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Harming Depositors and Helping Borrowers: The Disparate Impact of Bank Consolidation

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A model of multimarket spatial competition is developed where small, single-market banks compete with large, multimarket banks (LMBs) for retail loans and deposits. Consistent with empirical evidence, LMBs are assumed to have different operating costs, set retail interest rates that are uniform across markets, and have access to wholesale funding. If LMBs have significant funding advantages that offset any loan operating cost disadvantages, then market-extension mergers by LMBs promote loan competition, especially in concentrated markets. However, such mergers reduce retail deposit competition, especially in less concentrated markets. Prior empirical research and our own analysis of retail deposit rates support the model's predictions.

Key words: mergers, banking

JEL code: G21, G34

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I. Introduction

Banks in the United States have experienced rapid consolidation in recent years. Restructurings have been driven by advances in information technology and by deregulation of geographic restrictions on branching and acquisitions. Since the mid-1980s, the number of commercial banks and savings institutions more than halved from 17,900 in 1984 to 8,681 in 2006 and banks' average asset size (in inflation-adjusted 2006 dollars) more than tripled from $348 million to $1.366 billion. Much research has analyzed the competitive effects of this banking consolidation, especially how mergers impact potentially vulnerable customers, such as small businesses and consumers.

While banks have become fewer in number and larger on average, there has not been a systematic increase in the concentration of local banking markets. The Herfindahl-Hirschman Index (HHI) of deposit shares in Metropolitan Statistical Areas (MSAs) has averaged about the same as before the merger wave.[1] While some horizontal mergers (acquisitions involving two banks in the same market) have occurred, the major impact of consolidation has been to broaden the geographic scope of bank operations through market-extension mergers (acquisitions involving two banks in different markets).

As a result of market-extension mergers, large multimarket banking organizations (LMBs) increasingly compete with smaller community banks in many local markets. While an LMB's entry via acquisition may not directly change market concentration, there is concern that bank-dependent customers, such as small businesses and consumers, may be affected. Research such as Haynes, Ou, and Berney (1999), Cole, Goldberg, and White (2004), and Berger, Miller, Petersen, Rajan, and Stein (2005) document that LMBs tend to operate differently from smaller banks. A main difference is that LMBs' services are more standardized and lending decisions are

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[1] See Rhoades (2000) and Pilloff (2004). From 1994 to 2005, the average HHI of deposit shares for 369 MSAs rose from 1543 to 1601, but the median declined from 1427 to 1388.

based on a borrower's "hard" publicly-available financial information. In contrast, smaller banks tend to base lending on "soft" information such as the borrower's "character."

The current paper investigates the competitive effects of market-extension mergers that increase the presence of LMBs in local banking markets. It presents a model that accounts for three differences between LMBs and small banks that prior research has documented. First, LMBs' greater size and organizational complexity can give them costs of providing retail loans and deposits that differ from those of smaller banks. Second, LMBs standardize their services by setting retail deposit and loan rates that tend to be uniform across local markets. Third, LMBs have access to wholesale sources of funding while most small banks do not. The model is used to analyze how these three differences affect retail loan and deposit competition in local markets. The paper also examines how the model's predictions square with empirical evidence.

Our model of multimarket, spatial competition assumes small banks operate in one local market while LMBs operate in multiple markets. A small bank sets retail loan and deposit interest rates based on the competitive conditions in its single market while an LMB chooses retail rates that are uniform across markets and reflect its differential operating and funding costs as well as the competitive conditions in its multiple markets. The model's Bertrand-Nash equilibrium shows that retail loan and deposit rates set by banks in a particular market depend not only on the market's concentration but also the market's distribution of LMBs and small banks.

The model's most important result is that a greater presence of LMBs can promote competition in retail loan markets but harm competition in retail deposit markets. Depending on the magnitude of these two effects, profits of small banks in a particular market can decline or increase with greater penetration by LMBs. As we later document, several empirical studies support the model's implications. Empirical research consistently finds that a greater presence of LMBs in a local market tends to lower small business loan rates and also retail deposit rates.

The plan of the paper is as follows. The next section reviews research on large and small bank differences regarding retail loans, retail deposits, and wholesale funding. This evidence justifies the assumptions made by our model presented in Section III. The model considers large and small bank behavior in a setting of multimarket, spatial competition and solves for banks' equilibrium retail loan and deposit rates. Section IV examines the model's implications regarding a greater presence of LMBs and evaluates these predictions in light of prior empirical research.

Section V presents new empirical evidence using survey data on retail deposit interest rates collected by *Bankrate*, Inc. It also analyzes how LMBs' acquisitions of small banks affects Money Market Deposit Account (MMDA) interest rates obtained from Call Report and Thrift Financial Report data. Section VI contains concluding remarks.

II. Research on Differences in the Operations of Large and Small Banks

To motivate the modeling assumptions made in the next section, we briefly review three findings of prior research. First, bank size influences the technology used to make retail loans, thereby affecting operating costs. Second, LMBs tend to set retail loan and deposit interest rates that are uniform across markets, and, third, LMBs have access to wholesale sources of funding that are unavailable to smaller banks.

Theories of organization diseconomies, such as Williamson (1967) and Stein (2002), predict that large and small banks differ in how they service small businesses and consumers. An LMB's top management lacks control of branch-level operations because its complex hierarchy makes monitoring lower-level employees difficult. As a result, LMB managers may establish explicit decision rules rather than allow employee discretion, so that loan approval and pricing decisions rely on "hard" information, such as financial statements and credit histories. In contrast, small banks' simpler organization permits employee decisions based on "soft information," such as the borrower's "character" and local market conditions. Empirical research by Cole, Goldberg, and White (2004), Berger, Miller, Petersen, Rajan, and Stein (2005), and Haynes, Ou, and Berney (1999) supports such large and small bank operating differences.

While there are diseconomies of scale in utilizing soft information, there may be other economies of scale. As a bank grows to be an LMB, say via a market-extension merger of smaller banks, it may eliminate some duplicate activities, such as personnel and capital assigned to product marketing.[2] Geographic expansion also can increase loan diversification that reduces the costs of financial distress. Further, greater size may justify the fixed costs of determining standardized criteria for loan approvals and loan and deposit pricing that can reduce the marginal costs of these services.[3] Thus, relative to smaller banks, it is unclear whether LMBs face a net disadvantage in terms of their operating costs of retail loan-making and deposit-taking.[4]

Greater standardization by LMBs appears to extend to the setting of interest rates on consumer loans and deposits. Radecki (1998) states that many LMBs have centralized their management and operations along business, rather than geographic, lines. He documents from *Bankrate*, Inc. survey data that an LMB tends to quote rates for a given type of retail loan or deposit that is the same in different cities throughout a state and often throughout a wider area. Heitfield (1999), Heitfield and Prager (2002), and Biehl (2002) find that small banks set their rates based on the competitive conditions in their local MSA, but LMBs set uniform rates reflecting conditions over a larger area. The growth in internet advertising may reinforce this uniformity. By quoting uniform rates, rather than local market-specific ones, LMBs avoid offending consumers that would be offered a relatively unattractive rate due to their location.

Prior research highlights another difference between large and small banks. Bassett and Brady (2002) document that small banks' liabilities are mostly retail deposits, while the liabilities

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[2] Jayaratne and Strahan (1997) document an increase in bank efficiency after states removed intrastate branching restrictions, and Hughes, Lang, Mester, and Moon (1999) find that performance improves for banks that expand interstate.

[3] This is consistent with LMBs' greater adoption of credit scoring for small business loans. A survey by Whiteman (1998) found that more than two-thirds of large banks, but only 12 % of small banks, used credit scoring for small business loans. Berger, Frame, and Miller (2005) find similar evidence.

[4] Berger and Udell (2006) emphasize that LMBs may not be disadvantaged relative to small banks, even for loans to small, opaque businesses. LMBs typically use a different lending technology that does not rely on the soft information employed by small banks.

of LMBs include large proportions of wholesale funds.[5] LMBs, but not small banks, have access to wholesale financing because institutional investors view LMBs to be more transparent, more geographically diversified, and/or "too big to fail." Thus, small banks may consider the interest rate paid on retail deposits as their marginal cost of financing loans whereas LMBs' marginal funding cost is a wholesale rate, such as LIBOR.[6] Indirect evidence that small banks face limited financing opportunities stems from empirical tests of a "bank-lending channel" of monetary policy.[7] During monetary contractions, small banks, but not large ones, have difficulty funding loans, a result consistent with small banks facing retail deposit funding constraints.

Given these differences between LMBs and small banks, let us now consider a multimarket environment where the two types of banks compete.

III. A Theory of Banking Market Size Structure and Competition

To set the stage for analyzing the rate setting behavior of LMBs and small banks, we begin by analyzing a Salop (1979) circular city model that is similar to Chiappori, Perez-Castrillo, and Verdier (1995). We first consider a situation where all banks in a particular market are small, single-market banks, and later analyze markets where some banks have multimarket operations.[8]

III.A Basic Assumptions

A particular banking market has a continuum of two sets of retail customers: depositors and borrowers. These customers are located uniformly around a circle of unit length. Each depositor desires a fixed sized deposit while each borrower wants a fixed sized loan. Let *D* be the total volume of potential deposits in the market, which equals the product of the market's density

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[5] For example, defining an LMB as a top 100 bank ranked by asset size and a small bank as one below the top 1,000, in the year 2000 small banks' average proportion of assets funded by small time deposits was almost three times that of LMBs. In contrast, the category of "other liabilities," which are primarily wholesale sources of funding, financed 33.2 % of LMBs' assets but only 3.2 % of small banks' assets.

[6] Small banks' use retail deposits as a marginal source of funding is consistent with Bassett and Brady's (2002) finding that the average difference between small and large banks' rates paid on small time deposits is positively correlated with the average difference between small and large banks' asset growth rates.

[7] See Kashyap and Stein (2000), Jayaratne and Morgan (2000), Kishan and Opiela (2000), and Campello (2002).

of depositors and the fixed deposit size. Similarly, denote by L the market's total volume of potential loans, equal to the density of borrowers times each borrower's fixed loan size.

It is assumed that there are n identical banks located equidistantly around this unit circle, so that the distance between each bank is $1/n$.[9] These banks have the same technologies for producing financial services at constant marginal operating costs of c_D per unit of deposits and c_L per unit of loans. c_D includes deposit marketing expenses and the costs of sending monthly statements to depositors, while c_L reflects similar direct costs as well as the costs of screening a borrower's credit, of monitoring the borrower, and of default losses.

To obtain these services, customers are assumed to incur a cost of traveling to a bank, where t_D (t_L) equals a depositor's (borrower's) transportation cost per unit deposit (loan).[10] We assume these linear transportation costs do not exceed the gross surplus from consuming each of the banking services. Thus, a given bank has a comparative advantage in serving customers that are closest to it and directly competes for customers with only its two neighboring banks.

Let $r_{L,i}$ be the retail loan rate offered by bank i, and let $r_{L,i-1}$ and $r_{L,i+1}$ be the rates given by its two neighboring banks. A borrower located between bank i-1 and bank i and who is a distance $x_- \in [0, 1/n]$ from bank i is indifferent between obtaining the loan from bank i-1 and bank i if

$$r_{L,i} + t_L x_- = r_{L,i-1} + t_L \left(\frac{1}{n} - x_- \right) \qquad (1)$$

Similarly, a borrower located between bank i and bank i+1 and who is a distance $x_+ \in [0, 1/n]$ from bank i would be indifferent between obtaining the loan from bank i and bank i+1 if

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[8] The novelty of our model is its allowance for multiple markets and bank types. Equilibrium loan and deposit rates can differ among banks, even among the same type of banks located in the same market.

[9] These individual banks are best interpreted as bank offices or branches, with each bank having only a single office or branch in a given market. The focus of this paper is on inter-market linkages rather than the determinants of the market shares of individual banks that might result from intra-market mergers. The model could be extended to consider multiple locations (branches) of a bank in a single market.

[10] The assumption of transportation costs is supported by empirical evidence indicating that small businesses and consumers prefer banks that are located near to them. Using 1993 NSSBF data, Petersen and Rajan (2002) report that the median distance between a small business and its bank lender is 5 miles. Kwast, Starr-McCluer, and Wolken (1997) report that the Federal Reserve's 1992 Survey of Consumer

$$r_{L,i} + t_L x_+ = r_{L,i+1} + t_L \left(\frac{1}{n} - x_+ \right) \quad (2)$$

Therefore, given these loan rates, bank i's total demand is $(x_- + x_+)L$. Using equations (1) and (2), bank i faces the loan demand curve of

$$\left(x_- + x_+ \right) L = \left(\frac{r_{L,i-1} + r_{L,i+1}}{2} - r_{L,i} \right) \frac{L}{t_L} + \frac{L}{n} \quad (3)$$

Similarly, if depositors a distance of y_- or $y_+ \in [0, 1/n]$ are just indifferent to supplying deposits to bank i, this bank faces a supply curve of deposits given by

$$\left(y_- + y_+ \right) D = \left(r_{D,i} - \frac{r_{D,i-1} + r_{D,i+1}}{2} \right) \frac{D}{t_D} + \frac{D}{n} \quad (4)$$

Let r_W be the wholesale borrowing or lending interest rate, such as LIBOR, and let W be bank i's net amount invested at this wholesale rate. Consistent with the evidence discussed in Section II, we assume that small single-market banks can invest in wholesale instruments, but cannot borrow at the wholesale rate r_W. Therefore, if bank i is small, it faces the constraint

$$W \geq 0 \quad (5)$$

Later, when LMBs are analyzed, we assume that they have access to borrowing, in addition to investing, at rate r_W, so that the sign of W is unrestricted for them.

All banks are assumed to face a regulatory capital constraint of the form

$$E \geq \rho \left[(y_+ + y_-) D + \max\left(-W, 0 \right) \right] \quad (6)$$

where E is the amount of equity capital and ρ is the minimum required equity-to-debt ratio. The cost of issuing equity is given by r_E, and we assume $r_E > r_W$ due to debt having a lower agency cost and/or a tax advantage relative to equity.

Given these assumptions, a bank's balance sheet equation takes the form

$$W + \left(x_- + x_+ \right) L = \left(y_- + y_+ \right) D + E \quad (7)$$

Finance finds that the median distance between a household and its bank is 2 miles for checking accounts

III.B Equilibrium with Single-Market Operations

We can now state the profit maximization problem for a small bank in a particular market. It is

$$\underset{r_{L,i}, r_{D,i}, W}{\text{Max}} \; Wr_W + (x_- + x_+) L (r_{L,i} - c_L) - (y_- + y_+) D (r_{D,i} + c_D) - Er_E \tag{8}$$

subject to the constraints (5) and (6) and subject to the balance sheet equality (7).

As shown in the Appendix, there are two alternative cases for how this bank would optimally structure its balance sheet. First, if it is optimal for the bank to invest a positive amount of wholesale funds ($W > 0$), then its equity capital constraint (6) must be binding ($E = \rho(y_- + y_+)D$). This implies that the bank's optimal loan and deposit rates satisfy

$$r_{L,i} = \frac{1}{2}\left(\frac{r_{L,i-1} + r_{L,i+1}}{2}\right) + \frac{1}{2}\left(r_W + c_L + \frac{t_L}{n}\right) \tag{9}$$

$$r_{D,i} = \frac{1}{2}\left(\frac{r_{D,i-1} + r_{D,i+1}}{2}\right) + \frac{1}{2}\left(r_W - \rho(r_E - r_W) - c_D - \frac{t_D}{n}\right) \tag{10}$$

and in a symmetric Bertrand-Nash equilibrium where $r_{L,i} = r_{L,i-1} = r_{L,i+1}$ in equation (9), and $r_{D,i} = r_{D,i-1} = r_{D,i+1}$ in equation (10), we have

$$r_{L,i} = r_W + c_L + t_L / n \tag{11}$$

$$r_{D,i} = r_W - \rho(r_E - r_W) - c_D - t_D / n \tag{12}$$

This equilibrium holds when the market has total loans less than the total of retail deposits plus required capital; that is, $L < (1+\rho)D$. Banks' excess deposits are invested at the wholesale rate r_W, which is lower than the cost of raising equity, r_E, and leads banks to conserve capital. In this situation, the optimal loan and deposit rates are anchored by the wholesale rate.

Second, if it is optimal for the bank to issue excess equity capital ($E > \rho(y_- + y_+)D$) then its investment in wholesale funds must be zero ($W = 0$) so that constraint (5) binds. For this second case, a bank's optimal loan and deposit rates satisfy

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and 3 miles for savings accounts and Certificates of Deposit.

$$r_{L,i} = \frac{1}{2}\left(\frac{r_{L,i-1} + r_{L,i+1}}{2}\right) + \frac{1}{2}\left(r_E + c_L + \frac{t_L}{n}\right) \quad (13)$$

$$r_{D,i} = \frac{1}{2}\left(\frac{r_{D,i-1} + r_{D,i+1}}{2}\right) + \frac{1}{2}\left(r_E - c_D - \frac{t_D}{n}\right) \quad (14)$$

and in a symmetric Bertrand-Nash equilibrium where $r_{L,i} = r_{L,i\text{-}1} = r_{L,i+1}$ in equation (13), and $r_{D,i} = r_{D,i\text{-}1} = r_{D,i+1}$ in equation (14), we have

$$r_{L,i} = r_E + c_L + t_L / n \quad (15)$$

$$r_{D,i} = r_E - c_D - t_D / n \quad (16)$$

This second equilibrium occurs when the market's total loans exceed total deposits plus required equity capital; that is, $L > (1+\rho)D$. Banks must now use relatively expensive equity capital to fund the excess loans, so that the cost of equity, r_E, becomes the marginal cost of financing in equations (15) and (16).[11] This case is consistent with Bassett and Brady's (2002) empirical evidence that, relative to large banks, small banks tend to hold more equity capital and have a greater proportion of their assets in the form of loans.

Comparing the size of the equilibrium retail loan rates in (11) and (15), note that $r_{L,i}$ is lower for the case when small banks hold positive amounts of wholesale funds because $r_W < r_E$. Similarly, the equilibrium deposit rate in (12) where $W > 0$ is less than that in (16) where $W = 0$. Thus, both deposit and loan rates are lower when money market instruments are the marginal use of funds compared to when equity capital is the marginal source of funds.

Lastly, to gain intuition for the situation faced by an LMB, suppose that this bank sets possibly different loan and deposit rates for each of the markets in which it operates, so that profits are maximized on a market-by-market basis. As mentioned earlier, a key difference

[11] The model could be generalized to permit small banks to issue non-retail debt, such as uninsured jumbo CDs or privately placed notes. Qualitatively, the two types of equilibria would not change as long as the cost of these non-retail debt instruments, say, r_{JCD}, exceeded r_W. This assumption is reasonable if investors view small banks as less transparent and not "too big to fail." If $r_W < r_{JCD} < r_E$, then for the second equilibrium the small bank's marginal cost of funding would be $(1\text{-}\rho)r_{JCD} + \rho r_E$, rather than simply r_E.

between a small bank and an LMB is that the latter has access to borrowing at the wholesale rate. Hence, this bank's profit maximization problem for a particular market is given by (8) subject to (6) and (7), but not the wholesale borrowing constraint (5).

As with a small bank, there are two cases for how an LMB's balance sheet would be structured. When it has a positive investment in money market instruments, $W > 0$, the LMB acts like a small bank: its optimal loan and deposit rates are the same as (9) and (10). However, for the alternative case of $W < 0$, at the margin the LMB's capital constraint binds and it funds loans with a proportion $1/(1+\rho)$ of less expensive wholesale liabilities. Its optimal loan rate takes the form of the small bank loan rate (13) but with r_E replaced by $(r_W + \rho r_E)/(1+\rho)$. In addition, since wholesale liabilities, not equity, is the marginal funding source, its optimal retail deposit rate is of the form of the small bank deposit rate (14) but with r_E replaced by r_W.

Hence, an LMB's retail loan and deposit rates are lower than those of similarly situated small banks when wholesale liabilities are its marginal cost of financing. Since empirical evidence supports LMBs' reliance on wholesale funds, our analysis that follows focuses on this case. Also consistent with empirical evidence, our analysis assumes the case that total market loan demand is sufficiently larger than total deposit supply; that is, $L \gg (1+\rho)D$. This condition will ensure that in equilibrium small banks fund loans with excess shareholders' equity, even in markets where they face competition from LMBs.

III.C Equilibrium with Multimarket Operations

We now permit some banks to operate in multiple markets. This new structure can be interpreted as the result of market-extension mergers which have no effect on individual market concentrations. Thus, it is assumed that the numbers of banks in particular circular cities are unchanged, but merged banks now operate in two markets and are larger. Specifically, assume that small banks in two different markets merge to become an LMB, and the merged banks' cost structures and pricing practices change in the ways described in Section II.

To simplify the presentation, we start by assuming that only one bank in each of two markets merges to become an LMB. Thus, if k denotes the number of LMBs in each market, our beginning assumption is $k = 1$. As will be shown, extending the results to the $k \geq 1$ case is easy.

Let us assume that local bank i=1 is merged with a bank operating in a different circular city that has $m \leq n$ banks. We refer to the original market with n banks as the less concentrated market N, and this market's total loans and deposits are denoted L^N and D^N, respectively. The other local market having m banks is referred to as the concentrated market M, and this market's total loans and deposits are denoted L^M and D^M, respectively. Without loss of generality, assume that the merged bank (LMB) in market M is also bank i=1.

As discussed earlier, bank 1's operating and funding costs can differ from its smaller rivals due to economies or diseconomies of scale. Specifically, let c_L^* and c_D^* be this LMB's operating costs of making loans and issuing deposits, respectively, while c_L and c_D remain the operating costs of small banks. Bank 1 also has access to wholesale funding at the rate r_W. However, its retail interest rates in markets N and M now must be uniform, and its uniform rates will change the equilibrium interest rates set by the other banks in the two markets.

Assuming, for now, that each of the other banks in the two markets are small single-market banks, we solve for a Nash equilibrium where all banks set profit maximizing loan and deposit rates taking their neighboring banks' rates as given. As will be shown, the equilibrium rates set by the small banks are no longer equal but differ depending on their distance from the LMB (bank 1).[12] However, the equilibrium is symmetric in the sense that two small banks that are equidistant from the LMB charge the same rates. This situation is illustrated in Figure 1 for the case of a market with a total of eight banks.

We first examine the profit maximization problem for the single LMB, then the profit maximization problems for the smaller banks in both markets, and, finally, the equilibrium rates consistent with each bank's optimization. LMB 1 maximizes the joint profit from operating in both markets, taking as given the prices of its neighboring banks. Let $r_{L,2}^N$ and $r_{L,n}^N$ ($r_{D,2}^N$ *and* $r_{D,n}^N$) be the retail loan (*deposit*) rates of its two neighboring banks in market *N*, and let $r_{L,2}^M$ and $r_{L,m}^M$ ($r_{D,2}^M$ *and* $r_{D,m}^M$) be the retail loan (*deposit*) rates of its neighboring banks in market *M*. Given the aforementioned symmetry in rate setting of small banks that are equidistant from LMB 1, then $r_{L,n}^N = r_{L,2}^N$ ($r_{D,n}^N = r_{D,2}^N$) and $r_{L,m}^M = r_{L,2}^M$ ($r_{D,m}^M = r_{D,2}^M$). Hence, generalizing equations (3) and (4), the total demand for loans faced by LMB 1 is

$$D_1^L\left(r_{L,1}, r_{L,2}^N, r_{L,2}^M\right) \equiv \left(r_{L,2}^N - r_{L,1}\right)\frac{L^N}{t_L} + \frac{L^N}{n} + \left(r_{L,2}^M - r_{L,1}\right)\frac{L^M}{t_L} + \frac{L^M}{m} \tag{17}$$

and the total supply of deposits by LMB 1 is

$$S_1^D\left(r_{D,1}, r_{D,2}^N, r_{D,2}^M\right) \equiv \left(r_{D,1} - r_{D,2}^N\right)\frac{D^N}{t_D} + \frac{D^N}{n} + \left(r_{D,1} - r_{D,2}^M\right)\frac{D^M}{t_D} + \frac{D^M}{m}. \tag{18}$$

Then, the LMB 1's profit maximization problem is given by

$$\underset{r_{L,1}, r_{D,1}}{\text{Max}} \; Wr_W + D_1^L\left(r_{L,1}, r_{L,2}^N, r_{L,2}^M\right)\left(r_{L,1} - c_L^*\right) - S_1^D\left(r_{D,1}, r_{D,2}^N, r_{D,2}^M\right)\left(r_{D,1} + c_D^*\right) - Er_E \tag{19}$$

[12] The model assumes that small banks' post-merger locations around the circle remain the same as before the merger. This implies that a small bank's equilibrium rates and profit depend on its distance from the LMB. We justify this assumption by interpreting the model's results as a short-run equilibrium where a bank faces costs of adjusting its location. In a longer run, small banks might move to asymmetric points around the circle such that their profits are identical. This alternative equilibrium would not change the qualitative nature of the results regarding the impact of mergers on the market's average interest rates. Of course, a longer-run equilibrium also would consider market entry and exit decisions.

Since we assume that $L^N \gg (1+\rho) D^N$ and $L^M \gg (1+\rho) D^M$, the LMB's capital constraint binds and that it funds loans with both retail deposits and wholesale liabilities ($W < 0$). The first order conditions lead to the solutions

$$r_{L,1} = \frac{1}{2}\left(\frac{L^N r_{L,2}^N + L^M r_{L,2}^M}{L^N + L^M}\right) + \frac{1}{2}\left(\frac{r_W + \rho r_E}{1+\rho} + c_L^*\right) + \frac{t_L}{2}\left(\frac{L^N}{n} + \frac{L^M}{m}\right)\left(\frac{1}{L^N + L^M}\right) \tag{20}$$

$$r_{D,1} = \frac{1}{2}\left(\frac{D^N r_{D,2}^N + D^M r_{D,2}^M}{D^N + D^M}\right) + \frac{1}{2}\left(r_W - c_D^*\right) - \frac{t_D}{2}\left(\frac{D^N}{n} + \frac{D^M}{m}\right)\left(\frac{1}{D^N + D^M}\right) \tag{21}$$

which shows that LMB 1's retail loan and deposit rates depend on those of its neighboring banks in both local markets as well as the numbers of banks in both markets. Its rates are a volume - weighted average of the rates that would be individually optimal in each market.

Turning next to the profit maximization problems of the small banks in each market, note that small banks are faced with the same market environment as the LMB in that the volume of loans in each market exceeds the available retail deposits plus required capital. Thus, it is assumed that small banks, at the margin, fund loans using equity capital. The small banks in both market *N* and *M* choose retail loan and deposit rates using the conditions in equations (13) and (14). However, unlike the basic situation analyzed in Section III.A, $r_{L,i\text{-}1} \neq r_{L,i} \neq r_{L,i+1}$ and $r_{D,i\text{-}1} \neq r_{D,i} \neq r_{D,i+1}$ since these banks' loan and deposit rates will differ depending on their distances from LMB 1. As shown in the Appendix, when $L^N \gg (1+\rho) D^N$ the retail loan and deposit rate of the small banks in market *N* can be written in terms of LMB 1's rates as

$$r_{L,i} = \left(1-\delta_{i,n/k}\right)\left(r_E + c_L + \frac{t_L}{n}\right) + \delta_{i,n/k} r_{L,1}\ , \quad i = 2, \ldots, n/k. \tag{22}$$

$$r_{D,i} = \left(1-\delta_{i,n/k}\right)\left(r_E - c_D - \frac{t_D}{n}\right) + \delta_{i,n/k} r_{D,1}\ , \quad i = 2, \ldots, n/k. \tag{23}$$

where recall that $k = 1$ and for the case that n is an even number[13]

$$\delta_{i,n/k} \equiv \frac{\left(2+\sqrt{3}\right)^{\frac{n}{2k}+1-i} + \left(2-\sqrt{3}\right)^{\frac{n}{2k}+1-i}}{\left(2+\sqrt{3}\right)^{\frac{n}{2k}} + \left(2-\sqrt{3}\right)^{\frac{n}{2k}}} \tag{24}$$

Equations (22) and (23) shows that small bank i's interest rates are a weighted average of the standard Salop model rates and the rates charged by LMB 1, with $\delta_{i,n}$ being the weight on $r_{D,i}$ and $r_{D,i}$. The weight $\delta_{i,n}$ is a declining function of i over the range from $i = 2$ to $i = n/2 + 1$, the mid-point of the circle, and it satisfies the symmetry conditions: $\delta_{2,n}=\delta_{n,n}$, $\delta_{3,n}=\delta_{n-1,n}$,…, $\delta_{n/2,n}=\delta_{n/2+2,n}$. Thus, as one would expect, the interest rates of a small bank are less affected by LMB 1 the farther is the small bank's distance from LMB 1.

Moreover, the Appendix shows that for a given number of bank-intervals i, $i= 1,\ldots, n$ away from LMB 1, a small bank's interest rates are less sensitive to the LMB's rate the greater is the total number of banks in the market, that is, $\partial\delta_{i,n}/\partial n < 0$. For example, since $n \geq m$, then $0 < \delta_{2,n} \leq \delta_{2,m} < 1$. Therefore, the presence of the LMB has a larger impact in the concentrated market M for two reasons: first, there are fewer banks so that the average number of intervening banks between any small bank and the LMB is less; second, for any given bank-interval distance, i, a small bank's rate depends relatively more on that of the LMB.

The final step in determining the banks' equilibrium interest rates is to solve for LMB 1's rates given the form of the rates of its neighboring banks in both markets N and M. To find the LMB's equilibrium loan rate, we substitute equation (22) with $i = 2$ into equation (20) to obtain:

$$r_{L,1} = r_E + c_L + \left[\frac{\left(2-\delta_{2,n/k}\right)L^N}{n\left(L^N+L^M\right)} + \frac{\left(2-\delta_{2,m/k}\right)L^M}{m\left(L^N+L^M\right)}\right]\frac{t_L}{\Psi} - \frac{\Lambda}{\Psi} \tag{25}$$

[13] The case of n being an odd number is discussed in the Appendix.

where $\Psi \equiv 2-\left(L^N \delta_{2,n/k} + L^M \delta_{2,m/k}\right)/\left(L^N + L^M\right) > 0$ and $\Lambda \equiv \left(r_E - r_W\right)/\left(1+\rho\right) + c_L - c_L^*$ is the LMB's net loan operating and funding cost advantage relative to a small bank. The term in brackets in equation (25) shows that the LMB's loan rate reflects a market-weighted average of the competitive conditions in both markets. The final term in the equation indicates that its loan rate is lower the greater is its wholesale funding and loan operating cost advantages, Λ. The retail loan rate of any small bank in either market can also be found by substituting (25) into (22). In particular, the rates of the banks neighboring the merged bank in markets *M* and *N* are

$$r_{L,2}^M = r_E + c_L + \frac{t_L}{m} - \frac{\delta_{2,m/k}}{\Psi}\left[\Lambda + \frac{L^N\left(2-\delta_{2,n/k}\right)}{L^N + L^M}\left(\frac{1}{m} - \frac{1}{n}\right)t_L\right] \tag{26}$$

$$r_{L,2}^N = r_E + c_L + \frac{t_L}{n} - \frac{\delta_{2,n/k}}{\Psi}\left[\Lambda - \frac{L^M\left(2-\delta_{2,m/k}\right)}{L^N + L^M}\left(\frac{1}{m} - \frac{1}{n}\right)t_L\right] \tag{27}$$

Recall that the first three terms on the right hand sides of equations (26) and (27) are the equilibrium loan rates that the small banks would charge in the absence of the LMB. The final terms on the right hand sides of the equations reflect the impact of the LMB.

Based on similar logic, we can derive the equilibrium deposit rate charged by the LMB. It is straightforward to show that

$$r_{D,1} = r_E - c_D - \left[\frac{\left(2-\delta_{2,n/k}\right)D^N}{n\left(D^N + D^M\right)} + \frac{\left(2-\delta_{2,m/k}\right)D^M}{m\left(D^N + D^M\right)}\right]\frac{t_D}{\Omega} - \frac{\Delta}{\Omega} \tag{28}$$

where $\Omega \equiv 2-\left(D^N \delta_{2,n/k} + D^M \delta_{2,m/k}\right)/\left(D^N + D^M\right) > 0$ and $\Delta \equiv r_E - r_W - \left(c_D - c_D^*\right)$ is the difference between the LMB's funding and deposit operating cost advantages relative to a small bank. Then, the deposit rate of any small bank can be found by substituting (28) into (23). In particular, the banks neighboring the merged bank in markets *M* and *N* set deposit rates of

$$r_{D,2}^M = r_E - c_D - \frac{t_D}{m} - \frac{\delta_{2,m/k}}{\Omega}\left[\Delta - \frac{D^N\left(2-\delta_{2,n/k}\right)}{D^N + D^M}\left(\frac{1}{m} - \frac{1}{n}\right)t_D\right] \tag{29}$$

$$r_{D,2}^{N} = r_E - c_D - \frac{t_D}{n} - \frac{\delta_{2,n/k}}{\Omega}\left[\Delta + \frac{D^M\left(2-\delta_{2,m/k}\right)}{D^N + D^M}\left(\frac{1}{m} - \frac{1}{n}\right)t_D\right] \tag{30}$$

The equilibrium LMB and small bank loan and deposit rates given in equations (25) to (30) can be extended immediately to a case of $k \geq 1$ mergers of banks in each of the two markets. This is done by assuming that multiple LMBs are symmetrically located around markets *M* and *N*. Figure 2 illustrates an example of two LMBs and eight total banks in market *M* and 12 total banks in market *N*. LMBs are at points equidistant around the two circles, and there are an equivalent number of small banks between each LMB. This assumption allows us to generalize the previous results because each "cluster" of small banks between two LMBs face a similar situation to that of the small banks in a market with a single LMB. In turn, each LMB is surrounded by an equal numbers of small banks, making its situation analogous to the single merger case.

Consistent with Figure 2 and our earlier analysis, suppose that the numbers of small banks between each LMB in markets *M* and *N* are odd. Derivations nearly identical to those of the single merger case lead to the LMBs and their neighboring small banks having loan rates equal to (25), (26), and (27), and deposit rates equal to (28), (29), and (30), but where $k \geq 1$.[14]

IV. The Model's Predictions and Prior Empirical Evidence

Having derived the equilibrium retail loan and deposit rates for LMBs and small banks in concentrated and less concentrated markets, this section analyzes the impact of LMBs on market competition and whether the model's predictions are consistent with prior empirical research. We

[14] Equations for loan and deposit rates similar to (25) to (30) can be derived for a different structure of market extension mergers. One can assume that $k \geq 1$ LMBs operate in market *M* and each of them operate in a different market with *n* total banks where it is the only LMB. For this case, rates are given by (25) to (30) with $\delta_{2,n}$ replaced by $\delta_{2,n/k}$ in each equation. The qualitative effects of LMBs on market *M* are the same as our base case where all LMBs operate in the same two markets, *M* and *N*. However, in our base case LMBs have "multimarket contact" in that they compete in two markets, rather than one. This strengthens the competitive effects on market *M* relative to the case of single market contact. Thus if LMBs have a significant cost of funding advantage, multimarket contact strengthens competition in loans but weakens it for deposit. See Pilloff (1999a) and its references for discussions of multi-market contact and competition.

examine how greater numbers of LMBs affect small bank loan rates, deposit rates, and profits.

IV.A The Effects of LMBs on Loan Rates

The effects of LMBs on small bank loan rates depend on the last terms on the right-hand-sides of equations (26) and (27). Inspection of these equations leads to the following proposition.

Proposition 1: *Consider two markets, M and N, having even numbers of banks equal to m and n, respectively. Let k of the banks in each market be LMBs that are located equidistantly around each market's circle, where* $1 \le k \le m/2 \le n/2$. *Then an increase in k reduces the loan rates paid by small banks in*

a. concentrated market M iff $\Lambda > -\frac{t_L L^N}{L^N + L^M}\left(2-\delta_{2,n/k}\right)\left(\frac{1}{m}-\frac{1}{n}\right)$.

b. less concentrated market N iff $\Lambda > \frac{t_L L^M}{L^N + L^M}\left(2-\delta_{2,m/k}\right)\left(\frac{1}{m}-\frac{1}{n}\right)$.

The inequalities in conditions a. and b. are more likely to hold as k increases.

Proof: For the case of a small bank that neighbors an LMB, see equations (26) and (27) and note that $\partial\delta_{i,n/k}/\partial k > 0$. For other small banks, note from equation (22) that their loan rates move in the same direction (though to a lesser degree) as do the small banks that neighbor an LMB.

Proposition 1 permits us to distinguish the effect of LMBs' uniform pricing from the effect of their loan operating and funding cost advantage, Λ. If LMBs and small banks had identical loan operating and funding costs, so that Λ = 0, then since $\frac{t_L L^M}{L^N + L^M}\left(2-\delta_{2,m/k}\right)\left(\frac{1}{m}-\frac{1}{n}\right) > 0$

$> -\frac{t_L L^N}{L^N + L^M}\left(2-\delta_{2,n/k}\right)\left(\frac{1}{m}-\frac{1}{n}\right)$, the LMBs' uniform loan rate would lower loan rates in market *M* but raise them in market *N*. The LMBs' presence narrows the differences in rates between the two markets.

However, if LMBs have an operating and funding cost advantage so that Λ is positive, small bank loan rates may fall even in the less concentrated market *N*, thereby raising competition in both markets. Since $\partial\delta_{i,n/k}/\partial k > 0$, this is more likely to occur as the number of LMBs rises.

For the special case of $m = n$, so that uniform rate setting does not constrain LMBs because both markets have equal concentrations, a positive Λ leads to loan rates falling in both markets. This result also holds if concentrations were unequal but LMBs set non-uniform, market-specific rates.

The preponderance of empirical evidence is consistent with LMBs having a funding and operating cost advantage. Studies show that LMBs tend to charge lower retail loan rates compared to smaller banks and market-wide loan rates tend to be lower then LMBs have a greater presence. Berger and Udell (1996) examine small business loans using the Federal Reserve's Survey of Terms of Bank Lending to Business (STBL) during 1986 to 1994. Controlling for loan terms and local market concentration, they find strong evidence that LMBs charge lower small business loan rates and require less collateral compared to small banks. Erel (2005) uses 1987 to 2004 STBL data to study the effects of mergers on small business loan rates, finding that after a merger, acquiring banks lower their loan rates. She finds that the decline in rates tends to be especially large when the acquirer is an LMB (has assets exceeding $10 billion).

Research by Berger, Rosen, and Udell (2007) examine lines of credit made to small businesses using data from the 1993 National Survey of Small Business Finance (NSSBF). Controlling for borrower risk and market concentration, they find that when LMBs have a greater share of a local market, rates on small business loans by both LMBs and small banks are lower. They conclude that their findings are consistent with more aggressive competition for small business credits in markets where LMBs have a greater presence.

IV.B The Effects of LMBs on Deposit Rates

Let us now consider the effects of LMBs on retail deposit rates. The next proposition derives from the small bank loan rates given in equations (29) and (30).

Proposition 2. *Consider two markets, M and N, having even numbers of banks equal to m and n, respectively. Let k of each market's banks be LMBs that are located equidistantly around each market's circle, where* $1 \leq k \leq m/2 < n/2$. *Then an increase in k lowers retail deposit rates in* *a. concentrated market M iff* $\Delta > \frac{t_D D^N}{D^N + D^M}\left(2 - \delta_{2,n/k}\right)\left(\frac{1}{m} - \frac{1}{n}\right)$.

b. less concentrated market N iff $\Delta > -\frac{t_D D^M}{D^N + D^M}\left(2 - \delta_{2,m/k}\right)\left(\frac{1}{m} - \frac{1}{n}\right)$.

The inequalities in conditions a. and b. are more likely to hold as k increases.

Proof: For the case of a small bank that neighbors an LMB, see equations (29) and (30) and note that $\partial\delta_{i,n/k} / \partial k > 0$. For other small banks, note from equation (23) that their deposit rates move in the same direction (though to a lesser degree) as do the small banks that neighbor an LMB.

Similar to Proposition 1, if LMBs and small banks had identical deposit operating and funding costs, so that Δ = 0, the effect of LMBs' uniform rate setting is to increase deposit rates in concentrated market *M* and reduce deposit rates in market *N*. However, if LMBs have a significant wholesale funding advantage, so that Δ is sufficiently large, then Proposition 2 predicts that an increased presence of LMBs can decrease competition in both retail deposit markets. Moreover, for the special case of *m* = *n*, so that the markets have equal concentrations, deposit rates are lower in both markets whenever Δ is positive.

Thus, if LMBs have a significant funding advantage, as they expand into a market their anti-competitive effect on retail deposits is exactly opposite to their pro-competitive effect on retail loans. Consequently, our model predicts that market extension mergers tend to benefit retail borrowers but harm retail depositors. The intuition for the decline in deposit market competition stems from an LMB's unwillingness to compete aggressively for retail deposits if it has a cheaper source of wholesale funding. If, at the margin, an LMB is financing loans with wholesale funds, it would never set a retail deposit rate greater than $r_W - c_D^*$, and this constraint is more likely to bind in less concentrated markets.

Empirical studies on retail deposit market competition are generally supportive of our model's predictions. Empirical work in Hannan and Prager (2004) is motivated by a model similar to Barros (1999) which assumes that LMBs' deposit rates are exogenous but uniform across local markets. It, like our Proposition 2, predicts that the deposit rates paid by small banks become more like those of LMBs the greater is LMBs' share of the local market. This implication is tested using quarterly interest expense and deposit balance data from 1996 and 1999 Call Reports to impute the NOW and MMDA rates paid by small, single-market banks. They find that these deposit rates diminish as LMBs' share of the local market rises, primarily because LMBs' rates are lower, consistent with a wholesale funding advantage.[15]

Hannan and Prager (2006a) focus on NOW and MMDA rates paid by multimarket banks during 2000-2002 and find that rates are lower the larger is the bank's size.[16] They also find that a multimarket bank's deposit rate is negatively related to a weighted average of the HHIs of the markets in which it operates and, even more strongly, to the state-level HHIs where it has a presence. These findings support the notion that LMBs enjoy a funding advantage and, as in equation (21), an LMB's deposit rate is a deposit-weighted average of the competitive conditions of its markets. Hannan (2006) provides related evidence on deposit account fees, which might be viewed as "negative" deposit interest rates. He finds that LMBs charge higher fees than small banks, and a greater presence of LMBs raises the fee levels of the local single-market banks.

Our model's prediction that LMBs compete less aggressively for retail deposits is also consistent with Pilloff and Rhoades (2000). They examine the change from 1990 to 1996 in LMBs' deposit market shares in various MSAs. They find that LMBs retained their market shares of total deposits in more urban MSAs but lost market shares of deposits in relatively rural MSAs. Since LMBs obtain wholesale deposits in urban markets while only retail deposits are obtained in rural markets, these findings are consistent with LMBs' reliance on wholesale funding and their lack of competition for retail deposits.

IV.C The Effects of LMBs on Small Bank Profitability

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[15] Rosen (2003) presents contrary evidence that NOW and MMDA rates paid by single-market banks are higher in markets where multimarket banks have a greater market share. The difference appears to be due to different control variables and regression methodology.

[16] Their results are consistent with Kiser (2004) who uses banks' retail deposit rates from the single *Bankrate* survey taken in the first week of June 1998. She regresses deposit rates on a large number of control variables and finds that retail rates are negatively related to the log of bank assets.

This section analyzes how LMBs affect the overall profitability of small banks. To isolate the effect of an LMB's wholesale funding advantage from the effect of uniform rate setting, consider the case where the concentrations of *N* and *M* are equal. In this case, LMBs will charge uniform rates even if they were permitted to charge different ones. Setting $m = n$ in the equilibrium loan and deposit rate equations (25) to (30) and then calculating banks' profits based on these rates, it is straightforward to show that the profits of LMBs equal

$$\left(L^N + L^M\right)t_L\left[\frac{1}{n}+\frac{\Lambda}{t_L}\left(\frac{1-\delta_{2,n/k}}{2-\delta_{2,n/k}}\right)\right]^2 + \left(D^N + D^M\right)t_D\left[\frac{1}{n}-\frac{\Delta}{t_D}\left(\frac{1-\delta_{2,n/k}}{2-\delta_{2,n/k}}\right)\right]^2 \qquad (31)$$

while the profits of small bank i, $i = 2, \ldots, n/k$, equal[17]

$$L^N t_L\left[\frac{1}{n}-\frac{\Lambda}{t_L}\left(\frac{\delta_{i,n/k}}{2-\delta_{2,n/k}}\right)\right]^2 + D^N t_D\left[\frac{1}{n}+\frac{\Delta}{t_D}\left(\frac{\delta_{i,n/k}}{2-\delta_{2,n/k}}\right)\right]^2 \qquad (32)$$

The quantities in brackets in (31) and (32) are the individual banks' equilibrium market shares of total loans and deposits.[18] Thus, a bank's profit in a loan or a deposit market is proportional to its squared share of that market. Since $1/n$ is the average of the n banks' market shares, when LMBs' have a significant wholesale funding advantage such that Λ and Δ are both positive, LMBs (*small banks*) have loan market shares that are greater (*smaller*) than average. Conversely, LMBs (*small banks*) have deposit market shares that are smaller (*greater*) than average.

Moreover, when $\Lambda > 0$ we see from the first term in (32) that small banks' loan market shares and profits fall as the number of LMBs, k, rises. Furthermore, small banks located closest to an LMB experience the lowest loan market profits. Conversely, if $\Delta > 0$, the second term in (32) shows that small banks' deposit market shares and profits rise with an increase in the number

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[17] Equation (32) is for a small bank in market *N*. The equation is the same for a small bank in market *M* except that L^M replaces L^N and D^M replaces D^N.

[18] In deriving the profits in (31) and (32), it is assumed that the market shares in the brackets are all positive. This restriction constrains the parameters in our model to cases where the impact of LMBs is moderate enough to leave all banks with positive loan and deposit market shares and, hence, positive profits.

of LMBs, and small banks that are closest to LMBs have the highest deposit market profits.[19] The impact of LMBs on a particular small bank's total profits can be positive or negative depending on the relative sizes of total market loans to deposits and differences in loan and deposit transportation and operating costs. Thus, it is possible that a greater presence of LMBs increases small bank profits in some markets but decreases them in others.

For the general case of $m \leq n$, expressions for LMB and small bank profitability become more complex than (31) and (32). However, note from Propositions 1 and 2 that the competitive impact of LMBs on both loan and deposit markets is relatively greater for concentrated market *M* compared to less concentrated market *N*. Hence, all else equal, LMBs are more likely to reduce small banks' profits in relatively concentrated markets.[20] Intuitively, this is because LMBs' uniform rates are averages across markets, so that their loan rates tend to be lower, and their deposit rates tend to be higher, than those of small banks in concentrated markets.

Because the model's implications regarding the impact of LMBs on small bank profitability are case specific, it is unsurprising that empirical evidence examining this effect is mixed. Whalen (2001) finds that during 1995-1999, a small bank's profitability was lower when LMBs had a greater presence in its MSA, while during 1995-1996 Pilloff (1999b) reports that small bank profits in non-MSA rural counties increased with the presence of LMBs. Wolken and Rose (1991) use 1985 data on banks in both MSAs and non-MSA counties in eight unit banking states and find that the presence of LMBs reduced the profitability of small banks.

Berger, Dick, Goldberg, and White (2007) show that a greater LMB market share is associated with an increase in small bank profitability during the 1980s but a decline in small

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[19] Similarly, note from (31) that if Λ and Δ are positive, LMBs' loan (*deposit*) market profits fall (*rise*) as the number of LMBs, *k*, increase. Also, recall that since consumer demands for loans and deposits are inelastic, and that loan and deposit rates fall for all banks, the consumer surplus of borrowers (*depositors*) rises (*falls*) with an increase in the number of LMBs.

[20] This result suggests that in a dynamic model with entry and exit decisions, LMBs will find entry into more concentrated markets to be most attractive. For the case where both markets have the same concentration and have no initial LMB, note that the incentive for two small banks to merge to form an LMB equals the difference between profits given in (31) with k=1 and $(L^N+L^M)t_L/n^2 + (D^N+D^M)t_D/n^2$.

bank profitability during the 1990s. They surmise that technological progress in lending has allowed LMBs to more effectively compete with small, single market banks in recent years.[21] Finally, Hannan and Prager (2006b) report that during 1996-2003 an increased presence of LMBs reduced small bank profits in non-MSA counties but not in the less concentrated MSAs. Consistent with our model's prediction, they find that impact of LMBs in reducing small bank profits is the greatest in the most concentrated non-MSA counties.

V. New Evidence on Retail Deposit Competition

This section presents new empirical tests of our model's predictions regarding retail deposit market competition. We first examine equilibrium in a static setting using *Bankrate*, Inc. survey data. Second, we use Call Report and Thrift Financial Report data to investigate the dynamics of MMDA rates before and after LMBs' acquisitions of small banks.

V.A Evidence Using *Bankrate* Survey Data

This section analyzes individual LMB and small bank retail deposit rates observed in different local markets. We begin by describing the data used in our tests.

V.A.1 Data and Sample Selection

Our data includes retail deposit interest rates from annual *Bankrate*, Inc. surveys of individual commercial banks and thrift institutions over the seven-year period 1998 to 2004.[22] The deposit rates are for MMDAs, six-month maturity retail Certificates of Deposits (CDs), and one-year maturity retail CDs paid by banks in up to 145 different MSAs. The date of each year's survey is chosen to be the last week of June so as to match annual FDIC *Summary of Deposits* (SOD) data. The SOD data record the amount of deposits issued by individual banks in each MSA and are used to calculate the total deposits (market size) and HHI of each MSA, as well as

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[21] In terms of our model, technological change may have increased $c_L - c_L^*$, so that Λ has grown and intensified retail loan competition. Consistent with this result, Ergungor (2002) finds that during 1996-2002 when bank mergers were prevalent, community banks that specialized in small business loans under-performed other small banks.

[22] We are grateful to the Federal Reserve Bank of Cleveland for providing access to the deposit data.

each of our sample banks' deposits issued both within and outside of the surveyed MSAs. In addition, as a proxy for an LMB's wholesale funding cost, we obtained one-, six-, and twelve-month LIBOR corresponding to the survey dates from the British Bankers' Association.

The *Bankrate* data is attractive because it contains the actual MMDA and retail CD rates paid by an individual bank at a given date in a particular local market. However, not all MSAs and not all banks in a given MSA are surveyed by *Bankrate*. The first column in Table 1 lists the number of MSAs surveyed in each of the seven years, with 130 MSAs per year being the average.

Bankrate tends to select large- and medium-sized MSAs.[23] It surveys ten banks in each of the largest MSAs, but fewer in the others, with 5.6 being the average. Because *Bankrate* surveys relatively large MSAs, and within those MSAs it selects banks with the highest market shares, large banks are more likely to be surveyed than smaller ones. In our tests, we define an LMB as any bank having greater than $10 billion in total deposits while a small bank is one with less than $1 billion in total deposits. Columns three and five in Table 1 gives the total number of small bank and LMB observations per deposit type and year. In only a handful of cases were small banks surveyed in more than one MSA. However, there were approximately 51 different LMBs surveyed per year, and, on average, an LMB was surveyed in 9.67 different MSAs.

V.A.2 <u>Deposit Rates: Small Banks versus LMBs</u>

Our model assumes that LMBs set uniform rates across markets and have access to wholesale funding. We now show that the data are consistent with these assumptions. LMB rates tend to be uniform across the surveyed markets. Also, LMBs appear to have access to lower-cost wholesale funding because they do not compete aggressively for retail deposits. Large bank MMDA and retail CD rates tend to be lower than those of small banks.

Table 1 columns two and four give the mean MMDA and CD rates offered by small

[23] There are approximately 330 MSAs in the United States, and those surveyed by *Bankrate* tend to be larger and less concentrated than the U.S. average. The average and median HHI's of the MSAs in our dataset are approximately 1460 and 1300, respectively.

banks and LMBs for the years 1998 to 2004.[24] It also reports in column six a measure of LMB "rate diversity," defined as the proportion of markets in which a given LMB is surveyed for which it sets different rates. Specifically, the statistic reported is the median for all LMBs of

$$\text{Rate Diversity} = \frac{\text{Number of Different Survey Rates Quoted by an LMB - 1}}{\text{Number of Markets in which the LMB Was Surveyed -1}} \qquad (33)$$

Note that if an LMB sets a uniform rate across all markets, its rate diversity would be 0, while if it sets different rates in each market, its rate diversity would be 1. Column six of Table 1 shows that the tendency for LMBs to set uniform rates increased over the sample period. We also found that if an LMB's rate diversity is calculated at the state, rather than national, level, the median value was 0.0 for all deposit types for each of the years, indicating strong state-wide uniformity.

Table 1 reports that during each of the seven years, and for both MMDAs and CDs, the average deposit rates offered by small banks exceeded the corresponding average rates offered by LMBs. Moreover, the mean LMB retail rates were always lower than their equivalent maturity LIBOR, but this was not always the case for the mean small bank rates.

A simple comparison of mean deposit rates does not control for possible differences in the structure of markets in which small banks and LMBs operate. Thus, for each of the small banks surveyed by *Bankrate*, we computed the spread between the small bank's deposit rate and the average of the rates paid by the LMBs in this small bank's local market. Columns 8-11 of Table 1 show that the average spreads based on this market-by-market calculation are significantly positive at better than a 99 % confidence level for each type of deposit and each year. These results are clear and consistent evidence that LMBs do not compete for retail deposits as aggressively as small banks, and they match the empirical evidence discussed previously.

V.A.3 <u>The Effect of LMB Market Share on Retail Deposit Rates</u>

Proposition 2 predicts that if LMBs pay relatively low retail deposit rates, their greater presence lowers the deposit rates paid by smaller banks, especially in less concentrated markets.

[24] The median values for deposit rates were close to their reported mean values.

We test this proposition by regressing individual banks' retail deposit rates on market structure and bank size variables. The dependent variables in these regressions are MMDA, six-month CD, or one-year CD rates. The explanatory market variables are the MSA's HHI, the log of total MSA deposits (a proxy for market size), and the share of the MSA's total deposits issued by LMBs (LMB Share). Another explanatory variable is a bank size dummy variable that equals 1 if the bank is an LMB, and zero otherwise. Also, as explained below, an interaction variable, the product of HHI and LMB Share, is included.[25]

Our model predicts a negative coefficient on HHI, since rates should be lower in more concentrated markets. It also predicts a negative coefficient on the LMB dummy, since an LMB's access to wholesale funding reduces the rate it is willing to pay on its retail deposits. A final model prediction is that the coefficient on the interaction term, HHI*LMB Share, is positive, because a greater presence of LMBs lessens the negative effects of HHI on deposit rates due to their uniform pricing across markets. In particular, when LMBs control a greater share of less concentrated markets (those with lower HHI), retail deposit rates should be lower.

Table 2 Panel A presents results for MMDA interest rates based on cross-sectional regressions for each year from 1998 to 2004. As expected, the coefficient on HHI is always negative and is statistically significant for three of the seven years. The coefficient on the LMB dummy variable is negative and highly significant in all cases, a result consistent with the evidence previously reported in Table 1. The coefficient on the interaction variable, HHI*LMB Share is mildly supportive of the model in that it is positive for six of the seven years and statistically significant for three of them. The last column of the table reports the time series averages of the year-by-year regression coefficients along with their Fama-MacBeth standard errors. It shows that HHI, the LMB dummy, and the interaction variable HHI*LMB Share are statistically significant across the years and have their expected signs.

[25] In addition, because LMBs tend to set deposit rates that are uniform across different MSAs, especially those in the same state, the regressions control for bank fixed effects across same-state MSAs.

Panel B of Table 2 repeats the regressions in Panel A but accounts for the fact that some LMBs do not set perfectly uniform rates and, instead, may vary rates based on local market conditions. If this were the case, then one would expect less effect for the interaction term HHI*LMB Share since LMBs would set rates similar to small local banks. Hence, we modify the interaction variable to HHI*LMB Share*(1-RD), where RD is the average of the rate diversities for the LMBs surveyed in the MSA. The results with this modification are qualitatively similar to those in Panel A, perhaps because RD is relatively small in most markets. In particular, the Fama-MacBeth coefficient for HHI*LMB Share*(1-RD) remains statistically significant.

Tables 3 and 4 report similar year-by-year regressions for six-month CD rates and one-year CD rates, respectively. The results in these two tables are nearly identical to each other, and provide even stronger support for the model's predictions. The LMB dummy is always significantly negative. Similarly, the coefficient on HHI is always negative and is statistically significant in almost 90 % of the cases. Also, the coefficients on the interaction terms HHI*LMB Share or HHI*LMB Share*(1-RD) are positive over 90 % of the time and are significantly positive over one-half of the time. Based on the Fama-MacBeth coefficient averages, these variables are always statistically significant with their expected signs.

Table 5 gives regression results that pool the seven years of data for each deposit type. In addition to the previously described explanatory variables, these regressions include dummy variables to account for time fixed-effects. In all cases, HHI and the LMB Dummy are significantly negative and the interaction variables, HHI*LMB Share or HHI*LMB Share*(1-RD), are always significantly positive.[26]

[26] As discussed by Bassett and Zakrajšek (2003), during the slow growth years 2001-2003 as well as 1998 which endured the effects of the Asian financial crisis, larger banks were disproportionately affected by macroeconomic events compared to smaller banks. Loan demand at large banks fell while a flight to quality allowed them to aggressively cut deposit rates. As a robustness test to see whether our results are driven by these events, we repeated the pooled regressions in Table 5 but excluded the years 1998 and 2001-2003. The results, while weaker in some cases, were qualitatively similar. The coefficients on the HHI and LMB Dummy were always negative and statistically significant. The coefficients on the

As an example of the economic significance of these estimates, consider the six-month CD regression results in column three of Table 5. They imply that rates paid by LMBs are 27.3 basis points lower than other banks. They also imply that if the MSA becomes less concentrated due to the HHI falling by 1000, then six-month CD rates would increase by 17.0 basis points if there were no LMBs in the market but they would increase by only 9.65 basis points (0.170 – 0.50*0.147) if LMBs had a 50 % share of the market.

V.B Evidence from LMB Acquisitions of Small Banks

The previous section's results are consistent with our theory's prediction that LMBs pay lower retail deposit rates and that their greater presence in an MSA causes deposit rates to be lower. However, there is the possibility that the association between lower deposit rates and a greater LMB presence may have an alternative cause if our previous tests omitted a variable that affects both LMB presence and deposit rates. This section attempts to provide additional evidence that a greater LMB market share causes deposit rates to decline by analyzing the dynamics of deposit rates around the time of an LMB's acquisition of a small bank.

Similar to Focarelli and Panetta (2003), we examine the dynamics of deposit rates paid by banks involved in a merger. A finding that the small bank's deposit rate prior to a merger is higher than that of the acquiring LMB after the merger would support a causal relationship between LMB presence and lower deposit rates. An alternative finding of no decline in the pre- and post-merger rates would lend credence to another explanation for the link between LMB presence and lower deposit rates.

VI.B.1 Data and Sample Selection

We searched annual SOD data on all MSAs during 1994-2005 to identify instances where a small, single-market bank was acquired by an LMB. Our tests use both narrow and broad definitions of small banks and LMBs. Small, single-market banks are defined as having total

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interaction terms HHI*LMB Share were always positive and the coefficients on the interaction term HHI*LMB Share*(1-RD) were always positive and statistically significant.

deposits below $1 billion with at least 75 % (narrow) or 50 % (broad) of their deposits in a single MSA. LMBs are defined as having total deposits exceeding $10 billion (narrow) or $5 billion (broad).[27] Similar to prior studies on deposit competition, we calculated implicit MMDA rates for commercial banks using the bank's quarterly Call Report data on MMDA interest expense and deposit balances. For thrift institutions, MMDA rates were based on their weighted average cost of MMDAs as reported on their Thrift Financial Reports. MMDA rates for the acquired small bank and the acquiring LMB were estimated as of mid-year for the year prior to the acquisition. Also, mid-year MMDA rates for the LMB were estimated for each of the three years after the acquisition. MMDA rates were also estimated for each of the other banks in the small bank's MSA over this four-year period.[28]

For an acquisition to be included in our analysis, we required that an MMDA rate be available for the acquired small bank and the acquiring LMB for the year prior to the merger. Because data needed for calculating MMDA rates are often missing, this requirement led us to drop many potential merger observations. Under the narrow definitions of small banks and LMBs, there were 48 acquisitions that met our sample selection criteria. For the broader definitions, 74 acquisitions met our criteria.

VI.B.2 Pre- and Post-Acquisition MMDA Rates

As a benchmark for comparing MMDA rates for the small bank and the LMB involved in the merger, we calculated the spreads between their MMDA rates and the average of MMDA rates for the other banks in the small bank's MSA. We then compared the acquired small bank's pre-merger spread to the acquiring LMB's pre- and post-merger spreads to see if there were statistically significant differences. The results are given in Table 6.

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[27] The median deposit sizes for small banks (LMBs) in our samples are $191 million ($18.5 billion) under the narrow definition and $183 million ($11.4 billion) under the broad definition.

[28] Note that our calculation of an MMDA rate for each multimarket bank assumes that the bank pays a uniform rate across the markets in which it operates. This is due to the fact that Call Report and Thrift Financial Report data are not broken down by market but are aggregated across all of the bank's markets.

Panel A of Table 6 reports tests using the sample of 48 acquisitions meeting the narrow definitions of small banks and LMBs. The first two rows show that the mean and median MMDA spreads for the acquiring LMBs were somewhat lower than those of the acquired small bank in the year prior to the merger, though the difference is not statistically significant. In rows three and four we then examine the 34 of 48 mergers for which MMDA spreads could be computed one year after the merger. Here we see that for this sample the LMB's post merger spread was significantly lower than the small bank's pre-merger spread. Specifically, the mean pre-merger small bank spread was + 6.5 basis points while the mean post-merger LMB spread was – 39.1 basis points. Rows five and six show that of the 25 mergers for which MMDA spreads could be computed two years after the merger, the LMBs' post merger spread was, again, significantly lower than their acquired small banks' pre-merger spread. For three years after the merger, there is an average pre-merger small bank spread of 15 basis points and a post-merger average LMB spread of -15 basis points, but the difference is not significant.

Panel B of Table 6 reports results for the broader definitions of small banks and LMBs. Here, the number of merger observations is larger and the statistical significance of the pre- and post-merger spread differences is greater. The mean and median spreads of the acquiring LMBs for one, two, and three years following the merger are always significantly lower than those of the acquired small bank in the year prior to the merger. The decline in the average spread from the year before to one, two, and three years after the merger is 37, 48, and 37 basis points, respectively. In summary, these results support a causal relationship between LMB presence and lower deposit rates.

VI. Concluding Remarks

Prior empirical research finds that, relative to small banks, LMBs have more standardized operations and set retail interest rates that are uniform across many local markets. LMBs also differ from their smaller rivals in their ability to access wholesale financing. Our model of multimarket competition accounts for these findings and analyzes competition for retail loans and deposits when LMBs command a greater presence in local markets.

Our model predicts that if LMBs have a significant funding advantage that is not offset by a loan operating cost disadvantage, their rates on retail loans will be lower than their smaller bank competitors, especially in more concentrated markets. A greater presence of LMBs intensifies competition for retail loans and reduces small banks' loan rates. Interestingly, in such a situation, LMBs' effect on retail deposit market competition is the just the opposite. When LMBs have a significant wholesale funding advantage, they will not compete aggressively for higher-cost retail deposits. As a result, their smaller rivals can pay lower rates on retail deposits, especially in more less concentrated markets.

Our theory's predictions are supported by prior empirical research as well as new empirical research presented in this paper. Greater market share by LMBs has been found to increase competition in small business lending but reduce competition in retail deposit taking. The impact of LMBs on overall small bank profits depends on the relative magnitudes of these two opposing effects. Our analysis underscores the likelihood that market-extension mergers that increase the scope of LMBs have disparate welfare consequences for different groups of bank customers.

While our analysis has been in the context of banking markets, our theory is applicable to other industries where some competitors operate in multiple markets and set prices uniformly. For example, our model could be applied to a chain store retailer whose centralized management sets uniform prices for a wide geographic area that covers multiple local markets of varying concentrations.[29] Such firms would enhance competition primarily in concentrated markets, forcing a lowering of prices by single-market retailers. As in our analysis of banking, a general effect from the spread of multimarket competitors is to reduce the variation in prices across local markets.

[29] Examples include Wal-Mart, Home Depot, and Starbucks.

Appendix

A. Profit Maximization in a Market with Only Small Banks

Substituting in for E in (8) and (6) using (7), and using (3) and (4), the problem becomes

$$\begin{aligned}\max_{r_{L,i},r_{D,i},W}\ & W\left(r_W - r_E\right) + \left[\frac{r_{L,i-1}+r_{L,i+1}}{2} - r_{L,i} + \frac{t_L}{n}\right]\frac{L}{t_L}\left(r_{L,i} - c_L - r_E\right) \\ & - \left[r_{D,i} - \frac{r_{D,i-1}+r_{D,i+1}}{2} + \frac{t_D}{n}\right]\frac{D}{t_D}\left(r_{D,i} + c_D - r_E\right)\end{aligned} \tag{A.1}$$

subject to

$$W + \left[\frac{r_{L,i-1}+r_{L,i+1}}{2} - r_{L,i} + \frac{t_L}{n}\right]\frac{L}{t_L} \geq (1+\rho)\left[r_{D,i} - \frac{r_{D,i-1}+r_{D,i+1}}{2} + \frac{t_D}{n}\right]\frac{D}{t_D} \tag{A.2}$$

and to the constraint (5). Letting λ_1 be the Lagrange multiplier for constraint (A.2) and λ_2 be the Lagrange multiplier for the constraint (5), the first order Kuhn-Tucker conditions are[30]

$$\frac{r_{L,i-1}+r_{L,i+1}}{2} - 2r_{L,i} + \frac{t_L}{n} + c_L + r_E - \lambda_1 = 0 \tag{A.3}$$

$$2r_{D,i} - \frac{r_{D,i-1}+r_{D,i+1}}{2} + \frac{t_D}{n} + c_D - r_E + (1+\rho)\lambda_1 = 0 \tag{A.4}$$

$$\left(r_W - r_E + \lambda_1 + \lambda_2\right)W = 0 \tag{A.5}$$

From (A.5) we see that if $W > 0$, then $r_W - r_E + \lambda_1 + \lambda_2 = 0$. But when $W > 0$, it is also the case that the constraint (5) is not binding, so that $\lambda_2 = 0$. Hence, $\lambda_1 = r_E - r_W > 0$. With λ_1 strictly positive, the capital constraint is binding. Hence, for this case (A.3) and (A.4) become equations (9) and (10) in the text and the symmetric equilibrium is equations (11) and (12).

From (A.5) we see that if instead of $W > 0$ we have $W = 0$, then $\lambda_2 > 0$. For this case there are two possibilities: either the capital constraint is binding, so that $\lambda_1 > 0$; or it is not binding so that $\lambda_1 = 0$. If the capital constraint is binding, then using $W = 0$ it becomes

$$\left[\frac{r_{L,i-1}+r_{L,i+1}}{2} - r_{L,i} + \frac{t_L}{n}\right]\frac{L}{t_L} - (1+\rho)\left[r_{D,i} - \frac{r_{D,i-1}+r_{D,i+1}}{2} + \frac{t_D}{n}\right]\frac{D}{t_D} = 0 \tag{A.6}$$

or solving for the deposit rate

$$r_{D,i} = \frac{r_{D,i-1}+r_{D,i+1}}{2} - \frac{t_D}{n} + \frac{Lt_D}{Dt_L(1+\rho)}\left[\frac{r_{L,i-1}+r_{L,i+1}}{2} - r_{L,i} + \frac{t_L}{n}\right] \tag{A.7}$$

[30] We consider only the realistic cases where $r_{L,i}$ and $r_{D,i}$ are non-zero and the bank's quantity of loans and deposits are positive.

But using the first order conditions (A.3) and (A.4) and substituting out for λ_1 implies

$$r_{D,i} = \frac{1}{2}\left[\frac{r_{D,i-1}+r_{D,i+1}}{2} - \frac{t_D}{n} - c_D + r_E\right] + \frac{1}{1+\rho}\left[r_{L,i} - \frac{r_{L,i-1}+r_{L,i+1}}{4} - \frac{1}{2}\left(\frac{t_L}{n} + c_L + r_E\right)\right] \quad \text{(A.8)}$$

Since condition (A.8) cannot be satisfied by (A.7) for arbitrary L and D, it must be suboptimal for capital to be constrained. Hence, $\lambda_1 = 0$. Thus, when $W = 0$ and $\lambda_1 = 0$, (A.3) and (A.4) imply equations (13) and (14) in the text and the symmetric equilibrium is equations (15) and (16).

From equations (3) and (4) in the text, we see that for each of these symmetric equilibria, the individual banks' loans and deposits are L/n and D/n. For the first equilibrium (11) and (12) where $W > 0$ and the capital constraint is binding, we have from an individual bank's balance sheet constraint that $W = (1+\rho)D/n - L/n > 0$. For the second equilibrium (15) and (16) where $W = 0$ and the capital constraint does not bind, the individual bank's balance sheet implies $E = L/n - D/n > \rho D/n$. Hence, the first equilibrium of (11) and (12) occurs when $L < (1+\rho)D$ while the second equilibrium of (15) and (16) obtains when $L > (1+\rho)D$.

B. Equilibrium with Multimarket Operations

Suppose there are a total n banks competing in a local market with one LMB located at $i = 1$. Hence, banks $i = 2, \ldots, n$ are small banks. When $L \gg (1+\rho)D$, their optimal retail loan rates satisfy equation (13) which can be written in the form of a second order difference equation.[31]

$$r_{L,i+1} - 4r_{L,i} + r_{L,i-1} + 2\left(r_E + c_L + \frac{t_L}{n}\right) = 0 \quad \text{(A.9)}$$

This can be re-written using the backward operator as

$$\left(1 - 4B + B^2\right) r_{L,i} + 2\left(r_E + c_L + \frac{t_L}{n}\right) = 0 \quad \text{(A.10)}$$

for $i = 3, \ldots, n$. The roots to the quadratic equation for the backward operator are $B = 2 \pm \sqrt{3}$. Also, note that a particular solution to equation (A.10) is $r_{L,i} = r_E + c_L + t_L/n$. Therefore, the general solution to (A.10) takes the form

$$r_{L,i} = \alpha_1\left(2+\sqrt{3}\right)^i + \alpha_2\left(2-\sqrt{3}\right)^i + r_E + c_L + \frac{t_L}{n} \quad \text{(A.11)}$$

[31] The difference equation for retail deposit rates is similar but with the term $r_E + c_L + t_L/n$ replaced with the term $r_E - c_D - t_D/n$.

where the constants α_1 and α_2 must be determined subject to two boundary conditions. One boundary condition results from the rate set by the large, merged bank i=1, which, initially, we take as exogenous

$$r_{L,1} = \alpha_1\left(2+\sqrt{3}\right)+\alpha_2\left(2-\sqrt{3}\right)+r_E+c_L+\frac{t_L}{n} \tag{A.12}$$

The second boundary condition results from the symmetry property for the one or two banks that are farthest away from LMB 1. When n is an even number, the single farthest bank is $i = n/2 + 1$.[32] For this bank, symmetry implies that the loan rates of its two neighbors, $r_{L\,i-1}$ and $r_{L,i+1}$, are the same. Hence, equation (13) becomes

$$r_{L,\frac{n}{2}+1} = \frac{1}{2}r_{L,\frac{n}{2}}+\frac{1}{2}\left(r_E+c_L+\frac{t_L}{n}\right), \qquad n \text{ even.} \tag{A.13}$$

When n is an odd number, there are two banks farthest away from LMB 1, banks $i = (n+1)/2$ and $i = (n+1)/2 + 1$. If equation (13) is written down for each of these two banks, and the symmetry condition $r_{L,\frac{n+1}{2}+2} = r_{L,\frac{n+1}{2}-1}$ is imposed, then solving these two equations for $r_{L,\frac{n+1}{2}}$ results in the boundary condition

$$r_{L,\frac{n+1}{2}} = \frac{1}{3}r_{L,\frac{n+1}{2}-1}+\frac{2}{3}\left(r_E+c_L+\frac{t_L}{n}\right), \qquad n \text{ odd.} \tag{A.14}$$

It what follows, we derive the solution assuming that n is even.[33] Therefore, in addition to (A.12), the second boundary condition is based on (A.13). Substituting (A.11) into (A.13) and simplifying leads to a proportional relationship between α_1 and α_2:

$$\alpha_2 = \alpha_1\left(\frac{2+\sqrt{3}}{2-\sqrt{3}}\right)^{\frac{n}{2}+1} \tag{A.15}$$

Using (A.15) to substitute for α_2 in boundary condition (A.12), one finds the solution for α_1 to be

[32] For example, if there were $n = 4$ banks in the market, then $i = n/2 + 1 = 3$ would be the single bank farthest from LMB 1.
[33] The case of n odd is similar but uses condition (A.14) rather than (A.13).

$$\alpha_1 = \frac{r_{L,1} - \left(r_E + c_L + \frac{t_L}{n}\right)}{\left(2+\sqrt{3}\right)\left[1+\left(\frac{2+\sqrt{3}}{2-\sqrt{3}}\right)^{\frac{n}{2}}\right]} \tag{A.16}$$

Using (A.15) and (A.16) to substitute for α_1 and α_2 in (A.12), we obtain the solution

$$r_{L,i} = \left(1-\delta_{i,n}\right)\left(r_E + c_L + \frac{t_L}{n}\right) + \delta_{i,n} r_{L,1}\ , \quad i = 1,...,n. \tag{A.17}$$

where

$$\delta_{i,n} \equiv \frac{\left(2+\sqrt{3}\right)^{\frac{n}{2}+1-i} + \left(2-\sqrt{3}\right)^{\frac{n}{2}+1-i}}{\left(2+\sqrt{3}\right)^{\frac{n}{2}} + \left(2-\sqrt{3}\right)^{\frac{n}{2}}} \tag{A.18}$$

Note that (A.18) satisfies the symmetry conditions: $\delta_{2,n}=\delta_{n,n}$, $\delta_{3,n}=\delta_{n\text{-}1,n}$,…, $\delta_{n/2,n}=\delta_{n/2+2,n}$. Its derivative with respect to i is

$$\frac{\partial \delta_{i.n}}{\partial i} = \frac{\ln\left(2+\sqrt{3}\right)}{\left(2+\sqrt{3}\right)^{\frac{n}{2}} + \left(2-\sqrt{3}\right)^{\frac{n}{2}}}\left[\left(2-\sqrt{3}\right)^{\frac{n}{2}+1-i} - \left(2+\sqrt{3}\right)^{\frac{n}{2}+1-i}\right] \tag{A.19}$$

Since $0 < \left(2-\sqrt{3}\right) = \left(2+\sqrt{3}\right)^{-1} < 1 < \left(2+\sqrt{3}\right)$, $\partial\delta_{i,n}/\partial i < 0$ over the range from $i = 2$ to $i = n/2 + 1$, the mid-point of the circle. This implies that the small bank rate's weight on LMB 1's rate declines the further is its distance from LMB 1. The derivative of (A.18) with respect to n is

$$\frac{\partial \delta_{i,n}}{\partial n} = \frac{\ln\left(2+\sqrt{3}\right)}{\left[\left(2+\sqrt{3}\right)^{\frac{n}{2}} + \left(2-\sqrt{3}\right)^{\frac{n}{2}}\right]^2}\left[\left(2-\sqrt{3}\right)^{i-1} - \left(2+\sqrt{3}\right)^{i-1}\right] \tag{A.20}$$

Since i =2,…,n for the small banks, $\partial\delta_{i,n}/\partial n < 0$. This means that the rate charged by a small bank of a given distance $i - 1$ from LMB 1 will have a smaller weight on LMB 1's rate the less concentrated is the market. In other words, keeping distance constant, LMB 1's rate has less impact on a small bank's rate the greater is the number of small banks in the market.

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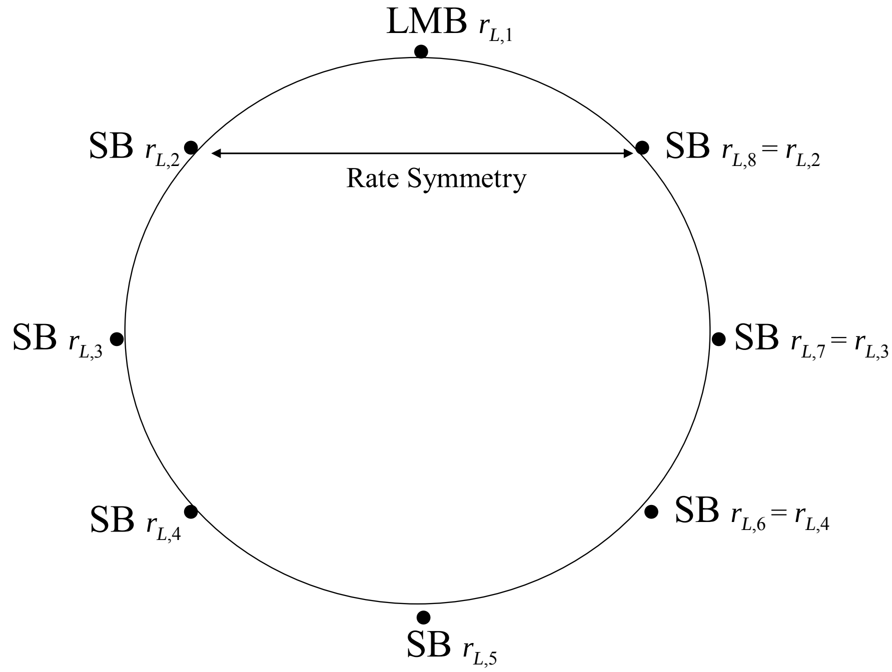
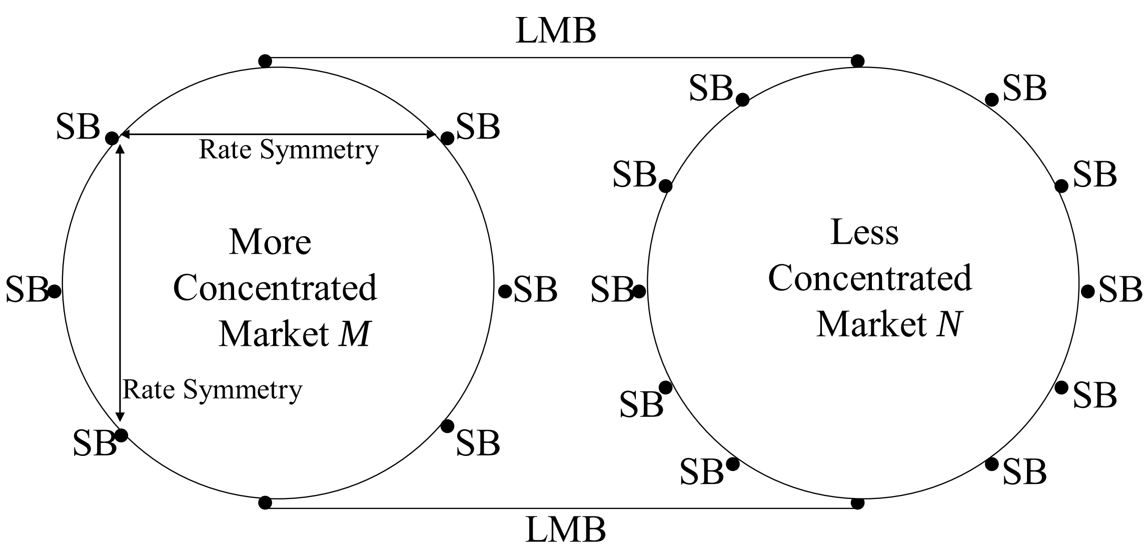
Figure 1 Rate Symmetry with a Single LMB



Note: LMB indicates a large multimarket bank while SB represents a small bank.

Figure 2 Circular Cities with Two LMBs



Note: LMB indicates a large multimarket bank while SB represents a small bank.

Table 1. MMDA and CD Rates and Spreads for Small Banks and LMBs, 1998-2004

This table reports summary statistics on individual banks' Money Market Deposit Account (MMDA) and Certificate of Deposit (CD) interest rates surveyed by *Bank Rate Monitor* for the fourth week in June during the years 1998-2004. To make MMDA and CD rates comparable to the equivalent maturity London Inter-Bank Offered Rates (LIBOR), we convert all MMDAs to monthly compounding, six-month CDs to semi-annual compounding, and one-year CDs to annual compounding. Small banks are defined as having total deposits less than $1 billion while large multimarket banks (LMBs) are defined as having total deposits greater than $10 billion. LIBOR data are from the British Bankers' Association. MMDA and CD rate spreads between small banks and LMBs are computed as the rate paid by each small bank less the average of the rates paid by the LMBs in the small bank's local market. Tests of whether the small bank – average LMB spread are positive are carried out using both a *t*-test and a Wilcoxon *z*-test. As reported below, both of these tests indicate a significantly positive spread at better than the 1 % level for all deposits and all years.

Deposit Type Year and (# of MSAs)	Small Bank Rates		LMB Rates				Small Bank – LMB Rate Spreads			
	Mean	Obs	Mean	Obs	Rate Diversity†	LIBOR	Mean	Obs	% > 0	Test of > 0 (p-values)
MMDA										
1998 (113)	2.83	175	2.22	425	0.33	5.66	0.61	174	82.8	0.00***
1999 (115)	2.57	191	1.73	435	0.26	5.23	0.83	186	90.3	0.00***
2000 (114)	2.75	91	1.86	447	0.33	6.64	0.87	91	83.5	0.00***
2001 (145)	2.36	72	1.42	544	0.20	3.86	0.99	72	88.9	0.00***
2002 (139)	1.26	75	0.81	443	0.23	1.83	0.44	75	80.0	0.00***
2003 (143)	0.78	62	0.42	510	0.16	1.12	0.38	62	80.6	0.00***
2004 (142)	0.79	59	0.50	532	0.17	1.36	0.37	59	83.1	0.00***
6-Month CD										
1998 (113)	4.93	193	4.55	444	0.40	5.78	0.40	192	84.9	0.00***
1999 (115)	4.29	199	3.96	441	0.33	5.65	0.33	199	84.4	0.00***
2000 (114)	5.32	100	5.06	466	0.30	7.00	0.30	100	61.0	0.00***
2001 (145)	3.84	77	3.27	565	0.25	3.90	0.66	79	96.2	0.00***
2002 (139)	2.06	74	1.57	478	0.22	1.95	0.45	74	90.5	0.00***
2003 (143)	1.22	66	0.82	519	0.14	1.11	0.40	65	90.8	0.00***
2004 (142)	1.22	69	0.99	546	0.16	1.94	0.27	69	75.4	0.00***
One-Year CD										
1998 (113)	5.22	193	4.81	444	0.40	5.84	0.41	192	89.6	0.00***
1999 (115)	4.61	199	4.30	441	0.33	5.84	0.32	199	79.4	0.00***
2000 (114)	5.87	100	5.43	466	0.26	7.18	0.44	100	73.0	0.00***
2001 (145)	4.08	77	3.47	565	0.24	4.18	0.68	79	93.7	0.00***
2002 (139)	2.46	74	1.92	478	0.18	2.28	0.47	74	94.6	0.00***
2003 (143)	1.47	67	0.88	519	0.17	1.19	0.53	63	95.2	0.00***
2004 (142)	1.58	70	1.45	546	0.13	2.46	0.20	70	68.6	0.00***

†Rate diversity is the proportion of markets in which a given LMB is surveyed for which it sets different interest rates. Specifically, the statistic reported is the median for all LMBs of the ratio (Number of different survey rates quoted by the LMB – 1)/(Number of markets in which the LMB was surveyed – 1).
*** indicates the significance level at 1 percent.

Table 2 Regressions of MMDA Rates on Market Structure and Bank Size Variables, 1998-2004

MMDA rates are from *Bank Rate Monitor* surveys conducted in the fourth week of June of each year. Deposit quantity data are from each year's FDIC *Summary of Deposits*. The independent variables are HHI: Herfindahl-Hirschman index of the MSA's deposits divided by 1000; Ln (MSADep): Log of the MSA's total deposits; LMB Share: share of MSA deposits issued by banks having total deposits exceeding $10 billion. LMB Dummy: equals 1 if the bank has total deposits exceeding $10 billion (0 otherwise); RD is rate diversity as defined in the text. *t*-statistics are in parentheses. The estimation accounts for fixed effects of multiple observations of the same bank operating in the same state. The column FM reports the average of time-series coefficients with Fama-MacBeth *t*-statistics in parentheses.

Independent Variable	Dependent Variable: MMDA Rate							
	1998	1999	2000	2001	2002	2003	2004	FM (98-04)
Panel A:								
Market Structure Variables								
HHI	-0.160	-0.100	-0.093	-0.332***	-0.160*	-0.227***	-0.032	-0.158***
	(-1.42)	(-1.24)	(-0.65)	(-2.84)	(-1.90)	(-3.68)	(-0.41)	(-4.23)
Ln (MSADep)	-0.018	0.030	-0.021	-0.010	0.011	0.008	0.073***	0.010
	(-0.86)	(1.28)	(-0.82)	(-0.51)	(0.74)	(0.84)	(2.62)	(0.84)
LMB Share	-0.273	0.034	0.625*	-0.273	-0.128	-0.222	0.147	-0.013
	(-1.05)	(0.12)	(1.80)	(-0.99)	(-0.66)	(-1.52)	(0.88)	(-0.10)
Bank Size Variable								
LMB Dummy	-0.440***	-0.676***	-0.552***	-0.748***	-0.360***	-0.305***	-0.299***	-0.483***
	(-7.61)	(-10.53)	(-7.29)	(-11.61)	(-8.64)	(-9.97)	(-7.28)	(-7.10)
Interaction Variable								
HHI * LMB Share	0.150	0.010	-0.095	0.362**	0.139	0.241***	-0.006	0.114*
	(1.05)	(0.07)	(-0.49)	(2.29)	(1.20)	(2.91)	(-0.07)	(1.92)
Adjusted R-Square	0.39	0.42	0.36	0.58	0.48	0.40	0.35	
DF	127	130	135	159	113	142	146	6
Observations	743	791	709	778	601	687	710	7
Panel B:								
Market Structure Variables								
HHI	-0.034	-0.144**	-0.176**	-0.110	-0.109***	-0.062	-0.103*	-0.105***
	(-0.66)	(-2.52)	(-2.17)	(-1.24)	(-2.80)	(-1.41)	(-1.71)	(-5.89)
Ln (MSADep)	-0.015	0.028	-0.022	-0.003	0.012	0.013	0.064**	0.011
	(-0.73)	(1.21)	(-0.88)	(-0.13)	(0.84)	(1.25)	(2.29)	(1.00)
LMB Share	0.004	-0.136	0.433	0.167	-0.071	0.112	0.017	0.075
	(0.02)	(-0.63)	(1.63)	(0.68)	(-0.50)	(0.89)	(0.11)	(1.06)
Bank Size Variable								
LMB Dummy	-0.440***	-0.668***	-0.549***	-0.736***	-0.360***	-0.299***	-0.293***	-0.478***
	(-7.59)	(-10.35)	(-7.13)	(-11.41)	(-8.65)	(-9.71)	(-7.11)	(-7.12)
Interaction Variable								
HHI * LMB Share*(1-RD)	-0.043	0.140	0.045	0.069	0.113	0.015	0.097	0.062**
	(-0.36)	(1.15)	(0.24)	(0.42)	(1.46)	(0.20)	(1.14)	(2.62)
Adjusted R-Square	0.39	0.42	0.36	0.58	0.49	0.39	0.35	
DF	127	130	135	159	113	142	146	6
Observations	743	791	709	778	601	687	710	7

*, **, and *** are the significance levels at 10, 5, and 1 percent, respectively.

Table 3. Regressions of 6-M CD Rates on Market Structure and Bank Size Variables, 1998-2004

Six-month CD rates are from *Bank Rate Monitor* surveys conducted in the fourth week of June of each year. Deposit quantity data are from each year's FDIC *Summary of Deposits*. The independent variables are HHI: Herfindahl-Hirschman index of the MSA's deposits divided by 1000; Ln (MSADep): Log of the MSA's total deposits; LMB Share: share of MSA deposits issued by banks having total deposits exceeding $10 billion. LMB Dummy: equals 1 if the bank has total deposits exceeding $10 billion (0 otherwise); RD is rate diversity as defined in the text. *t*-statistics are in parentheses. The estimation accounts for fixed effects of multiple observations of the same bank operating in the same state. The column FM reports the average of time-series coefficients with Fama-MacBeth *t*-statistics in parentheses.

Independent Variable	Dependent Variable: Six-Month CD Rate							
	1998	1999	2000	2001	2002	2003	2004	FM (98-04)
Panel A:								
Market Structure Variable								
HHI	-0.214***	-0.075*	-0.234*	-0.295***	-0.248***	-0.182***	-0.115**	-0.195***
	(-2.83)	(-1.69)	(-1.82)	(-4.13)	(-3.95)	(-3.74)	(-2.41)	(-6.71)
Ln (MSADep)	-0.060***	-0.015	-0.016	-0.011	-0.006	-0.011	0.057***	-0.009
	(-4.39)	(-1.16)	(-0.72)	(-0.88)	(-0.56)	(-1.26)	(3.23)	(-0.67)
LMB Share	-0.315*	-0.153	0.065	-0.122	-0.294**	-0.080	-0.063	-0.137**
	(-1.82)	(-1.00)	(0.21)	(-0.72)	(-2.04)	(-0.67)	(-0.59)	(-2.73)
Bank Size Variable								
LMB Dummy	-0.198***	-0.266***	-0.165**	-0.468***	-0.432***	-0.297***	-0.121***	-0.278***
	(-5.27)	(-7.77)	(-2.47)	(-12.15)	(-13.92)	(-12.01)	(-4.49)	(-5.58)
Interaction Variable								
HHI * LMB Share	0.254***	0.054	0.131	0.250**	0.278***	0.158**	0.099*	0.175***
	(2.65)	(0.76)	(0.76)	(2.56)	(3.20)	(2.39)	(1.79)	(5.35)
Adjusted R-Square	0.50	0.38	0.45	0.65	0.56	0.52	0.47	
DF	128	133	138	160	119	132	154	6
Observations	764	804	725	778	638	669	745	7
Panel B:								
Market Structure Variables								
HHI	-0.068**	-0.034	-0.177**	-0.226***	-0.076***	-0.119***	-0.134***	-0.119***
	(-2.00)	(-1.13)	(-2.47)	(-4.20)	(-2.83)	(-3.45)	(-3.54)	(-4.73)
Ln (MSADep)	-0.057***	-0.015	-0.016	-0.009	0.001	-0.009	0.052***	-0.008
	(-4.23)	(-1.20)	(-0.69)	(-0.72)	(0.07)	(-1.10)	(2.89)	(-0.64)
LMB Share	-0.066	-0.007	0.160	-0.017	0.023	0.033	-0.102	0.003
	(-0.55)	(-0.06)	(0.67)	(-0.11)	(0.22)	(0.31)	(-1.11)	(0.10)
Bank Size Variable								
LMB Dummy	-0.189***	-0.267***	-0.157**	-0.457***	-0.426***	-0.290***	-0.116***	-0.272***
	(-5.02)	(-7.76)	(-2.32)	(-11.92)	(-13.61)	(-11.79)	(-4.31)	(-5.49)
Interaction Variable								
HHI * LMB Share*(1-RD)	0.140*	-0.032	0.101	0.217**	0.057	0.091	0.150***	0.103**
	(1.80)	(-0.49)	(0.60)	(2.14)	(1.04)	(1.53)	(2.80)	(3.48)
Adjusted R-Square	0.50	0.38	0.45	0.65	0.55	0.52	0.47	
DF	128	133	138	160	119	132	154	6
Observations	764	804	725	778	638	669	745	7

*, **, and *** are the significance levels at 10, 5, and 1 percent, respectively.

Table 4. Regressions of 1-Y CD Rates on Market Structure and Bank Size Variables, 1998-2004

One-year CD rates are from *Bank Rate Monitor* surveys conducted in the fourth week of June of each year. Deposit quantity data are from each year's FDIC *Summary of Deposits*. The independent variables are HHI: Herfindahl-Hirschman index of the MSA's deposits divided by 1000; Ln (MSADep): Log of the MSA's total deposits; LMB Share: share of MSA deposits issued by banks having total deposits exceeding $10 billion. LMB Dummy: equals 1 if the bank has total deposits exceeding $10 billion (0 otherwise); RD is rate diversity as defined in the text. *t*-statistics are in parentheses. The estimation accounts for fixed effects of multiple observations of the same bank operating in the same state. The column FM reports the average of time-series coefficients with Fama-MacBeth *t*-statistics in parentheses.

Independent Variable	Dependent Variable: One-Year CD Rate							
	1998	1999	2000	2001	2002	2003	2004	FM (98-04)
Panel A:								
Market Structure Variables								
HHI	-0.134**	-0.062	-0.141	-0.279***	-0.244***	-0.260***	-0.143**	-0.180***
	(-2.06)	(-1.30)	(-1.05)	(-3.59)	(-3.59)	(-4.21)	(-2.21)	(-5.91)
Ln (MSADep)	-0.032***	-0.008	-0.018	-0.015	-0.007	-0.006	0.100***	0.002
	(-2.72)	(-0.59)	(-0.76)	(-1.11)	(-0.58)	(-0.57)	(4.23)	(0.12)
LMB Share	-0.028	0.056	0.308	-0.117	-0.186	-0.302**	-0.106	-0.054
	(-0.19)	(0.34)	(0.96)	(-0.64)	(-1.20)	(-1.97)	(-0.75)	(-0.73)
Bank Size Variable								
LMB Dummy	-0.266***	-0.326***	-0.270***	-0.480***	-0.451***	-0.406***	-0.098***	-0.328***
	(-8.16)	(-8.60)	(-3.87)	(-11.27)	(-13.51)	(-12.99)	(-2.72)	(-6.58)
Interaction Variable								
HHI * LMB Share	0.136*	-0.010	0.039	0.231**	0.248***	0.266***	0.118	0.147**
	(1.66)	(-0.13)	(0.21)	(2.17)	(2.66)	(3.18)	(1.57)	(3.62)
Adjusted R-Square	0.55	0.37	0.42	0.61	0.59	0.55	0.44	
DF	129	133	137	161	119	136	153	6
Observations	764	799	724	777	639	674	743	7
Panel B:								
Market Structure Variables								
HHI	-0.064**	-0.079**	-0.197***	-0.249***	-0.081***	-0.170***	-0.203***	-0.149***
	(-2.20)	(-2.35)	(-2.63)	(-4.26)	(-2.84)	(-3.88)	(-3.97)	(-5.37)
Ln (MSADep)	-0.031***	-0.008	-0.018	-0.014	0.000	-0.005	0.087***	0.002
	(-2.65)	(-0.60)	(-0.79)	(-1.07)	(0.02)	(-0.45)	(3.69)	(0.10)
LMB Share	0.076	-0.006	0.122	-0.100	0.125	-0.149	-0.225*	-0.022
	(0.73)	(-0.05)	(0.49)	(-0.60)	(1.13)	(-1.11)	(-1.80)	(-0.43)
Bank Size Variable								
LMB Dummy	-0.261***	-0.324***	-0.252***	-0.470***	-0.447***	-0.395***	-0.089**	-0.320***
	(-7.98)	(-8.52)	(-3.56)	(-11.09)	(-13.29)	(-12.66)	(-2.49)	(-6.38)
Interaction Variable								
HHI * LMB Share*(1-RD)	0.103	0.031	0.236	0.267**	0.030	0.184**	0.235***	0.155***
	(1.54)	(0.42)	(1.34)	(2.43)	(0.51)	(2.45)	(3.24)	(4.10)
Adjusted R-Square	0.55	0.37	0.42	0.61	0.59	0.54	0.45	
DF	129	133	137	161	119	136	153	6
Observations	764	799	724	777	639	674	743	7

*, **, and *** are the significance levels at 10, 5, and 1 percent, respectively.

Table 5. Pooled Regressions of MMDA and CD Rates on Market Structure and Bank Size Variables, 1998-2004

MMDA, six-month CD, and one-year CD rates are from *Bank Rate Monitor* surveys conducted in the fourth week of June of each year. Deposit quantity data are from each year's FDIC *Summary of Deposits*. The independent variables are HHI: Herfindahl-Hirschman index of the MSA's deposits divided by 1000; Ln (MSADep): Log of the MSA's total deposits; LMB Share: share of MSA deposits issued by banks having total deposits exceeding \$10 billion. LMB Dummy: equals 1 if the bank has total deposits exceeding \$10 billion (0 otherwise); RD is rate diversity as defined in the text. *t*-statistics are in parentheses. The estimation accounts for fixed effects of multiple observations of the same bank operating in the same state. It also includes dummy variables for each year.

Independent Variable	**Dependent Variable: Deposit Rate**					
	MMDA	**MMDA**	**Six-Month CD**	**Six-Month CD**	**One-Year CD**	**One-Year CD**
Market Structure Variables						
HHI	-0.156***	-0.118***	-0.170***	-0.093***	-0.160***	-0.111***
	(-4.25)	(-5.36)	(-6.61)	(-6.16)	(-5.88)	(-6.93)
Ln (MSADep)	0.005	0.005	-0.015***	-0.014***	-0.008	-0.008
	(0.76)	(0.66)	(-2.80)	(-2.58)	(-1.48)	(-1.48)
LMB Share	-0.040	0.029	-0.121*	0.034	-0.021	0.071
	(-0.44)	(0.43)	(-1.89)	(0.71)	(-0.32)	(1.38)
Bank Size Variable						
LMB Dummy	-0.489***	-0.485***	-0.273***	-0.269***	-0.322***	-0.319***
	(-22.31)	(-22.10)	(-17.92)	(-17.65)	(-19.86)	(-19.62)
Interaction Variable						
HHI * LMB Share	0.115**		0.147***		0.122***	
	(2.40)		(4.35)		(3.41)	
HHI * LMB Share*(1-RD)		0.096**		0.063**		0.084***
		(2.44)		(2.30)		(2.89)
Adjusted R-Square	0.75	0.75	0.96	0.95	0.95	0.95
DF	928	928	940	940	944	944
Observations	5019	5019	5123	5123	5120	5120

*, ** and *** are the significance levels at 10, 5 and 1 percent, respectively.

Table 6 Tests of Differences in Pre-Merger versus Post-Merger MMDA Spreads

This table tests for differences in MMDA spreads prior to, and following, large multimarket banks' (LMBs') acquisitions of small banks (SBs) during the years 1994-2005. Implicit MMDA rates are calculated from Call Report or Thrift Financial Report data. A SB's or LMB's spread is its MMDA rate minus the average MMDA rate of all other banks in the SB's local MSA. In Panel A (Panel B), LMBs are defined as having total deposits exceeding $10 ($5) billion, while SBs are defined as having total deposits below $1 billion where at least 75 % (50 %) of the total deposits are in a single MSA in the year prior to the merger.

Panel A: LMBs have deposits exceeding $10 billion, SBs have at least 75% of deposits in one market

Year-to-Merger	**-1**		**1**	**2**	**3**
Bank Type	*SB*	*LMB*	*LMB*	*LMB*	*LMB*
Pre-Merger Small Bank LMB Comparison (48 observations)					
Mean	-0.028	-0.080			
t-test (p-value) with SB		(0.677)			
Median	-0.026	-0.110			
Wilcoxon test (p-value) with SB		(0.543)			
Pre-Merger Small Bank Versus Post Merger Year 1 LMB Comparison (34 Observations)					
Mean	0.065	-0.154	-0.391		
t-test (p-value) with SB		(0.128)	(0.009)***		
Median	0.089	-0.293	-0.343		
Wilcoxon test (p-value) with SB		(0.136)	(0.008)***		
Pre-Merger Small Bank Versus Post Merger Year 2 LMB Comparison (25 Observations)					
Mean	0.150	-0.195		-0.363	
t-test (p-value) with SB		(0.061)*		(0.010)**	
Median	0.201	-0.308		-0.358	
Wilcoxon test (p-value) with SB		(0.072)*		(0.010)**	
Pre-Merger Small Bank Versus Post Merger Year 3 LMB Comparison (25 Observations)					
Mean	0.150	-0.195			-0.149
t-test (p-value) with SB		(0.061)*			(0.109)
Median	0.201	-0.308			-0.236
Wilcoxon test (p-value) with SB		(0.072)*			(0.170)

Panel B: LMBs have deposits exceeding $5 billion, SBs have at least 50% of deposits in one market

Year-to-Merger	**-1**		**1**	**2**	**3**
Bank Type	*SB*	*LMB*	*LMB*	*LMB*	*LMB*
Pre-Merger Small Bank LMB Comparison (74 Observations)					
Mean	-0.000	-0.056			
t-test (p-value) with SB		(0.572)			
Median	-0.017	-0.051			
Wilcoxon test (p-value) with SB		(0.424)			
Pre-Merger Small Bank Versus Post Merger Year 1 LMB Comparison (58 Observations)					
Mean	0.057	-0.092	-0.314		
t-test (p-value) with SB		(0.174)	(0.002)***		
Median	0.089	-0.078	-0.201		
Wilcoxon test (p-value) with SB		(0.181)	(0.002)***		
Pre-Merger Small Bank Versus Post Merger Year 2 LMB Comparison (47 Observations)					
Mean	0.126	-0.147		-0.351	
t-test (p-value) with SB		(0.025)**		(0.000)***	
Median	0.188	-0.109		-0.214	
Wilcoxon test (p-value) with SB		(0.033)**		(0.001)***	
Pre-Merger Small Bank Versus Post Merger Year 3 LMB Comparison (43 Observations)					
Mean	0.085	-0.149			-0.282
t-test (p-value) with SB		(0.099)*			(0.006)***
Median	0.175	-0.111			-0.236
Wilcoxon test (p-value) with SB		(0.117)			(0.009)***

*, **, and *** are the significance levels at 10, 5, and 1 percent, respectively.