J Financ Serv Res (2010) 38:1–21
DOI 10.1007/s10693-010-0082-7

Investment Strategies and Market Structure: An Empirical Analysis of Bank Branching Decisions

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Received: 12 December 2008 / Revised: 3 November 2009 / Accepted: 22 February 2010 /
Published online: 18 March 2010

Abstract This paper analyzes the relationship between the competitive environment faced by depository institutions and the decisions these institutions make regarding the size of their branch networks. Specifically, we consider branches as a sunk investment that potentially increases utility for consumers and examine how local competition and product differentiation affect firms' decisions regarding whether to make such investments. We account for endogenous market structure using an equilibrium structural model, which corrects for bias caused by correlation in the unobservables associated with market structure and branching activity. We estimate the model using data from 1,882 concentrated rural markets. Our results demonstrate the importance of accounting for market structure and product differentiation, and are consistent with a potential entry-deterring effect of bank branch investments.

Keywords Investments · Competition · Market structure · Banking industry

JEL classification L11 · L13 · G21 · G28

1 Introduction

Defying predictions from the late 1990s that advances in information technology might render bank branches obsolete, financial institutions have been aggressively extending their local retail presence over the past several years. A variety of explanations for this "return to

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retail" have been put forward; this paper explores the potential competitive effects of bank branch expansion.[1] Industry analysts report that investing in branch networks has increasingly been utilized as a strategy to steal market share from competitors, targeting consumers who value more convenient access to branches. Industrial organization theory suggests that firms may be able to use investments to deter entry or facilitate the exit of competitors, in cases where investments increase willingness-to-pay and are largely sunk. Because investments in branches arguably have these characteristics, we investigate the relationship between market structure—the operating banks in a market—and the number of branches operated by the market's participants.

Geographic markets for retail banking are inherently local; our data contains a large cross-section of market observations. The dataset includes 1,882 non-MSA markets, and we analyze the branching activity of 4,891 financial institutions that operate in these markets. We also distinguish among firms that operate in many markets ("multimarket banks"), just one market ("single-market banks") and thrift institutions ("thrifts").[2] These distinctions allow us to assess the competitive consequences of recent deregulation that has facilitated the spread of institutions across multiple markets, and the role of branch expansion strategies in this competition.

Our empirical analysis exploits recent developments in the industrial organization literature to address the econometric endogeneity of market structure in the relationship between branching and competition. As a consequence, the results demonstrate interesting and subtle connections among branching, competition and product differentiation. Most substantially, where institutions (of any type) compete in markets where operating a multimarket bank is particularly attractive, their branch networks are *larger*. Correcting for market structure endogeneity turns out to be crucial. It allows us to uncover a strong negative correlation between unobservables associated with branching and multimarket bank presence—in markets that appear attractive for multimarket banks but into which multimarket banks have not entered, the institutions that do operate have more branches than would otherwise be expected. While this finding does not provide conclusive support for a deterrence effect of branching, it is one of the few empirical studies to provide empirically rigorous evidence consistent with entry deterrence.

The remainder of the paper is organized as follows. Section 2 provides background: first a brief review of the industrial organization literature on investments and market structure and then a discussion of the rural bank branching application. We describe the estimation strategy in Section 3 and the data we use for the study in Section 4. Section 5 presents the empirical results and Section 6 concludes.

2 Background

This paper uses data on branching activity in retail banking to empirically investigate the relationship between market structure and the investment strategies of competing firms.

[1] See Clark et al. (2007) for a comprehensive survey of the "return to retail" including various explanations for, and implications of, this trend.

[2] The banks that we classify as "single-market" in our dataset would also qualify as "community banks" under almost all of the definitions that have been used in the community banking literature. Thrift institutions refer to savings banks and savings and loans. These institutions operate under different charters, statutory requirements and regulatory agencies than commercial banks. The categorization of banks as either single-market or multimarket corresponds quite closely to a potential alternative type-distinction based on bank size. Section 4 contains additional discussion on this point.

Assuming endogenous investments in branches, an individual firm would compare the costs associated with opening additional branches with the additional revenue that could be generated from the investment. This tradeoff could potentially be complicated depending on the amount of market competition faced by firms. In particular, investments in branch networks could increase market concentration if entry is more difficult or exit more likely where operating firms have made such investments. While a substantial industrial organization theory literature analyzes these issues, few empirical studies (in any industry) have been able to tackle it directly.[3]

In this paper, we explore the relationship between branch networks and competition in a cross-section of rural banking markets, distinguishing among single-market (or community) banks, thrift institutions, and multimarket banks. Certain features of this application make for an especially useful setting to analyze potential interactions between investment and market structure. First, there is evidence to suggest that a bank's investments in branches are largely sunk. Specific construction requirements often make commercial space designed for bank branches inappropriate for alternative retail uses.[4] Analysts have suggested that larger branch networks may also serve an advertising function, as branches are thought to represent the "face" of the bank to customers. Many authors (Judd 1985; Sutton 1991, et al.) have noted that the commitment associated with sunk investments makes them more credible in influencing competition.

In addition, practitioners and analysts in the banking industry consider retail branches to be a crucial determinant of a firm's demand. Former Federal Reserve Governor Mark Olson noted that, "Branch offices and networks continue to be critical factors to customers as they choose their financial services providers…Surveys conducted by the Federal Reserve Board indicate that the single most-important factor influencing a customer's choice of banks is the location of the institution's branches."[5] Of course, there are other product characteristics that are likely to be important to consumers. Some consumers may value more personalized service, accessibility of an institution's executives, or longer hours of operation. In fact, we will be able to investigate whether there are different branching strategies for different types of financial institutions and if these strategies depend on the type of competitors a firm faces.

The potential connection between branching and competition was not empirically relevant until relatively recently, as regulation severely limited the potential entry and branching strategies of financial institutions. As late as 1970, only a handful of U.S. states allowed banks to have more than one branch, and several states restricted branching activity through the early 1990s. In addition, banks were typically not permitted to cross

[3] Tirole's (1988) textbook presents the relevant theory literature; empirical studies include Lieberman (1987), Vogt (1999), Ellison and Ellison (2000), Dafny (2005) and Hamilton and McManus (2005). Ishii (2008) analyzes the ATM deployment decision of operating financial institutions, but does not explore the margin of operating versus not operating. This margin will play an important role in our empirical work.

[4] Steve Reider (cited in Muto 2005), president of the market-research firm Bancography, states, "There's not a lot of demand for retailers for a space where a good chunk of it is taken up by a cast-iron and concrete vault." Reider goes on to say that "some banks are reluctant to retrofit a former bank location to fit their own design criteria, which can be as expensive as building another bank from scratch."

[5] Speech delivered to the Fortieth Annual Conference on Bank Structure and Competition in Chicago, IL on May 6, 2004. The surveys to which Governor Olson refers are the 2001 Survey of Consumer Finances and the 1998 Survey of Small Business Finances. Studies like Berger et al. (1997) support the role of branches in consumer demand. They find about twice as many branches as would minimize costs, but suggest that having extra branches may nonetheless be profit maximizing, "since additional offices provide convenience for the bank's customers that may be recaptured by the bank on the revenue side."

state lines until the late 1980s.[6] In this context, there has been vigorous debate in industry and policy circles over whether smaller "single-market" banks and thrift institutions would represent an important potential source of competition as multimarket banks are permitted to expand their operations.[7] While pointing out that branching is generally related to better financial performance, the FDIC notes that "these relationships are especially evident among community banks, which are less profitable on average than larger institutions."[8]

Our study is close in spirit to Dick's (2005) analysis of large (MSA) banking markets. She relates various measures of quality—including the density of a bank's branch network—to market size, and finds that quality tends to be greater in larger MSAs. Dick's findings suggest that banks use sunk investments in quality, e.g., branch networks, to raise the costs of potential entrants and thereby affect market concentration. Our findings are complementary to Dick's, as we analyze rural markets. Furthermore, because we restrict attention to these smaller markets, we are able to formally combine an analysis of branching activity with a model of endogenous market structure, and thereby provide a more explicit link between local branch network size and the actual competitiveness of markets (controlling for market size).

3 Empirically analyzing branching and market structure

A goal of our paper is to understand the relationship between bank branching decisions and market structure. Other researchers (at least as far back as White 1976) have investigated this issue by running a straightforward regression of the form:

$$B_{j,m} = Z_{j,m}\gamma + h\left(\varphi; \vec{N}_m\right) + \mu_{j,m} \tag{1}$$

where $B_{j,m}$ is the number of branches that institution j has in market m, $Z_{j,m}$ is a vector of control variables that may vary by firm and/or market, the vector $\vec{N}_m$ is a measure of market structure in market m, and $\mu_{j,m}$ represents the unobservable factors that influence observed branching decisions.

Estimating a regression equation such as (1) assumes that the observed market structure, $\vec{N}_m$, is exogenous. It is reasonable, however, to expect that unobservable factors that affect the returns to operating additional branches within a market may also affect that banking

[6] A series of papers has examined the consequences of regulatory changes on dynamic efficiency (Jayaratne and Strahan 1998), entry (Amel and Liang 1992), merger and acquisition activity (Berger et al. 2004) and entrepreneurship (Kerr and Nanda 2008).

[7] For example, Hannan and Prager (2004) find that the share of deposits held by multimarket banks is negatively related to deposit rates offered by single-market banks. Cohen (2004) rejects the hypothesis that banks and thrifts operate in independent product markets. Berger et al. (2007) focus on how efficiency improvements affected the competition between single-market and multimarket banks.

[8] The FDIC report goes on to say that "these results suggest that maintaining a branch network may be one way in which smaller institutions can close the profitability gap with their larger rivals." This notion may have deep roots in historical bank performance, as Carlson and Mitchener (2007) study of branching and Depression-era bank performance suggests. See also Hirtle (2005), which focuses on the returns to the overall branch network of banks (across multiple local geographic markets), for more evidence on the pressure (particularly on multimarket banks) to increase their branching activity.

market's overall concentration, or market structure. That is, we would expect there to be some correlation between $\mu_{j,m}$ and $\vec{N}_m$. Without addressing such correlation, estimates of the γ and ϕ parameters would be biased.

To address this endogeneity problem, we employ a two-step estimation procedure that has been adapted to industrial organization applications by Mazzeo (2002a), Watson (2009) and Manuszak and Moul (2008).[9] The first step is a model that predicts observed market structure, $\vec{N}_m$. As highlighted in the previous sections, our analysis will distinguish between different types of institutions: multimarket banks, single-market banks and thrifts. Therefore, our market structure measure $\vec{N}_m$ will incorporate the number and institution type of all the operating firms in the market. We will explicitly model the determination of $\vec{N}_m$, and then use the parameter estimates from this model to calculate a series of correction terms that are proportional to the correlation between $\mu_{j,m}$ and $\vec{N}_m$. Once computed, we insert these correction terms into (1) to offset any correlation between $\mu_{j,m}$ and $\vec{N}_m$ and thereby obtain unbiased estimates of γ and ϕ.[10]

The market structure model follows the approach of the empirical entry literature developed by Bresnahan and Reiss (1991) and Berry (1992). Specifically, as in Cohen and Mazzeo (2007), market structure is represented by an ordered triple (M, S, T) that represents the number of multimarket banks (M), single-market banks (S), and thrifts (T) that are operating. Within each institution type, firms are assumed to be homogeneous and make decisions on whether to operate based on a latent payoff function of the form:

$$\pi_{I,m} = X_{I,m}\beta_I + g\left(\theta_I; \vec{N}_m\right) + \varepsilon_{I,m} \tag{2}$$

There is a separate payoff function for each institution type, I, consisting of market characteristics, $X_{I,m}$; the effect of competitors captured by $\vec{N}_m$; and unobserved factors for each type, $\varepsilon_{I,m}$. It is the potential correlation between the $\varepsilon_{I,m}$'s and $\mu_{j,m}$ that is the source of the endogeneity bias in Eq. 1. Note that the parameters β_I and θ_I are permitted to vary by type—for example, the effects of multimarket competitors may be different for thrifts, single-market banks and other multimarket banks.

Translating the latent payoff functions into observed market outcomes requires specifying an equilibrium decision process for market participants. We assume a Stackelberg game in which the (homogeneous) firms of each type make irrevocable decisions about whether to operate in sequence. As they make these decisions, the firms anticipate that potential competitors will subsequently make entry decisions once the earlier movers have committed to their choice. This characterization yields a Nash equilibrium in which: (1) all operating firms have positive payoffs (Panel A, below); (2) no firm of (any type) would have positive payoffs if it were to enter (Panel B, below); and, (3) payoffs are higher for each firm in the current configuration than for a hypothetical firm of either other type in an alternative configuration that differed by that one firm's institution type (Panel C,

[9] These IO applications mirror the approach commonly employed in labor econometrics—see Heckman and MaCurdy (1986) for a discussion and several empirical applications.

[10] The idea is the same as the Heckman "two-step" estimator.

below). As such, an observed market structure $\vec{N} = (\mathrm{M,\ S,\ T})$ implies the following set of 12 inequality restrictions on Eq. 2 will hold:

Panel A

$$\pi_M = X_M\beta_M + g\left(\theta_M; \vec{N} = (M, S, T)\right) + \varepsilon_M > 0$$
$$\pi_S = X_S\beta_S + g\left(\theta_S; \vec{N} = (M, S, T)\right) + \varepsilon_S > 0$$
$$\pi_T = X_T\beta_T + g\left(\theta_T; \vec{N} = (M, S, T)\right) + \varepsilon_T > 0$$

Panel B

$$\pi_M = X_M\beta_M + g\left(\theta_M; \vec{N} = (M+1, S, T)\right) + \varepsilon_M < 0$$
$$\pi_S = X_S\beta_S + g\left(\theta_S; \vec{N} = (M, S+1, T)\right) + \varepsilon_S < 0$$
$$\pi_T = X_T\beta_T + g\left(\theta_T; \vec{N} = (M, S, T+1)\right) + \varepsilon_T < 0$$

Panel C

$$\pi_M = X_M\beta_M + g\left(\theta_M; \vec{N} = (M, S, T)\right) + \varepsilon_M > \pi_S = X_S\beta_S + g\left(\theta_S; \vec{N} = (M-1, S+1, T)\right) + \varepsilon_S$$
$$\pi_M = X_M\beta_M + g\left(\theta_M; \vec{N} = (M, S, T)\right) + \varepsilon_M > \pi_T = X_T\beta_T + g\left(\theta_T; \vec{N} = (M-1, S, T+1)\right) + \varepsilon_T$$
$$\pi_S = X_S\beta_S + g\left(\theta_S; \vec{N} = (M, S, T)\right) + \varepsilon_S > \pi_M = X_M\beta_M + g\left(\theta_M; \vec{N} = (M+1, S-1, T)\right) + \varepsilon_M$$
$$\pi_S = X_S\beta_S + g\left(\theta_S; \vec{N} = (M, S, T)\right) + \varepsilon_S > \pi_T = X_T\beta_T + g\left(\theta_T; \vec{N} = (M, S-1, T+1)\right) + \varepsilon_T$$
$$\pi_T = X_T\beta_T + g\left(\theta_T; \vec{N} = (M, S, T)\right) + \varepsilon_T > \pi_M = X_M\beta_M + g\left(\theta_M; \vec{N} = (M+1, S, T-1)\right) + \varepsilon_M$$
$$\pi_T = X_T\beta_T + g\left(\theta_T; \vec{N} = (M, S, T)\right) + \varepsilon_T > \pi_S = X_S\beta_S + g\left(\theta_S; \vec{N} = (M, S+1, T-1)\right) + \varepsilon_S$$

Under the assumption that an additional market participant always decreases payoffs and that the decrease is larger if the market participant is of the same product type, a unique equilibrium exists.[11] Therefore, 12 inequalities corresponding to a particular ordered triple market structure outcome (M, S, T) are satisfied for every possible realization of $(\varepsilon_{M,}\ \varepsilon_{S,}\ \varepsilon_T)$ based on the data for the market in question and values for the payoff function parameters. A predicted probability for each of the possible outcomes is calculated by integrating $f(\varepsilon_{M,}\ \varepsilon_{S,}\ \varepsilon_T)$, which we specify as independent standard trivariate normal, over the regions of the $\{\varepsilon_{M,}\ \varepsilon_{S,}\ \varepsilon_T\}$ corresponding to that outcome. Maximum likelihood selects the payoff

[11] Mazzeo (2002b) contains proofs of existence and uniqueness of the equilibrium, as well as a discussion of the structural derivation of the underlying payoff functions.

function parameters that maximize the probability of the observed market configurations across the dataset. The likelihood function is:

$$L = \prod_{m=1}^{M} \text{Prob}\left[(M,S,T)_m^O\right] \tag{3}$$

where $(M,S,T)_m^O$ is the observed configuration of firms in market m.

Having estimated the payoff function parameters, we can turn to the calculation of the terms we will use to correct Eq. 1. Consider, for example, a market where $\vec{N} = (1,1,1)$. In this case, we can specify the troublesome correlation as follows:

$$E\left[\mu_{j,m}\middle|(\varepsilon_M,\varepsilon_S,\varepsilon_T)_m : \vec{N}_m = (1,1,1)\right] = \rho_M E\left[\varepsilon_M|\vec{N}_m = (1,1,1)\right] + \rho_S E\left[\varepsilon_S|\vec{N}_m = (1,1,1)\right] + \rho_T E\left[\varepsilon_T|\vec{N}_m = (1,1,1)\right] \tag{4}$$

Using the estimated parameters from (3), we can back out estimates of the three expectation terms in Eq. 4. These are then inserted as data (for each market) into (1):

$$B_{j,m} = Z_m\gamma + h\left(\varphi;\vec{N}_m\right) + \rho_M\,\hat{E}\left[\varepsilon_M|\vec{N}_m = (1,1,1)\right] + \rho_S\,\hat{E}\left[\varepsilon_S|\vec{N}_m = (1,1,1)\right] + \rho_T\,\hat{E}\left[\varepsilon_T|\vec{N}_m = (1,1,1)\right] + \zeta_{j,m} \tag{5}$$

and the ρ_I become additional parameters to be estimated. This procedure ensures that $\zeta_{j,m}$ in Eq. 5 now has mean zero. As a result, the regression isolates the relationship between branching and competition from unobserved factors that may influence both the underlying attractiveness of operating for the firms and common unobservables in the returns to branching. In addition, we will recover estimates of the ρ_I's which will have an economic interpretation as discussed in Section 5.

The logic behind our parameter identification is illustrated in Fig. 1 (simplified by abstracting from institution types). To start, the γ parameter is determined by comparing markets represented by points A and B, for which N and $\hat{\varepsilon}$ are the same, but Z varies. Points C and D are used to identify the ϕ and ρ parameters. Assuming that the diagonal line in the figure represents the true γ, the value of $\hat{\varepsilon}$ at point C will determine the estimate of ρ. The benefit of the correction procedure is that with the influence of $\rho\hat{\varepsilon}$ accounted for in the regression, the estimate for ϕ can appropriately come from the difference between points D and E. Figure 2 shows how bias results in the uncorrected regression—here γ is biased upward and ϕ is determined by the vertical distance between C and D.[12] While this example shows ϕ being biased downward without the correction, this is not generically the case. The direction of the bias depends on the sign of ρ, which is an empirical question for each application.

[12] To simplify the exposition, we omit point B from Figure 2. This slightly changes the magnitude, but not the direction of the bias, in the ϕ and γ coefficients.

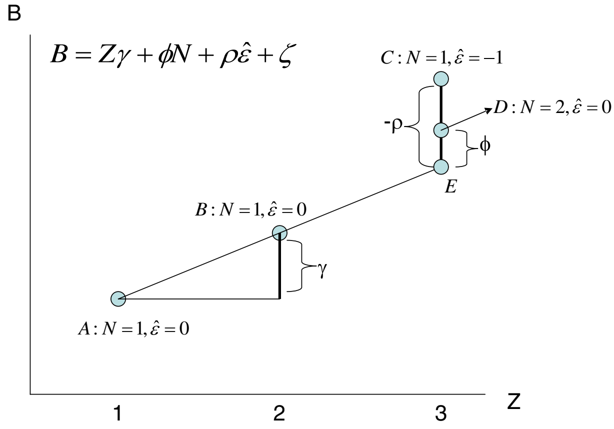

Fig. 1 Graphical representation of parameter interpretation: corrected version

Employing a structural approach for addressing market structure endogeneity is particularly useful in cases where the potential correlation is between competitive outcomes and market structure. More traditional instrumental variable methods are hampered by the difficulty of finding appropriate instruments in this context (see Manuszak and Moul (2008) for a detailed discussion of this point and the pitfalls of incorporating *ad hoc* exclusion restrictions). While the resulting econometric identification relies on functional form, our particular application differs from more traditional selection models in which some may argue that the underlying distributional assumptions are arbitrary. In our context, a well-specified game that determines the equilibrium configuration of firms introduces a fundamental non-linearity into the market structure equation (through the 12 threshold inequalities introduced above). The behavioral assumptions underlying the game combine the discrete decisions of potential firms and the strategic interaction among them to yield the threshold conditions associated with a particular configuration of operating institutions. Thus, the market structure equation is

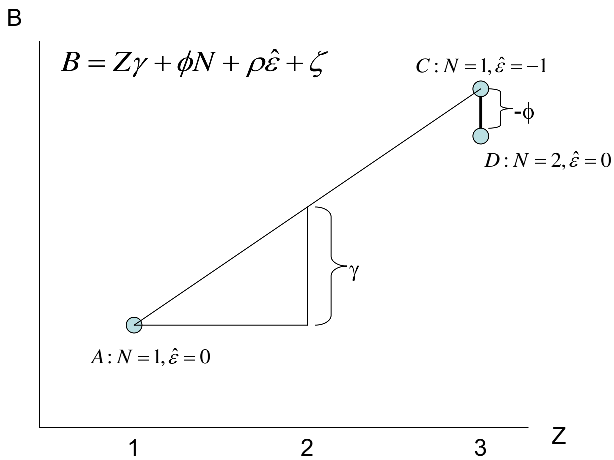

Fig. 2 Graphical representation of parameter interpretation: uncorrected version

inherently non-linear—no comparable linear market structure model could be constructed in this case.[13]

While establishing a link between entry behavior and branching decisions in a competitive environment, the proposed framework contains some important caveats that should be noted. Our analysis assumes that the market structure of operating institutions (and their branches) is an equilibrium during each observation period. This abstracts from the reality that market structure equilibria are arrived at through dynamic processes where sunk costs are present and path dependence likely contributes to outcomes. Unfortunately, dynamic structural models in industrial organization impose Markov Perfection in their equilibrium assumptions to permit estimation—ruling out the type of historical considerations that would be most interesting to study.[14] Similarly, models that accommodate more possible discrete options for competitors may allow branching to be an explicit part of the optimization (which it almost certainly is in reality), but these models do not also analyze entry behavior.[15] Since our goal is to address potential correlation between branching and market presence, making this compromise and not directly estimating branching behavior seems appropriate. As the econometric techniques available in empirical industrial organization become more sophisticated, incorporating more of these real world concerns into an empirical analysis will become more possible.

4 Data

We use data on institutions and their branch networks from 1,882 non-MSA labor market areas (LMAs) as of June 30, 2004. To represent individual observations, geographic markets must be defined in such a way that (1) all the firms in the geographic area compete with each other and (2) consumers do not typically use firms outside their own geographic area. To accomplish (1), we focus on less populated geographic markets, which are unlikely to contain distinct submarkets. We therefore eliminated all urbanized areas (MSAs) and rural areas with relatively high population (LMAs with over 115,000 residents). The Bureau of Labor Statistics defines LMAs as integrated economic areas, combining contiguous counties into a single LMA if at least 15 percent of the workers from one county commute for work to the other. Using LMAs (as opposed to counties) gives us more confidence that two neighboring markets are indeed competitively distinct.[16]

To construct the dependent variable for each step of the model—the number of institutions of each of the three types within each LMA, and the number of branches belonging to each of those institutions—we use data from several sources. The FDIC

[13] That is, under our behavioral assumptions a system of linear equations would not be capable of identifying the underlying structural parameters of the payoff function that determines the equilibrium configuration of firms. As such, X and Z are the same for the two steps in our analysis. While not required for identification, the market structure model may contain instruments that are not included in the second-stage regression. The following section provides additional details about our empirical specification.

[14] See, for example, Bajari et al. (2007), Aguirregabiria and Mira (2007) and the references these papers cite.

[15] Thus, while Ishii's (2008) paper on ATM network competition would seem to be a direct analog, her paper analyzes competition in ATM deployment among the existing banks in the market only. The relationship between the number of ATMs and the number of existing banks cannot be addressed in this type of model. See also Pakes et al (2007).

[16] In addition, these markets have far fewer competitors than do MSAs, making the endogenous market structure model more tractable. Importantly, many of the mergers that raise competitive concerns with regulators do so because of their effect on the market structure of these smaller markets.

Summary of Deposits contains location information on all banks and their branches. We classified each bank and branch within its LMA market: to be classified as a single-market bank, an institution must have a bank charter and receive at least 80 percent of its deposits from branches in that market; otherwise, the bank was classified as a multimarket bank.[17] Analogous information about operating thrifts was obtained from the Office of Thrift Supervision's Branch Office Survey. Table 1 shows the distribution of firm configurations among the LMA markets in our dataset. Each panel of the table represents a particular number of thrifts in the market, with the rows and columns of each panel referring to single-market banks and multimarket banks, respectively. The numbers in the table represent the number of markets in which the operating firms follow the given configurations—for example, there are 64 markets that include one multimarket bank, one single-market bank and zero thrifts.[18] Table 2 summarizes the branching data for the institution/market combinations in the dataset. Note that in approximately 55 percent of the cases a firm operates only one branch (this includes all the active firms in approximately 19 percent of our markets). About ten percent of the firms have more than three branches in a particular market. Differences in branching across different market configurations will be exploited in the empirical analysis.[19]

The control variables are summarized in Table 3. These variables represent market characteristics that may contribute to the attractiveness of operation for financial institutions as well as exogenous factors that may influence the decision of banks to open additional branches in a particular LMA. These variables include: (1) population; (2) the number of non-farm establishments; (3) the number of farms; (4) per capita income; (5) a dummy variable for LMAs in the five states that still had some restrictions on branching activity as of 2004;[20] and (6) a dummy variable indicating whether the LMA borders an MSA. The sources for these variables are the Census Bureau, the Agricultural Census, and the Bureau

[17] This definition is consistent with previous papers that distinguish "single-market" banks. Note that a bank with 90 percent of its deposits in market A and 10 percent in market B would, according to this definition, be classified as a single-market bank in market A and a multimarket bank in market B. This reflects the view that the decision to operate in market B would be significantly more affected by the role of the branch in B in the bank's overall network, as opposed to in market A, where the presence of any branches in market B would be less important.

[18] In our estimation of the endogenous market structure model we have collapsed the distribution of markets from above for each of the three categories—that is, all markets with three or more thrifts are treated as if they have at least three, all markets with four or more single-market banks are treated as if they have at least four, and all markets with six or more multimarket banks are treated as if they have at least six. This reduces the complexity of the estimation without appreciably influencing the results; see Cohen and Mazzeo (2007).

[19] Distinguishing between single-market and multimarket bank types has a tradition in the literature (see Cohen and Mazzeo (2007) and the references therein); we choose to employ this distinction because it is very clearly reflects an endogenous decision made by banks. However, categorizing banks by an outcome variable such as size does have some conceptual appeal, as theories of differentiation in lending and funding behavior often relate to bank size. In addition, large banks may be more likely to have brand recognition (see Berger and Dick 2007 as well as DeYoung and Ors 2009) that can affect entry and competition. In our empirical setting there is considerable overlap between the single-market/multimarket and small/big institution distinction, reinforcing our results. Some supporting tables are provided in Appendix A.

[20] See A Profile of state-chartered banking (2004/2005) published by the Conference of State Bank Supervisors. Such restrictions included limiting the number of branches a bank is permitted to operate within a county as well as within a certain distance from its, or a rival's, main office—depending on county population.

Table 1 Market configurations

		Multimarket banks								
		0	1	2	3	4	5	6+	*Total*	Thrifts=0
Single-market banks	0	14	86	116	106	92	58	86	*558*	
	1	19	64	92	66	62	38	48	*389*	
	2	12	31	30	27	33	20	24	*177*	
	3	7	5	11	23	7	8	14	*75*	
	4+	2	5	13	13	9	7	27	*76*	
	Total	*54*	*191*	*262*	*235*	*203*	*131*	*199*	*1,275*	
		Multimarket banks								
		0	1	2	3	4	5	6+	*Total*	Thrifts=1
Single-market banks	0	0	6	14	32	26	25	51	*154*	
	1	3	12	16	18	20	12	46	*127*	
	2	4	4	9	11	13	12	28	*81*	
	3	0	2	9	4	7	11	13	*46*	
	4+	1	3	1	7	9	16	16	*53*	
	Total	*8*	*27*	*49*	*72*	*75*	*76*	*154*	*461*	
		Multimarket banks								
		0	1	2	3	4	5	6+	*Total*	Thrifts=2
Single-market banks	0	0	1	1	6	3	6	19	*36*	
	1	2	0	2	5	9	4	13	*35*	
	2	1	0	1	2	3	1	6	*14*	
	3	0	2	1	1	2	2	5	*13*	
	4+	0	0	1	1	1	3	11	*17*	
	Total	*3*	*3*	*6*	*15*	*18*	*16*	*54*	*115*	
		Multimarket								
		0	1	2	3	4	5	6+	*Total*	Thrifts=3+
Single-market banks	0	0	0	0	1	1	0	4	*6*	
	1	0	0	0	0	0	0	4	*4*	
	2	0	0	2	1	0	0	2	*5*	
	3	0	0	0	0	1	1	6	*8*	
	4+	0	0	1	0	1	0	6	*8*	
	Total	*0*	*0*	*3*	*2*	*3*	*1*	*22*	*31*	

of Economic Analysis.[21] Note that we maintain the assumption that these factors are not influenced themselves by bank entry and branching activity.[22]

5 Results

This section presents and discusses the estimated parameters that measure the relationship between competition and branching activity in our sample of rural banking markets. We

[21] The continuous explanatory variables (population, establishments, farms and per capita income) are scaled to facilitate estimation in the results that follow. The value for each variable will equal that market's observation divided by the sample mean for that variable across the 1,882 markets in the dataset.

[22] Though this assumption might not be completely innocuous in this context—see, for example, Black and Strahan (2002).

Table 2 Distribution of branches per market, by type

# of branches	Type			
	Multimarket banks	Single-market banks	Thrifts	All
1	53%	55%	68%	55%
2	25%	25%	21%	25%
3	11%	11%	7%	11%
4	5%	5%	2%	5%
5	3%	2%	1%	2%
6+	3%	2%	1%	2%

begin with a brief overview of the results from the market structure model. Then, we proceed to the branching regressions, whose parameter estimates demonstrate the more nuanced competitive effects on branching. These results highlight the importance of addressing market structure endogeneity in the analysis of branching and distinguishing the competitive effects of the defined institution types.

5.1 Market structure model

We begin with a brief review of the results from the market structure model, which estimates the latent payoff function parameters in Eq. 2. Note that we specify separate effects for each type of depository institution in each market (multimarket banks, single-market banks and thrifts), since our likelihood is based on the observed triples (M,S,T) of extant firms across the markets in our dataset. The $g\left(\theta_I;\vec{N}_m\right)$ term from Eq. 2 includes individual competitive effect dummy variables whose parameters represent the incremental effects of additional competitors; Table 4 lists the effects estimated. Critically, separate parameters are estimated for the effect of each of the three types of competitors on multimarket banks, single-market banks and thrifts.

Table 4 displays the competitive effects in the top panel and the control variables below. These estimates indicate the relative effect on the returns to operating each type of financial institution under different market conditions and with various sets of competitors. For the competitive effects, the key result is the large difference between the impact of same-type and different-type institutions. For example, the effect of the first multimarket competitor on multimarket banks (−1.111) is more than three times the effect of the first single market

Table 3 Summary statistics for explanatory variables

	Mean	Med	Std Dev	Min	Max
Population	24,315	17,119	21,892	51	114,424
Establishments	567	389	556	1	5,305
Farms	683	565	526	1	8,249
Per capita income (in 000s)	24,599	24,102	4,796	11,362	89,471
State branching restriction dummy	0.19	0	0.39	0	1.00
Border market dummy	0.56	1.00	0.50	0	1.00

N=1,882 markets

Table 4 Parameter estimates from endogenous market structure model. (Asymptotic t statistics in parentheses)

	Multimarket bank payoffs		Single-market bank payoffs		Thrift payoffs	
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
First MM competitor	−1.111	(−16.65)	−0.278	(−1.59)	−0.050	(−0.27)
Second MM competitor	–	–	–	–	–	–
Additional MM competitors	−0.747	(−39.72)	−0.098	(−3.04)	−2.E-08	(−0.00)
First SM competitor	−0.304	(−3.64)	−0.916	(−29.07)	−0.003	(−0.03)
Second SM competitor	–	–	−0.624	(−19.48)	–	–
Additional SM competitors	−0.126	(−3.30)	−0.504	(−14.27)	−1.E-09	(−0.00)
First thrift competitor	−0.020	(−0.31)	−2.E-06	(−0.00)	−1.178	(−24.65)
Second thrift competitor	–	–	–	–	−0.920	(−11.58)
Additional thrift competitors	−3.E-01	(−3.32)	−5.E-08	(−0.00)	–	–
Population (000s)	0.009	(2.79)	−0.009	(−2.79)	0.005	(1.71)
Establishments (000s)	2.2355	(17.27)	0.543	(4.17)	0.617	(5.77)
Farms (000s)	0.971	(14.84)	1.120	(18.71)	0.264	(3.55)
Per capita income ($000s)	0.017	(3.40)	0.032	(5.39)	0.031	(4.21)
Border market dummy	0.097	(1.77)	−0.130	(−2.37)	−0.022	(−0.34)
State branching restriction dummy	−0.492	(−6.98)	0.204	(2.60)	−0.010	(−0.11)
Intercept	0.765	(5.31)	−0.718	(−3.16)	−1.841	(−7.34)

Population, establishments, farms and percapita income are expressed as percentages of sample mean

MM multimarket bank, *SM* single-market bank

N=1,882

Log Likelihood = −6,749.8

competitor, while the effect of the first thrift is negligible (−0.020).[23] The incremental effects of additional competing firms are smaller than for the first competitor; for example, the effect of the second multimarket competitor on multimarkets is roughly four-fifths the effect of the first (−1.111 vs. −0.895).

The control-variable parameters indicate the demographic conditions under which an operating institution of each type will be more or less attractive. For example, the number of establishments has a positive and significant impact on all three types, but the relative magnitude of the coefficients reveals that multimarket banks benefit from local commercial activity the most. Multimarket banks are also most affected, positively, by proximity to urbanized areas. Single-market banks (but not thrifts) tend to operate more in markets with substantial agricultural activity. Branching restrictions have a significant adverse effect on multimarkets (larger than the effect of having a second single-market bank competitor), but a significant positive effect on single-market banks. This suggests that the option to branch is a particularly important consideration for multimarket banks, which we will revisit in our discussion of branching strategies of the different types of institutions. Finally, combining the control variables and the relative value of the three sets of intercept terms

[23] The comparisons are similar for the payoffs of single-market banks (–0.916 vs. −0.278 and 0) and thrifts (−1.178 vs. −0.050 and −0.003).

indicates that, all else equal, multimarket banks would earn the highest baseline payoffs ($C_M = 2.94$ vs. $C_S = 1.01$ vs. $C_T = -.45$).[24]

5.2 Branching regressions

Most importantly, the estimates presented in Table 4 allow us to calculate the corresponding error-term predictions for each market that are used to estimate Eq. 5. Table 5 displays the results from the second step branching regressions, run separately for institutions of each of the three types in the three vertical panels of the Table. In each panel, an observation is an institution (of that type)/LMA combination, and the dependent variable is the number of branches the institution operates in that LMA. We have implemented an ordered-probit specification for estimating these equations; this treats the branching variable as a discrete choice and can more easily capture potential differences between institutions with a single branch (a prerequisite for operating in the market) and those with more than one branch.[25] The likelihood for each observation represents the probability that the error term (assumed to be normal) lies in the region that is consistent with the observed number of branches for that bank/market, given the parameters. We have reported the marginal effect of each regressor on the expected number of branches per firm/market evaluated at the sample mean for the respective type[26]; the expected number of branches is the sum over the total number of branches of the probability of an institution having a particular number of branches multiplied by that number of branches. There are two columns of results in each panel, a base case corresponding to Eq. 1 in which no endogeneity corrections are made and a version in which the estimated error terms from the market structure model are included as regressors, as in Eq. 5.

The estimated marginal effects representing the impact of competitors on the expected number of branches are listed in the top three rows of Table 5. We have specified the competitive effects to be linear by product type; therefore, we have nine (pairs) of estimated parameters corresponding to the effect of additional competitors of each type on the number of branches operated by multimarket banks, single-market banks and thrifts, respectively.[27] The top row of Table 5, describing the impact of multimarket competitors, is of particular interest. Critically, the endogeneity correction matters here substantially—the estimates are generally negative and significant in the unadjusted results, but positive and significant in the right-hand column of each pair which reflects the adjustment for potential endogeneity. In particular, the adjusted results suggest that the presence of an additional multimarket bank *increases* the expected number of branches for a given multimarket bank, single-market bank, or thrift by about .16, .10, and .16, respectively. On the other hand, the unadjusted results suggest that an additional multimarket competitor *reduces* the expected number of branches for a given multi- or single-market bank by about .05 and .04,

[24] These numbers reflect payoffs assuming that each type of firm is a monopolist operating in a market that borders an MSA, has branching restrictions, and where the other control variables are at the sample mean. Positive payoffs correspond to a prediction of entry (operation) in a market; thrifts appear as the effects of the explanatory variables become more strongly positive (to offset the negative baseline payoffs).

[25] The results are qualitatively similar if we treat the dependent variable as linear or employ a Tobit specification. We note that the estimates on the market presence unobservables should be interpreted as a function of the correlation between market presence and the branching unobservables rather than the actual correlation.

[26] The marginal effect associated with the dummies for markets bordering MSAs and the presence of branching restrictions correspond to a change in the dummy variable from zero to one.

[27] We report the linear specification of the competitive effects for clarity. An alternative specification with incremental competitive effects (as in the market structure model) produced similar results.

Table 5 Estimated marginal effects from ordered probit model. Effect on number of branches per firm/market for changes in explanatory variables, evaluated at sample mean for each type. (Asymptotic t statistics in parentheses)

	Multimarket bank branches				Single-market bank branches				Thrift branches			
	Unadjusted		Adjusted		Unadjusted		Adjusted		Unadjusted		Adjusted	
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
MM competitors	−0.048	(−3.79)	0.159	(5.85)	−0.035	(−2.03)	0.096	(2.11)	0.055	(2.48)	0.161	(3.57)
SM competitors	−0.100	(−8.57)	−0.084	(−1.14)	−0.151	(−6.85)	−0.136	(−2.14)	−0.042	(−1.93)	0.058	(0.48)
Thrift competitors	−0.042	(−2.02)	−0.165	(−1.35)	−0.055	(−1.53)	−0.316	(−1.52)	−0.051	(−1.32)	−2.788	(−3.20)
MM market presence unobservable			−0.337	(−8.74)			−0.198	(−3.20)			−0.145	(−2.44)
SM market presence unobservable			0.009	(0.11)			−0.017	(−0.17)			−0.112	(−0.76)
Thrift market presence unobservable			0.112	(1.13)			0.231	(1.41)			2.776	(3.17)
Population (000s)	0.016	(9.09)	0.011	(6.29)	0.013	(3.67)	0.011	(3.10)	0.009	(3.27)	0.021	(4.07)
Establishments (000s)	0.123	(1.69)	0.053	(0.61)	0.128	(0.88)	0.149	(0.82)	−0.038	(−0.38)	1.366	(2.81)
Farms (000s)	0.065	(2.08)	−0.085	(−0.89)	−0.008	(−0.21)	−0.100	(−1.27)	−0.015	(−0.26)	0.462	(1.89)
Per capita income ($000s)	−0.002	(−0.37)	−0.006	(−1.31)	−0.003	(−0.51)	−0.003	(−0.43)	−0.006	(−0.81)	0.068	(2.61)
Border Market Dummy	−0.040	(−1.26)	−0.082	(−2.56)	−0.017	(−0.33)	−0.058	(−1.11)	−0.151	(−2.46)	−0.196	(−3.11)
State Branching Restriction Dummy	0.029	(0.65)	0.142	(2.95)	−0.029	(−0.47)	0.035	(0.50)	−0.156	(−2.11)	−0.146	(−1.90)
Psuedo R-squared	0.0502		0.0577		0.0447		0.0500		0.0599		0.0689	
Observations	7,371				2,329				793			
Observations with 1 branch	3,923				1,060				542			

Population, establishments, farms and percapita income are expressed as percentages of sample mean

MM multimarket bank

SM single-market bank

respectively (there is a .06 expected increase per thrift competitor). While statistically significant, we also note that these effects as estimated would be of minimal economic significance, particularly given the relatively low number of institutions in our sample markets.

Correspondingly, the estimated coefficients on the terms representing the correlations between the branching and the multimarket payoff function errors are negative and significantly different from zero (in the next set of rows in the table). It appears that there is a strong enough negative correlation between the unobservables associated with multimarket bank presence and with branching to significantly bias the uncorrected results. Competition from single-market banks and thrifts, however, is associated with fewer branches per firm. Note that these results contrast with the market structure model estimates, in which the important distinction was between undifferentiated and differentiated competitors (though the presence of thrifts does not have a statistically significant effect on the branching decisions of single-market banks, and vice versa). Here, the particular product type of the competitor is the key distinguishing factor in the effect of competitors on branching—multimarket competition induces a different strategic response (from all types) as compared with single-market bank and thrift competitors.

We interpret the adjusted regressions to strongly suggest that the *market conditions that are conducive to operating multimarket banks induce institutions (of all types) to expand their branch networks*. In contrast this competitive response is not optimal where single-market banks or thrifts are more likely to operate. Just as competition with operating multimarket banks induces additional branching, incumbent firms may also be able to discourage potential multimarket bank entrants from joining particular local markets by increasing the size of their own branch networks. We cannot infer this behavior directly, but our results are nonetheless consistent with a scenario in which incumbent firms that anticipate further entry by multimarket banks (in markets with characteristics that would make operating multimarket banks particularly attractive) add additional branches, and multimarket banks correspondingly choose not to enter.[28] In that case, we would observe the incumbent firms offering more branches than expected and markets containing fewer multimarket banks than expected, which is consistent with the estimated negative correlation between the branching unobservable and the multimarket bank presence unobservable.

A simple regression of branches on market structure would indicate that institutions operate more branches in more concentrated markets (i.e., negative parameter estimates), to the extent that markets in which additional branching and a lack of multimarket banks are prevalent. The uncorrected results would therefore obscure the fact that while multimarket banks' underlying behavior is to compete in branches, this behavior induces other types to do so as well. Once we account for endogenous market structure, this is revealed. Though our methodology cannot allow us to distinguish it from other possible explanations, the correlation it reveals is consistent with the interpretation that the competitive implications are strong enough to permit an institution to use branching investments to pre-empt the

[28] This may reflect the differentiated strategies of these types of institutions—single-market banks and thrifts focus on providing more personalized service, while multimarket banks have broader branch networks by nature. By expanding their branch networks, incumbent single-market banks may be effectively co-opting the favored strategy of multimarket banks where conditions for their entry appear attractive.

entry of multimarket banks.[29] Crucially, these branching strategies appear to depend critically on the identity of (potential) competitors—only the multimarket banks are associated with more branching activity by operating institutions.[30]

The remainder of Table 5 presents the estimated control variable parameters regarding the baseline propensity of financial institutions to establish additional branches in a market. While the estimated effects of the control variables generally have the expected signs, the magnitudes are reasonably small. Population is the only control variable that is statistically significant across the three types, with the adjusted regression parameter values indicating that a 10,000 person increase in market population is associated with a little more than a tenth of an additional branch per operating multimarket and single-market bank. Interestingly, higher income residents do not correlate with more branching activity, even though income predicts entry of each type of firm. The branching restriction dummy estimate is unexpectedly positive for multimarket banks, but the increase in the coefficient in the adjusted regression (and the results from the market structure model) may indicate that entry of multimarket banks is being deterred by these regulatory rules.

Taken together, the results from Table 5 suggest important strategic interactions between branching investments, competition and product differentiation. The comparison between the first and second columns in each pair of results demonstrates the importance of accounting for market structure endogeneity in this context. Advice from industry analysts and regulatory agencies based on the correlation between branches and profitability that fails to consider the potential effects of branching on market structure may result in ineffective investments by community banks and thrifts (i.e., in markets where multimarket banks already operate). In particular, the profound difference between multimarket bank competition and other financial institutions is highlighted by these results. Policy makers may be interested in this market-level consequence of multimarket bank competition. Along with the efficiency benefits other studies have documented, our results suggest that when multimarket banks are present, consumers are provided with more branch locations than would be expected in a similar economic environment or if the market consisted of only single-market banks and thrifts. Given the impact of the market structure endogeneity correction, the mere threat of entry by multimarket firms may be sufficient to induce this response.

6 Conclusion

This paper adds to the relatively small empirical literature that explores the connection between the investment strategies of firms and the amount of competition they face, by examining the decision of financial institutions regarding the extent of their local branching networks. We acknowledge the importance of product heterogeneity in this industry by distinguishing between multimarket banks, single-market banks and thrift competitors in the analysis. By doing so, we uncover interesting insights about investment strategies in the presence of heterogeneous competitors. While competition from traditional single-market banks and thrifts is associated with smaller branching networks, all types of institutions tend to have more branches when they face (or could potentially face) multimarket banks as

[29] To be clear, while we can address market structure endogeneity, our methodology cannot allow us to distinguish the preemption hypothesis from others that could potentially explain the estimated correlation. We intend to pursue this in future work.

[30] Of course, competition from single-market banks and thrifts may induce additional investments as well—just along different dimensions. Unfortunately, there is no data (such as access to bank executives or familiarity of bank employees with regular customers) that would enable us to address this possibility.

their competitors. These insights are lost if the analyst (1) ignores product differentiation among these three types of firms and (2) fails to account for the endogeneity of competitors' presence when analyzing branching decisions. The empirical results also provide a powerful demonstration for why (2) is particularly important in an application like this where market structure could affect investment and vice versa—failing to account for the endogeneity of market structure would have obscured the key result relating multimarket bank competition and branch network expansion. This sort of analysis will be crucial as empirical industrial organization researchers continue to explore applications in which investment strategies and market structure are interrelated.

The empirical analysis undertaken in this paper makes inferences based on differences among a cross-section of banking markets, all of which are observed at a single moment in time. While this identification strategy is informative, it does not fully incorporate the dynamic process in which markets become more concentrated over time as firms enter and exit the market and make investments in additional branches. An important extension to this analysis would incorporate data on the timing of firm entry, as well as the opening of additional branches within markets where institutions are already operating. Such an extension could potentially verify that incumbents use branching to pre-empt the entry of multimarket banks, as suggested by our results. Finally, it is important to note that while we have demonstrated correlations between investment in branches and market competition, the effects on consumer welfare are ambiguous. Consumers may face lower or higher deposit and loan rates depending on competition, which will trade off against the effects of different type of institutions having more (or fewer) branches.

Acknowledgments We thank Dean Amel, Leemore Dafny, Shane Greenstein, Tim Hannan, Robin Prager, and participants at the 2005 Econometric Society World Congress, the 2004 IOS conference, the Southern Economics Association conference, and seminars at Arizona, Indiana, Harvard/MIT, Toronto, Stanford, Columbia, Dartmouth (Tuck), the Department of Justice, the Federal Reserve Bank of Kansas City and the Federal Reserve Board for helpful comments. All errors are the responsibility of the authors.

Appendix A

As discussed in Section 4 of the paper, our assignment of banks into multimarket or single-market categories reflects (1) differences between banks in these two categories that potentially affect costs and consumer demand differently and (2) the fact that the number of markets in which it operates is an explicit endogenous decision made by banks. In terms of the first criterion, our definitions may be approximating a related phenomenon—it may not be that consumers care about the number of markets in which a bank is operating, but that the distinction between multimarket and single-market bank proxies for bank size. Classifying banks based on their size does have conceptual appeal, as theories of differentiating in lending and funding behavior often relate to bank size. In addition, large banks may be more likely to have brand recognition (see Berger and Dick 2007; DeYoung and Ors 2009) that can affect entry and competition. Unfortunately, categorizing based on bank size is problematic for a number of reasons—in particular, because size is an outcome variable rather than an endogenous choice made by firms. Furthermore, it is difficult to establish an appropriate size cut-off to separate banks into discrete categories based on size (which is required, given our econometric framework). Nevertheless, we feel more confident in employing a multimarket vs. single-market categorization since we are able to document considerable overlap between this categorization and one based on size outcomes. By any measure, single-market banks in our dataset are considerably smaller than multimarket banks. The tables below provide evidence of the extensive similarity between the two definitions in our dataset.

Table 6 presents a summary of the distribution of assets and deposits across the banks in the dataset. While there are clearly some smaller multimarket banks, the multimarket banks are substantially larger—as measured by either assets or by deposits—on average and across the distribution.

Table 6 Size distributions by defined institution types

	Single-market banks	Multimarket banks
Assets		
Mean	68,306	2,070,397
Standard deviation	62,543	21,200,000
10th percentile	17,849	49,574
25th percentile	28,969	83,248
Median	50,702	155,750
75th percentile	84,764	342,959
90th percentile	136,938	867,084
Deposits		
Mean	56,258	188,569
Standard deviation	50,510	844,100
10th percentile	14,985	19,284
25th percentile	24,513	41,193
Median	41,944	81,907
75th percentile	70,726	156,669
90th percentile	113,701	301,851

For another look, Table 7 below divides banks (at the Bank Holding Company and at the Bank levels) into discrete asset categories. While there are some deviations, there would be broad consistency if (for example) a cutoff of $100 million in assets were used to distinguish “small” and “big” banks—76% on banks would be classified into the same category at the Bank Holding Company level and 72% at the bank level.

Table 7 Count of institutions by asset-size category

Asset size category	Bank holding company level		Bank level	
	Multimarket banks	Single-market banks	Multimarket banks	Single-market banks
<100 million	608	1,505	722	1,879
100–250 million	713	313	759	412
250–500 million	377	28	375	39
500–750 million	134	2	128	6
750 million–1 billion	66	0	57	0
1–1.5 billion	58	0	20	0
1.5–2 billion	26	0	25	0
Over 2 billion	132	0	120	0
				0
Total	2,112	1,848	2,236	2,336

Finally, we can look at how the size of the single-market banks and the multimarket banks compare within markets. To capture this, an interesting statistic is the ratio between the size, measured at the bank level, of the average multimarket and single-market banks within each market. Because there is generally at least one very large multimarket bank in each market, the ratios displayed in Table 8 are somewhat larger than might be expected, given the data in Table 6.

Table 8 Size ratio distributions across markets in the dataset

Ratio of Avg. multimarket bank size to Avg. single-market bank size	Assets	Deposits
Mean	2,645.68	180.01
Standard deviation	7,195.82	452.14
10th percentile	2.19	1.77
25th percentile	8.79	5.94
Median	253.97	35.52
75th percentile	2,173.23	151.43
90th percentile	6,872.96	445.14

Based on the data in these tables, categorizing banks using the single-market versus multimarket definition appears to adequately represent potential differences in demand and costs that are typically associated with the distinction between small and large banks. We prefer this categorization, because it is more clearly associated with an endogenous decision (as opposed to size, which can be thought of as an outcome variable) and because the assignment into the discrete categories is less arbitrary.

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