5006*	-100
	(1.1590346)	(534.26828)	(8.3436345)	(104.26753)
$\beta_{t=-2}$	-1.5541	-580	-2.7652	-130
	(1.73698767)	(472.66771)	(2.2806282)	(86.633089)
$\beta_{t=0}$	-0.9583	-520***	-6.7706***	-44
	(0.64765682)	(181.46642)	(2.8223014)	(67.404415)
$\beta_{t=1}$	-3.2763***	-1100***	-5.017	-170
	(1.0734936)	(317.02964)	(4.1644062)	(166.8066)
$\beta_{t=2}$	-1.0842	-390	-12.1535***	-290
	(1.2920065)	(328.70943)	(4.3032914)	(182.79258)
$\beta_{t=3}$	-2.3267	-740**	-17.3655***	-360***
	(1.5179669)	(369.75282)	(3.8718824)	(147.39572)
$\beta_{t=4}$	-4.6404***	-1800***	-21.062***	-570**
	(1.5452193)	(380.02946)	(4.7625788)	(219.15713)
$\beta_{t=5}$	-2.5496	-1100***	-24.0485***	-810***
	(1.7487837)	(396.90232)	(5.937167)	(258.5282)
$\beta_{t=6}$	-2.4095	-1100***	-23.2413***	-660***
	(1.7887422)	(384.33612)	(4.0219392)	(165.32061)
$\beta_{t>6}$	-0.7269	-560	-14.8348***	-800***
	(2.2257599)	(670.48499)	(4.7690476)	(225.27458)
Pre-Merger Year Mean	71.91	17320.04	191.01	6057.82
Obs	405,452	405,452	405,452	405,452

Sources: FFIEC CRA, HMDA; FHFA; FDIC; and Census. The regression include the full set of year fixed effects, tract fixed effects and controls for tract level characteristics, including: population, housing price index, unemployment rate, median rent, median house value, minority fraction, median family income. All demographic variables are calculated based on Census 1990, 2000, and 2010. All median income, HPI and unemployment variables are the values in year t. Pre-Merger Mean is the mean value of the exposed groups in the year prior to the merger. Standard errors are clustered at tract level and are in parentheses. ***p<0.01, **p<0.05, *p<0.1

To better interpret the results, I further simplify Equation 6.1:

$$Y_{it} = \alpha_i + \gamma_t + \beta Expose_i \times Post_{it} + X'_{it}\delta_t + \epsilon_{it} \tag{6.2}$$

where the observation of analysis varies by Census Tract i and year t; Y_{it}, α_i, γ_t and X_{it} are the same variables as in Equation 3.1; $Close_i$ is the indicator of merger-induced branch closures, $Expose_i$ is an indicator for merger-exposed tracts; $Expose_i = 1$ if tract i has ever been exposed to the merger, otherwise, 0; for home mortgage lending, $Post_{it} = 1$ if year t is within six years of the merger which tract i is exposed to, otherwise, 0; for small business lending, $Post_{it} = 1$ if year t is after the merger for tract i, otherwise, 0.

The results in Figure 6.2 and 6.2 show that branch closures have short-term effects on home mortgage lending, while the effects on small business lending last in the long run. Therefore, for home mortgage lending, I use β to capture the average effect over the six year period after mergers become effective; for small business lending, I use β to capture the average effect over all years after merger. For home mortgage lending, $Post_{it} = 1$ only when year t is within six years of the merger which tract i is exposed to, otherwise, 0; for small business lending, $Post_{it} = 1$ if year t is after the merger for tract i, otherwise, 0.

Table 6.2 presents the results of Equation 6.2 with varying control variables. Panel A is the estimation of Equation 6.2 without controlling for tract level variables. It shows that both home mortgage and small business lending are negatively affected by the merger, however, the effect on mortgage loans is not statistically significant. Exposure to merger-induced closures lead to an average loss of \$0.27 million small business lending in the years after the merger. That is approximately 5% of all small business loans originated in the exposed tracts in the year prior to the merger. In terms of the total number of small business loans, the effect is also negative and significant - branch closures cause a loss of 3 small business loans, which is 1.5% of the total number of loans. For home mortgage lending, the effects are negative but small and insignificant.

After controlling for tract-specific variables, Panel B reports larger effects size on the total number and volume of loan originations in both markets except for the total volume of small business loans. This specification is similar to Nguyen's approach, while the estimated effects sizes are comparable to her findings. She finds a loss of 2.5 loans and a decrease of $0.2 million in small business lending. It shows that exposure to mergers lowers the local small business lending by $0.25 million, which accounts for approximately 5% of the total volume. The effects on home mortgage lending are still small and not significant.

Table 6.2: The Effects of Branches Closures on Local Lending: Reduced Form, 1998-2016

	(1)	(2)	(3)	(4)
	Small Business Loan		Home Mortgage Lending	
	Originations(#)	Dollar(000s)	Originations(#)	Dollar(000s)
	Panel A. Basic Model			
Expose × *Post*	–2.84*	–275.64***	–0.55	–26.23
	(1.60)	(68.37)	(0.48)	(137.26)
Tract Level Characteristics	No	No	No	No
Year and Tract Fixed Effects	Yes	Yes	Yes	Yes
Adj. R squared	0.38	0.13	0.14	0.13
Observations	405,452	405,452	405,452	405,452
	Panel B. Control for Tract Level Characteristics			
Expose × *Post*	–3.10*	–250.12***	–0.78	–40.54
	(1.60)	(67.74)	(0.50)	(143.19)
Tract Level Characteristics	Yes	Yes	Yes	Yes
Year and Tract Fixed Effects	Yes	Yes	Yes	Yes
Adj. R squared	0.40	0.14	0.15	0.15
Observations	405,452	405,452	405,452	405,452
Pre-Merger Year Mean	191.01	6057.82	71.91	17320.04

Sources: FFIEC CRA, HMDA; FHFA; FDIC; and Census. All regression are based on the full sample of the study. All specifications include the full set of year fixed effects and tract fixed effects. In addition, bottom panel are controlled for tract level characteristics, including: population, housing price index, unemployment rate, median rent, median house value, minority fraction, median family income. All demographic variables are calculated based on Census 1990, 2000, and 2010. All median income, HPI and unemployment variables are the values in year t. Pre-Merger Mean is the mean value of the exposed groups in the year prior to the merger. Standard errors are clustered at tract level and are in parentheses. ***p<0.01, **p<0.05, *p<0.1

6.2.2 Instrumental Variable Results

Lastly, I estimate Equations 3.2 using merger exposures as an instrument for branch closures. I use $Expose_i \times Post_{it}$ as an instrument for $Close_{it} \times Post_{it}$ and present results of the two-stage IV estimations in Table 6.3.

Same as the reduced form regression, I consider three time periods: all years prior to the merger, the short-run which is the years within six years after a merger, and the long-run which is the years beyond six years after the merger.

Panel A of Table 6.3 is the basic IV regression without controlling for tract level characteristics. It shows that exposures to branch closures have negative effects on both local home mortgage and small business lending, while the effect on home mortgage lending is not significant. The total number of small business loan originations drops by 15 due to branch closures, that is approximately 8% of all originated small business loans in the merger-exposed tracts before merger. The effect on the volume of small business lending is larger: in the years after the merger, on average, branch closures cause a loss of $1.5 million in small business loans. That is a 22% decrease in the total volume of small business lending. Home mortgage lending is much less affected and the effect is not as significant. In the six years after the merger, branch closures cause a 5% decreases in the total number and a 1% decreases in the volume of home mortgage loan originations, respectively.

Panel B controls for tract level demographic and economic variables. The results do not change much from Panel A. Branch closures cause a decline of 16 loan originations in the small business lending, that is 8% of the total number of loan originated in the exposed tracts and the year prior to the merger. The volume of small business lending drops by $1.3 million, as large as 22% out of all small business loans, in dollar value, originated in the exposed tracts in the pre-merger year. For home mortgage lending, the effect is much smaller and insignificant.

These results of this study are comparable to Nguyen(2017)'s finding. Nguyen shows that branch closures have a long term negative effects on small business lending for up to six years and the effects on mortgage lending is minimal. During the six years

after the merger, branch closures account for 19% annual decline in small business lending. I find similar effects on small business lending, however, the effects last much longer than suggested in Nguyen's paper.

Nguyen's study is based on the mergers that took place before the Great Recession and has a different sets of requirements for the mergers. In addition, the definitions of the exposed and control tracts are different from this paper. I check the robustness of the results using mergers before the crisis[1]. and find similar results as using the full sample. The differences in identification strategies should be the reason of the differences in the results.

[1] See Appendix A

Table 6.3: The Effects of Branches Closures on Local Lending: Instrumental Variable, 1998-2016

	(1)	(2)	(3)	(4)
	Small Business Loan		Home Mortgage Lending	
	Originations(#)	Dollar(000s)	Originations(#)	Dollar(000s)
	Panel A. Basic Model			
Close × *Post*	–15.04*	–1461.72***	–2.93	–139.11
	(8.54)	(364.67)	(2.55)	(727.86)
First-Stage F-statistics	2114.36			
Prob> F	0.0000			
Tract Level Characteristics	No	No	No	No
Year and Tract Fixed Effects	Yes	Yes	Yes	Yes
Observations	405,452	405,452	405,452	405,452
	Panel B. Control for Tract Level Characteristics			
Close × *Post*	–16.44*	–1326.92***	–4.13	–215.06
	(8.56)	(361.25)	(2.63)	(759.59)
First-Stage F-statistics	4755.13			
Prob> F	0.0000			
Tract Level Characteristics	Yes	Yes	Yes	Yes
Year and Tract Fixed Effects	Yes	Yes	Yes	Yes
Observations	405,452	405,452	405,452	405,452
Pre-Merger Mean	191.01	6057.82	71.91	17320.04

Sources: FFIEC CRA, HMDA; FHFA; FDIC; and Census. All regression are based on the full sample of the study. All specifications include the full set of year fixed effects, tract fixed effects and a county-by-group specific time trend. In addition, bottom panel are controlled for tract level characteristics, including: population, housing price index, unemployment rate, median rent, median house value, minority fraction, median family income. All demographic variables are calculated based on Census 1990, 2000, and 2010. All median income, HPI and unemployment variables are the values in year t. Pre-Merger Mean is the mean value of the exposed groups in the year prior to the merger. Standard errors are clustered at tract level and are in parentheses. ***p<0.01, **p<0.05, *p<0.1

6.3 Why is mortgage lending not affected?

Exposures to branch closures have a prolonged negative effect on small business lending while local home mortgage lending is not much affected. Does it mean that mortgage lending is no longer tied to local branches? To further examine the changes in home mortgage lending after branch closure, I separate the originated loans by lender type and observe how different lenders respond to the shock in branching network. I begin with defining the lender types and follow by a discussion.

In order to identify the types of mortgage lenders, I combine the HMDA reporter panel with the "HMDA lender file" which is created by Robert Avery from Federal Housing Finance Agency(FHFA). The lender file documents the type, parent company and identifying information for all historical HMDA lenders. It allows me to track the same lender from 1990s to 2016.

I separate the lenders into three categories: depository institutions from the merging banks, mortgage company subsidiaries from the merging banks, and all other lenders. Depository institutions from the merging banks includes the commercial banks, thrift institutions and credit unions that owned by the merging banks; mortgage company subsidiaries from the merging banks are the mortgage company subsidiaries and independent mortgage companies that owned by the merging banks; all other lenders are the remaining depository and non-depository lenders who report under HMDA. The sample of study covers $13,555$ distinct lenders of which $9,095$ are depository institutions. The summary statistics of the lenders is further discussed in Section 6.

Unlike in the small business lending market where depository institutions originate most of the loans, a large portion of home mortgage loans are borrowed from non-depository institutions. Depository lenders include all financial institutions that accept deposits of the general public. Commercial banks, thrift institutions and credit unions are the major depository institutions who report to HMDA. Non-depository lenders including mortgage companies owned by depository institutions and independent mortgage companies, who also report their lending activities under HMDA but

are not subject to the same level of regulations as depository institutions.

Table 6.4 summarizes all lender types that originate home mortgage loans to the sampled tracts in this study. The sample covers 13,521 lenders, of which two-thirds are depository institutions and the rest are non-depository institutions.[2] In terms of market share, depository institutions originate 50% of the total volume of home mortgage loans.

I first split the lenders into depository and non-depository institutions and observe their lending activities in the sampled areas. Figure 6.3 and 6.4 plot the changes in home mortgage market structures in the exposed and control tracts after the merger. Figure 6.3 shows the changes in market shares by the total numbers of loan originations. The upper panel indicates that after mergers become effective, depository institutions market share in the exposed area drops immediately and recovers within three years. The lower panel shows that non-depository lenders quickly penetrate the exposed area and fill the need of credits.

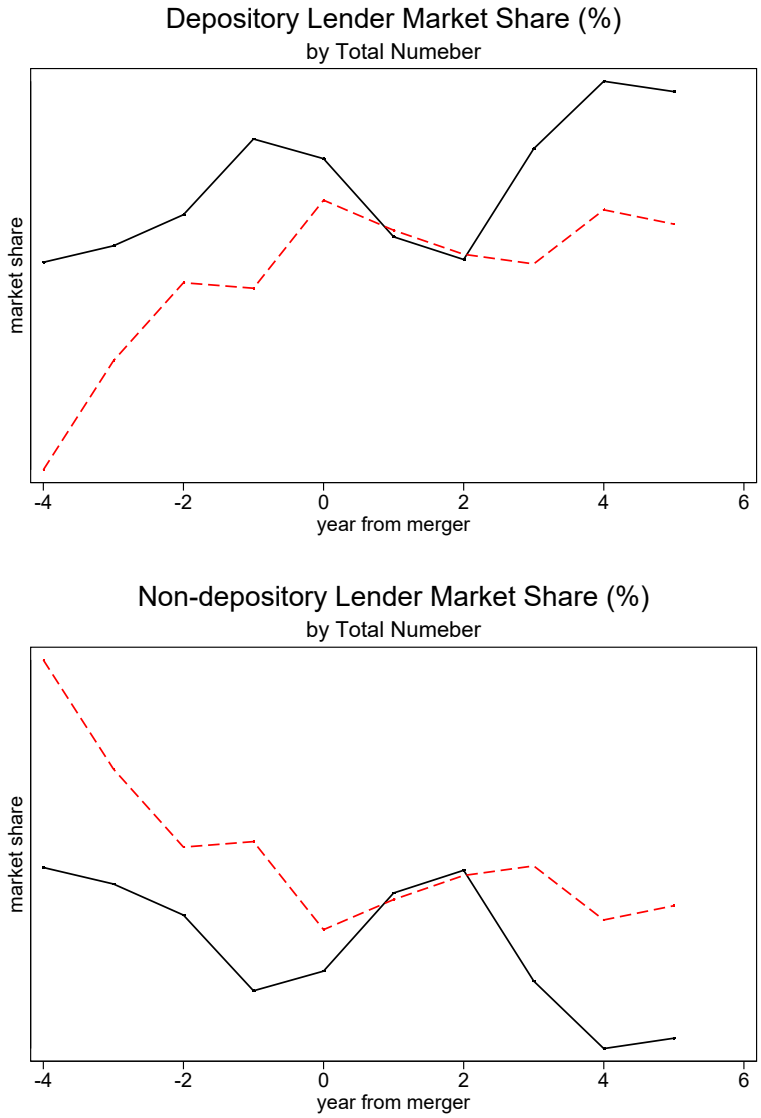
[2] Commercial banks, thrift institutions and credit unions are the depository institutions. Other lenders are non-depository.

Table 6.4: Lender Type

Type	Number of Lenders	Percent (%)	Market Share in Lending Volume (%)
Commercial Bank	5,447	40.29	32.64
Commercial Bank Subsidiary	840	6.21	14.97
Subsidiary of a Commercial Bank Holding Company	148	1.09	3.10
Thrift Institution	1,745	12.91	15.35
Thrift institution Subsidiary	155	1.15	4.15
Subsidiary of a Thrift Holding Company	4	0.03	1.14
Credit Union	1,903	14.07	1.48
Subsidiary of a Credit Union	46	0.34	0.04
Credit Union Service Company	16	0.12	0.02
Independent Mortgage Bank	3,217	23.79	27.11
Total	13,521	100	

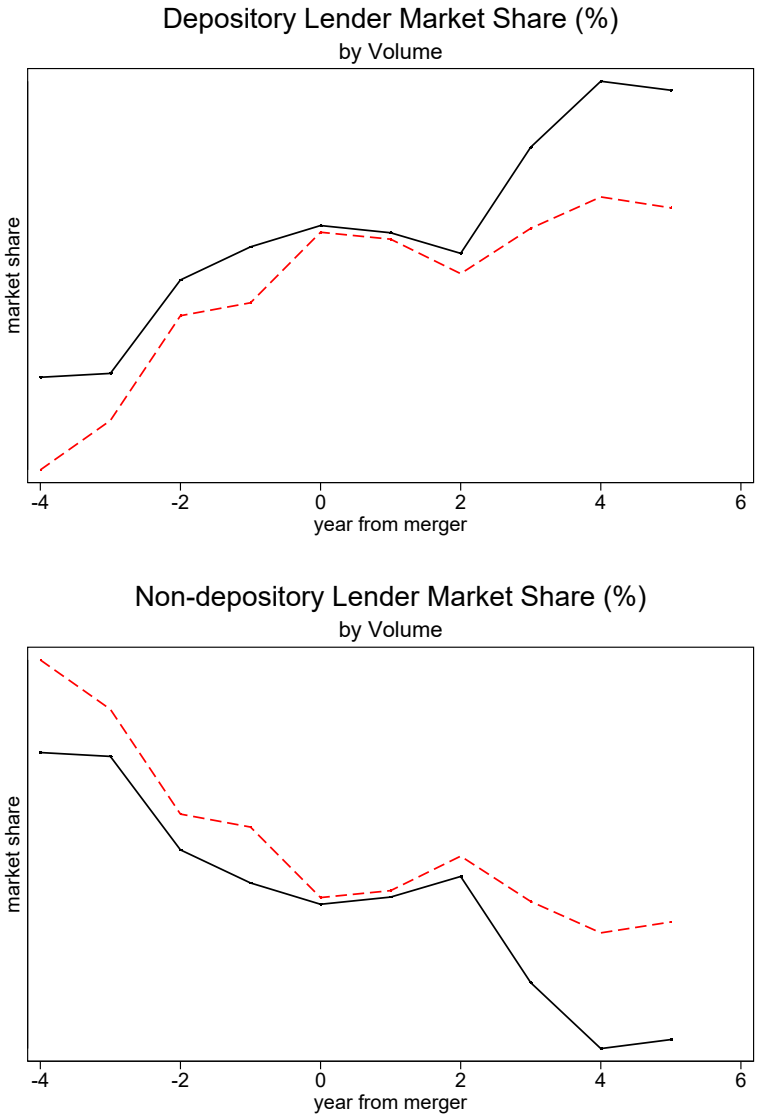
Source: The HMDA Lender File by Robert Avery. Author's calculation.

Figure 6.3: Home Mortgage Loan Market Share by Lender Type (Total Number)



Source: Author's calculation using HMDA and "HMDA lender file" by Robert Avery. Dashed lines are the market share of lenders in control tracts; solid lines are the market share of lenders in exposed tracts.

Figure 6.4: Home Mortgage Loan Market Share by Lender Type (Volume)



Source: Author's calculation using HMDA and "HMDA lender file" by Robert Avery. Dashed lines are the market share of lenders in control tracts; solid lines are the market share of lenders in exposed tracts.

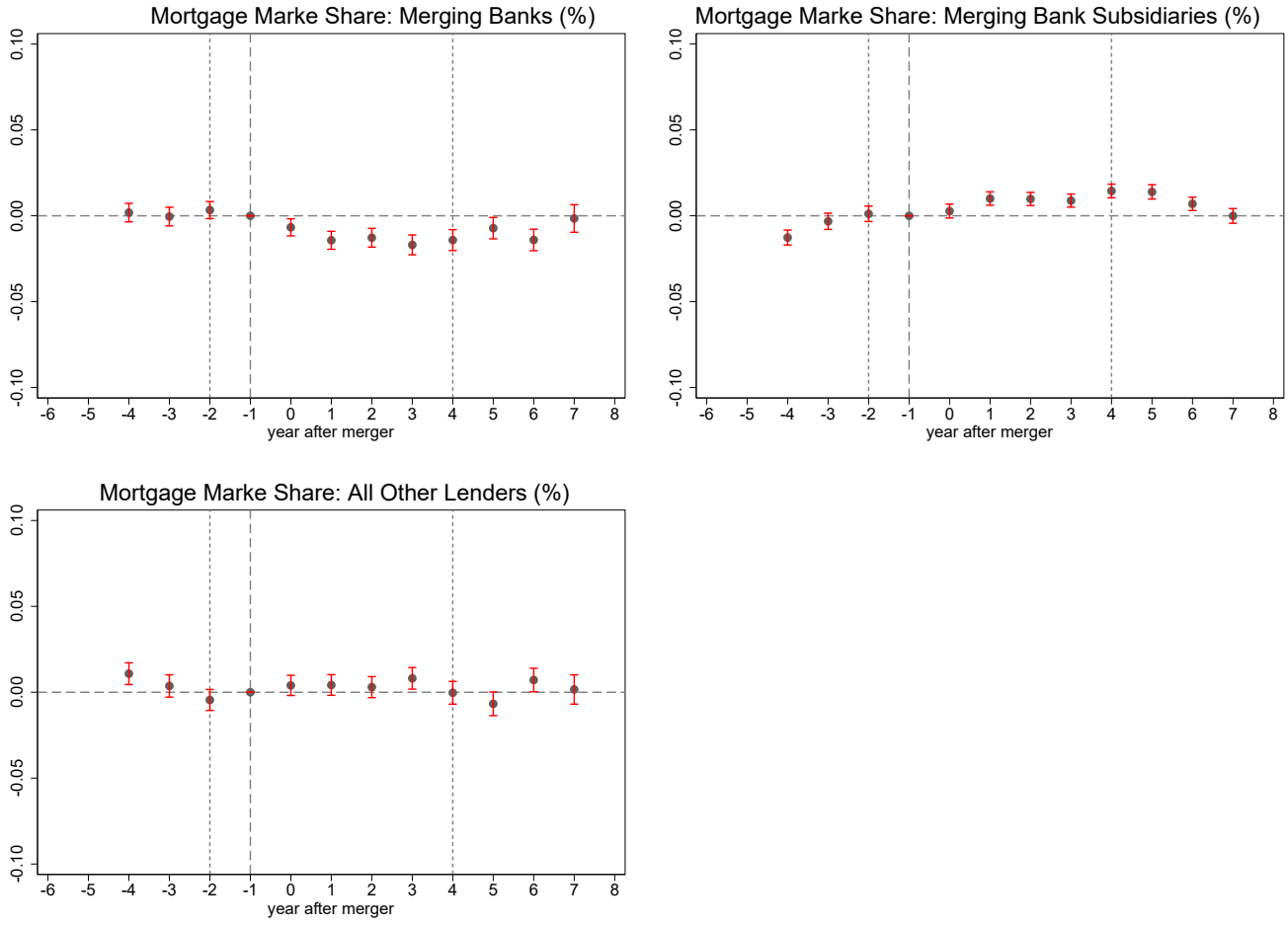
Does this mean that independent mortgage companies enter the market when traditional banks close their branches? I further explore the changes in lending activities by dividing lenders into three categories: merging banks, mortgage companies owned by the merging banks, and all other lenders.

I re-estimate Equation 6.1 using the market shares of the above three groups of lenders as the dependent variables. The market shares are measures by the percentage of total volume of home mortgage loans originated by each group of lenders. Figure 6.5 and 6.5 presents the point estimates and 95% confidence interval of β. The plots show that merging banks cut their lending as the merger and branch closures take place. However, their mortgage company subsidiaries quickly penetrates these markets and increase their market share. Moreover, lenders that are not related to the mergers are not much affected.

A possible explanation is that home mortgage lending relies more on hard information such as credit scores rather than soft information that stores in the borrower-lender relationship. Comparing to small business lenders, home mortgage lenders put less effort in screening the borrowers' creditworthiness as they tend to sell the mortgage loans shortly after the origination and share little risk from these loans. This hard information could easily be stored and transmitted. Therefore, banks who have informational advantages could keep their market share even without a physical bank branch presence.

However, this finding does not suggest that branch closures do not have any effect on home mortgage lending. Unlike depository lenders, the mortgage companies and other non-depository lenders face much lower regulation burdens. Although the credit supply remains unaffected, whether the price of credit is affected is worth studying.

Figure 6.5: Home Mortgage Loan Market Share by Lender Type (Total Volume)



Chapter 7

CONCLUSION

In this paper, I examine the effect of branch closures on local lending. To address the endogeneity issue, I consider the merger between big banks as an exogenous source of post-merger branch closures in the exposed neighborhoods. Using mergers as an instrument, I investigate the effects of the branch closures on local lending.

Exposure to qualified mergers could be considered as a valid instrument for branch closures by selecting mergers that are not driven by local economic conditions and by using homogeneous exposed and control groups in the sample. Using instrumental variable approach, my estimates suggest that, in the surrounding neighborhoods, exposure to branch closures lead to a 22% decrease in the total dollar amounts of small business lending, regardless of whether the closed branch is located in the same Census Tract. Home mortgage lending is not much affected. The merging banks cut their loan originations through local branches while their mortgage companies take over the market share. Other lenders barely respond to this shock on branching network.

This paper shows that local branch closures have negative and persistent effects on small business lending. It indicates that small business lending still heavily relies on lender-borrower relationships through which the soft information is collected. This result is similar to previous findings (Nguyen 2018; DeYoung, Glennon, and Nigro 2008; Agarwal and Hauswald 2010; Hauswald and Marquez 2006). For home mortgage lending, I find that branch closures have little effects. The merged depository institutions easily maintain their market shares by originating more loans through their mortgage company subsidiaries even though their lending via depository institutions drops. It is consistent with previous studies that shows mortgage lenders care less about screening the borrowers (Rajan, Seru, and Vig 2015; Loutskina and Strahan 2011).

This paper suggests that improvements in technology and credit score models have not provided enough hard information to replace the soft information in small business lending, which heavily relies on lender-borrower relationships. In the contrary, home mortgage lenders rely more on hard information which could be more easily stored and transmitted within the bank. It allows the merging banks to maintain their informational advantages and keep lending in the neighborhoods where they closed physical branches. However, this finding does not mean that branch closures have no effect on home mortgage lending. Unlike depository lenders, the mortgage companies and other non-depository lenders face much less regulation. Although the credit supply remains unaffected, the effect on price of credit remains to be explored.

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Appendix A

ROBUSTNESS

In this section, I check the robustness of the results. One remaining concern is whether the post-crisis policy changes contributed to the decline in small business lending. I re-investigage the effect of branch closures on local lending using the sample of mergers before the Great Recession that occur from 1998 to 2007. I check the baseline balance and re-estimate Equation 6.2 and 3.2. The results are reported in the following tables.

As shown in Table A.1 and A.2, similar to the results on the full sample, the exposed and control tracts are similar before the mergers occur. Table A.3 presents the results of the reduced form regression. It shows similar effects as found in the full sample.

Table A.1: Pre-Merger Trend: Treatment and Control Tracts, For Mergers between 1998-2006

	Treat-Control	Control Mean
population	-776.1***	4666.6
	(94.19)	
population_density	-769.0	16789.0
	(1907.0)	
Minority(%)	-0.330	36.30
	(2.193)	
Tract/MSA Median Income (%)	1.607	108.5
	(5.118)	
Tract Median Income (000s)	0.986	60.99
	(2.725)	
Median Rent (000s)	0.00635	0.803
	(0.0265)	
Housing Price Index	-14.94	2639.9
	(34.17)	
Total Number of Branches	0.342	2.399
	(0.269)	
Tract Unemployment Rate(%)	0.310	6.414
	(0.564)	
N	3,896	11,427

Source: FFIEC, FDIC and FHFA. All variables are the average growth rates/change over the three years before merger.

Table A.2: Pre-Merger Trend: Treatment and Control Tracts, For Mergers between 1998-2006

	Treat-Control	Control Mean
Change in Total Bank Branches(#)	0.0678	0.0178
	(0.0407)	
Change in Total Branch Closures(#)	0.0145	-0.00826
	(0.0175)	
Change in Total SML Originations(%)	19.10	13.11
	(11.68)	
Change in Total Mortgage Originations(%)	-0.115	-0.0381
	(0.526)	
Growth in Housing Price Index(%)	-0.193	7.959
	(0.179)	
Growth in Unemployment Rate(%)	-0.273	2.220
	(0.612)	
N	3,896	11,427

Source: FFIEC, FDIC and FHFA. All variables are the average growth rates/change over the three years before merger.

Table A.3: The Effects of Branches Closures on Local Lending: Difference-in-Differences, For Mergers between 1998-2006

	(1)	(2)	(3)	(4)
	Small Business Loan		Home Mortgage Lending	
	Originations(#)	Dollar(000s)	Originations(#)	Dollar(000s)
	Panel A. Basic Model			
Expose × *Post*	1.37	–353.48***	–0.79	–2.96
	(2.22)	(91.82)	(0.58)	(172.60)
Tract Level Characteristics	No	No	No	No
Year and Tract Fixed Effects	Yes	Yes	Yes	Yes
Adj. R squared	0.39	0.13	0.21	0.18
Observations	278,181	278,181	278,181	278,181
	Panel B. Adding Tract Level Characteristics			
Expose × *Post*	0.49	–286.20***	–0.91	–26.87
	(2.21)	(89.82)	(0.59)	(175.51)
Tract Level Characteristics	Yes	Yes	Yes	Yes
Year and Tract Fixed Effects	Yes	Yes	Yes	Yes
Adj. R squared	0.39	0.13	0.21	0.18
Observations	278,181	278,181	278,181	278,181
Pre-Merger Mean	220.41	6339.31	76.55	18108.78

Sources: FFIEC CRA, HMDA; FHFA; FDIC; and Census. All regression are based on the full sample of the study. All specifications include the full set of year fixed effects, tract fixed effects and a county-by-group specific time trend. In addition, bottom panel are controlled for tract level characteristics, including: population, housing price index, unemployment rate, median rent, median house value, minority fraction, median family income. All demographic variables are calculated based on Census 1990, 2000, and 2010. All median income, HPI and unemployment variables are the values in year t. Pre-Merger Mean is the mean value of the exposed groups in the year prior to the merger. Standard errors are clustered at tract level and are in parentheses. ***p<0.01, **p<0.05, *p<0.1

Table A.4: The Effects of Branches Closures on Local Lending: Instrumental Variable, For Mergers between 1998-2006

	(1)	(2)	(3)	(4)
	Small Business Loan		Home Mortgage Lending	
	Originations(#)	Dollar(000s)	Originations(#)	Dollar(000s)
	Panel A. Basic Model			
Close × *Post*	8.02	–2068.31***	–4.60	–17.31
	(12.96)	(545.00)	(3.41)	(1009.93)
First-Stage F-statistics	1175.08			
Prob> F	0.0000			
Tract Level Characteristics	No	No	No	No
Year and Tract Fixed Effects	Yes	Yes	Yes	Yes
Observations	405,452	405,452	405,452	405,452
	Panel B. Control for Tract Level Characteristics			
Close × *Post*	2.90	–1694.62***	–5.39	–159.12
	(13.08)	(538.30)	(3.53)	(1039.18)
First-Stage F-statistics	1816.54			
Prob> F	0.0000			
Tract Level Characteristics	Yes	Yes	Yes	Yes
Year and Tract Fixed Effects	Yes	Yes	Yes	Yes
Observations	278,181	278,181	278,181	278,181
Pre-Merger Mean	191.01	6057.82	71.91	17320.04

Sources: FFIEC CRA, HMDA; FHFA; FDIC; and Census. All regression are based on the full sample of the study. All specifications include the full set of year fixed effects, tract fixed effects and a county-by-group specific time trend. In addition, bottom panel are controlled for tract level characteristics, including: population, housing price index, unemployment rate, median rent, median house value, minority fraction, median family income. All demographic variables are calculated based on Census 1990, 2000, and 2010. All median income, HPI and unemployment variables are the values in year t. Pre-Merger Mean is the mean value of the exposed groups in the year prior to the merger. Standard errors are clustered at tract level and are in parentheses. ***p<0.01, **p<0.05, *p<0.1

Appendix B

MAPS OF ALL SAMPLES

Figure A1: Eposed Tracts

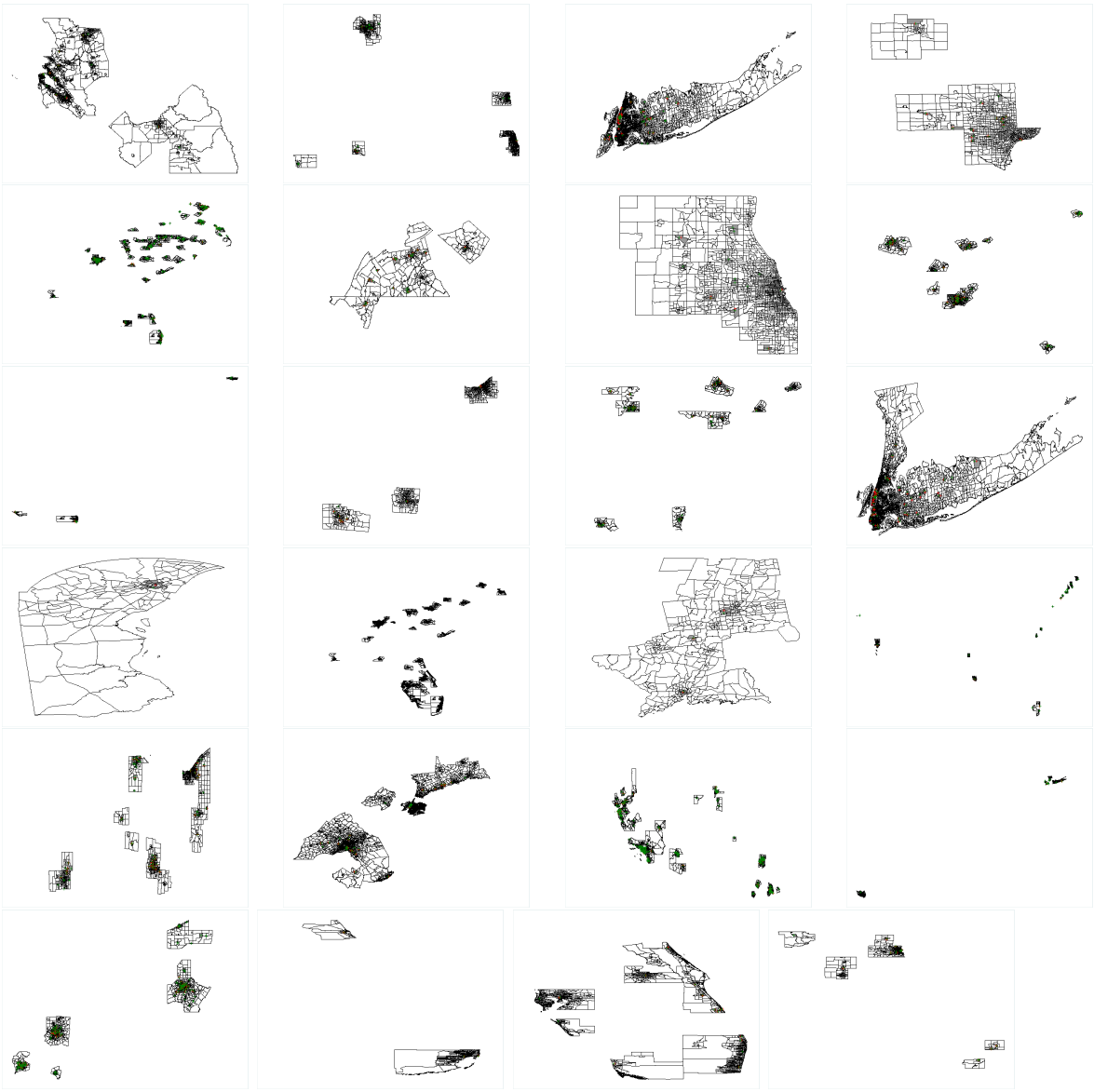
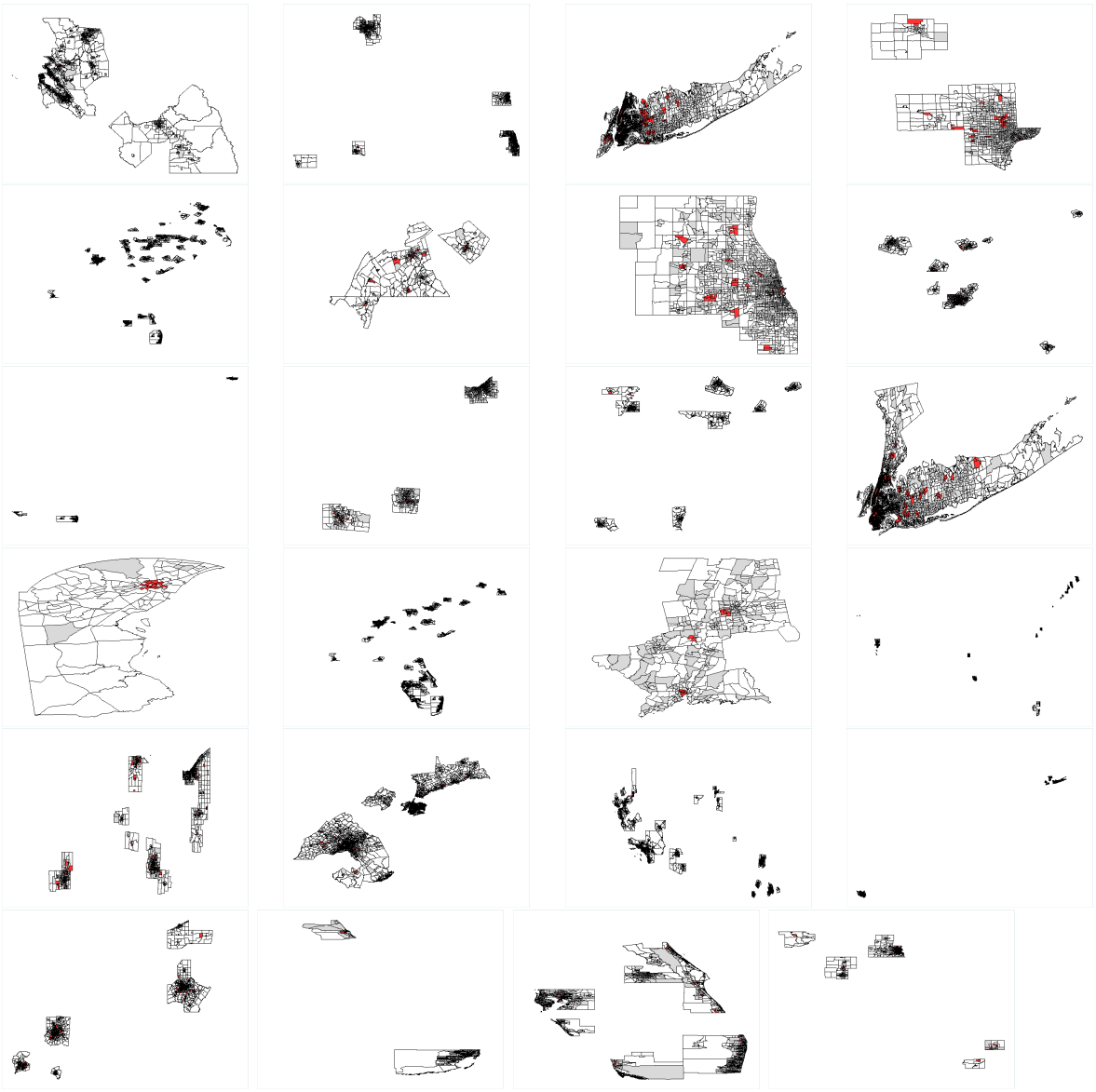


Figure A2: Sample



Appendix C

OTHER TABLES

Table C.1: Geocoding Accuracy

Year	Total Branches	Mapped Branches	Mapped Percentage	Unmapped Percentage
1998	83,314	76,176	91.43	8.57
1999	84,312	77,735	92.20	7.80
2000	85,492	79,391	92.86	7.14
2001	86,069	80,301	93.30	6.70
2002	86,577	81,424	94.05	5.95
2003	87,785	83,327	94.92	5.08
2004	89,785	85,774	95.53	4.47
2005	92,043	88,511	96.16	3.84
2006	94,752	91,454	96.52	3.48
2007	97,274	94,248	96.89	3.11
2008	99,163	97,353	98.17	1.83
2009	99,550	92,594	93.01	6.99
2010	98,519	95,391	96.82	3.18
2011	98,193	97,811	99.61	0.39
2012	97,340	96,934	99.58	0.42
2013	96,339	96,017	99.67	0.33
2014	94,725	94,495	99.76	0.24
2015	93,272	93,130	99.85	0.15
2016	91,861	91,722	99.85	0.15

Source: FDIC. Author's calculation. This table summarizes geocoding accuracy.

Table C.2: Total Number of Branch Closures, 1999-2016

Year	Total Number of Branch Closures
1999	2,446
2000	3,740
2001	2,522
2002	2,680
2003	2,189
2004	2,102
2005	2,008
2006	1,876
2007	1,914
2008	2,114
2009	3,128
2010	3,141
2011	2,326
2012	2,500
2013	2,558
2014	2,914
2015	2,777
2016	3,071
2017	1,011

Source: FDIC. Author's calculation. This table summarizes the total number of annual branch closures.