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The competitive implications of multimarket bank branching ☆

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Abstract

Retail banking markets have traditionally been viewed as locally limited. However, recent studies have found evidence that large multimarket banking organizations tend to offer uniform interest rates for retail deposit accounts throughout the area that they serve, at least within a given state. This uniform pricing phenomenon raises questions about the continued relevance of the concept of local banking markets for both research and antitrust purposes.

We address this issue by employing a model designed to explain the pricing behavior of single-market banks that face competition from multimarket banks. Empirical results are found to be consistent with the many implications of the model. We find that even with multimarket banks present in the market, local market concentration influences the pricing behavior of single-market banks; however, this relationship weakens as the market share of multimarket banks grows. We also find that, on average, multimarket banks offer lower deposit interest rates than do single-market banks operating in the same market, and, in most cases, greater multimarket bank presence is associated with lower deposit interest rates offered by single-market banks.

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1. Introduction

As currently practiced in the United States, regulatory analyses of competition among banks rest on the presumption that markets for at least some of the products

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of banking organizations are local in nature. Over the years, a very large number of studies have found evidence consistent with this presumption. Numerous studies have reported evidence of higher loan rates or lower retail deposit rates, all else equal, in local areas characterized by high levels of market concentration; and surveys of consumers and small businesses have reported consistently that depositors and small businesses typically obtain basic financial services from institutions located a short distance from their home or business. [1]

However, much has changed in the US banking industry in recent years. Deregulation has removed many of the previously existing geographic constraints on banking organizations, allowing banks to establish branches across numerous local areas within states and even across state lines and throughout the country. Thus, increasingly, large banking organizations in the US are spreading out over a larger number of the areas typically defined as local banking markets in regulatory analyses, obtaining smaller and smaller proportions of their deposit base from any one of them. [2]

Arguably, this phenomenon would not affect the logic of regulatory analyses that focus on the structure of local markets if these multimarket banks offered or charged different rates in different geographic areas, depending on local conditions. Under such circumstances, the structure of a properly defined local market, as might be measured by an index of concentration, could be as relevant to the competitive behavior of banks in that market as it would be if all banks operated only in a single market. There is, however, substantial evidence that, at least in the case of deposit interest rates, many banks offer the same rate for a given type of account in all of the local areas in which they operate. This uniform pricing phenomenon raises questions about the continued relevance of the concept of local banking markets for both research and antitrust purposes.

We believe that these questions can best be addressed by focusing on the pricing behavior of banks that operate in only one local area (which we will refer to as "single-market banks"), taking into account the competitive impact of multimarket banks operating in the same local area. [3] To this end, we employ a model that

[1] For studies employing small business commercial loan rates, see Hannan (1991) and Cyrnak and Hannan (1999). For examples of studies employing retail deposit rates, see Berger and Hannan (1989) and Calem and Carlino (1991). Data from the Federal Reserve Board's Survey of Consumer Finances and Survey of Small Business Finances indicate that households and small businesses, respectively, obtain many of their financial services predominantly from local providers. See Kwast et al. (1997) for a full discussion of the results of both of these surveys.

[2] In many other countries, large banking organizations that operate in numerous local areas have dominated the scene for some time.

[3] The alternative of focusing on the pricing behavior of multimarket banks would present greater empirical problems. Assuming that banking markets are indeed local, multimarket banks offering uniform prices across all of the local markets they serve would presumably establish prices that reflect a weighted average of the market conditions in those markets. Thus, an examination of the determinants of the prices offered by multimarket banks would require that we construct weighted average measures of local market conditions. Tests of any hypotheses concerning the relationships between local market conditions and bank prices would then be joint tests of the hypotheses we are interested in and the hypothesis that we have chosen the correct weights for each local market. In this case, failure to find support for a hypothesis of interest could simply indicate that we have chosen inappropriate weights.

explains the pricing behavior of single-market banks. The model yields predictions concerning the role of (1) local market structure, (2) the degree to which multimarket banks operate in the market, and (3) the interactions of multimarket presence with both market structure and the rates offered by multimarket banks in determining the deposit rates offered by single-market banks. Econometric analyses for two different years yield results consistent with the implications of the model.

Of greatest policy relevance are results relating to the role of local market structure in influencing the deposit interest rates offered by single-market banks when multimarket banks are present in the market. We find that even with multimarket banks present in the market, local market concentration influences the pricing behavior of single-market banks; however, the relationship between local concentration and the deposit interest rates offered by single-market banks weakens as the market share of multimarket banks grows. Our results suggest that local market structure still matters in explaining the pricing behavior of most single-market banks, but that as multimarket banks come to dominate in more local areas, we can expect that the structure of individual local markets will become less relevant in explaining the behavior of single-market banks operating in those markets. We also find that, on average, multimarket banks offer lower deposit rates than do single-market banks operating in the same market, and, in the overwhelming majority of cases observed in the data, an increase in the share of branches operated by multimarket banks is associated with a reduction in the deposit interest rates offered by single-market banks.

The remainder of the paper is organized as follows: Section 2 summarizes the existing evidence with regard to the pricing behavior of multimarket banking organizations. In Section 3 we describe a model for determining the deposit interest rates offered by single-market banks facing competition from both other single-market banks and multimarket banks. Section 4 discusses the empirical specification, Section 5 describes the data and sample employed in the analysis, and Section 6 presents results. Section 7 summarizes our findings and discusses welfare and policy implications.

2. Uniform pricing by multimarket banks

Several recent studies investigate the pricing behavior of multimarket banking organizations. Using survey data on deposit interest rates collected by Bank Rate Monitor in various Metropolitan Statistical Areas (MSAs) around the country, Radecki (1998) finds strong evidence of uniform pricing across local markets within a state. Radecki interprets this uniform pricing behavior as evidence that banking markets are not locally limited. Heitfield (1999), in a reexamination of the Bank Rate Monitor data, confirms Radecki's finding that larger banks often set uniform rates across cities. He notes, however, that this finding does not imply expanded geographic markets, since deposit interest rates offered by banks whose operations are limited to a single metropolitan area are found to vary substantially from one city to another.

Biehl (2002) also uses Bank Rate Monitor data to examine more closely some of the implications of the uniform pricing phenomenon. Using deposit rates offered by single-market banks and multimarket banks operating in five metropolitan areas within New York state, he finds that (1) multimarket banks offer lower deposit rates, on average, than do single-market banks; (2) single-market banks offer rates that are highly correlated with those offered by other single-market banks in the same city; and (3) multimarket banks offer rates that are not correlated with those offered by other banks (either multimarket or single-market) in the same city. His findings suggest that deposit rates offered by single-market banks reflect local market conditions, while those offered by multimarket banks do not.

While the Bank Rate Monitor surveys relate only to large urban areas, the phenomenon of banks pricing uniformly across areas typically considered local markets appears to apply also to more rural areas. Thus, in their survey of bank rates in Idaho and Montana, Tokle and Tokle (2000) observe that "When conducting the survey, it was noticed that often these chain banks paid the same interest rates on savings deposits and on one- and two-year CDs for all of their branches throughout the state" (p. 436).

3. The model

For the purpose of this paper, we accept as true the phenomenon of uniform pricing on the part of multimarket banks across local geographic areas. Given this presumption, we borrow heavily from a model developed by Barros (1999) and derive implications concerning the relationship between the presence of multimarket banks in a local geographic market and the deposit rates offered by banks operating solely in that market (single-market banks). The feature of the Barros model that we find particularly attractive is that it explicitly addresses the issue of spatial competition among banks (focusing on the location of their branches) while also allowing for the possibility of collusive behavior. [4]

3.1. Model derivation

A formal derivation of the model and its predictions are presented in Appendix A. Because the predictions are fairly intuitive, we present in this section only a heuristic description of the model and its underlying assumptions.

As with many spatial models, a local market is represented by a one-dimensional characteristics space (circle) of length one. Geographic location is one important element in the definition of the characteristics space, but not necessarily the only one. Other characteristics, such as range of services offered and personalization of service,

[4] Other related models could also be employed, one of which is mentioned briefly in footnote 6. At a minimum, they require the assumption of imperfect competition in order to avoid the implication, contradicted by empirical evidence, that single-market banks simply set their deposit rates equal to those of multimarket banks.

interact in some unspecified way with geographic location to determine the location of each branch in characteristics space. Bank customers are located continuously about the circle, with a uniform distribution of density δ. Each customer deposits one unit of money, which has no alternative application. These assumptions, which imply a perfectly inelastic supply of deposits to the market as a whole, are restrictive. Thus, our results will apply only to the range of deposit interest rates that are not so low that depositors opt to forego bank deposits.

Depositors choose to do business with the branch offering the highest deposit rate, net of transportation costs, and transportation costs are assumed to be linear in "distance" to the branch. [5] Under these rather standard assumptions for spatial models, the supply of deposits to each branch in a particular local market is a positive function of the density of bank customers, δ, the average distance to neighboring branches, d, the deposit rate offered at the branch, and transportation costs per unit distance, t; it is a negative function of the deposit rates offered at neighboring branches.

For a given single-market bank i, summation of branch deposit supply over all of its branches yields the total deposits to bank i, which, when multiplied by the net interest margin (adjusted for reserve requirements and real resource costs), yields bank i's variable profits as a function of the model's parameters, bank i's deposit rate, and the deposit rates of the neighbors of each of its branches. The distribution of branch locations is exogenous to the model. Because a branch's location in characteristics space depends on more than just its geographic location, bank i is uncertain about the identities of its neighbors, and hence the deposit rate offered by its neighbors. Bank i's expectations regarding the deposit rates offered by the neighbors of each of its branches can be shown to depend in a straightforward way on the proportion of the branches in the market (other than those owned by bank i) owned by each market competitor. [6]

To allow for different degrees of collusive behavior among banks, the objective function of bank i includes terms representing the profits of each of the other market participants, π_j, multiplied by λ_{ij}, where λ_{ij} reflects the extent to which bank i internalizes the effect of its price on the profits of bank j. The value of $\lambda_{ij} = \lambda_{ji} = 1$ implies perfect collusion between banks i and j, while values of $\lambda_{ij} = \lambda_{ji} = 0$ imply Nash–Bertrand behavior. In explaining the rate offered by a single-market bank i, we will assume that the collusion parameter *vis-à-vis* other single-market banks, λ^{sm}, is the same for all single-market banks and that the parameter relevant to multimarket banks, λ^{mm}, is equal to zero. This latter assumption is made in part for simplicity, but it is also quite plausible, since single-market banks may have little reason to fear a price response from multimarket banks that charge the same rates in all markets and have only a small proportion of their deposit base in the market.

[5] Note that "distance" is measured in characteristics space and may reflect other factors besides geographic distance.

[6] This yields the plausible implication that the expected impact of bank j's deposit rate on the market deposits of bank i (the cross-price effect) is proportional to the share of branches in the market (other than bank i's branches) accounted for by bank j. It can easily be shown that equivalent implications would result from a less explicitly spatial model in which cross-price effects were simply assumed to be proportional to the competitor's shares of total competitor branches in the market.

Solving the first-order condition yields single-market bank i's optimal deposit rate, r_i^{sm}, as a function of the parameters of the model, the rate offered by multimarket banks, and the rates offered by other single-market banks. To obtain a simple closed-form solution that allows us to assess the comparative static properties of the model, we examine specifically the case in which all single-market banks have the same number of branches and the same net rate of return on invested funds, and the deposit interest rate offered by multimarket banks (treated as the same for all multimarket banks in the market) is exogenously determined. [7] As shown in Appendix A, this yields

$$r^{\text{sm}} = \frac{-\dfrac{td(n-1)}{n-n^{\text{sm}}} + r^{\text{mm}}S^{\text{mm}} + \bar{r}_{\text{sm}}[1-\lambda^{\text{sm}}(1-S^{\text{mm}})]}{S^{\text{mm}} + [1-\lambda^{\text{sm}}(1-S^{\text{mm}})]} \tag{1}$$

where r^{sm} denotes the deposit rate offered by a single-market bank; $\bar{r}_{\text{sm}}$ denotes the return on invested funds obtained by the single-market bank, adjusted for reserve requirements and net of relevant costs; r^{mm} denotes the deposit rate offered by multimarket banks operating in the market; λ^{sm} denotes the collusion parameter *vis-à-vis* other single-market banks; t denotes transportation cost per unit distance, or, in product space, the degree of product differentiation; d is the average distance between neighboring branches in the market; n denotes the total number of branches in the market; n^{sm} denotes the number of branches of the representative single-market bank; and S^{mm} denotes the share of total branches in the market (excluding the number of branches owned by the representative single-market bank) owned by multimarket banks.

3.2. Comparative statics

Eq. (1) yields a number of testable implications concerning the relationship between the deposit rates offered by single-market banks and various bank and market characteristics. Consider the first term in the numerator, which captures the spatial aspects of competition among banks. Since the denominator is positive, it can easily be seen that increases in the average distance between branches, d, and increases in transport costs (or, in product space, the degree of product differentiation), t, result in lower deposit rates. This results because, with these changes, switching to a neighboring branch becomes less attractive to the depositor, allowing banks to offer less attractive deposit rates. Note also from (1) that the expression $(n-1)/(n-n^{\text{sm}})$ is negatively related to the single-market bank's deposit interest rate. It follows that, given the total number of branches in the market, n, deposit rates decline as the number of branches owned by the individual single-market bank, n^{sm} increases. This occurs because, with such a change, it becomes more likely that

[7] We address the issue of endogeneity in the empirical section of the paper. In an earlier version of this paper, it is shown that relaxing the assumption of exogenously determined multimarket bank deposit rates does not alter the model's implications in any fundamental way.

depositors will find themselves located between two branches owned by the same bank, allowing the bank to exploit this fact by lowering deposit rates. Note also that in the limit, as n^{sm} approaches n, the predicted deposit rate approaches $-\infty$. This results because deposit supply under the model is perfectly inelastic. This highlights the fact that (1) applies only to the range of deposit rates that are high enough to induce depositors to hold bank accounts.

It is easily shown (see Appendix A) that

$$\frac{\partial r^{sm}}{\partial r^{mm}} \geqslant 0 \quad \text{and} \quad \frac{\partial^2 r^{sm}}{\partial r^{mm} \partial S^{mm}} > 0. \tag{2}$$

The rate offered by multimarket banks in the market (assumed to be exogenous) exerts a positive influence on the rates offered by single-market banks, and this effect is greater, the larger the proportion of market branches that are owned by multimarket banks. Intuitively, if there is a positive probability that a branch of a multimarket bank will be a neighbor ($S^{mm} > 0$), a change in r^{mm} causes an optimal change in r^{sm} in the same direction, and the magnitude of this effect increases as the probability increases (i.e, as S^{mm} increases). Obviously, no effect occurs if no market branch is owned by a multimarket bank ($S^{mm} = 0$). [8]

The derivative of r^{sm} with respect to λ^{sm} can be shown to be negative as long as the net interest margin, $\bar{r}_{sm} - r^{sm}$, is positive, a condition that is sure to be met. This implies that greater levels of collusion result in lower deposit interest rates (see Appendix A). If the level of recognized interdependence, and therefore collusion, is influenced by market structure, then one obtains the common prediction of a negative relationship between deposit rates and market concentration.

Because the implied relationship between the deposit rate offered by single-market banks and the branch share of multimarket banks, S^{mm}, is more subtle, we provide a more detailed discussion of the comparative-static results here:

$$\frac{\partial r^{sm}}{\partial S^{mm}} = \left[(r^{mm} - r^{sm}) + \lambda^{sm}(\bar{r}_{sm} - r^{sm})\right][S^{mm} + 1 - \lambda^{sm}(1 - S^{mm})]^{-1}. \tag{3}$$

If we presume for a moment that conduct is Nash–Bertrand ($\lambda^{sm} = 0$), then it would follow that the sign of (3) depends solely on the sign of $(r^{mm} - r^{sm})$. A lower rate for multimarket banks than for single-market banks would lead to a negative relationship between S^{mm} and r^{sm}, while a higher rate for multimarket banks than for single-market banks would yield a positive relationship between S^{mm} and r^{sm}. This result reflects the fact that, with multimarket banks offering lower rates than single-market banks, an increase in S^{mm} implies an increase in the likelihood that the neighbors of the branches of a single-market bank are multimarket bank branches, resulting in a reduction in the expected rate offered by neighbors. This, in turn, leads to a reduction in the single-market bank's optimal rate. If multimarket banks offer higher rates than single-market banks, the effect is in the opposite direction.

[8] An interesting interpretation of Eq. (1) is that it expresses r^{sm} as a weighted average of r^{mm} and the net return on invested funds at the single-market bank, $\bar{r}_{sm}$, with a downward adjustment reflecting market power attributable to spatial differentiation. The predictions in (2) follow readily from this interpretation.

With $\lambda^{sm} > 0$, the second term in the first bracket is positive, reflecting the fact that as S^{mm} increases, any given level of collusion among single-market banks becomes less effective in lowering deposit rates, causing r^{sm} to be higher than would otherwise be the case. In other words, as S^{mm} increases, the share of the market controlled by single-market banks declines, and this reduces their ability to keep deposit rates low through the exercise of market power. Thus, with $\lambda^{sm} > 0$, the sign of (3) will be negative only if r^{mm} is less than r^{sm} by an amount great enough to overcome this effect.

Of particular relevance to policy is the question of how the relationship between r^{sm} and λ^{sm} might be affected by the presence of multimarket firms charging the same rate in all markets in which they operate. It can be shown (see Appendix A) that

$$\frac{\partial^2 r^{sm}}{\partial \lambda^{sm} \partial S^{mm}} > 0 \tag{4}$$

for plausible values of r^{mm} and r^{sm}. Intuitively, an increase in collusion among single-market banks (λ^{sm}) will have less of a depressing effect on r^{sm}, the greater the likelihood that a neighboring branch will be owned by a multimarket bank, which is not part of the collusive arrangement. Employing measures of market concentration as a proxy for λ^{sm}, this implies that the negative relationship between market concentration and the deposit rates of single-market banks should become weaker, the more prominent are multimarket banks in the market.

4. Empirical specification

The model described above makes several assumptions (such as perfectly inelastic deposit supply and symmetry of single-market banks) that are unlikely to be met in any real-world markets. Nonetheless, we believe that it captures many of the key variables that are likely to influence the deposit interest rates offered by single-market banks, and that the comparative statics of the model are likely to carry over to more realistic (less restrictive) situations. Thus, rather than estimating a nonlinear equation with the precise functional form suggested by (1), we estimate a linear equation that incorporates the variables traditionally considered to be determinants of the deposit interest rates offered by banks, as well as several additional variables suggested by our theoretical model. Our basic empirical specification is as follows:

$$\begin{aligned} r_i^{sm} = {} & \beta_0 + \beta_1 \text{CONC} + \beta_2 \text{BANKSIZE}_i + \beta_3 \text{INCOME} + \beta_4 \text{MKTSIZE} \\ & + \beta_5 \text{RURALDUM} + \beta_6 \text{DISTANCE} + \beta_7 \text{TRANSPORT} \\ & + \beta_8 \text{BRANCHVAR}_i + \beta_9 \text{MMSHARE}_i + \beta_{10} (\text{MMSHARE}_i \\ & \times \text{MMRATE}_i) + \beta_{11} (\text{MMSHARE}_i \times \text{CONC}) + \varepsilon_i. \end{aligned} \tag{5}$$

The dependent variable, r_i^{sm}, is the interest rate offered on a particular type of deposit account by single-market bank i. The first five right-hand-side variables are the ones traditionally included in studies of the determinants of deposit interest rates.

CONC is a measure of concentration in the local market; BANKSIZE_i is a measure of the size of bank i; INCOME and MKTSIZE are measures of average income and overall market size, respectively, for the market; and RURALDUM is a dummy variable equal to one if the local market is a rural market and zero if it is an urban market.

The last six variables are the ones that our theoretical model suggests should be included in the equation. DISTANCE is a measure of the average distance between bank branches in the market; TRANSPORT is a measure of transportation costs in the market; and BRANCHVAR_i is equal to $(n-1)/(n-n_i)$, where n is the total number of branches in the market, and n_i is the number of branches belonging to single-market bank i in the market. These three variables are intended to capture the spatial competition component of the model, which, from the above discussion, implies

$$\beta_6 < 0, \quad \beta_7 < 0, \quad \text{and} \quad \beta_8 < 0.$$

The variables of greatest interest in the context of this paper are the last three, which capture the effects of the presence of multimarket banks on the deposit interest rates offered by single-market banks. MMSHARE_i is the share of the market's branches (excluding the branches of bank i) that are operated by firms that are classified as multimarket banks. To capture the somewhat complex relationship between r^{sm} and MMSHARE_i suggested by (1), this variable is allowed to enter the equation by itself, interacted with the concentration measure, and interacted with MMRATE, the weighted average of interest rates offered by multimarket banks operating in the market. [9,10]

Eq. (1) leads us to expect $\beta_9 < 0$ and $\beta_{10} > 0$. It can be shown that the sign of β_{11} will be positive as long as $\bar{r}_{\text{sm}} > r^{\text{mm}}$, i.e., the net return on invested funds earned at single-market banks exceeds the deposit interest rate offered by multimarket banks. [11] This condition is likely to hold in most markets, and, in fact, must hold if $r^{\text{mm}} < r^{\text{sm}}$, since $r^{\text{sm}} < \bar{r}_{\text{sm}}$.

5. Data

To assess the robustness of our results over time, we estimate Eq. (5) using data from two different years, 1996 and 1999. The data were derived from a number of sources, including (i) quarterly Reports of Condition and Income filed by each depository institution; (ii) the Federal Deposit Insurance Corporation's Summary of Deposits (SOD); (iii) the Office of Thrift Supervision's Branch Office Survey (BOS); and (iv) the Department of Commerce's Regional Accounts Data.

[9] We address concerns about the possible endogeneity of MMRATE below.

[10] Note that we do not include an empirical proxy for $\bar{r}_{\text{sm}}$, the net return on invested funds at single-market banks. We have assumed that this is the same across all single-market banks, and is therefore captured in the constant term in our equation. At any rate,we do not have access to any data that would allow us to investigate the impact of any cross-sectional differences in this net return.

[11] Note that the comparative-static results presented in Section 3.2 above do not translate directly into expected coefficient signs for all of the individual terms in the estimated equation, since some variables enter the equation through more than one term. See Appendix A for more details.

Following the previous literature, we define local banking markets as either Metropolitan Statistical Areas (MSAs or urban markets) or non-MSA counties (rural markets). [12] For purposes of our analysis, we define a single-market bank (thrift) as one that derives at least 90% of its deposits from the market being considered, and a multimarket bank (thrift) as one that derives less than 30% of its deposits from that market. [13] These definitions are based on the expectation that a bank deriving at least 90% of its deposits from a single market will set its deposit interest rates based primarily on conditions prevailing in that particular market, while a bank deriving less than 30% of its deposits from a particular market will set its deposit interest rates based largely on conditions prevailing in other markets that it serves. It should be noted that most banks that are classified as multimarket banks in our sample derive far less than 30% of their deposits from any single market in which they are considered to be multimarket institutions. [14] Perhaps for this reason, we find our results to be quite robust to alternative choices of the threshold used to define a multimarket bank.

In conducting our analysis, we restrict the sample to commercial banks because thrift institutions may behave differently than commercial banks with regard to setting deposit interest rates. However, we do take into account the branches and deposits held by thrift institutions in determining the values of several of the explanatory variables. Our sample includes 7700 single-market banks in 1996 and 6502 single-market banks in 1999. [15] These single-market banks operated in 1925 different local banking markets in 1996 (288 urban markets and 1637 rural markets) and 1806 local markets in 1999 (294 urban markets and 1512 rural markets).

Deposit interest rate measures were constructed for three types of deposit accounts – NOW accounts, money market deposit accounts (MMDAs) and savings accounts. The method employed to construct these measures from quarterly data on interest expenses and deposit balances (taken from Reports of Condition and Income) is described in detail in Appendix B.

Information about the locations of branches and the deposits held by each depository institution in each local market were obtained from the SOD (for commercial banks) and the BOS (for thrifts). [16] This information was used to determine the share of each institution's deposits held in each market, thereby enabling us to classify each bank (thrift) in our sample as a single-market bank (thrift), multimarket bank (thrift), or neither, and to determine the share of market branches held by institutions classified as multimarket banks or thrifts. Conforming with the theoretical

[12] See, for example, Berger and Hannan (1989), Prager and Hannan (1998) and Pilloff and Rhoades (2002).

[13] Institutions deriving at least 30% but less than 90% of their deposits from the market under consideration are considered neither single-market nor multimarket institutions.

[14] The average percentage of a multimarket bank's deposits derived from an individual market in which it is treated as a multimarket firm was 7.7% in 1996 and 6.8% in 1999.

[15] In each year, we excluded from the sample those single-market banks that were monopolists in their local banking markets (65 institutions in 1996 and 45 in 1999) because the variable $BRANCHVAR_i$ is not defined for those observations.

[16] Throughout this paper, the terms "branches" or "branch offices" should be interpreted to include head offices.

Table 1
Summary statistics

Variable	1996			1999		
	# of obs.	Mean	Std. dev.	# of obs.	Mean	Std. dev.
NOW account rate (%)	6793	2.4242	0.6052	5606	2.2274	0.7087
MMDA rate (%)	6437	3.3351	0.6387	5392	3.3861	0.7146
Savings account rate (%)	6682	2.9346	0.6039	5579	2.7178	0.6651
HHI (all banks)	7700	0.2349	0.1311	6502	0.2256	0.1283
HHI (excluding multimkt. banks)	7700	0.3080	0.2204	6502	0.3357	0.2333
Bank deposits ($1000)	7700	119,305	606,383	6502	135,453	795,645
Per capita income ($1000)	7700	21.990	4.9460	6502	24.269	5.6853
Population (1000)	7700	1034	2047	6502	1092	2086
Rural market dummy	7700	0.5442	0.4981	6502	0.5306	0.4991
Distance (sq. miles/branch)	7700	73.028	146.25	6471	67.725	139.93
Population density (1000/sq. mile)	7700	0.3483	0.8218	6471	0.3638	0.8547
Branch variable	7700	1.0691	0.1943	6502	1.0658	0.1826
Multimarket share	7700	0.3311	0.2483	6502	0.4287	0.2497

model, the branch share of multimarket banks (MMSHARE_i) employed is the share of branches of all banks and thrifts, other than the branches of the observed bank, that are owned collectively by multimarket institutions in the market being considered. [17]

Branch level deposit data were also used to construct measures of local market concentration for each banking market. We employ a deposit-based Herfindahl–Hirschmann Index (HHI) for commercial banks (excluding the deposits held at thrift institutions) as our concentration measure. [18]

Note that concentration is included in our estimating equation both as one of the traditional determinants of deposit interest rates and as a proxy for λ^{sm}, the collusion parameter. Because of the dual role that concentration plays in this equation, it is not clear, a priori, whether we should use a concentration measure based on the market shares of all banks or one that excludes the shares of multimarket banks. We report results using both approaches. As it turns out, this choice does not affect any of our conclusions.

Bank size is measured as the natural logarithm of total bank deposits. Our income measure is per capita income for the market, as determined from the Department of Commerce's Regional Accounts Data. The natural logarithm of market population is used as a measure of market size. As a rough proxy for the average distance between branches, we employ the ratio of total market area (in square miles, obtained from the Bureau of the Census) to the number of bank and thrift branches in the market. Lacking a reasonable measure of transportation cost per unit of distance for each market, we employ population density (population per square mile) as a crude proxy

[17] For notational simplicity, the subscript "i" hereafter will be dropped from the variable name.

[18] Alternative concentration measures, such as HHIs that include thrift institutions with 50% or 100% weights and three-firm concentration ratios weighting thrifts at 0%, 50% and 100% were employed as well. Results were not substantially affected by the choice of concentration measure.

for average transportation cost, based on the notion that it is more difficult to travel a given distance in more densely populated areas than in less densely populated areas.

Summary statistics for all variables included in the analysis are reported in Table 1. Note, in particular, that the average share of banking offices operated by multimarket banking organizations increased from approximately 33% in 1996 to approximately 43% in 1999, representing a fairly substantial increase in the importance of multimarket banking over a relatively short time period.

6. Results

We begin by comparing the deposit interest rates offered by single-market banks in the sample with those offered by multimarket banks serving the same local markets. For each market that is home to at least one single-market bank and one multimarket bank, we compute the average deposit interest rate offered by each type of bank on each type of account, as well as the difference between the average single-market rate and the average multimarket rate in that market. The means and medians of these measures, across all markets, are presented in Table 2. On average, deposit interest rates offered by multimarket banks are lower than those offered by single-market banks in both 1996 and 1999, except for the case of MMDA accounts in 1996. The mean differences (except for MMDAs in 1996) are significantly different from zero at the 0.01 level in each case.

We test the implications of the model by estimating Eq. (5), using OLS with robust standard errors. This approach produces standard error estimates that allow for the possibility that errors are correlated across banks that operate in the same local market. The results of our estimation for NOW accounts, MMDA accounts, and savings accounts are presented in Tables 3–5, respectively. Each table consists of two panels. The left panel contains results for 1996 and the right panel contains results for 1999. Each panel includes three specifications. The first specification (columns 1 and 4) employs a concentration measure that includes all commercial banks, while the second specification (columns 2 and 5) employs a concentration measure that excludes multimarket banks. The third specification (columns 3 and 6) includes only those variables that are traditionally included in studies of the determinants of deposit interest rates and is presented for purposes of comparison.

The comparative static analysis (see Section 3.2) suggests a negative relationship between local market concentration (a proxy for the collusion parameter) and deposit interest rates. Such a relationship has often been found in previous literature, although some studies suggest that the relationship has weakened or disappeared in recent years. [19] We find a strong negative relationship between concentration and deposit interest rates for NOW accounts and MMDA accounts in 1996 and for all three account types in 1999.

The estimated coefficient on the share of market branches operated by multimarket banks (MMSHARE) is negative, as predicted by the model, and significantly

[19] See, for example, Radecki (1998).

Table 2
Comparison of interest rates offered by single-market and multimarket banks

	1996			1999		
	NOW	MMDA	SAVINGS	NOW	MMDA	SAVINGS
Single-market rate						
Mean (%)	2.47	3.33	2.96	2.28	3.35	2.74
Median (%)	2.45	3.27	2.92	2.27	3.32	2.71
Multimarket rate						
Mean (%)	2.27	3.35	2.75	2.09	3.22	2.36
Median (%)	2.24	3.31	2.70	2.05	3.22	2.35
Difference between single-market and multimarket rates						
Mean (percentage pts.)	0.20	−0.01	0.21	0.19	0.13	0.38
Median (percentage pts.)	0.20	−0.001	0.18	0.18	0.13	0.37

different from zero at the 0.01 level in all twelve equations in which it appears. Also consistent with model predictions, the estimated coefficient on the interaction term between MMSHARE and the deposit interest rate offered by multimarket banks (MMRATE) is positive and significant at the 0.01 level in every case. As also implied by the model for empirically relevant values of r^{sm} and r^{mm}, we find that the coefficient on the interaction term between concentration and the multimarket bank share (MMSHARE × CONC) is positive in eleven out of twelve cases, although it is significantly different from zero at the 0.10 level in only six of them. [20] In general, our results provide strong evidence that multimarket banks influence the deposit interest rates offered by single-market banks with which they compete in a manner consistent with the predictions of the model. [21]

[20] Another interesting implication that follows directly from (3) is that the relationship between r^{sm} and S^{mm} will be weaker, the greater is S^{mm}. Since the average value of the measure of S^{mm}, MMSHARE, was substantially higher in 1999 than 1996, this implies that estimated coefficients for terms involving MMSHARE should be smaller in magnitude in 1999 than in 1996. This prediction is borne out in results for MMDAs and (less strongly) for savings accounts, but not for NOW accounts. It should be noted that nonlinear estimation might yield coefficient estimates that are stable across the two years.

[21] We have considered the possibility of reverse causality in explaining the relationship between multimarket bank share and the deposit interest rates offered by single-market banks. That is, multimarket banks might disproportionately enter local markets that exhibit lower deposit rates, in anticipation of higher profits. Such a relationship might be expected if entry into new markets were de novo, but multimarket banks almost always expand into new geographic markets through acquisition. Lower deposit rates in a market should be capitalized into the purchase price of a branch, thus reducing the likelihood of a causal relationship running from deposit rates to multimarket share.

Nonetheless, given that the average level of MMSHARE increased substantially between 1996 and 1999, we tested for evidence of this process by regressing the change in MMSHARE between 1996 and 1999 on average market deposit rates in 1996, controlling for the level of MMSHARE in 1996. Coefficients of the three deposit rates (NOW, MMDA, and savings) were far from statistically significant and were mixed in sign. Thus, we find no evidence of reverse causality, at least for the period 1996–1999.

Table 3
Regression results for NOW accounts

Variable	1996			1999		
	(1)	(2)	(3)	(4)	(5)	(6)
INTERCEPT	3.6776***	3.7135***	3.5636***	3.6975***	3.6923***	3.4865***
	(20.55)	(20.89)	(21.30)	(19.77)	(19.73)	(17.72)
CONC (all banks)	−0.4403***	–	−0.2058**	−0.3769*	–	−0.2168**
	(−2.61)	–	(−2.27)	(−1.89)	–	(−2.01)
CONC (excluding multimkt. banks)	–	−0.3845***	–	–	−0.3440**	–
	–	(−3.14)	–	–	(−2.39)	–
BANKSIZE	−0.0306***	−0.0311***	−0.0363***	−0.0381***	−0.0372**	−0.0400***
	(−2.92)	(−3.00)	(−3.61)	(−2.59)	(−2.56)	(−2.81)
INCOME	−0.0168***	−0.0167***	−0.0175***	−0.0176***	−0.0180***	−0.0174***
	(−3.65)	(−3.52)	(−4.43)	(−4.46)	(−4.53)	(−4.81)
MKTSIZE	−0.0631***	−0.0652***	−0.0638***	−0.0675***	−0.0688***	−0.0633***
	(−3.59)	(−3.92)	(−3.25)	(−3.88)	(−4.06)	(−3.35)
RURALDUM	−0.0571	−0.0639	−0.0367	−0.1251**	−0.1150**	−0.0873
	(−1.11)	(−1.25)	(−0.063)	(−2.16)	(−1.98)	(−1.41)
DISTANCE	−0.0001*	−0.0001*	–	−0.0003***	−0.0003***	–
	(−1.66)	(−1.92)	–	(−2.99)	(−3.01)	–

TRANSPORT	−0.0431**	−0.0466**	–	−0.0308	−0.0290	–
	(−2.10)	(−2.21)	–	(−1.46)	(−1.29)	–
BRANCHVAR	−0.0100	−0.0226	–	−0.0264	−0.0237	–
	(−0.22)	(−0.50)	–	(−0.45)	(−0.42)	–
MMSHARE	−0.9735***	−0.9740***	–	−1.0136***	−0.9575***	–
	(−6.16)	(−6.26)	–	(−7.37)	(−7.05)	–
MMSHARE× MMRATE	0.2134***	0.2119***	–	0.3480***	0.3510***	–
	(3.58)	(3.66)	–	(7.64)	(7.69)	–
MMSHARE×CONC (all banks)	0.8902***	–	–	0.4136	–	–
	(3.10)	–	–	(1.36)	–	–
MMSHARE×CONC (excluding multimkt. banks)	–	0.6718***	–	–	0.2910	–
	–	(3.76)	–	–	(1.56)	–
# of obs.	6141	6141	6793	5209	5209	5606
R^2	0.1293	0.1311	0.1086	0.1076	0.1084	0.0788

t-Statistics in parentheses.

*, **, *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 4
Regression results for MMDA accounts

Variable	1996			1999		
	(1)	(2)	(3)	(4)	(5)	(6)
INTERCEPT	2.5410***	2.5590***	2.6571***	3.1778***	3.2087***	3.4944***
	(17.22)	(17.31)	(18.75)	(14.61)	(14.57)	(16.75)
CONC (all banks)	−0.3018**	–	−0.2921***	−0.6715***	–	−0.5380***
	(−2.00)	–	(−3.02)	(−3.69)	–	(−4.64)
CONC (excluding multimkt. banks)	–	−0.1942	–	–	−0.4663***	–
	–	(−1.59)	–	–	(−3.49)	–
BANKSIZE	0.0801***	0.0795***	0.0731***	0.0384***	0.0385***	0.0237*
	(7.59)	(7.46)	(7.32)	(2.59)	(2.60)	(1.69)
INCOME	0.0197***	0.0198***	0.0196***	0.0127***	0.0122***	0.0108**
	(5.17)	(5.12)	(4.77)	(3.06)	(2.91)	(2.49)
MKTSIZE	−0.0561***	−0.0550***	−0.0797***	−0.0347**	−0.0325*	−0.0752***
	(−3.76)	(−3.75)	(−5.54)	(−2.06)	(−1.91)	(−3.96)
RURALDUM	−0.1457***	−0.1518***	−0.1638***	−0.1653***	−0.1651***	−0.2689***
	(−2.97)	(−3.08)	(−3.19)	(−2.81)	(−2.79)	(−3.72)
DISTANCE	−0.00001	−0.00005	–	−0.00001	−0.00008	–
	(−0.19)	(−0.68)	–	(−0.09)	(−0.94)	–

TRANSPORT	−0.0698***	−0.0734***	–	−0.0911***	−0.0939***	–
	(−2.92)	(−3.05)	–	(−3.63)	(−3.42)	–
BRANCHVAR	−0.0290	−0.0522	–	−0.0830	−0.1282**	–
	(−0.61)	(−1.10)	–	(−1.56)	(−2.46)	–
MMSHARE	−2.1073***	−2.1388***	–	−1.1824***	−1.2038***	
	(−10.48)	(−10.66)	–	(−6.73)	(−6.62)	–
MMSHARE × MMRATE	0.5774***	0.5792***	–	0.3442***	0.3469***	–
	(10.95)	(10.95)	–	(7.01)	(7.02)	–
MMSHARE × CONC (all banks)	0.4552*	–	–	0.4651*	–	–
	(1.69)	–	–	(1.80)	–	–
MMSHARE × CONC (excluding multimkt. banks)	–	0.3796**	–	–	0.4880***	–
	–	(2.33)	–	–	(2.87)	–
# of obs.	5970	5970	6437	5200	5200	5392
R^2	0.0664	0.0670	0.0251	0.0443	0.0435	0.0230

t-Statistics in parentheses.
*, **, *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 5
Regression results for savings accounts

Variable	1996			1999		
	(1)	(2)	(3)	(4)	(5)	(6)
INTERCEPT	3.3768***	3.4119***	3.2377***	3.7685***	3.7617***	3.5601***
	(21.90)	(22.69)	(19.43)	(25.21)	(25.23)	(24.49)
CONC (all banks)	−0.0879	–	−0.1060	−0.4406***	–	−0.2364***
	(−0.53)	–	(−1.18)	(−2.64)	–	(−2.65)
CONC (excluding multimkt. banks)	–	−0.1085	–	–	−0.2350**	–
	–	(−0.91)	–	–	(−1.97)	–
BANKSIZE	−0.0240**	−0.0241**	−0.0278***	−0.0586***	−0.0592***	−0.0602***
	(−2.54)	(−2.54)	(−2.96)	(−5.82)	(−5.85)	(−6.20)
INCOME	0.0087**	0.0083**	0.0109***	−0.0010	−0.0012	0.0003
	(2.17)	(2.04)	(2.90)	(−0.31)	(−0.40)	(0.08)
MKTSIZE	−0.0553***	−0. 0554***	−0.0482***	−0.0487***	−0.0451***	−0.0349**
	(−3.46)	(−3.62)	(−2.70)	(−3.28)	(−3.01)	(−2.26)
RURALDUM	0.0126	0.0097	0.0327	−0.0019	0.0037	0.0569
	(0.26)	(0.20)	(0.57)	(−0.04)	(0.08)	(1.11)
DISTANCE	0.0001	0.0001	–	0.0001	0.0001	–
	(1.55)	(1.34)	–	(1.22)	(0.63)	–

TRANSPORT	0.0422**	0.0402**	–	0.0356**	0.0336**	–
	(2.27)	(2.26)	–	(2.08)	(2.11)	–
BRANCHVAR	−0.0751**	−0. 0862**	–	−0.0059	−0.0398	–
	(−1.98)	(−2.38)	–	(−0.12)	(−0.83)	–
MMSHARE	−0.7860***	−0.8317***	–	−0.7253***	−0.6829***	–
	(−4.66)	(−5.24)	–	(−5.24)	(−4.68)	–
MMSHARE × MMRATE	0.2706***	0.2647***	–	0.2259***	0.2205***	–
	(5.52)	(5.37)	–	(5.03)	(4.90)	–
MMSHARE × CONC	−0.0912	–	–	0.2582	–	–
(all banks)	(−0.35)	–	–	(0.99)	–	–
MMSHARE × CONC	–	0.1173	–	–	0.1987	–
(excluding multimkt. banks)	–	(0.74)	–	–	(1.15)	–
# of obs.	6149	6149	6437	5353	5553	5579
R^2	0.0422	0.0421	0.0257	0.0519	0.0508	0.0383

t-Statistics in parentheses.

*, **, *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively.

Because of the various interaction terms included in the specification, the magnitude, and in some cases even the sign, of the change in r^{sm} attributable to a change in the value of a given right-hand-side variable depend on the values of other right-hand-side variables. Thus, while it is clear from our results that the impact of MMRATE is positive, the magnitude of the effect depends on the multimarket bank share. For example, a 50 basis point decrease in the interest rate offered on MMDA accounts by multimarket banks would be associated with a 3.4–5.8 basis point decline in the rate offered by single-market banks in a market where the multimarket bank share was 20%, as compared with an 8.5–14.5 basis point decline in a market where the multimarket bank share was 50%.

Similarly, the effect of an increase in the multimarket bank share depends on both the level of interest rates offered by multimarket banks and market concentration. For sufficiently high values of concentration and the multimarket bank rate, an increase in multimarket bank share can be associated with an increase in the deposit interest rates offered by single-market banks. However, we find that the effect of an increase in multimarket share on the single-market rate predicted by the empirical model is negative for more than 95% of the actual combinations of concentration and the average multimarket bank rate observed in the data.

The value of MMSHARE also influences the magnitude of the effect that a change in concentration has on the deposit interest rates offered by single-market banks. Our estimates indicate that a 10 percentage point increase in MMSHARE is associated with a 6–20% decrease in the absolute value of the impact of the concentration measure. Thus, while local market concentration continues to be an important determinant of the deposit interest rates offered by single-market banks, its importance diminishes as the share of branches operated by multimarket banks increases.

The results obtained for variables intended to capture the spatial aspects of competition among banks provide some (though admittedly weak) support for their use in explaining bank deposit rates. The estimated coefficients on these variables (DISTANCE, TRANSPORT and BRANCHVAR) are typically negative, as predicted, but vary in significance across account types. On the whole, the coefficients of these spatial variables are more consistent with model predictions in the case of NOW and MMDA accounts than in the case of savings accounts. This may stem from the fact that savings accounts have traditionally required less frequent contact between bank and depositor, making spatial considerations less important in setting rates for such accounts.

Throughout the analysis, we have assumed that the deposit interest rates offered by multimarket banks operating in a particular local banking market are exogenously determined. Given (i) the empirical evidence indicating that multimarket banks engage in uniform pricing across the local areas that they serve, and (ii) the fact that multimarket banks obtained, on average, a very small proportion of their deposits from the local markets in the sample, we believe that this is a reasonable assumption. However, if multimarket banks' deposit interest rates are in fact endogenous, the parameter estimates reported in Tables 3–5 would be biased. To address this concern, we constructed predicted deposit interest rates for the multimarket banks operating in each market in our sample, and used these predicted rates (interacted with multimarket bank share) as instruments in an instrumental variables (IV) estimation of Eq. (5) for each account type in each year. [22] For each estimated equation, we then conducted a Hausman test of the hypothesis that there are no systematic differences between the OLS estimates and the IV estimates. We could not reject the hypothesis for MMDA accounts or savings accounts in either year, or for NOW accounts in 1996; only in the case of NOW accounts in 1999 could the hypothesis be rejected. We interpret this result as generally supportive of the assumption that multimarket banks' deposit interest rates are exogenously determined.

7. Summary and conclusion

In this paper, we employ and test a model designed to explain the deposit interest rates offered by single-market banks when they face competition from multimarket banking organizations that charge uniform deposit rates in all of the local areas in which they operate. Econometric analyses for two different years yield results consistent with the implications of the model. We find that, even with multimarket banks present in the market, local market concentration influences the pricing behavior of single-market banks; however, the relationship weakens as the market share of multimarket banks grows. These results suggest that local market structure still matters in explaining the pricing behavior of most single-market banks, but that as multimarket banks come to dominate in more local areas, we can expect that the structure of individual local markets will become less relevant in explaining the behavior of single-market banks operating in those markets. We also find that, on average, multimarket banks tend to offer lower deposit rates than do single-market banks operating in the same market. Further, for more than 95% of actual combinations of multimarket bank rates and market concentration observed in the data, increases in the share of branch offices owned by multimarket banks are associated with reductions in the deposit interest rates offered by single-market banks.

Our findings lead us to conclude that local market structure remains relevant to the competitive behavior of market participants, even in the presence of multimarket banks charging uniform prices across many markets. We do find, however, that the relationship between a local market's structure and the deposit rates offered by single-market banks is substantially weaker than it would be if the phenomenon of multimarket banks charging uniform prices across markets were not a factor.

[22] We constructed the predicted interest rates as follows: Using a sample consisting of all banks that operated in more than one local market, we ran an OLS regression of the deposit interest rate offered for a particular type of account in a particular year on bank size; deposit weighted averages of local market size, per capita income, and concentration; deposit weighted averages of state size, per capita income, and concentration; and the percentage of the bank's deposits derived from urban markets. We then used the estimated coefficients from these equations to generate a predicted interest rate for each account type and year for each multimarket bank. Finally, a weighted average of the predicted rates for all multimarket banks operating in each market was calculated.

As the average share of branches in local areas operated by multimarket banks increases over time, we can expect an even greater attenuation in the strength of this relationship.

Our findings also lead us to speculate about the implications of multimarket banking for social welfare. Any assessment of the welfare implications of multimarket banking must consider the possible reasons for the generally lower rates offered by multimarket banks.One possibility is that multimarket banks themselves exercise substantial market power in setting their uniform prices over the larger geographic areas in which they operate. [23] A second possibility is that multimarket banks are less efficient than single-market banks, perhaps because of diseconomies of scope or scale. Either of these explanations would imply a reduction in social welfare attributable to multimarket banking, with the former suggesting that more attention should be directed to the issue of competition among multimarket banks in broader geographic areas.

An explanation having opposite welfare implications is that multimarket banks offer more and better services to the retail customer and that these services more than compensate for the lower deposit rates offered. A related hypothesis, with unclear welfare implications, is that reputation effects or advertising effects cause customers to perceive that there are benefits to dealing with a multimarket bank, when such benefits do not actually exist. These hypotheses, however, do not explain why single-market banks would actually lower deposit rates in response to competition from multimarket banks offering a more attractive combination of rates and (perceived) product characteristics.

Another possibility is that multimarket banks do not compete aggressively for retail deposits because they have greater access to low-cost wholesale funds than do single-market banks. In this case, multimarket banking might lead to a reduction in the welfare of retail depositors but an improvement in overall social welfare, as large multimarket banking organizations find that they can fund their investments more efficiently through alternative sources of funds.

Investigating the various possible explanations for observed differences between deposit interest rates offered by single-market banks and multimarket banks serving the same local areas, along with their welfare implications, would seem to be a fruitful avenue for future research.

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[23] This could result because multimarket banks find it in their interest to complete less vigorously with each other. One possible reason is the so-called mutual forbearance hypothesis. See Bernheim and Whinston (1990) for a thorough treatment.

Appendix A. The model

As with most spatial models, a local market is represented by a one-dimensional characteristic space (circle) of unit length. Bank customers are located continuously, with a uniform density δ, and each customer deposits one unit of money, which has no alternative application. Let B denote the set of branches in a market and B_i denote the subset of those branches operated by bank i, which is assumed to operate only in this one market. Suppose that there are a total of n branches in B, of which $n_i < n$ are in B_i. Depositors choose the branch that offers the highest deposit rate, net of transportation costs, where transportation costs are assumed to be linear in distance to the branch. Consider branch m, operated by bank i, which has neighboring branches designated as $m+$ and $m-$. The distances between branch m and its neighboring branches are d_{m+} and d_{m-}, respectively. A standard derivation of the implied distances at which a depositor would be indifferent between branch m and its two neighbors, multiplied by the density of depositors, δ, yields the supply of deposits to branch m of bank i, D_{mi}, as

$$D_{mi} = \delta\left[\frac{d_{m+} + d_{m-}}{2} - \frac{r_{m+} + r_{m-} - 2r_m}{2t}\right], \tag{A.1}$$

where r_k denotes the deposit rate offered at branch k, and t denotes the transport cost in the market. [24]

Let $\bar{r}_i$ denote the interest rate obtained by bank i from investing the funds, adjusted for the existence of reserve requirements and net of the real resource cost of maintaining and servicing the deposits and investing the funds. Summing over its n_i branches, the expected profits of bank i may be represented as

$$\begin{aligned} E(\Pi_i) &= E\Big[D_i(\bar{r}_i - r_i)\Big] = E\left[\sum_{m\in B_i} D_{mi}(\bar{r}_i - r_i)\right] \\ &= \sum_{m\in B_i} \delta\left[d_m - \frac{E(r_{m+}) + E(r_{m-})}{2t} + \frac{r_i}{t}\right](\bar{r}_i - r_i), \end{aligned} \tag{A.2}$$

where $d_m = E(d_{m+} + d_{m-})/2$, the expected average distance from branch m to its neighboring branches. Because a branch's location in characteristics space depends on more than just its geographic location, bank i is uncertain about the locations, and even the identities, of its neighboring branches.

Banks are assumed to be risk neutral, and the linearity of deposit supply implies that uncertainty about the identity of neighbors is reflected only in the expected interest rate of neighbors. The likelihood that a neighboring branch will belong to a given bank is simply that bank's share of the $n - 1$ other branches in the market.

[24] Because the empirical analysis is confined to cross-sections, intertemporal differences in the cost of funds are not an issue. Thus, interest rates are not expressed as net of the cost of funds.

Thus,

$$E(r_{m+}) = E(r_{m-}) = \sum_{j \neq i} \left(\frac{n_j}{n-1} \right) r_j + \left(\frac{n_i - 1}{n-1} \right) r_i. \tag{A.3}$$

To allow for different degrees of collusive behavior among banks, the objective function of bank i may be written as

$$V_i = E(\Pi_i) + \sum_{j \neq i} \lambda_{ij} E(\Pi_j) = (\bar{r}_i - r_i) E(D_i) + \sum_{j \neq i} \lambda_{ij} (\bar{r}_j - r_j) E(D_j), \tag{A.4}$$

with $D_i = \sum_{m \in B_i} D_{mi}$, and $D_j = \sum_{m \in B_j} D_{mj}$, where the parameter λ_{ij} reflects the extent of bank i's internalization of the effect of its price changes on the profits of others. The value of $\lambda_{ij} = \lambda_{ji} = 1$ implies perfect collusion between banks i and j, while values of $\lambda_{ij} = \lambda_{ji} = 0$ imply Nash–Bertrand behavior.

Substitution of (A.3) into (A.4) and solving the first-order condition with respect to r_i^{sm} for r_i^{sm} yields [25]

$$r_i^{\text{sm}} = -\frac{td(n-1)}{2(n-n_i)} + \frac{1}{2}(1+\lambda^{\text{sm}}) \sum_{\substack{j \neq i \\ j \in \text{sm}}} \frac{n_j}{n-n_i} r_j^{\text{sm}} + \frac{1}{2} r^{\text{mm}} \sum_{\substack{j \neq i \\ j \in \text{mm}}} \frac{n_j}{n-n_i} + \frac{1}{2} \bar{r}_i - \frac{1}{2} \lambda^{\text{sm}} \bar{r}_{\text{sm}} \sum_{\substack{j \neq i \\ j \in \text{sm}}} \frac{n_j}{n-n_i}, \tag{A.5}$$

where sm and mm denote the set of single-market and multimarket banks in the market, respectively, and the average distance from a branch to it neighbors is assumed to be the same (d) for all banks in the market. We also assume that the collusion parameter *vis-à-vis* other single-market banks, λ^{sm}, is the same for all single-market banks and that the parameter relevant to multimarket banks, λ^{mm}, is equal to zero. Also for simplicity, the net return to invested funds, $\bar{r}_{\text{sm}}$, is assumed the same for all single-market banks in the market, as is the rate charged by multimarket banks in the market, r^{mm}.

Eq. (A.5) expresses the rate offered by single-market bank i as a function of a weighted average of the rates offered by the other single-market banks in the market, and, among other things, the share of branches (other than bank i's branches) in the market owned collectively by multimarket banks $(\sum_{j \neq i, j \in \text{mm}} \frac{n_j}{n-n_i})$ and the share owned by single-market banks, $(\sum_{j \neq i, j \in \text{sm}} \frac{n_j}{n-n_i})$. In what follows, we denote these shares as S_i^{mm} and S_i^{sm}, respectively, with $S_i^{\text{mm}} + S_i^{\text{sm}} = 1$.

To obtain a simple closed-form solution, we examine specifically the case in which all single-market banks have the same number of branches and the deposit interest rate offered by multimarket banks is exogenously determined. Solving the system of first-order conditions in (A.5) for this case yields

$$r^{\text{sm}} = \frac{-\frac{td(n-1)}{n-n^{\text{sm}}} + r^{\text{mm}} S^{\text{mm}} + \bar{r}_{\text{sm}}[1 - \lambda(1 - S^{\text{mm}})]}{S^{\text{mm}} + [1 - \lambda(1 - S^{\text{mm}})]}, \tag{A.6}$$

[25] A more detailed derivation is available from the authors upon request.

where r^{sm} denotes the common single-market rate and where, for simplicity, we represent λ^{sm} as simply λ.

A.1. Comparative static results

The following comparative-static results were obtained through differentiation of (A.6) and, in most cases, substitution of (A.6) into the resulting expression:

For r^{mm} and its interaction with S^{mm}:

$$\partial r^{\mathrm{sm}}/\partial r^{\mathrm{mm}} = S^{\mathrm{mm}}/[S^{\mathrm{mm}} + 1 - \lambda(1 - S^{\mathrm{mm}})] > 0,$$

$$\partial^2 r^{\mathrm{sm}}/\partial r^{\mathrm{mm}}\partial S^{\mathrm{mm}} = [2S^{\mathrm{mm}}(1+\lambda) + 1 + \lambda]/[S^{\mathrm{mm}} + 1 - \lambda(1 - S^{\mathrm{mm}})] > 0.$$

For λ:

$$\frac{\partial r^{\mathrm{sm}}}{\partial \lambda} = -(\bar{r}_{\mathrm{sm}} - r^{\mathrm{sm}})(1 - S^{\mathrm{mm}})[S^{\mathrm{mm}} + 1 - \lambda(1 - S^{\mathrm{mm}})]^{-1}.$$

This expression is negative as long as the net interest margin, $(\bar{r}_{\mathrm{sm}} - r^{\mathrm{sm}})$, is positive.

For S^{mm} and its interaction with λ:

$$\frac{\partial r^{\mathrm{sm}}}{\partial S^{\mathrm{mm}}} = \Big[(r^{\mathrm{mm}} - r^{\mathrm{sm}}) + \lambda(\bar{r}_{\mathrm{sm}} - r^{\mathrm{sm}})\Big][S^{\mathrm{mm}} + 1 - \lambda(1 - S^{\mathrm{mm}})]^{-1}.$$

The sign of this expression is undetermined, and is discussed at length in the text.

$$\frac{\partial^2 r^{\mathrm{sm}}}{\partial \lambda \partial S^{\mathrm{mm}}} = \frac{\Big\{(r^{\mathrm{mm}} - r^{\mathrm{sm}}) + (\bar{r}_{\mathrm{sm}} - r^{\mathrm{sm}})[(2 + \lambda - \lambda S^{\mathrm{mm}})/(1 - S^{\mathrm{mm}})]\Big\}(1 - S^{\mathrm{mm}})}{[S^{\mathrm{mm}} + 1 - \lambda(1 - S^{\mathrm{mm}})]^2}.$$

The term in square brackets in the numerator can easily be shown to exceed 2; it follows that in order for this expression to be negative, the multimarket bank rate must be less than the single-market rate by an amount that is at least twice the single-market bank's net interest margin, $\bar{r}_{\mathrm{sm}} - r^{\mathrm{sm}}$. Since this seems unlikely, we expect a positive sign in the most empirically relevant case.

Predictions of coefficient signs. The above comparative-static results do not translate directly into expected coefficient signs for those terms involving variables that appear in more than one term in (5). Sign predictions for β_1, β_9, β_{10} and β_{11} in (5) are obtained by differentiating (A.6) with respect to each individual term, λ, S^{mm}, $r^{\mathrm{mm}}S^{\mathrm{mm}}$, and λS^{mm}, respectively, in each case holding the other terms constant.

Appendix B. Construction of interest rate measures

We used data obtained from quarterly Reports of Condition and Income to construct deposit interest rate measures for three types of accounts – NOW accounts, MMDA accounts and savings accounts. We first constructed quarterly interest rates for each type of account by dividing the quarterly expenses associated with that type of account by the average of the current quarter's and previous quarter's end-of-quarter account balances. Prior to doing these calculations, we screened the expense and balance data to eliminate implausible or erroneous values. The screening process involved the following steps: (1) We eliminated any observations for which the account expenses were negative or the end-of-quarter account balances were less than or equal to zero, since these are implausible values. (2) We eliminated any observations where the reported expenses for the quarter were less than 25% or more than 400% of the previous quarter's value, assuming that such dramatic changes from one quarter to the next are likely to indicate reporting errors or changes in accounting practices.

The annual interest rate was then calculated for each year as the annualized geometric mean of the quarterly interest rates. Observations in the top percentile and bottom percentile were dropped. Our screening process eliminated approximately 6% of the initial observations for each account type in each year.

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