Strategic Complementarities in Bank Branching Decisions

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Abstract

Deregulation in the banking industry in the early 1990s stimulated banks to expand the size of their branch networks. This paper studies how complementarities between the branching decisions of rival banks, impacted the effects of deregulation. I use an instrumental variables approach to separately identify banks’ strategic response to rivals’ branching decisions, from common market factors. The results indicate that a bank is 74% more likely to open an additional branch if every one of their market rivals has also expanded their local network by one branch. I then estimate a model of consumer demand for banking services and bank branch network choices, to quantify the importance of accounting for this response when assessing the impact of deregulation. I find that the response to a rival merger or expansion is significant, and that strategic complementarities in the branching decision have contributed to banking markets being over-branched.

1 Introduction

In this paper I use bank branching decisions to study how firms react to increases in product quality by their rivals. This has important policy consequences, given that the effect that an event such as a merger has on the competitiveness of a local market, crucially depends on the reaction of other local competitors. While there is a substantial literature on how competitors respond in terms of the prices that they charge, there is less work studying the relationship between rival firms’ choices over product quality.¹ The direction of this response could have important implications for the welfare effects of policies that encourage investment in product quality, and its direction and magnitude could lead to an over- or under-investment in quality compared to if competitor reactions are ignored.

I study quality competition in the banking industry, where deregulations in the late 1980s and early 1990s encouraged banks to expand the size of their branch networks. This culminated in 1994 with the Riegle Neal Act, which deregulated interstate banking², and led to substantial growth in bank branch networks, both across markets and within incumbent markets. In this paper, I consider the number of branches a bank has

¹There is a growing literature that studies how endogenizing quality affects merger analysis, including Zhou (2008), Fan (2013), and Draganska, Mazzeo, and Seim (2009).
²While the Riegle Neal Act allowed for interstate branching as of 1997, many states had deregulated before that time. Thus, the timing of deregulation varied, and consolidation of the banking industry actually began earlier in the 1980s.
open as a measure of its quality. This is substantiated by surveys that show consumers’ banking choices are heavily influenced by the size of the bank’s branch network\(^3\), and by prior work that considers branching as a means of vertical differentiation (e.g. Dick (2007) and Cohen and Mazzeo (2007)).

The first goal of the paper is to then identify the nature of the strategic response to a rival bank expanding their branch network. The direction and size of this response has important implications for the overall effect of deregulation in banking. Theoretically the direction of this response is ambiguous. It depends on whether the main role of branching is to increase differentiation and lower price competition, or if the main driver of branch network expansion is to steal market share from competitors. To resolve the ambiguity in this setting, I use data on observed branch network sizes to estimate a model of how branching choices are related to the branch network sizes of competitors. I then look at how that response has shaped the size of local branch networks following the Riegle Neal Act, and how the resulting networks have affected local market competition, and ultimately welfare. If branching is predatory, in that it mainly leads to business stealing among competing banks, then banks will not take into account the negative effect an additional branch will have on competitors, when making their branching decision. In this case, complementarities in this branching decision will lead to an over-entry of branches, compared to an alternative where banks could commit to smaller branch networks.\(^4\) In the opposite direction, banks also do not internalize the increases in consumer surplus from opening additional branches.\(^5\) This could lead to an under-entry of branches, wherein complementarities would be welfare increasing.

To first identify whether branch network expansion is a strategic complement or substitute, I estimate a regression of the bank’s choice of the number of branches to open in a market, on the number of branches that their competitors have in the market. Competitor branches are endogenous due to unobserved market effects. The issue is similar to the reflection problem of Manski (1993). Turning to the peer effects literature, I instrument for the competitors’ number of branches in that market, with their number of branches in other markets in which the dependent variable bank does not compete. The number of competitor branches in these other markets, shouldn’t have an effect on the dependent variable bank’s number of branches, except through how it relates to that competitor’s number of branches in the market they are competing in. This is similar to the strategy used by Ellickson (2013), which looks at strategic complementarities in supermarket sizes. The results indicate that if the average number of competitor branches increases by one, then a bank is 73.9% more likely to add an additional branch themselves. I estimate a series of alternative specifications, and find that this result of strategic complementarities in the branching decision is robust to variations in the instrument and year of analysis.

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\(^3\)For each Survey of Consumer Finances since 1989, the most popular response to the question of what was the most important reason for choosing the institution for your main checking account, was the location of their offices. In 2013, 43.7% of respondents chose this reason, while the second most popular reason was the ability to obtain many services in one place, which was chosen by 18.0% of respondents.

\(^4\)Evidence that local banking markets tend to be over-branched can be found in Hallinan (2003) and Thompson (2004). Both are articles written after the Riegle Neal Act went into effect, observing how banks continued to pursue aggressive branching strategies in what were seen as “over-branched” markets.

\(^5\)These two countervailing effects are highlighted in Spence (1976), Mankiw and Whinston (1986), and more recently, empirically in Fan and Yang (2016)
I then look at how accounting for this complementarity in the bank branching decision, affects the measured impact of deregulation. I do this by estimating a structural model of bank branch network choice. In the model banks choose the number of branches to open in each market, taking into account the costs of branching, the demand effect that additional branches have, and the number of branches of their rivals. The effect branches have on demand is evaluated using a nested logit model, where consumers choose to place their deposits in the bank that gives them the highest utility. Utility depends on, among other things, the number of branches a bank has in the market, and also the number of branches the bank has relative to competitors. The effect of rival branches is broken down based on the competing bank's type, which is defined based on their bank charter and the geographic reach of their branch network. The estimation results indicate that competition for deposits is heaviest among banks of similar types.

With estimates of the nested logit demand model, I then use the branch choice model to estimate the costs of branching based on the necessary condition for a Nash equilibrium holding at the observed outcome. These estimates are then used to evaluate a series of counterfactuals aimed at uncovering the size of the complementary response, how it affects local branch network sizes, and the impact on welfare. I look at a pair of counterfactuals that simulate how banks respond to the expansion of one of their competitors, and another pair of counterfactuals that simulate the response to a merger between two local rivals. The results show a substantial response by local banks to the counterfactual event, justifying the importance of accounting for this response when assessing the impact of deregulation. I then look at if the expansion of branch networks has led to over-branching, by measuring the effect on consumer surplus and bank profits of the closing down of one branch in each market. I find that for 70% of markets, the closing down of one branch by the largest bank would be welfare increasing (and that for 82% of markets, the closing down of one branch by the smallest bank is welfare increasing). These results indicate that banking markets have too many branches, and that strategic complementarities in the branching decision most likely contributed to the over-branching.

1.1 Related Literature

This paper is related to the literature on banking markets, particularly that on branching decisions, and what determines the size of bank branch networks. Dick (2007) studies how bank quality (including the size of a bank’s branch network) is related to market size, and finds that quality is higher in larger markets. Adams and Amel (2016) look at how branching decisions are affected by past entry. They find that past entry is positively correlated with new entry, but that changes in the number of rival branches in a market has no significant effect on the probability of an incumbent bank adding more branches. This paper, as well as Amel and Liang (1997), also look at how branching decisions are affected by demographic characteristics, which I include in my analysis. The most similar paper to mine is Cohen and Mazzeo (2010), which analyzes

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6Seelig and Critchfield (2003), Berger, Bonime, Goldberg, and White (2004), and Keeton (2000), all too find a positive correlation between consolidation and bank entry, but these papers focus on new bank entry rather than entry through the expansion of existing banks' branch networks.
how branching decisions are affected by changes in local market structure. They find that increases in competition tend to lead to less branches, but that this response differs by bank type. My paper expands upon the results of that paper by focusing specifically on increases in competition due to rival branch network expansion.

The structural model I use in this paper also draws on the prior literature. The consumer demand model I develop is based on the model of Dick (2008), but uses a different nested logit specification. Here the nests are based on bank charter type and network reach, and consumer utility from branches is more nuanced, depending on the relative number of branches compared to rivals. Adams, Brevoort, and Kiser (2007) also estimate a similar demand model to test the substitutability between different types of institutions. They find that competition between banks of the same type is stronger than competition between banks of different types, a result that mirrors what I find in my estimation results. Another paper that focuses on consumer preference for branch networks is Ho and Ishii (2010), in which the authors use a spatial model where consumers experience disutility from having to travel long distances to a bank branch. They find that consumers do prefer banks with larger branch networks. They also find that consumer welfare has increased over the last two decades as branch networks have expanded, but they do not look at the role played by competing rivals’ branching decisions.

More broadly the results of this paper are consistent with models of endogenous sunk costs, à la Sutton (1991). This framework was applied to the banking industry previously in Dick (2007). Here I find that increases in branch network sizes can be explained by incumbent firms adding branches in response to their rivals’ expansion, and not be new firms entering the market. This is similar to what is found in an endogenous sunk cost model where larger market sizes lead to higher product qualities rather than more firm entry. Applying this framework to other settings has produced similar results. Using an identification strategy similar to that used in this paper, Ellickson (2013) finds strategic complementarities in supermarket sizes as evidence in favor of the Sutton (1991) model.

There are a variety of other papers that also look at quality competition by looking at firm response functions. Brueckner and Luo (2014) looks at airlines’ decisions on the frequency of flights to offer, and find complementarities in this decision. Kugler and Weiss (2016) looks at Austrian gas stations choosing their opening hours. They find that stations of the same network coordinate somewhat on opening hours implying strategic complementarities. Ferreria, Petrin, and Waldfogel (2012) studies the benefits of trade through its endogenous effect on product quality in the international movie industry. Using a nested logit demand model, they find that investing in quality exhibits strategic complementarities in their setting.

This paper is also part of a broader literature studying the effects of endogenizing the product quality choice. Zhou (2007) looks at how merger simulations are affected by post-merger changes to bank quality through changes to a bank’s branch network. Also, Cohen and Mazzeo (2007) use the strategy of Mazzeo (2002) to analyze banks’ decisions to enter as multi-market or single-market institutions. My paper comple-

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7There is also a broader literature that looks at the relationship between product quality and market concentration in other markets including Berry and Waldfogel (2001) (radio) and Mazzeo (2003) (airlines).
ments their work by looking at how this quality choice is affected by the quality choices made by rivals.

2 Industry Background and Data

Figure 1: Trend in Bank Institutions and Branches from 1990 to 2015

Between 1990 and 2010, the banking industry underwent a period of consolidation as seen in Figure 1. Over this time the number of banking institutions declined from just over 12,000 FDIC-insured commercial banks in 1990, to around 6,500 institutions in 2010. At the same time, the size of the remaining banks' branch networks steadily increased from around 51,000 total branches in 1990, to around 82,500 branches in 2010. This meant that the number of branches per institution increased over this time period from 4.1 branches per bank in 1990, to 12.6 branches per bank in 2010, as can be seen in Figure 2.8

Figure 2: Trend in Branches Per Bank Institution from 1990 to 2015

8The number of branches per institution continued to climb after 2010, up to 15.3 branches per institution in 2015, but this was mainly due to the continued decline in the number of banking institutions, rather than an expansion in existing banks' branch networks, which is the focus of this paper.
Much of the growth in bank branch networks in the 1990s, can be explained by efforts to deregulate prior restrictions on where banks could open branches. Prior to the 1970s, no bank could operate in more than one state, and the majority of states restricted banks to having no more than one branch. Throughout the 1970s and 1980s, many of these restrictions were removed. This culminated in 1994 with the Riegle-Neal Act, which removed all remaining restrictions to nationwide branching. Since that time, bank branch networks have steadily increased in size, both on the intensive and extensive margin. In addition to the number of branches per institution increasing, the number of banks operating in multiple counties has grown from 37.6% of banks in 2000, to 51.2% of banks in 2010.

2.1 Data
To empirically investigate the role that competition in branch network sizes played in this observed expansion, I use data from the Federal Deposit Insurance Corporation (FDIC) on bank branch locations and bank characteristics in 2010\(^9\). Branch locations, and the total dollar value of deposits at each branch, come from the FDIC’s Summary of Deposits (SOD). I then aggregate branches to the county level.\(^{10}\)

Data on bank characteristics comes from the Federal Reserve Board’s Report on Condition and Income (or Call Reports). These call reports contain the balance sheets and income statements of banks at the institution level. From them I get data on each bank’s total deposits, total assets, total interest income, total interest expenses, total number of employees, and their non-interest expenses, such as expenses on premises and fixed assets, and “other” expenses. I then impute the deposit (loan) interest rate from this data, by dividing total interest expenses (income) by total deposits (loans). These imputed rates do not vary at the market level. This may seem restrictive at first, but most of the prior literature, including Hannan and Prager (2004), Hetfield and Prager (2004), and Calem and Nakamura (1998), suggests that banks set rates that are uniform across large geographic areas.

I supplement the bank data with demographic data on each county. Data on county population and land area comes from the U.S. Census Bureau, and data on personal income, employment, and earnings comes from the Bureau of Economic Analysis. Together the sample consists of 7,075 banks or thrifts, across 3,115 U.S. counties. Table 1 contains summary statistics for the data set.

3 Complementarities in Bank Branching
The large size of bank branch networks shows that, even today, branches play an important role for banks. The 2013 Survey of Consumer Finances found that 43.7% of respondents cited “location of branch offices,” as the primary reason for choosing their particular banking institution. Even if consumer use of branches

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\(^9\) I only use a cross-section of data from one year (2010) so that I can ignore issues with timing lags between when a bank decides to open a branch, and when that branch actually opens and appears in the dataset.

\(^{10}\) The prior literature, including Amel, Kennickell, and Moore (2008), has found that banking markets continue to be relatively local markets, defined at either the MSA or county level.
Table 1: Data Summary Statistics for 2010

<table>
<thead>
<tr>
<th>Institution Variables</th>
<th>Num of Obs = 7,152</th>
<th>Mean</th>
<th>Median</th>
<th>Std. Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employees</td>
<td>269</td>
<td>375</td>
<td>4471</td>
<td></td>
</tr>
<tr>
<td>Assets ($000)</td>
<td>1,723,685</td>
<td>148,479</td>
<td>3.3 x 10^7</td>
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</tr>
<tr>
<td>Total Deposits ($000)</td>
<td>1,185,576</td>
<td>122,992</td>
<td>2.2 x 10^7</td>
<td></td>
</tr>
<tr>
<td>Total Loans ($000)</td>
<td>955,080</td>
<td>95,707</td>
<td>1.6 x 10^7</td>
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<tr>
<td>Interest Income ($000)</td>
<td>35,221</td>
<td>3,531</td>
<td>576,884</td>
<td></td>
</tr>
<tr>
<td>Interest Expenses ($000)</td>
<td>27,445</td>
<td>2,918</td>
<td>419,593</td>
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</tr>
<tr>
<td>Deposit Rate* (%)</td>
<td>0.602</td>
<td>0.651</td>
<td>0.279</td>
<td></td>
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<tr>
<td>Loan Rate* (%)</td>
<td>3.092</td>
<td>3.041</td>
<td>0.651</td>
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<table>
<thead>
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<th>Market Variables</th>
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<th>Mean</th>
<th>Median</th>
<th>Std. Dev</th>
</tr>
</thead>
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<tr>
<td>Population</td>
<td>99,739</td>
<td>26,309</td>
<td>318,323</td>
<td></td>
</tr>
<tr>
<td>Land Area (sqr. miles)</td>
<td>1,057</td>
<td>612</td>
<td>2,478</td>
<td></td>
</tr>
<tr>
<td>Per Capita Income ($)</td>
<td>33,872</td>
<td>32,110</td>
<td>7,832</td>
<td></td>
</tr>
<tr>
<td>Per Capita GDP ($)</td>
<td>40,073</td>
<td>39,807</td>
<td>6,564</td>
<td></td>
</tr>
<tr>
<td>Total Banks</td>
<td>8.9</td>
<td>6</td>
<td>9.6</td>
<td></td>
</tr>
<tr>
<td>Total Branches</td>
<td>31.4</td>
<td>11</td>
<td>78.1</td>
<td></td>
</tr>
<tr>
<td>Total Bank Deposits ($000)</td>
<td>2,446,449</td>
<td>385,285</td>
<td>1.4 x 10^7</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Market-Institution Variables</th>
<th>Num of Obs = 25,419</th>
<th>Mean</th>
<th>Median</th>
<th>Std. Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Branches</td>
<td>3.58</td>
<td>2</td>
<td>7.49</td>
<td></td>
</tr>
<tr>
<td>Deposits ($000)</td>
<td>274,048</td>
<td>61,238</td>
<td>2,254,227</td>
<td></td>
</tr>
</tbody>
</table>

*The deposit rate and loan rate are imputed from interest expenses and income, respectively.

declines\(^\text{11}\), they still are important for marketing the bank, as they represent the “face” of the institution (Cohen and Mazzeo (2010)). As noted by Dick (2007), branches can even take on an advertising role for the bank, similar to that of a flashy billboard. Banks with larger branch networks may also enjoy economies of scale in operation and management, as well as in screening for loans, where costly screening technologies can be spread over a larger customer base. Branch networks can also help banks geographically diversify their risks, as noted in Aguirregabiria, Clark, and Wang (2012), and can also help differentiate banks from non-banking alternatives, such as money market mutual funds and credit unions, which don’t rely on the same branch network structure that retail banks do. For all these reasons, the number of branches that a bank opens in each market, is an important determinant of the bank’s overall quality, affecting the bank’s demand and revenue, as well as costs.

In deciding how many branches to open in a market, banks need to consider the entire structure of the market they are competing in. This includes the number of branches their competitors have open. It is commonly observed that banks tend to open more branches in markets where their competitors also have larger branch networks. This can be seen in Table 2, which displays the correlations between the number of branches in each market, for each of the top 4 banks in 2010. The table shows a significant positive correlation between the branching decisions of these banks. Still, it is difficult to determine if this observation is due to

\(^{11}\) According to the 2015 Consumers and Mobile Financial Services Survey, 19.32% of respondents hadn’t visited a branch within the last month, and the mean and median number of branch visits within the last month were 2.33 and 2.0, respectively. In comparison, among survey respondents, the mean (median) number of ATM visits in the last month were 4.03 (2.0), the mean (median) number of times telephone banking was used were 2.99 (1.0), and the mean (median) number of times online banking was used were 8.96 (5.0).
banks making strategic choices to open branches in response to their rivals having larger branch networks, or is simply due to common observable or unobservable market characteristics. The empirical strategy employed below is meant to isolate the strategic response from the common market effect.

3.1 Theoretical Background

The prior theoretical literature on quality competition does not provide a clear answer on the nature of the strategic interaction in product quality choice. The direction of the response depends on the specific structure of the model. For example, consider a simple duopoly model where firms choose their number of branches \((B_1, B_2)\) in the first stage, and then set prices \((p_1, p_2)\) in the second stage in order to maximize profit \((\Pi_j(B_1, B_2, p_1(B_1, B_2), p_2(B_1, B_2))\) for \(j = 1, 2\)). Differentiating with respect to branches, one can find that the direction of each firm’s response function in branches will depend on the sign of \(\frac{\partial \Pi_j}{\partial B_1 \partial B_2}\). If the sign of this derivative is positive then bank \(j\) will respond to an increase in branch network size by their rival, by increasing their own number of branches (strategic complementarities). If the sign is instead negative, then banks will want to close down branches in response to rival expansion (strategic substitutes). As noted by Kugler and Weiss (2016), the sign of this effect will depend on whether the “differentiation effect” or the “demand stealing effect” is larger.

The “differentiation effect” can be seen in the model of Ronnen (1991), which itself is based on the models of vertical differentiation in Shaked and Sutton (1982) and Champsaur and Rochet (1989). Ronnen (1991) develops a model of a duopoly where each firm chooses quality in the first stage, and then competes in prices in the second stage. The model is presented here in the Appendix, where I also derive the signs of the above second derivatives. There it is shown that price competition intensifies as the difference in qualities between firms shrinks. Thus, when a high-quality firm increases their quality, this provides more room for the low-quality firms to increase their quality and avoid an increase in price competition. This increases the marginal return to a low-quality firm from increasing their quality. Similarly, when a low-quality firm increases their quality, this increases the incentives of the high-quality firms to differentiate themselves by increasing quality, thus also increasing the marginal return to a high-quality firm from adding quality. Therefore, in both cases there are strategic complementarities in the quality decision.

Valletti (2000) alters the model of Ronnen (1991) from Bertrand competition in the second stage to Cournot competition. The derivations of the response functions for this model can also be found in the

<table>
<thead>
<tr>
<th>Bank</th>
<th>Chase</th>
<th>BofA</th>
<th>Citi</th>
<th>WF</th>
<th>Other 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chase</td>
<td>1.0</td>
<td>0.778</td>
<td>0.747</td>
<td>0.664</td>
<td>0.785</td>
</tr>
<tr>
<td>Bank of America</td>
<td>0.778</td>
<td>1.0</td>
<td>0.749</td>
<td>0.833</td>
<td>0.892</td>
</tr>
<tr>
<td>CitiBank</td>
<td>0.747</td>
<td>0.749</td>
<td>1.0</td>
<td>0.575</td>
<td>0.758</td>
</tr>
<tr>
<td>Wells Fargo</td>
<td>0.664</td>
<td>0.833</td>
<td>0.575</td>
<td>1.0</td>
<td>0.879</td>
</tr>
</tbody>
</table>

Table 2: Correlation Between Number of Branches in Each Market for the Top 4 Banks
Appendix. In this case, while the high quality firm still increases their quality in response to an increase in quality by the low quality firm, quality is instead a strategic substitute for the low quality firm. This is because price competition is milder under Cournot competition. Thus, improving differentiation to avoid price competition is no longer the main driver in the quality response. Instead, a demand stealing effect dominates, where an increase in quality by the high quality firm, lowers the number of consumers that would be available to the low quality firm if they increased quality themselves. This lowers their incentive to increase quality, and so that choice is now a strategic substitute for low quality firms.

These contrasting models show how the particular structure of the model affects whether the “differentiation effect” or the “demand stealing effect” is greater, which then affects whether quality decisions are strategic complements or substitutes. Other features of the model matter as well. Models that emphasize horizontal differentiation in addition to vertical differentiation, tend to result in quality decisions being strategic substitutes rather than complements. Brueckner and Luo (2014) develop a model where airlines choose flight frequency (their quality choice), but that consumers also have brand preferences to choose one airline over the other (horizontal differentiation). In this case, an increase in quality by one firm, decreases the number of consumers available to their rival, and thus decreases the marginal return to that rival of also increasing their quality. Thus, theoretically the direction and size of this response function depends on the structure of the model. Therefore I turn to the data on observed branching decisions to resolve this ambiguity in the setting of bank branching.

3.2 Strategic Interaction Regression

To identify the nature of the strategic interaction between banks, I run a regression of a bank’s decision to add branches on their competitors’ number of branches. In particular, I model the bank’s choice of the number of branches to open in each market they have entered, by:

\[
MarketBranches_{im} = \beta_0 + \beta_1 \left( \frac{1}{N_m} \sum_{j \in m, j \neq i} MarketBranches_{jm} \right) + \beta_2 \left( \frac{1}{M_i} \sum_{m' \neq m} MarketBranches_{im'} \right) + \beta_3 X_i + \beta_4 W_m + \epsilon_{im}
\]

The dependent variable, \(MarketBranches_{im}\), is the number of branches bank \(i\) has in market \(m\). The regressors are \(\left( \frac{1}{N_m} \sum_{j \in m, j \neq i} MarketBranches_{jm} \right)\), which is the average number of branches of \(i\)'s competitors in market \(m\), \(\left( \frac{1}{M_i} \sum_{m' \neq m} MarketBranches_{im'} \right)\), firm \(i\)'s average number of branches outside of market \(m\), and \(X_i\) and \(W_m\), which are firm characteristics and market characteristics, respectively. The firm characteristics, \(X_i\), include the bank’s age and its size measured by its number of assets. The market characteristics, \(W_m\), are the county population, land area, per capita income, and population growth from 2000 to 2010.

The problem with estimating this model with simple OLS, is the endogeneity of the competitors’ number of branches. The endogeneity is caused by unobserved market effects that are not captured by \(W_m\). If
these unobserved market variables affect the market $m$ branch decisions of a bank $i$, and also the number of branches chosen by their competitors, then this could be misinterpreted as a strategic effect. Generally, the best way to deal with unobserved market effects, is to estimate the model with market fixed effects, but in this instance the variable of interest is a market variable (average market competitors’ number of branches), and the fixed effect would absorb this variable. As a first step, I add state fixed effects to control for large statewide shocks, but there still remains the problem of dealing with county-specific unobserved effects.

This problem is similar to the reflection problem first posited by Manski (1993), and found throughout the peer effects literature. To identify the strategic interaction effect, I thus turn to an instrumental variables approach that is common in this literature. The instrument I propose, is to use a competitor’s average number of branches in markets outside the market of interest, to instrument for their total number of branches inside the market. In calculating this out-of-market average, I only use markets in which the bank $i$ has no branches.

The idea behind this instrument is that a bank’s decision on the number of branches to open in each market, should be related across markets. For the instrument to be valid, it also must be the case that the competitors’ choices of the number of branches to open in markets that a particular bank $i$ has no presence in, are not correlated with any unobserved factors influencing that particular bank $i$’s choice of the number of branches to open in the markets that they do enter. This assumes that an institution $i$ only cares about their rivals’ number of branches in other markets, in that this is related to the number of branches these rivals have in markets that $i$ competes in.

Table 3 presents the results of this regression. The first column contains the results of the first stage regression. The coefficient on the instrument is positive and statistically significant. This indicates that the number of branches that rival banks have in other markets, does a good job of explaining the number of branches these banks have in the market of interest, or that the instrument is valid. The three columns to the right in Table 3, contain the results of the main regression. In the first column only state fixed effects are used, in the second column only institution fixed effects are used, and in the third column both sets of fixed effects are used.

The results show that there is a positive and significant relationship between the number of branches a bank opens in a market, and the average number of branches that competitors have in the market. Comparing the first and second specifications, state fixed effects decrease the magnitude of the strategic complementarity. This is expected in the presence of unobservable state characteristics that affect the branching decisions of all firms in the market. Still, the coefficient on competitor average branches remains positive and significant with the fixed effects. According to the final column, if the average number of competitor branches increases by 1 (or each of a bank’s rivals adds one additional branch), then a bank is expected to increase their number of branches by 0.7390 branches (or the bank is 73.9% more likely to add one additional branch).

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12Both Blume et al. (2010), and Hartmann et al. (2008), are good reviews of the identification issues commonly encountered in models of social interaction, and the potential solutions that can be found throughout the literature.

13One reason these decisions should be related, is that many bank characteristics are the same across markets, and so the marginal returns from adding branches are related across markets.
These findings suggest that the bank branching decision exhibits strategic complementarities.

### 3.3 Robustness Checks

I perform several robustness checks, and the results are provided in Table 4.\(^{14}\) One concern with the above identification strategy is with the definition of markets at the county-level. If unobserved demand shocks extend across county lines, then a shock that increases the number of branches of the dependent variable bank could also increase the number of branches a rival has in outside markets, if those markets are nearby. In this case, the above instrument would violate the exclusion restriction.

To see how this might affect the above estimation results, I again use competitors’ average number of branches in outside markets as an instrument, but only look at markets that are not adjacent to the market of interest and are farther than 20 miles away. Thus, the instrument now only includes branches by rivals in

---

\(^{14}\)Only the results of the IV regressions are provided in Table 4. The first stage estimation results are instead found in the Appendix.
markets that the dependent variable bank has no branches in and are farther than 20 miles away from the market of interest. I then run the same regression as before. The results are in column (1) of Table 4, and are very similar to those in the last column of Table 3.

To account for demand shocks that might spread out over an ever larger distance, I also calculate the instrument using only competitor branches in markets outside the state for which the dependent variable bank has no branches themselves. The results of the regression using this instrument are in column (2) of Table 4. The coefficient on competitor branches remains positive and statistically significant despite some loss in precision due to a decrease in the instrument’s relevance from ignoring a large set of counties.

Table 4: Strategic Interaction Regression Robustness Checks

<table>
<thead>
<tr>
<th>IV Regressions</th>
<th>DepVar: MarketBranches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exclude Adjacent Counties from IV (1)</td>
<td>Exclude Counties Only Include Branches Acquired by Merger in the IV (3)</td>
</tr>
<tr>
<td>Comp Branches Ave</td>
<td>0.7390 (5.14)</td>
</tr>
<tr>
<td>Population</td>
<td>9.00 × 10^{-7} (14.19)</td>
</tr>
<tr>
<td>Land Area</td>
<td>2.25 × 10^{-5} (1.31)</td>
</tr>
<tr>
<td>Per Capita Income</td>
<td>4.40 × 10^{-5} (8.60)</td>
</tr>
<tr>
<td>Population Growth</td>
<td>-0.0150 (-0.11)</td>
</tr>
<tr>
<td>Institution FE</td>
<td>Yes</td>
</tr>
<tr>
<td>State FE</td>
<td>Yes</td>
</tr>
<tr>
<td>Obs</td>
<td>24,434</td>
</tr>
<tr>
<td>R²</td>
<td>0.1259</td>
</tr>
</tbody>
</table>

The t-statistic associated with each parameter estimate is given in parentheses below the estimate. The first stage results associated with each IV regression are given in the Appendix.

A second robustness check I perform is to use only competitor branches acquired by merger in constructing the instrument. Mergers are generally executed at the national level and so are less likely to be driven by a demand shock in a particular county. Therefore, I use as an instrument the average number of branches that competitors acquired by merger in outside markets in which the dependent variable bank has no presence in.

The results of the regression with this instrument are in column (3) of Table 4. The coefficient on competitor branches does go down to 0.5623, but remains statistically significant. The decrease in the coefficient does suggest that the complementary response is weaker for rivals that increase their branch networks mainly through mergers rather than de novo branch openings.

As a further check, I also look only at competitor branches acquired in mergers after the Riegle-Neal Act went into effect in the given state. Branches that were acquired before this time are more likely to be a result of a local demand shock compared to branches acquired by merger after the state allowed for...
interstate branching. The results of the regression using this instrument are in column (4) of Table 4. The coefficient on competitor number of branches is almost identical in columns (3) and (4), indicating that excluding branches acquired by merger before the Riegle-Neal Act from the instrument, does not affect the results.

A third robustness check I perform is to look at prior years and see if the strategic complementary remained. I estimate the same regression based on the branch network structure in 2000, and then for the branch network structure in 2005. The results for 2000 are in column (5), and the results for 2005 are in column (6). The strategic interaction coefficient is higher in both 2000 and 2005. The coefficient is 1.2379 in 2000 and 1.1448 in 2005, as opposed to 0.7390 in 2010. Thus, it appears that branches opened after 2005 are less likely to be a result of complementarities compared to older branches.

I also estimate the same model using a different instrument. In this case I instrument for rivals’ average number of branches with the average distance to those rivals’ headquarters. The idea behind this instrument is that rival banks will have more branches in markets that are closer to their headquarters, and so it should be relevant. The instrument is exogenous if the unobserved factors that affect a bank’s decision on how many branches to open in a market, are unrelated to the average distance of the market to their competitors’ headquarters. This could be violated if rival banks cluster their headquarters in large cities.

The results of the regression using this instrument are in column (7) of Table 4. The coefficient on competitor branches goes up to 0.9579 in this case. This is likely because bank headquarters are clustered in certain markets. Thus, the average distance from rival banks’ headquarters is likely correlated with the dependent variable bank’s distance to their headquarters, which in turn affects their decision of how many branches to open in the market.

As a final robustness check, I run a market level regression of deposits per branch on the number of branches in the market and other market variables. This is meant to check whether the identified complementarity in competing banks’ branch investment decisions, is actually strategic rather than being driven by banks jointly branching in more profitable markets. I add branches, deposits, and demographic data going back to 1999, so that I have a panel of markets from 1999 to 2010. The regression is run with and without market fixed effects. The results of the regression are in Table 5, and they show that markets with more branches have lower deposits per branch. This shows that branch network expansion does not expand the deposit market for banks, but instead mostly leads to market share stealing between banks. This is further evidence that the above complementarities are strategic rather than solely a result of banks jointly opening branches in markets with the most available deposits.

This also indicates that some markets may be over-branched due to these strategic complementarities in branching decisions. Prior work in the banking industry has also found that banks tend to build branches in over saturated markets in an effort to steal customers away from their competitors, rather than penetrate less supplied markets. Such an “arm’s race” can be harmful to the industry as whole, as these markets

---

15Cohen and Mazzeo (2010) find that banks tend to have more branches when competing against multi-market banks. Chang, Chaudhuri, and Jayaratne (1997) look at the bank branching decision in New York City and find evidence of rational herding.
Table 5: Regression of Market Level Deposits Per Branch on Branches: 1999-2010

<table>
<thead>
<tr>
<th>Dep : ln(Deposits/Branch)</th>
<th>OLS</th>
<th>Market FE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ln(Branches)</td>
<td>-0.2903</td>
<td>-0.6419</td>
</tr>
<tr>
<td></td>
<td>(-116.5)</td>
<td>(-190.7)</td>
</tr>
<tr>
<td>ln(Institutions)</td>
<td>0.0454</td>
<td>0.0372</td>
</tr>
<tr>
<td></td>
<td>(18.9)</td>
<td>(12.8)</td>
</tr>
<tr>
<td>ln(Population)</td>
<td>0.3937</td>
<td>1.2710</td>
</tr>
<tr>
<td></td>
<td>(247.3)</td>
<td>(232.9)</td>
</tr>
<tr>
<td>ln(Per Capita Income)</td>
<td>0.6723</td>
<td>0.8031</td>
</tr>
<tr>
<td></td>
<td>(207.4)</td>
<td>(302.0)</td>
</tr>
<tr>
<td>ln(Per Capita GDP)</td>
<td>0.1961</td>
<td>0.2268</td>
</tr>
<tr>
<td></td>
<td>(40.2)</td>
<td>(29.7)</td>
</tr>
<tr>
<td>ln(Land Area)</td>
<td>-0.0635</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(31.8)</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-1.644</td>
<td>-12.490</td>
</tr>
<tr>
<td></td>
<td>(-31.9)</td>
<td>(-149.5)</td>
</tr>
</tbody>
</table>

The t-statistic associated with each parameter estimate is given in parentheses below the estimate.

become costly to enter without much of a return in deposit revenue. Strategic complementarities in branching imply that banks with large branch networks will raise the equilibrium level of branches for all firms in the markets that they enter. This could make it difficult for smaller firms to still compete in these markets, as it essentially raises the costs of market participation. This could partially explain some of the industry wide consolidation over the last 20 years. This is further investigated in the next section, where I develop a structural model of the bank’s decision to add branches. This is done in order to take a closer look at how complementarities between rival bank branch network sizes, have affected the impact of deregulation on local market structures and welfare.

4 Empirical Model of Deposit Demand and Bank Branch and Deposit Rate Choice

In this section I develop a two-stage model of the banking industry. In the first stage firms decide how many branches to open in each market. In the second stage they then choose deposit rates, and collect deposits based on a model of demand for banking services. The initial branching decision takes into account the costs of building branches, and the effect branches will have on revenue in the second stage, through the consumer demand model. The demand model is specified as a nested logit model. I also assume that bank branching

According to Aspan (2013), banks are not building branches so that, “more rural customers have better access to them.” Instead they are building branches in “over saturated areas like New York, in the hopes of getting a few affluent customers to defect from the rival bank right across the street.”
decisions are made independently across markets. I start by explaining the demand model in Section 4.1, and then work backwards to the bank’s first stage branch choice, which is described in Section 4.2.

4.1 Demand

Consumers in each market face a discrete set of choices of depository institutions. Each market \( m = 1, \ldots, M \), contains \( J_m \) banks indexed by \( j = 0, 1, \ldots, J_m \) (where \( j = 0 \) is the outside option). Firms are classified into \( G \) groups based on their charter type, and whether they are a single branch bank, a single market bank with multiple branches, a single state bank operating in multiple markets, or a multi-state bank. This grouping captures differences between local community banks and larger multi-state banks.\(^\text{16}\) I denote the set of banks in a particular group \( g \) in market \( m \) as \( \mathcal{J}_{gm} \), and the set of all banks in market \( m \) as \( \mathcal{J}_m \).

Each consumer \( i \) in market \( m \), will choose to place all of their deposits in the bank (or outside option) that gives them the highest level of utility. The utility that consumer \( i \) receives from bank \( j \) in group \( g \), located in market \( m \), is given by:

\[
U_{ijm} = \beta_0 + \beta_1 R_j + B_{jm} \ast \left( \beta_0 + \beta_2 B_{jm} + \sum_{g'} \sum_{j' \in \mathcal{J}_{g'm}} \lambda_{gg'} B_{j'm} \right) + \beta_3 X_j + \delta_{jm} + \zeta_{ig} + (1 - \sigma) \epsilon_{ijm} \tag{2}
\]

\( R_j \) is the deposit rate of bank \( j \), and \( B_{jm} \) is the number of branches that bank \( j \) has open in market \( m \). The marginal utility that a consumer receives from an additional bank branch depends on a constant (\( \beta_1 \)), the number of branches the bank has (\( \beta_2 \)), and then the number of branches the bank’s rivals have in that market. The effect that rival branches have on marginal utility, \( \lambda_{gg'} \), depends on both the type of the bank, and the type of the rival. These coefficients measure how consumers value branches relative to the number of branches of rival banks, and how that depends on how similar the banks are in terms of type.

Consumer utility also depends on observable bank characteristics, \( X_j \). This includes the bank’s age and its number of employees per branch. Utility also depends on unobservable bank characteristics, \( \delta_{jm} \). Finally, utility depends on an unobservable composite term \( \zeta_{ig} + (1 - \sigma) \epsilon_{ijm} \). This term is associated with the nested logit model of Berry (1994). This model avoids the restrictive substitution patterns imposed by a simple logit demand model, by allowing for consumer preferences to be correlated among banks in the same group. The term \( \epsilon_{ijm} \) is a consumer-bank unobservable term that is distributed iid according to the type 1 extreme value distribution. The term \( \zeta_{ig} \) is an unobservable term that is common to all banks in group \( g \), and measures the preference that consumer \( i \) has for banks of type \( g \). The distribution of this unobservable is such that the term \( \zeta_{ig} + (1 - \sigma) \epsilon_{ijm} \) has an extreme value distribution. The parameter \( \sigma \) lies between 0 and 1, and is a parameter to be estimated. It measures how correlated consumer preferences are for banks of the same group. If \( \sigma = 0 \), then the model simplifies to the simple logit model, where \( \zeta_{ig} \) plays no role in the consumer’s choice. Then consumers are just as likely to switch to banks in the same group as they are

\(^{16}\)The decision to group banks based on their “type” was motivated by the results of Cohen and Mazzeo (2007). They separate single-market and multi-market banks, and find that how these banks respond to increases in competition, crucially depends on their type.
to switch to banks in different groups. As σ approaches 1, the role of the independent shock \( \epsilon_{ijm} \) is reduced, and so consumer tastes become perfectly correlated across banks in the same group.

The mean level of utility for each bank \( j \) in market \( m \), is then defined as:

\[
U_{jm} = \beta_0 + \beta_r R_j + B_{jm} \times \left( \beta_b + \beta_{b2} B_{jm} + \sum_{g' \in g' \setminus j} \lambda_{gg'} B_{j'm} \right) + \beta_x X_j + \delta_{jm}
\]  

(3)

The mean utility of the outside option is normalized to zero in each market. Then the predicted market share of a bank \( j \) from group \( g \) in market \( m \), is given by:

\[
s_{jm} = \frac{\exp \left\{ U_{jm}/(1 - \sigma) \right\}}{\sum_{j' \in J_{gm}} \exp \left\{ U_{j'm}/(1 - \sigma) \right\}} \times \frac{\left[ \sum_{j' \in J_{gm}} \exp \left\{ U_{j'm}/(1 - \sigma) \right\} \right]^{1-\sigma}}{\left[ 1 + \sum_{g=1}^G \sum_{j' \in J_{gm}} \exp \left\{ U_{j'm}/(1 - \sigma) \right\} \right]^{1-\sigma}}
\]  

(4)

The first term is the within-group market share of bank \( j \), and the second term is group \( g \)'s total share of the entire market \( m \).

Market shares are defined in the data as the total dollar value of deposits of a bank over the total number of available deposits in a market.\(^{17}\) The total number of market deposits is set equal to total income in the market. I choose this definition for the market size so that the outside option encompasses the many different alternatives that consumers have for depositing their income, rather than just thrifts and credit unions, which has been used in the prior literature. The estimating equation is then given by:

\[
\log(s_{jm}) - \log(s_{0m}) = \beta_0 + \beta_r R_j + B_{jm} \times \left( \beta_b + \beta_{b2} B_{jm} + \sum_{g' \in g' \setminus j} \lambda_{gg'} B_{j'm} \right) + \beta_x X_j + \sigma \ln(s_{j/g}) + \delta_{jm}
\]  

(5)

where \( s_{j/g} \) is the first term in equation (4), or bank \( j \)'s within-group market share.

The within-group market share is endogenous, as is the deposit rate, and so instruments are needed for these variables. As instruments for the deposit rate, I use a pair of cost shifters. The first is expenses on premises and fixed assets, which includes costs for maintenance, utilities, lease payments, etc. The second is “other” expenses in the bank call reports, which measures operating costs such as fees and taxes. Both of these measures are normalized by the bank’s total assets. I also use labor costs as an instrument for the rate, which I proxy for with mean market wages from the Bureau of Economic Analysis.\(^{18}\) I assume, like much of the prior literature, that the other observed bank characteristics, are not correlated with the unobserved bank quality term, \( \delta_{jm} \).\(^{19}\) Therefore, to instrument for the within-group market share, I use the exogenous characteristics of rival banks in the same group.

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\(^{17}\)Data on the number of deposit accounts for each bank at the market level is not available (it is available for the bank as a whole), and so market share is based on deposit dollars.

\(^{18}\)I also have data on employee salaries, but do not use salaries as an instrument since it contains quality components that would be correlated with unobserved bank quality.

\(^{19}\)Dick (2008) makes the argument that bank characteristics such as the number of employees, take time to adjust to unobserved demand shocks. Thus, they are less likely to be correlated with these shocks, compared to deposit rate which can adjust quickly, and is thus more likely to be correlated with unobserved shocks.
4.2 Bank Choice Model

On the supply-side, banks choose how many branches to open, and what deposit rate to set, taking into account the demand model of the previous section. Markets are assumed to be independent of each other, and firms are assumed to have complete information. Banks simultaneously choose their number of branches, $B_{jm}$, in order to maximize profits given by:

$$\Pi_{jm} = VP_{jm}(B_{jm}, B_{-jm}, \cdot) - VC_{jm}(B_{jm}) - FC_{m}$$ (6)

$VP_{jm}(B_{jm}, B_{-jm}, \cdot)$ is the bank’s variable profits from deposits based on their choice of deposit rate, and the demand model from the previous section. The variable profits are specified as:

$$VP_{jm} = (L_{jm} - R_{jm} - mc_{jm}) \cdot D_{m} \cdot s_{jm}(B_{jm}, B_{-jm}, R_{jm}, R_{-jm}, \cdot)$$ (7)

where for each bank $j$ in market $m$, $L_{jm}$ is their loan rate, $R_{jm}$ is their deposit rate, and $mc_{jm}$ is their marginal cost of deposit collection. This equation assumes that banks profit off of deposits by issuing loans of the same dollar amount at rate $L_{jm}$. This assumption has been made before in prior work on banking.\textsuperscript{20}

The total dollar value of deposits available in the market is given by $D_{m}$, and $s_{jm}(\cdot)$ is the the market share of firm $j$ in market $m$, which is determined by the nested logit demand model from the previous section.

I assume that $L_{jm}$ is determined exogenously, and that in the second stage banks only choose deposit rate, $R_{jm}$. Taking their branch network, and that of their rivals, as given, firms choose their deposit rates assuming Bertrand competition. Thus, optimal deposit rates must satisfy the following first order condition:

$$(L_{jm} - R_{jm} - mc_{jm}) = s_{jm}(\cdot) \frac{\partial s_{jm}(\cdot)}{\partial R_{jm}}$$ (8)

I assume that the marginal costs of deposit collection are a constant parameter that does not vary with the number of branches a bank opens or closes. The first order condition can be rearranged into:

$$mc_{jm} = L_{jm} - R_{jm} - s_{jm}(\cdot) \frac{\partial s_{jm}(\cdot)}{\partial R_{jm}}$$ (9)

This condition is used to determine the firm-market marginal cost parameter, $mc_{jm}$, in estimation.

The costs of opening a branch are then broken down into variable costs that depend on the number of branches the bank builds, and fixed costs, which are the same for all firms in market $m$. The variable costs take the form of:

$$VC_{jm} = \gamma_{1jm} B_{jm} + \gamma_{2jm} B_{jm}^2$$ (10)

\textsuperscript{20}The prior literature that has used a similar function for bank variable profits includes Ishii (2008), Zhou (2007), and Dai and Yuan (2013). Another interpretation of this variable profit equation is that $L_{jm}$ is the marginal return on deposits, which doesn’t necessarily just come from issuing loans, but also other ways banks can profit off of consumer deposits. Since $L_{jm}$ is imputed in the data from interest income, this interpretation that it is not an observed interest rate on a loan product, but instead some average rate of return on deposits, makes sense.
Notice that the coefficients are specific to each firm-market. Since the number of branches is not a continuous variable, I estimate these parameters using the necessary conditions for a Nash equilibrium in branches. These necessary conditions are that at the optimal choice of branches, $B^*_{jm}$, the following must hold:

$$
\Pi_{jm}(B^*_{jm}, B^*_{-jm}, \cdot) \geq \Pi_{jm}(B^*_{jm} + 1, B^*_{-jm}, \cdot) \tag{11}
$$

$$
\Pi_{jm}(B^*_{jm}, B^*_{-jm}, \cdot) \geq \Pi_{jm}(B^*_{jm} - 1, B^*_{-jm}, \cdot) \tag{12}
$$

These two conditions are then used to infer the values of the variable cost parameters in equation (10).

To then get the fixed cost parameter, I use the free entry condition that:

$$
\Pi_{jm}(B^*_{jm}, B^*_{-jm}, \cdot) \geq 0 \quad \forall j \in J_m \tag{13}
$$

I set the fixed cost of entry in each market equal to the highest value at which this condition will still hold for all firms in the market. In other words, the fixed cost parameter is set so that the least profitable firm in each market is just breaking even at the observed branch networks.

### 4.3 Strategic Complementarities in the Model

As described in Section 3.1, the direction of the strategic response will depend on the relative magnitudes of two effects. One is that branching by rivals affects bank differentiation, which then affects the intensity of price competition. Secondly, branching directly affects market shares since consumer utility depends on each bank’s number of branches. The degree to which each of these effects impacts bank responses to rival branching, depends on the parameter estimates of the model, and the characteristics of the banks and markets involved.

For the above model, the marginal revenue a bank receives from an additional branch is given by:

$$
\frac{\partial VP_{jm}}{\partial B_{jm}} = D_m \left( (L_{jm} - R_{jm} - mc_{jm}) \left( \frac{\partial s_{jm}(\cdot)}{\partial B_{jm}} + \sum_{k \in J_m} \frac{\partial s_{jm}(\cdot)}{\partial R_{km}} \frac{\partial R_{km}}{\partial B_{jm}} \right) - s_{jm}(\cdot) \frac{\partial R_{jm}}{\partial B_{jm}} \right) \tag{14}
$$

where

$$
\frac{\partial s_{jm}(\cdot)}{\partial B_{jm}} = \frac{\partial U_{jm}}{\partial B_{jm}} \left( \frac{1}{1 - \sigma} \right) \left( 1 - \sigma \frac{s_{jm}(\cdot)}{s_{jm}(\cdot)} - (1 - \sigma) s_{jm}(\cdot) \right) s_{jm}(\cdot) \tag{15}
$$

The size of the demand stealing effect depends on several parameters. This includes the coefficients on the interaction terms between branches and rival branches in equation (5). The signs of these parameters determine the direction that $\frac{\partial U_{jm}}{\partial B_{jm}}$ will move when a rival opens a branch. Thus, these parameters are key in determining whether opening branches is a complementary or substitutable action between competitors. These parameters are identified by how variation in the number of competitor branches of a particular type, affects the relationship between the number of branches a bank has and their market share. If in markets
where a bank’s rivals of a particular type have many branches, there is a stronger positive correlation between own branches and market share, then this will lead to a positive coefficient on the interaction term. If in markets where a bank’s rivals of a particular type have lots of branches, there is less correlation between own branches and market share, then that will lead to a negative estimate for the interaction coefficient.

The $\sigma$ parameter is important for determining the relative role of group and overall market competition in influencing the nature of strategic interaction between rival banks. This parameter determines whether an additional branch from a bank of a particular type, leads mainly to business-stealing or market expansion for banks of that type. If $\sigma$ is close to 0, then adding branches is going to take market share away from all other banks (and the outside option) equally, and is going to lead to market expansion. On the other hand, if $\sigma$ is close to 1, then as a bank adds branches, they are going to take a larger portion of their increased market share away from similar banks in the same group.

The impact branching has on price competition then depends on the relative magnitude of the parameter on deposit rate. As seen in equation (14), rival branching also affects $\frac{\partial V_{jm}}{\partial B_{jm}}$, by affecting a bank’s pricing adjustment when adding a branch. The term $\sum_{k \in J_m} \frac{\partial s_{jm}(\cdot)}{\partial R_{km}} \frac{\partial R_{km}}{\partial B_{jm}}$ in equation (14), determines how rival firms’ rate adjustments to bank $j$ adding a branch, affect bank $j$’s market share. When rivals are more differentiated, this response, which lowers $\frac{\partial V_{jm}}{\partial B_{jm}}$, is smaller. The final term in equation (14) is the direct price effect. The more differentiated a bank is from their rivals, the more they will adjust their rate downward post-expansion, which increases $\frac{\partial V_{jm}}{\partial B_{jm}}$. The magnitude of both of these effects depends on the estimated parameter on deposit rate.

### 4.4 Nested Logit Results

Table 6 presents the results of estimating the nested logit model from equation (5). To reduce the number of parameters that need to be estimated, I assume that the effect that rival branches of a different type have on marginal utility ($\lambda_{gg'}$, for $g' \neq g$), is the same for all rival types, $g'$. This means that for each of the 16 types of banks, there are two parameters to estimate: the effect of rival branches of the same type, and the effect of rival branches of different types. Table 6 only displays the estimated interaction parameters for a subset of 8 (out of the total 32 interaction parameters) of the most popular bank types.21 The first column presents the results of an OLS regression of the simple logit version of the model without nests, the second column presents results of the nested logit where only the within-group market share is instrumented for, and the third column instruments for both deposit rate and the within-group market share. Finally, the fourth column shows the results where the competitor branch effects are aggregated across all bank types.

Looking at the results in the third column, where both deposit rate and group market share are instrumented for, the value of $\sigma$ is significant and close to 1 with a value of 0.8310. This indicates that consumers have a strong preference for particular types of banks, and are more likely to substitute between banks of the same group. This means that as firms in the same group add branches, they mostly steal market share

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21 The complete table of results is available upon request.
The results of Table 6 also indicate that consumers prefer banks with more branches. The coefficient away from other banks in that group.
on branches is statistically significant and consistent across all four specifications. For the most part, the interaction terms also maintain the same signs across the different specifications. For specification (3), all but 2 of the own-group branch coefficients are positive and statistically significant. For banks of these types, this indicates that consumers value additional branches more if rivals of the same type have more branches. This may be a result of consumers viewing branches in relative terms rather than absolute terms. This could explain why survey evidence shows that consumers prefer banks with more branches, but that they don’t actually use those branches very often. This supports the notion of branches as a form of advertising, since advertising exhibits a similar feature, where the benefits to advertising are generally in relation to the amount of advertising dollars spent by rivals.\(^{22}\)

The coefficients on the interaction terms for banks of different types are mostly negative. This implies that while strategic complementarities may exist between banks of the same type, opening branches will most likely be a strategic substitute for banks of different types. The results in Table 6 also indicate that consumers prefer older banks and banks with more employees per branch.

The deposit rate elasticities for firms in a selection of the groups, using the preferred estimates from specification (3), are given in Table 7. The overall mean own-price elasticity is 1.7596. The own-price elasticity is highest for state-chartered banks that operate in one state, but multiple counties in that state (2.4843), and lowest for nationally-chartered multi-state banks (1.3987). This makes sense if we think that larger branch networks improve the quality of the bank and reduce the price sensitivity of its customers.

Cross-price elasticities are also much higher in magnitude for banks of the same type compared to those of different types. The overall mean cross-price elasticity among banks of the same type is -1.3221, while the overall mean cross-price elasticity among banks of different types is -0.0329 (this is the effect that a 1% increase in that bank’s deposit rate has on other banks’ market shares). This again shows that competition is strongest among banks of the same type, and that consumers mostly substitute between banks of a similar type. The lowest mean cross-price elasticities are for nationally chartered multi-state banks, at -0.5380 for banks within the same group, and -0.0167 for banks outside their group. These elasticities indicate that price competition between multi-state banks and other bank types is usually pretty soft. This means that multi-state banks will care less about differentiating from other bank types when making their branching decision, which also affects their strategic response to larger rival branch networks.

5 Counterfactual Scenarios

In this section, I use the above branch choice model to simulate a series of counterfactuals to get a sense of the magnitude of the strategic response to a rival’s increase in branch network size, how that response affects the structure of local banking markets, and the impact on welfare.

\(^{22}\)Papers that study the prisoner’s dilemma inherent in this view of advertising include Chen, Joshi, Raju, and Zhang (2009), Erickson (2003), Horvath, Leeflang, Wieringa, and Wittink (2005), and Steenkamp, Nijs, Hanssens, and Dekimpe (2005).
Table 7: Nested Logit Regression: Average Elasticities for Firms in Selected Groups using Specification (3) Demand Estimates

<table>
<thead>
<tr>
<th></th>
<th>Own-Price Elasticity</th>
<th>Cross-Price Elasticity (Own Group)</th>
<th>Cross-Price Elasticity (Outside Group)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Median</td>
<td>St. Dev</td>
</tr>
<tr>
<td>National Charter Multi-State</td>
<td>1.2987</td>
<td>1.0089</td>
<td>0.9518</td>
</tr>
<tr>
<td>National Charter Single-State, Multi-County</td>
<td>1.5956</td>
<td>1.0543</td>
<td>1.2979</td>
</tr>
<tr>
<td>State (FRB) Charter Multi-State</td>
<td>1.3554</td>
<td>1.0244</td>
<td>1.1115</td>
</tr>
<tr>
<td>State (FRB) Charter Single-State, Multi-County</td>
<td>1.5738</td>
<td>0.9117</td>
<td>1.3066</td>
</tr>
<tr>
<td>State (FDIC) Charter Multi-State</td>
<td>1.9580</td>
<td>1.7998</td>
<td>1.3580</td>
</tr>
<tr>
<td>State (FDIC) Charter Single-State, Multi-County</td>
<td>2.4843</td>
<td>2.4305</td>
<td>1.4596</td>
</tr>
<tr>
<td>State (FDIC) Charter Single-County</td>
<td>1.6003</td>
<td>0.8922</td>
<td>1.3796</td>
</tr>
<tr>
<td>State (FDIC) Charter Single-Branch</td>
<td>1.8566</td>
<td>1.4187</td>
<td>1.5611</td>
</tr>
<tr>
<td>Overall</td>
<td>1.7596</td>
<td>1.3562</td>
<td>1.3622</td>
</tr>
</tbody>
</table>

This table shows the mean, median, and standard deviation of own-price and cross-price elasticities for firms in the 8 most populated groupings. The cross-price elasticities are the effect a price change by a firm in the row group, has on the market share of firms in the column group.

5.1 Counterfactual Response to Competitor Expansion

The first two counterfactuals simulate how banks respond to the expansion of one of their local rivals. These counterfactuals are informative of how local firms responded to the pervasive expansion of branch networks following deregulation in the early 1990s (as evidenced previously in Figures 1 and 2). In the first counterfactual, one branch is added to the local network of the smallest (where smallest is defined in terms of market share) bank in the market. The above model is then used to simulate rival banks’ responses to this expansion, in terms of their choices of deposit rate and number of branches. The second counterfactual setup is similar, but the additional branch is instead opened by the largest bank in the market, and their rivals’ responses are then simulated. I run these two counterfactuals for each market in the U.S., assuming that markets are independent of one another.

To simulate the response to each of the counterfactual situations, I resolve for the equilibrium in each local market under the counterfactual scenario. In equilibrium, each bank chooses the number of branches to open in order to maximize profit. Profit depends on the revenue a bank receives from their branches,
calculated using the demand model of Section 4.1, and the cost of opening branches, which is estimated using the equilibrium conditions (11) and (12). These 2 conditions provide a lower and upper bound on the cost of opening a branch, and I set the cost parameters for each bank to the midpoint between these bounds. I restrict each firm’s choice set on the number of branches to open or close, by allowing each firm to at most increase or decrease their number of branches by 3 compared to the observed equilibrium. This is done to avoid outliers. I also do not allow the firm that initially expands, to further adjust their number of branches in calculating the new equilibrium (but do allow them to adjust their deposit rate in response to market changes), since I am interested in the equilibrium response of their competitors. I expect there to be multiple equilibria for each market, and so I use an algorithm that finds the equilibrium that is closest to the observed one.\footnote{The counterfactual equilibrium I compute is closest to the observed one in the sense that my algorithm starts at the observed equilibrium, and iteratively allows firms to add or close branches, or exit the market. Refer to the Online Appendix in Kuehn (2017) for a description of this algorithm.}

Table 8: Counterfactual Response to the Smallest Bank in the Market Opening an Additional Branch

<table>
<thead>
<tr>
<th>Average Market Response Change in Branches</th>
<th>All Markets</th>
<th>Below Med PCI</th>
<th>Above Med PCI</th>
<th>Rural</th>
<th>Small City</th>
<th>Large City or Metro</th>
</tr>
</thead>
<tbody>
<tr>
<td>By Firms of Same Type as Adding Bank</td>
<td>+0.2084</td>
<td>+0.2158</td>
<td>+0.2010</td>
<td>+0.2325</td>
<td>+0.2424</td>
<td>-0.3113</td>
</tr>
<tr>
<td>By Firms of Different Types</td>
<td>+0.3985</td>
<td>+0.2877</td>
<td>+0.5093</td>
<td>+0.2861</td>
<td>+0.6460</td>
<td>+0.8742</td>
</tr>
<tr>
<td>By Firms that Have Over 50% of their Nest’s MS</td>
<td>+0.1294</td>
<td>+0.1439</td>
<td>+0.0970</td>
<td>+0.1591</td>
<td>+0.0661</td>
<td>-0.1921</td>
</tr>
<tr>
<td>By Firms that Have Less Than 50% of their Nest’s MS</td>
<td>+0.0880</td>
<td>+0.0719</td>
<td>+0.1040</td>
<td>+0.0733</td>
<td>+0.1763</td>
<td>-0.1192</td>
</tr>
</tbody>
</table>

The results of the counterfactual simulations are given in Tables 8 and 9. Table 8 summarizes rival responses to the smallest bank in their local market opening an additional branch, and Table 9 summarizes the responses to the largest bank opening an additional branch. Each table shows the average change in branches across all markets, both overall, and broken down by market per capita income and population density. The tables also show the percent of markets with an overall positive, neutral, and negative response to the counterfactual.

According to Table 8, in the average market, the number of branches rose by 0.2084 branches in response to the counterfactual expansion by the smallest bank in that market. This positive effect was mostly in rural and small city markets, and in large city and metro markets, the number of branches actually declined by 0.3113 branches, on average. The reason for this discrepancy is that in smaller markets, the demand stealing effect described above, is smaller. This is because there is less competition in these markets and more “marginal customers” (customers that are on the margin and likely to switch between local banks based on changes in their quality, or branch network size). Thus an increase in network size by one bank is...
more likely to steal these “marginal customers” away from rivals, and thus incentivize these rivals to open an additional branch themselves, to steal these customers on the margin back.

Rows 2 and 3 of Table 8 also show that most of the complementary response is coming from banks of the same type. Among banks of the same type, the average response across all markets is an increase of 0.3985 branches. For banks of different types, the average response is to decrease network size by 0.1901 branches. Rows 4 and 5 of Table 8 show that the complementary response is also stronger for banks that have a higher market share in their group. In Section 3.1, it was shown that the demand stealing effect disincentives low quality banks from adding branches when their rivals do, but works in the opposite direction for high quality banks. This is because when a smaller firm adds a branch and steals some of the larger firm’s “marginal customers”, the larger firm has an added incentive to open an additional branch and steal those “marginal customers” back. That is why we see a larger complementary response from banks with larger market shares.

Table 9: Counterfactual Response to the Largest Bank in the Market Opening an Additional Branch

<table>
<thead>
<tr>
<th></th>
<th>All Markets</th>
<th>Below Med PCI</th>
<th>Above Med PCI</th>
<th>Rural</th>
<th>Small City</th>
<th>Large City or Metro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Market Response Change in Branches</td>
<td>-0.0642</td>
<td>-0.0340</td>
<td>-0.0440</td>
<td>-0.0004</td>
<td>-0.1791</td>
<td>-0.4702</td>
</tr>
<tr>
<td>By Firms of Same Type as Adding Bank</td>
<td>-0.0225</td>
<td>-0.0161</td>
<td>-0.0289</td>
<td>+0.0022</td>
<td>-0.0840</td>
<td>-0.0927</td>
</tr>
<tr>
<td>By Firms of Different Types</td>
<td>-0.0417</td>
<td>-0.0180</td>
<td>-0.0653</td>
<td>-0.0018</td>
<td>-0.0950</td>
<td>-0.3775</td>
</tr>
<tr>
<td>By Firms that Have Over 50% of their Nest’s MS</td>
<td>-0.0285</td>
<td>-0.0071</td>
<td>-0.0520</td>
<td>-0.0089</td>
<td>-0.0537</td>
<td>-0.2185</td>
</tr>
<tr>
<td>By Firms that Have Less Than 50% of their Nest’s MS</td>
<td>-0.0347</td>
<td>-0.0270</td>
<td>-0.0424</td>
<td>+0.0094</td>
<td>-0.1253</td>
<td>-0.2517</td>
</tr>
<tr>
<td>Percent of Markets with Positive Overall Response</td>
<td>1.19%</td>
<td>64.00%</td>
<td>1.73%</td>
<td>1.12%</td>
<td>0.83%</td>
<td>3.97%</td>
</tr>
<tr>
<td>Percent of Markets with Neutral Overall Response</td>
<td>93.80%</td>
<td>96.21%</td>
<td>91.39%</td>
<td>96.74%</td>
<td>88.43%</td>
<td>76.16%</td>
</tr>
<tr>
<td>Percent of Markets with Negative Overall Response</td>
<td>5.01%</td>
<td>3.15%</td>
<td>6.87%</td>
<td>2.15%</td>
<td>10.74%</td>
<td>19.87%</td>
</tr>
</tbody>
</table>

The first column shows the average counterfactual response for all markets. The second 2 columns show the average counterfactual response for markets broken down by per capita income. The final 3 columns show the average counterfactual response for markets based on their population density. Markets designated as “Rural” are markets with a population density of less than 100 people per square mile, those designated as “Small City” have a population density between 100 and 1,000 people per square mile, and those designated as “Large City or Metro” are markets with a population density greater than 1,000 people per square mile.

Looking at how banks instead respond to their largest rival opening an additional branch in Table 9, the response is much less complementary. On average, across all markets, the number of branches decreases by .0642 branches, in response to the counterfactual rival expansion. The reason for this is that expansion by larger banks tends to not lead to an increase in the number of customers on the margin like the expansion by smaller banks did. It instead increases the number of customers that would remain loyal to that large bank, even if a competitor were to add an additional branch themselves. In other words, the demand stealing effect is increasing in the size of the expanding bank. Therefore, strategic complementarities in branching are more likely to result as a response to a small bank’s expansion rather than that by a large bank.

5.2 Counterfactual Response to a Merger Between Competitors

In the third and fourth counterfactuals I analyze how firms respond to a merger between two of their local rivals, an event that was also prevalent in the post-deregulation period. In the third counterfactual, I look at how rival banks respond to an acquisition by the largest firm in the market, of all the branches of the smallest firm in the market. In the fourth counterfactual, I simulate the response to an acquisition by the
largest firm in the market, of all the branches of the second largest firm in the market. These simulations are implemented the same way as before.

Table 10: Counterfactual Response to the Largest Bank in the Market Acquiring the Branches of the Smallest Bank in the Market

<table>
<thead>
<tr>
<th></th>
<th>All Markets</th>
<th>Below Med PCI</th>
<th>Above Med PCI</th>
<th>Rural</th>
<th>Small City</th>
<th>Large City or Metro</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average Market Change in Branches</strong></td>
<td>+0.0071</td>
<td>-0.0424</td>
<td>+0.0565</td>
<td>-0.0317</td>
<td>+0.1763</td>
<td>-0.2318</td>
</tr>
<tr>
<td>By the Acquiring Bank</td>
<td>-0.0511</td>
<td>-0.1631</td>
<td>+0.0610</td>
<td>-0.2190</td>
<td>+0.4036</td>
<td>+0.2517</td>
</tr>
<tr>
<td>By Firms of Same Type as Acquiring Bank</td>
<td>-0.0022</td>
<td>+0.0520</td>
<td>-0.0565</td>
<td>+0.0519</td>
<td>-0.1791</td>
<td>+0.0464</td>
</tr>
<tr>
<td>By Firms of Same Type as Acquired Bank</td>
<td>-0.1503</td>
<td>-0.0918</td>
<td>-0.2887</td>
<td>-0.0711</td>
<td>-0.3333</td>
<td>-0.4437</td>
</tr>
<tr>
<td>By Firms of Different Types</td>
<td>+0.2152</td>
<td>+0.1747</td>
<td>+0.2566</td>
<td>+0.2213</td>
<td>+0.2424</td>
<td>-0.0066</td>
</tr>
<tr>
<td>By Firms that Have Over 50% of their Nest’s MS</td>
<td>+0.0173</td>
<td>+0.0045</td>
<td>-0.0058</td>
<td>+0.0003</td>
<td>-0.1515</td>
<td>-0.2517</td>
</tr>
<tr>
<td>By Firms that Have Less Than 50% of their Nest’s MS</td>
<td>+0.0408</td>
<td>+0.0083</td>
<td>+0.0013</td>
<td>+0.0097</td>
<td>-0.0758</td>
<td>-0.2318</td>
</tr>
</tbody>
</table>

Percent of Markets with Positive Overall Response
- All Markets: 21.19%
- Below Med PCI: 24.15%
- Above Med PCI: 24.15%
- Rural: 19.58%
- Small City: 24.50%
- Large City or Metro: 25.48%

Percent of Markets with Neutral Overall Response
- All Markets: 63.39%
- Below Med PCI: 57.10%
- Above Med PCI: 70.94%
- Rural: 44.21%
- Small City: 43.71%
- Large City or Metro: 43.71%

Percent of Markets with Negative Overall Response
- All Markets: 15.41%
- Below Med PCI: 18.24%
- Above Med PCI: 18.75%
- Rural: 9.48%
- Small City: 30.30%
- Large City or Metro: 31.79%

The first column shows the average counterfactual response for all markets. The second 2 columns show the average counterfactual response for markets broken down by per capita income. The final 3 columns show the average counterfactual response for markets based on their population density. Markets designated as “Rural” are markets with a population density of less than 100 people per square mile, those designated as “Small City” have a population density between 100 and 1,000 people per square mile, and those designated as “Large City or Metro” are markets with a population density greater than 1,000 people per square mile.

The results of the third counterfactual are in Table 10, and the results of the fourth counterfactual are in Table 11. In both cases the merger, on average, leads to an increase in the number of branches. Following the merger between the largest and smallest bank, in the average market the number of branches increases by 0.0071 branches. Following the merger between the 2 largest banks, the average market sees an increase of 0.5999 branches. Both these include the adjustment in branch network size by the merged bank post-merger. In the case of the acquisition of the smallest bank, the acquiring bank decreases their number of branches by 0.0511 on average, and in the case of the acquisition of the second largest bank, the acquiring bank decreases their number of branches by 0.3738 on average. Rival banks then take into account both that they are facing a decrease in competition, and that their largest rival increased the size of their branch network. On average, these rivals respond by also increasing the size of their branch networks, partially due to complementarities in the branching decision. The results in the two tables also show that again this response varies across different types of markets, with complementarities more likely in smaller markets for the same reason as before. One major difference with the previous counterfactuals, is that here the complementary response is most likely for banks that are neither the type of the acquiring or acquired bank, and banks that are smaller in terms of market share. This is because these are the banks for which the demand stealing effect is smallest, since they are generally competing for a different group of customers than the merged bank due to the high estimated value of $\sigma$, and the low estimated cross-price elasticities of the largest banks.

5.3 Are Markets Over-Branched?

The final question I look at here, is how do additional branches opened by banks responding to their rivals, ultimately affect welfare. When making their branching decisions, banks don’t account for the negative effect
Table 11: Counterfactual Response to the Largest Bank in the Market Acquiring the Branches of the Second Largest Bank in the Market

<table>
<thead>
<tr>
<th>Average Market Change in Branches</th>
<th>All Markets</th>
<th>Below Rural</th>
<th>Above Large</th>
<th>Small City</th>
<th>Large City or Metro</th>
</tr>
</thead>
<tbody>
<tr>
<td>By the Acquiring Bank</td>
<td>+0.5999</td>
<td>+0.5748</td>
<td>+0.6249</td>
<td>+0.6097</td>
<td>+0.7493</td>
</tr>
<tr>
<td>By Firms of Same Type as Acquiring Bank</td>
<td>-0.3738</td>
<td>-0.4432</td>
<td>-0.3044</td>
<td>-0.4922</td>
<td>-0.3388</td>
</tr>
<tr>
<td>By Firms of Same Type as Acquired Bank</td>
<td>+0.1577</td>
<td>+0.2441</td>
<td>+0.01713</td>
<td>+0.2329</td>
<td>+0.1033</td>
</tr>
<tr>
<td>By Firms of Different Types</td>
<td>+0.1348</td>
<td>+0.1978</td>
<td>+0.0790</td>
<td>+0.2249</td>
<td>+0.0978</td>
</tr>
<tr>
<td>By Firms that have Over 50% of their Nest’s MS</td>
<td>+0.1615</td>
<td>+0.3834</td>
<td>-0.0604</td>
<td>+0.5203</td>
<td>-0.3678</td>
</tr>
<tr>
<td>By Firms that have Less Than 50% of their Nest’s MS</td>
<td>+0.8121</td>
<td>+0.6346</td>
<td>+0.9897</td>
<td>+0.5816</td>
<td>+1.4559</td>
</tr>
<tr>
<td>Percent of Markets with Positive Overall Response</td>
<td>45.57%</td>
<td>43.29%</td>
<td>47.85%</td>
<td>44.57%</td>
<td>49.45%</td>
</tr>
<tr>
<td>Percent of Markets with Neutral Overall Response</td>
<td>34.04%</td>
<td>39.43%</td>
<td>28.64%</td>
<td>42.24%</td>
<td>12.40%</td>
</tr>
<tr>
<td>Percent of Markets with Negative Overall Response</td>
<td>20.39%</td>
<td>17.28%</td>
<td>23.51%</td>
<td>13.19%</td>
<td>38.15%</td>
</tr>
</tbody>
</table>

The first column shows the average counterfactual response for all markets. The second 2 columns show the average counterfactual response for markets broken down by per capita income. The final 3 columns show the average counterfactual response for markets based on their population density. Markets designated as “Rural” are markets with a population density of less than 100 people per square mile, those designated as “Small City” have a population density between 100 and 1,000 people per square mile, and those designated as “Large City or Metro” are markets with a population density greater than 1,000 people per square mile.

Table 12: Average Welfare Change to a Branch Being Closed

<table>
<thead>
<tr>
<th>Smallest Bank Closes Branch</th>
<th>Median Bank Closes Branch</th>
<th>Largest Bank Closes Branch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Change in Consumer Surplus</td>
<td>-0.2599</td>
<td>-0.5261</td>
</tr>
<tr>
<td>Holding Deposit Rate Constant</td>
<td>-0.1625</td>
<td>-0.4872</td>
</tr>
<tr>
<td>Only Changing Deposit Rate</td>
<td>-0.0973</td>
<td>-0.0389</td>
</tr>
<tr>
<td>Average Change in Bank Variable Profits</td>
<td>+0.1827</td>
<td>-1.2277</td>
</tr>
<tr>
<td>Holding Deposit Rate Constant</td>
<td>-0.2388</td>
<td>-1.3319</td>
</tr>
<tr>
<td>Only Changing Deposit Rate</td>
<td>+0.4216</td>
<td>+0.1042</td>
</tr>
<tr>
<td>Average Change in CS + VP</td>
<td>-0.0771</td>
<td>-1.7538</td>
</tr>
<tr>
<td>Average Lower Cost Bound</td>
<td>2.1525</td>
<td>4.4749</td>
</tr>
<tr>
<td>Average Upper Cost Bound</td>
<td>2.3176</td>
<td>5.0018</td>
</tr>
</tbody>
</table>

Percent of Markets Where the Lower Cost Bound > -(CS + VP) | 81.54% | 80.06% | 70.26% |

opening branches has on their competitors (which reduces welfare), or the positive effect additional branches have on consumers (which increases welfare). Thus, how complementarities affect the welfare impact of a merger or policy that encourages expansion, is not clear.

I address this question using the approach of Fan and Yang (2017), where I remove one branch from each local market. I then recompute each firm’s optimal deposit rate (but don’t allow the firms to update their branch networks like above), and look at how the removal affected bank variable profits and consumer surplus. I choose the bank that counterfactually closes one branch, from the banks in the market that have more than one branch. I then select 3 banks from this list, and run the simulation on each market for each of the cases. The first case is to remove the branch from the largest branch’s branch network, the second is removing a branch the median sized bank’s branch network (or the smaller of the 2 banks closest to the median), and the final is removing a branch from the smallest bank’s branch network. The results of each of these counterfactual are displayed in Table 12.
The results shows that in all 3 cases, consumer surplus declines on average when one bank in the market closes down a branch. This is due to consumer preferences for branches. The negative impact on consumers is worse, the larger the bank that closes down the branch. The average impact of the smallest bank closing one branch is a loss in consumer surplus of $0.2599 million, while the average impact of the largest bank closing one branch is a loss of $0.5379 in consumer surplus. However, the larger losses incurred by consumers when larger banks close their branches, is somewhat mitigated by increases in deposit rates, which are greater when a larger bank closes a branch. This can be seen in rows 2 and 3 of Table 12, which breakdown the change in consumer surplus between that due to the loss in branches, and that due to the change in deposit rates. The adjustment of deposit rates downward when the smallest bank closes a branch leads to a further loss in consumer surplus of $.0973 million. Deposit rates also adjust downward when the median-sized bank closes down a branch, leading to a further loss of $0.0389 million in consumer surplus. However, when the largest bank closes a branch, deposit rates adjust upward, and consumers gain $0.5235 million in surplus compared to if deposit rates were held fixed at their observed values. The reason deposit rates go down when the smallest or median-sized bank closes a branch, is that there is less competition for deposits and so banks adjust their rates downward. When the largest bank closes a branch there is still a decrease in competition which puts downward pressure on rates, but a larger effect is that a large number of deposits are now available as the largest bank in the market just shut down a branch. To compete for these available deposits, banks will increase their deposit rate, so that on average, deposit rates go up in this case.

The impact on bank variable profits can be seen in row 4 of Table 12. Again, I breakdown the effect on variable profits into that which results just from the closing down of the branch (row 5 of Table 12), and that which results from the adjustment of deposit rates (row 6 of Table 12). When the smallest banks closes down one of their branches, variable profits actually increase by $0.1827 million. This is due to lower competition in the market allowing many of the rival banks to lower their deposit rates, and thus earn more profit on the deposits they do collect. However for the case of the median-sized and large bank, variable profits decline on average by $1.2277 million, and $8.4707 million, respectively.

In rows 8-9 of Table 12, I provide the average of the lower and upper bound branch cost estimates for the bank which closed the branch in the counterfactual. If the total decrease in surplus from closing a branch is smaller than the increased cost savings, then it is overall welfare increasing to close the branch. The estimated bounds show that this is true for all 3 cases. In all 3 cases the estimated lower bound on the cost of opening a branch exceeds the loss in total surplus, meaning that closing the branch is welfare increasing.

The final row of Table 12 displays the percent of markets in which the lower bound on the cost savings from closing the branch, exceeds the total losses in surplus. This is true in 81.54% of markets for the case of the smallest bank’s branch, 80.06% of markets for the case of the median bank’s branch, and 70.26% of markets for the case of the largest bank’s branch. These result suggest that banking markets are over-branched, and that welfare would be increased by less branches, particularly by the smallest banks. This implies that the complementary response by banks to the expansion of their rivals, will on average lead to
losses in welfare that should be taken into account when assessing the impact of a merger, or when evaluating policies that encourage branch network expansion, such as the Riegle Neal Act.

6 Conclusion

Understanding how banks respond to expansion decisions by their rivals, is a crucial component to analyzing how such expansion affects local market competition. The theoretical literature is not clear on the nature of the response function in quality competition, and so I use data on observed branching decisions to resolve the ambiguity in this setting. Using an instrumental variables approach, I find that, on average, banks respond to an increase in branch network size by their rivals, by expanding their own branch networks. The ultimate effect of this complementary response is then explored using a model of bank choice over number of branches and deposit rate. The model accounts for consumer demand for deposits, which depends on the bank’s number of branches, their rivals’ number of branches, the deposit rates set by the banks, and other bank characteristics. The model is estimated and then used to run a series of counterfactuals which show how strategic complementarities in the branching decision affect the banking market response to expansion or a merger by a local competitor. The results indicate that the response varies by bank and market characteristics, but overall has a substantial impact on local banking markets. This implies that banks’ responses to branching by their competitors is an important determinant of the overall impact of deregulation in banking. The welfare effect is then assessed by evaluating the impact closing down one branch has on total surplus. The results suggest that in the majority of markets, closing down a branch would be welfare increasing. This implies that these markets are over-branched, and that complementarities in the branching decision will most likely exacerbate the negative effects of expansion due to mergers or otherwise.

References


Appendix

A.1 2 Models of Quality Competition

I present here two models of quality competition between banks in a duopoly setting. The first uses Bertrand competition and the second Cournot competition. These 2 models follow from Ronnen (1991) and Valletti (2000), respectively.

In both cases the market consists of a continuum of consumers indexed by their preference for bank quality $\theta$, which is distributed $U[0,1]$. The surplus each consumer receives from choosing bank $j$ with quality $B_j$ (i.e. number of branches $B_j$) and price $p_j$ (i.e. the difference between the loan rate and deposit rate) is then given by $\theta B_j - p_j$.

On the supply side there are 2 banking firms, which are identical in all respects. The cost to each firm of increasing their quality is given by $C(B_j)$ where $C'(B_j) > 0$ and $C''(B_j) > 0$. This is the only cost to the firms for providing banking services. Firms then play a 2-stage game. In the first stage, firms choose their quality levels. The second stage is where the two models differ. In the first model, firms will compete in prices in the second stage. In the second model, firms will instead decide how many customers to serve in the second stage.

I denote the firm with higher quality as $H$, and the firm with lower quality as $L$ (i.e. $B_H \geq B_L$). Then the marginal customer that is indifferent between choosing the high quality bank and the low quality bank is given by:

$$t_H = \frac{p_H - p_L}{B_H - B_L}$$

(16)

The marginal customer that is indifferent between choosing the low quality bank and choosing neither is given by:

$$t_L = \frac{p_L}{B_L}$$

(17)

Then the market share for the high quality bank is given by $s_H = 1 - t_H$, and the market share of the low quality bank is given by $s_L = t_H - t_L$.

In the first model where firms compete on prices in the second stage, the subgame perfect equilibrium of the second stage is unique and is given by:

$$p_H = 2B_H \left( \frac{z - 1}{4z - 1} \right)$$

$$p_L = B_L \left( \frac{z - 1}{4z - 1} \right)$$
where $z = \frac{B_H}{B_L}$. Thus, the market shares for each bank can be written as:

$$s_H = 1 - 2 \left( \frac{z - 1}{4z - 1} \right)$$
$$s_L = \frac{z}{4z - 1}$$

And the revenue for each bank is given by:

$$R_H = B_H \left( \frac{4z(z - 1)}{(4z - 1)^2} \right)$$
$$R_L = B_L \left( \frac{z(z - 1)}{(4z - 1)^2} \right)$$

Taking the derivative of the high quality firm’s revenue with respect to the quality choice of the low quality firm, results in:

$$\frac{\partial R_H}{\partial B_L} = -z^2 \frac{(4z - 1)^2 + 12z}{(4z - 1)^3} < 0 \quad (18)$$

Intuitively, if the low quality bank raises their quality, then they become more substitutable with the high quality bank, and thus reduce the high quality bank’s revenue. Likewise, taking the derivative of the low quality firm’s revenue with respect to the quality choice of the high quality firm, results in:

$$\frac{\partial R_L}{\partial B_H} = \frac{2z + 1}{(4z - 1)^3} > 0 \quad (19)$$

Intuitively, when the high quality firm increases their quality, this expands the disparity between the two banks and increases revenue for the low quality bank. This is because the low quality bank then doesn’t have to compete as heavily with the high quality bank on price, and so they can raise their price.

The response functions for each bank then depend on the signs of $\frac{\partial^2 R_H}{\partial B_H \partial B_L}$ and $\frac{\partial^2 R_L}{\partial B_L \partial B_H}$. For the low quality firm this is given by:

$$\frac{\partial^2 R_L}{\partial B_L \partial B_H} = \frac{z(16z + 14)}{B_L(4z - 1)^4} > 0 \quad (20)$$

When the low quality firm increases their quality, they have to worry about this increasing price competition with the high quality firm. This concern over increasing price competition diminishes the benefit the low quality bank receives from increasing quality. Yet, when the high quality firm increases their quality, this increases the disparity between the 2 firms so that elevated price competition due to an increase in quality by the low quality firm is less likely. Thus, low quality firms have to worry less about increasing price competition by increasing quality, and so their incentive to increase quality increases.

The response function for the high quality firm then depends on the sign of:

$$\frac{\partial^2 R_H}{\partial B_H \partial B_L} = \frac{z(48z^2 + 8z - 2)}{B_L(4z - 1)^4} > 0 \quad (21)$$
If the low quality firm raises their quality level, then they are a closer substitute for the high quality bank. This increases the incentive for the high quality firm to differentiate themselves by increasing their own quality level. Thus, the response by the high quality firm is also complementary. So for the case of Bertrand pricing in the second stage, both the high quality and low quality firms exhibit strategic complementarities in the quality choice.

If instead the second stage competition is in quantity, then the inverse demand functions are:

\[ p_H = B_H (1 - (1 - t_H)) - B_L (t_H - t_L) \]  
\[ p_L = B_L (1 - (1 - t_L)) \]  

(22)  

(23)

where \( t_H \) and \( t_L \) are the marginal customers for the high quality and low quality bank, respectively, and are defined the same as above. This implies that the revenues for each bank as a function of their quality choices are given by:

\[ R_H = B_H \left(1 - \frac{2B_H}{4B_H - B_L}\right)^2 \]  
\[ R_L = B_L \left(1 - \frac{B_H}{4B_H - B_L}\right)^2 \]  

(24)  

(25)

The derivative of each firm’s revenue with respect to the quality choice of their rival is given by:

\[ \frac{\partial R_H}{\partial B_L} = \left(1 - \frac{2B_H}{4B_H - B_L}\right) \left(-\frac{4B_H^2}{(4B_H - B_L)^2}\right) < 0 \]  
\[ \frac{\partial R_L}{\partial B_H} = \left(1 - \frac{B_H}{4B_H - B_L}\right) \left(\frac{2B_L - 6B_H^2}{(4B_H - B_L)^2}\right) < 0 \]  

(26)  

(27)

The second result differs from what we got under Bertrand competition. Here \( \frac{\partial R_L}{\partial B_H} \) is negative, because price competition is softer than with Bertrand competition. Thus, the main effect that an increase in quality by the high quality bank, has on the low quality bank, is that it steals market share from that bank. The benefit the increase in quality by the high quality bank provides to the low quality bank by softening price competition isn’t as strong in this case. This then leads to strategic substitutability in the quality choice for the low quality bank:

\[ \frac{\partial^2 R_H}{\partial B_H \partial B_L} > 0 \]  
\[ \frac{\partial^2 R_L}{\partial B_L \partial B_H} < 0 \]  

(28)  

(29)

So while quality is still a strategic complement for the high quality bank, it is now a strategic substitute for the low quality bank. This is because under the Cournot model the customer stealing effect is stronger, and the differentiation effect is weaker, due to a softening of price competition.
### A.2 First Stage Results for Robustness Checks in Section 3.3

Table 13: First Stage Results for IV Regressions from Table 4

<table>
<thead>
<tr>
<th>DepVar: AverageCompetitorBranches</th>
<th>Exclude Adjacent Counties within the State from IV</th>
<th>Exclude Counties Only Include Branches Acquired by Merger in the IV</th>
<th>Only Include Branches Acquired by Merger after RN in the IV</th>
<th>Year 2000 Results</th>
<th>Year 2005 Results</th>
<th>IV with Distance to HQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comp Branches in Other Markets</td>
<td>0.2578</td>
<td>0.2571</td>
<td>0.2611</td>
<td>0.2873</td>
<td>0.2796</td>
<td>8.62 × 10⁻⁴</td>
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<tr>
<td>Average Distance to Comp HQ</td>
<td>(27.54)</td>
<td>(30.13)</td>
<td>(29.32)</td>
<td>(30.33)</td>
<td>(32.16)</td>
<td>(29.75)</td>
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<tr>
<td>Population</td>
<td>2.15 × 10⁻⁷</td>
<td>2.00 × 10⁻⁷</td>
<td>2.37 × 10⁻⁷</td>
<td>2.42 × 10⁻⁷</td>
<td>2.10 × 10⁻⁷</td>
<td>2.33 × 10⁻⁷</td>
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<tr>
<td></td>
<td>(23.58)</td>
<td>(22.20)</td>
<td>(25.84)</td>
<td>(26.30)</td>
<td>(20.05)</td>
<td>(24.15)</td>
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<tr>
<td>Land Area</td>
<td>3.81 × 10⁻⁵</td>
<td>3.80 × 10⁻⁵</td>
<td>3.94 × 10⁻⁵</td>
<td>3.98 × 10⁻⁵</td>
<td>4.20 × 10⁻⁵</td>
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<td></td>
<td>(7.03)</td>
<td>(7.03)</td>
<td>(7.28)</td>
<td>(7.35)</td>
<td>(6.40)</td>
<td>(6.11)</td>
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<tr>
<td>Per Capita Income</td>
<td>2.68 × 10⁻⁵</td>
<td>2.60 × 10⁻⁵</td>
<td>2.66 × 10⁻⁵</td>
<td>2.66 × 10⁻⁵</td>
<td>3.55 × 10⁻⁵</td>
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<tr>
<td></td>
<td>(30.66)</td>
<td>(29.72)</td>
<td>(30.56)</td>
<td>(30.60)</td>
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<td>Population Growth</td>
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<td>0.1260</td>
<td>0.1556</td>
</tr>
</tbody>
</table>

The t-statistic associated with each parameter estimate is given in parentheses below the estimate.