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Banks Vs. Credit Unions: Dynamic Competition in Local Markets

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ABSTRACT

One interesting aspect of the financial services industry is that for-profit institutions such as commercial banks compete directly with not-for-profit financial intermediaries such as credit unions. In this article, we analyze competition among banks and between banks and credit unions using a dynamic model of spatial competition. The model allows for the co-existence of (for-profit) banks and (not-for-profit) credit unions. Using annual county-level data on banking market concentration and credit-union participation rates for the period 1989-96, we find empirical evidence of two-way competitive interactions between banks and credit unions.

Keywords: Bank; Concentration; Credit Unions; Not-for-profit institutions
JEL classifications: G21, L11, L31

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BANKS VS. CREDIT UNIONS: DYNAMIC COMPETITION IN LOCAL MARKETS

Competition between banks and credit unions is interesting in part because it entails a for-profit sector (commercial banks) competing with a not-for-profit sector (credit unions). In addition, the distribution of market shares across financial intermediaries with different clienteles, service offerings, and cost structures may have implications for efficiency. This article shows that bank-credit union competition is potentially unstable in the sense that it could lead to a complete crowding-out of one sector or the other. We develop a dynamic model of competition that includes both types of financial intermediary and we analyze the model's stability properties. Then, using annual county-level observations of the concentration of commercial-bank deposit market shares and household participation in occupational credit unions for the period 1989-96, we find empirical support for the model's predictions about competitive interactions between the two sectors. In particular, we find evidence that banks and credit unions directly affect each other's performance in local deposit markets that are dominated by commercial banks and thrifts.

Previous research (Emmons and Schmid, 1999a) finds a link between the concentration of local commercial-bank deposit shares (as measured by the Herfindahl index [1]) and indicators of credit-union efficiency (wage expense) and risk-taking (loan-loss allowances). In addition, higher bank-deposit concentration is associated with higher household participation rates (the fraction of those who are eligible who choose to join) at credit unions (Emmons and Schmid, 1999b). Thus, competitive conditions among banks appear to influence the behavior of credit unions and their (potential) members.

The purpose of this article is to investigate the two-way interaction between banks and credit unions in local markets. We develop and analyze a dynamic model of spatial competition between banks and credit unions. We derive and empirically estimate dynamic response functions of the local banking sector and of households (who comprise the credit unions).

The article is organized as follows: The first section briefly discusses our approach in light of the existing literature on banking market structure and competition. The second section develops a model of spatial competition between credit unions and banks. The model allows for two countervailing influences on occupational credit-union participation rates (previously discussed and documented by Emmons and Schmid, 1999b). These are, first, economies of scale as the credit union's operations grow, and second, decreasing within-group affinity (that is, strength of the "common bond") as the membership increases. The banking sector is modeled as a homogenous Cournot oligopoly. The third section describes the dataset and the econometric methods we employ. The fourth section presents our empirical results, and the fifth section draws conclusions. Two appendixes appear at the end of the article with details on the econometric methodology and on the construction of the dataset, respectively. The dynamics of the model are demonstrated in Appendix 3.

1 CREDIT UNIONS AND COMPETITIVE ANALYSIS OF LOCAL BANKING MARKETS

There is a large and growing literature investigating competition among banks (for example, see Berger, Demsetz, and Strahan, 1999; Amel and Hannan, 1998; or Prager and Hannan, 1998). Much less research focuses on the interactions between credit unions (or thrift institutions) and banks (Hannan and Liang, 1995). This section briefly discusses the bank-competition literature and asks whether credit unions are important for banking competition.

1.1 Banking Market Concentration, Prices, and Profits

Mergers among depository institutions and steady expansion of credit unions have been two hallmarks of the U.S. financial landscape in the 1980s and 1990s, but simply acknowledging these trends is not sufficient to characterize the evolution of competitive conditions in local deposit markets. The number of commercial-bank charters in existence has declined by between

three and five percent annually since 1988, resulting in a nine-year (1988-97) cumulative disappearance of 33 percent of all bank charters (Berger, Demsetz, and Strahan, 1999, Tables 1 and 2). Mergers accounted for about 84 percent of disappearances and failures for 16 percent. Deposit-market concentration, however, actually declined slightly over this period. Average commercial-bank deposit Herfindahl indexes in metropolitan statistical areas fell from 0.2020 to 0.1949, and those in non-metropolitan counties fell from 0.4317 to 0.4114 (Berger, Demsetz, and Strahan, 1999, Table 1). Meanwhile, credit-union membership grew more than 38 percent in the decade ending in 1996, while the country's population grew about 10 percent (U.S. Treasury, 1997, p. 24).

Does market concentration matter for prices and profits? In a non-banking context, Tirole notes that, "Most cross-sectional analyses find a weak but statistically significant link between concentration and profitability (1988, p. 222)." With regard to banking markets, Gilbert (1984) concluded in an early review of the empirical literature that the economic significance of market concentration by banks before deregulation was very difficult to assess, not least because of the poor quality of much of the empirical research. More recently, Shaffer (1992) summarized the (lack of) current consensus by stating that the degree to which banking market structure matters for competition and performance is "a hotly debated topic."

The predominant empirical approach to banking competition in the last several decades has been the so-called SCP (Structure-Conduct-Performance) paradigm. Also, the SCP approach remains the dominant approach in the regulatory analysis of antitrust issues in banking (Kwast, Starr-McCluer, and Wolken, 1997). This approach presumes that measures of banking market structure, including measures of market concentration, are good indicators of the intensity of competition that occurs ("conduct") (Scherer and Ross, 1990, pp. 4-7). The intensity of competition influences the price for financial services, which are, in turn, assumed to determine firms' profits ("performance"). In a nutshell, the higher the concentration in the local banking

market, the higher are the prices for financial services, and consequently the higher are banks' profits. The policy implication is that higher market concentration is associated with lower social welfare and, therefore, higher concentration is undesirable. However, the sources of differential levels of market concentration are left unexplained.

Numerous banking studies demonstrate statistical relationships that are consistent with some aspects of the SCP paradigm, at least in a static context (Berger and Hannan, 1989; Neumark and Sharpe, 1992; Hannan, 1997; Prager and Hannan, 1998; Amel and Hannan, 1998). On the other hand, some evidence is inconsistent with the predictions of this framework (Shaffer, 1989). Moreover, some of the evidence that is consistent with the predictions of the SCP paradigm is subject to a different interpretation. For example, the link between market structure and profitability may be spurious in the sense that an important variable is omitted. Firms of all kinds that are more efficient may have larger market shares simply because their costs are lower (Demsetz, 1973; Berger, 1995). This is a desirable outcome, not one that reduces social welfare.

It is not the purpose of this paper to test the SCP paradigm. We do not observe financial-services prices directly (corresponding to the "conduct" element), for example, and our measure of performance is not bank profits. The SCP framework is related to our theoretical model, however, so it is useful to outline what our model has in common with the SCP paradigm as well as to clarify those respects in which they differ.

The SCP paradigm is predominantly an empirical approach and has been applied most often without explicit reference to a theoretical model of competition. Consequently, the link between higher prices and higher profitability is usually viewed as an empirical question. It is this link between prices and profitability, however, that is questionable on theoretical grounds. Even if higher concentration leads to higher prices for financial services (and consequently to a decline in demand), this does not necessarily translate into higher bank profits. With free entry and exit, the zero-profit condition may hold even in a world of oligopolistic competition. If

oligopolistic competitors operate with fixed costs—a reasonable assumption in most cases—then higher concentration may co-exist with higher prices without violating the zero-profit condition. In such a case, the higher price would be caused by higher average costs due to lower market output.[2] Thus, while users of the SCP paradigm typically draw the conclusion that higher prices (caused by higher concentration) lead to higher profitability, this conclusion is not warranted on purely theoretical grounds. It remains an empirical question whether higher concentration actually leads to higher profitability—that is, whether barriers to entry or exit matter.

1.2 Credit Unions in the Analysis of Banking Competition: Do They Belong?

The primary focus of bank antitrust enforcement in the merger-review process carried out by the Antitrust Division of the Department of Justice and by federal bank regulators (the Federal Reserve, the Office of the Comptroller of the Currency, and the Federal Deposit Insurance Corporation) is "the availability of banking services, including loans and credit, to small and medium-sized businesses" (Nanni, 1998, p. 193). This focus on the availability of small-business credit means that credit unions, which serve the household sector almost exclusively, are routinely ignored for purposes of regulatory analysis of banking market competition. Compounding the problem of defining and measuring the relevant market, the only comprehensive local-market data available are annual observations of commercial-bank and thrift deposits. Deposit data do not differentiate between commercial and retail ownership (that is, business and household deposits), so comparisons of depository institutions with different mixes of deposit customers are necessarily imprecise.[3]

Direct empirical evidence that credit unions matter in banking markets has been difficult to find. Amel and Hannan (1998) conclude on the basis of empirically estimated residual deposit supply elasticities that commercial banks in a local market continue to be their own most relevant competitors. That is, it does not appear that non-local or non-bank financial institutions such as

out-of-market banks, credit unions, other thrift institutions, finance companies, or providers of money-market mutual funds are important determinants of deposit rate-setting behavior by banks.

There is at least some indirect evidence that credit unions matter to banks, however. Bankers themselves frequently complain about (possibly unfair) competition from credit unions.[4] Banks have collectively spent large sums of money lobbying Congress to inhibit credit-union expansion. Thus, there is at least a reasonable presumption that banks view credit unions as competitors—actual or potential—in at least some of their market segments, such as the market for household deposits.

2 A MODEL OF COMPETITION BETWEEN BANKS AND CREDIT UNIONS

In this section we present a model of local market competition between banks and credit unions. Credit unions operate as not-for-profit institutions in a spatial setting. Banks, which are for-profit firms, interact strategically with each other, forming a homogenous oligopoly. All households are potential members of occupational credit unions.[5] Each household may join its credit union or do business with a bank, but not both.

In our model, a decrease (increase) in the price of bank services that follows decreased (increased) bank concentration is caused by a rising (falling) market share in the presence of economies of scale and zero (that is, normal) profits. The zero-profit condition distinguishes our model from the SCP paradigm. In contrast to the SCP paradigm, our model does not assume that higher concentration necessarily results in abnormally high profits even though prices may increase.

2.1 The Model

We examine a circular-city economy similar to the one first described by Salop (1979) and subsequently analyzed by many other researchers interested in markets with diverse preferences among consumers. The perimeter of a circle of length L (representing the city) is

covered by a continuum of households. All households are identical except for their location on the circle. We interpret the location, or address, of each household as the reading on an index that describes its unique preferences for financial services. A given household's most-preferred bundle of financial services would be provided precisely at the household's location. Financial services provided anywhere else on the circle are inferior. Following Salop, we will say that a household's consumption of financial services at any location other than its own address involves costly "traveling."

Providers of financial services are of two types, both of which also lie along the circle. We assume that credit unions exist only at discrete points along the circle while bank branches are ubiquitous. One could think of banks providing a full range of electronic banking services to every home, while credit unions only offer limited services through physical branches at selected locations. Since banks are able to deliver their bundles of financial services to every household's living room, households do not need to travel when doing business with banks. Households must travel if they buy from credit unions, however. This corresponds to the fact that the credit union's financial services may not suit a given household's preferences exactly. Thus, the travel cost is meant to reflect the restricted nature of financial services credit unions typically offer rather than literal physical distance. The number of credit unions is limited in the model because each is required to demonstrate a "common bond" among its members, and not all possible membership groups can support a credit union (Emmons and Schmid, 1999a, 1999b).

2.1.1 Credit Unions. All credit unions are identical except for their location. For simplicity, we assume that all credit unions have a single-common-bond charter.[6] A credit union's costs of production are

(1) $$C_{\mathrm{CU}}(x_{\mathrm{CU}}) = f + v \cdot x_{\mathrm{CU}} \ ,$$

where f is a fixed cost of operation (net of any subsidy from the employer), v is the variable cost of providing one unit of financial services, x^{CU} is the number of bundles of financial services

this credit unions sells. Because each household consumes one unit of financial services, the number of bundles of financial services the credit union sells, x^{CU}, is identical to its number of members, denoted m. Credit unions exhibit strictly decreasing average costs with respect to the amount of financial services they provide, consistent with empirical evidence on credit unions (Emmons and Schmid, 1999b). This feature of credit unions, along with their policy of setting price equal to average cost, renders the nature of competition between banks and credit unions particularly interesting.[7]

2.1.2 Households. The households located on the circle are split into N contiguous segments, each of length L/N. Each segment i $(i = 1,...,N)$ comprises the households of employer i. If employer i $(i = 1,...,N)$ sponsors a credit union (credit union i), it will be located in the center of the arc that forms household segment i. The central location of the credit union results from the one member-one vote governance structure, as suggested by the median-voter model. Employment defines the "common bond." That is, all households located in segment i are eligible to join credit union i but not any other credit union.

Each household consumes (exactly) one unit of financial services, which may be purchased either from a bank or from a credit union. Households face marginal costs of t per unit of distance r when traveling to the credit union, where t is a travel-cost parameter. A household located r_j away from credit union i, $i = 1,...,N$, incurs total travel costs to the credit union of $t \cdot r_j$.

Households follow a least-cost dealing rule when deciding on whether to join a credit union or purchase their bundle of financial services from a bank. The membership of credit union i, $i = 1,...,N$, will comprise all households j within the potential membership for which the following inequality holds:

(2) $$p_{\mathrm{CU}} + r_j \cdot t \leq p_{\mathrm{CB}} \ .$$

We assume that households take the price of financial services, p_{CB} and p_{CU}, as given when deciding between joining a credit union and purchasing from a commercial bank.

2.1.3 Credit-Union Equilibrium. As equation (5) shows, membership in a credit union is worthwhile only if the price of financial services it offers is sufficiently lower than those of a bank to offset the travel costs households face to do business with a credit union. A household relatively far from the credit union (at a distance greater than r^*) buys financial services from a commercial bank. The marginal households, those located at the distance r^* on either side of the credit union, are indifferent between joining their credit union and doing business with a bank:

(3) $$p_{\mathrm{CU}} + m^* \cdot \frac{t}{2} = p_{\mathrm{CB}} \ ,$$

where $m^* \equiv 2r^*$ is the equilibrium number of members credit union i attracts.

For $m^* \equiv 2r^* \geq L/N$, there is a corner solution. All households will join their nearest credit union, and no banks will exist. Another corner solution results for $m^* \leq 0$. The average cost of the credit union, that is, its price for a unit bundle of financial services, is too high to attract members. In this case, the employer in question will not sponsor a credit union.

The price of credit unions' financial services is determined by its average cost:

(4) $$p_{\mathrm{CU}} = \frac{C_{\mathrm{CU}}(x_{\mathrm{CU}})}{x_{\mathrm{CU}}} = \frac{f}{m^*} + v \ .$$

Inserting the average-cost function, (4), into the indifference condition (3), generates the following quadratic equation for the equilibrium number of credit union members, m^*:

(5) $$\frac{t}{2} m^{*2} - (p_{\mathrm{CB}} - v) \cdot m^* + f = 0 \ .$$

Note that the condition $p_{\mathrm{CB}} - v < 0$ is necessary for the existence of credit unions.[8] Thus, we obtain for the equilibrium number of credit union members:

$$(6) \qquad m^* = \frac{(p_{\mathrm{CB}} - v) + \sqrt{(p_{\mathrm{CB}} - v)^2 - 2 \cdot t \cdot f}}{t} \ .$$

The number of credit union members is a strictly increasing function of the price banks charge for financial services. Also, the number of credit union members increases with decreasing marginal or fixed costs of production at the credit union, f or v, respectively, and with decreasing marginal travel costs, t, all else equal.[9]

We define the participation rate, q, as the fraction of the household continuum on the circle that joins a credit union:

$$(7) \qquad q \equiv \frac{m^* \cdot N}{L} \ ,$$

where L/N is the length of each household continuum j, $j = 1, ..., N$.

Inserting equation (6) into equation (7) leads to:

$$(8) \qquad q = \frac{N}{L} \cdot \frac{(p_{\mathrm{CB}} - v) + \sqrt{(p_{\mathrm{CB}} - v)^2 - 2 \cdot t \cdot f}}{t} \ .$$

2.1.4 Banks. There are K identical banks. These banks face the residual demand for financial services, that is, the demand that is not served by credit unions. Total demand amounts to L, while the demand served by credit unions equals $N \cdot m^*$. Thus the following demand function defines the residual market:

$$(9) \qquad x_{\mathrm{CB}} = L - N \cdot m^* \equiv L - N \cdot \frac{(p_{\mathrm{CB}} - v) + \sqrt{(p_{\mathrm{CB}} - v)^2 - 2 \cdot t \cdot f}}{t} \ .$$

Because banks are ubiquitous, their market is not segmented by travel costs. This means that each bank faces the total (residual) market. Also, since banks are homogenous, there is a uniform price for bank services.

The profit of bank j, $j = 1,...,K$ is:

(10) $$\pi_j = p_{\mathrm{CB}} \cdot x_{\mathrm{CB}_j} - w \cdot x_{\mathrm{CB}_j} - e \ ,$$

where x_{CB_j} is the output of bank j, and the parameters w and e are the bank's marginal and the fixed costs of production of financial services, respectively.

We assume that the costs of entry to and exit from the banking industry are zero. This assumption imposes a zero-profit condition on the banking industry, which in turn allows us to solve for the number of banks in the market independent of the assumed competitive structure in the banking sector. The zero-profit condition of the banking industry reads:

(11) $$0 = (p_{\mathrm{CB}} - w) \cdot K \cdot x_{\mathrm{CB}} - K \cdot e \equiv (p_{\mathrm{CB}} - w) \cdot (L - N \cdot m^*) - K \cdot e \ .$$

After inserting the definition for the residual demand (9) and the equilibrium condition (5) into equation (11), we obtain:

(12) $$0 = (\frac{t \cdot m^*}{2} + \frac{f}{m^*} + v - w) \cdot (L - N \cdot m^*) - K \cdot e \ .$$

Solving equation (12) for the equilibrium number of banks, K, yields:

(13a) $$K^* = \frac{(\frac{t \cdot m^*}{2} + \frac{f}{m^*} + v - w) \cdot (L - N \cdot m^*)}{e} \ .$$

Inserting the definition for the participation rate, q, gives:

(13b) $$K^* = \frac{(\frac{t \cdot q^* \cdot L}{2N} + \frac{f \cdot N}{q^* \cdot L} + v - w) \cdot (1 - q^*) \cdot L}{e} \ .$$

We ignore the fact that, empirically, K^* can only be an integer. While this assumption simplifies the following comparative-static and empirical analyses, it is immaterial for the results.

Similarly, for reasons of simplicity, we assume that all banks are the same size. Therefore, the Herfindahl index, h, (calculated as the sum of the squared market shares of all

banks) equals $1/K^*$, which in turn yields a relation between two variables that are, save for corner solutions, restricted to the (0;1] interval:

$$(14) \qquad h^* = \frac{e}{(\frac{t \cdot q^* \cdot L}{2N} + \frac{f \cdot N}{q^* \cdot L} + v - w) \cdot (1 - q^*) \cdot L} \; .$$

Figure 1 exhibits the (nonlinear) relation between credit union participation rate and the concentration in the (local) banking market. Stopped here August 26, 2002 quote Gorton and Rosen

local the participatoin rate of We can now state Proposition 1, which establishes a relationship between the degree of concentration in the local banking market, $herf = 1/K^*_{\text{int}}$, and the credit-union participation rate, $part$.

<u>Proposition 2:</u> An increase in credit-union participation leads to higher banking-market concentration.

<u>Proof:</u> Inserting equation (17) into equation (18), we have

(20) .

By starting with equation (20), assume that there is an increase in the participation rate, $part$, which corresponds to an increase in *m*. This decreases $L - Nm$, which requires a decline in *K*, to bring equation (20) back into equilibrium. For a sufficiently big decrease in *K*, the number of competitors, K^*_{int}, will drop to the next lower integer.

3 DATA AND EMPIRICAL METHODS

This section describes our data briefly and outlines the empirical methods we employ. Further details on both topics are given in separate appendixes at the end of this paper.

TABLE 1 HERE

3.1 Data

The observations in our empirical analysis are annual credit-union participation rates and bank Herfindahl-index levels in individual counties (and independent cities). In other words, we aggregate information about credit unions and banks to the county level. We use these aggregated observations to estimate the response functions specified in equations (22).

To construct our county-level variables, we begin with all federally chartered and federally insured occupational credit unions in the period 1989-96. Community, associational, and corporate credit unions also exist, but occupational credit unions are by far the dominant type of retail credit union, holding almost 85 percent of member deposits (U.S. Treasury, 1997, p. 19). Table 1 shows the Type of Membership (TOM) codes that apply to the occupational credit unions in our dataset. These include credit unions with single and with multiple common bonds. We do not examine community, associational, or corporate credit unions because they are less numerous than occupational credit unions and because their members and purposes may differ substantially from those of occupational credit unions. Including these diverse types of credit unions would make interpretation of our results more difficult.

TABLE 2 HERE

Table 2 provides a breakdown of our credit-union dataset in each year according to the type of membership (TOM) group. The most common type (single and multiple-common bonds) is manufacturing, followed by government authorities. The number of credit unions covered remains fairly constant at just over 5,000 in each year between 1989 and 1996, with a pooled total of 41,329 before screens are applied on the county level that reduce this number slightly.

TABLE 3 HERE

Table 3 summarizes the bank-concentration measure we use, the Herfindahl index of bank deposit shares calculated at county level, for each of the years in our sample. The median and mean values of the annual county Herfindahl index levels decline over our sample period,

which is consistent with the index values reported in Berger, Demsetz, and Strahan (1999, Table 1). Concentration ratios fell during this period of frequent bank mergers because many combinations were of the "market-extension" type. That is, the number of banks decreased in the country as a whole, but new and perhaps stronger competitors were entering local markets via acquisition. If a new entrant (acquiring bank) increases its market share, the target market's Herfindahl index will decline even as the number of independent banks in the country decreases. The number of counties (and independent cities) for which values of the Herfindahl index are calculated varies slightly from year to year because we discard counties that do not have any banks or credit unions in a given year.

TABLE 4 HERE

Table 4 gives an overview of the credit-union participation rates at county level in our sample in each of the years we examine. As noted above, we discarded counties in which the participation rate was zero (that is, there were no credit unions). We also discarded counties with participation rates equal to one for econometric reasons, as discussed in Appendix 2. The range of participation rates in the remaining counties is large, with a low of around 1 percent and a high of nearly 100 percent. The median and mean participation rates show a tendency to increase until they peak in the year 1994 at around 59 percent. They then decline slightly, ending at values in the year 1996 that are still notably higher than in the year 1989.

We use control variables in the regression to account for exogenous differences in the competitive environment in cross section and over time. We control for county-level differences in urbanization patterns by using each county's population density in each year as an exogenous regressor. We also use state indicator variables in our regressions to proxy for cross-sectional differences in state law and regulation, and in economic activity. We use year indicator variables to control for changes in economic activity and legislation at the national level over time. Further details are provided in Appendix 2.

3.2 Empirical Methods

We use a semi-parametric model to allow the influence of the loan-to-member ratio on the dependent variable to be nonlinear. The parametric part of the model contains zero-one variables that indicate the TOM code. In particular, we use a semi-parametric model of a credit union's participation rate of the form:

$$y_i = f(z_i) + x_i \cdot \beta + \varepsilon_i,\ i = 1,...,n\ ,$$

where y_i is the i-th observation of the dependent variable; x_i is a vector consisting of the i-th observation of the explanatory variables in the nonparametric part of the model, the loan-to-member ratio and (in unreported versions of the model) the Herfindahl index; x_{pi} is a row vector consisting of the i-th observation of the explanatory variables of the linear (parametric) part of the model; β_p is a column vector of the parameters of the linear part of the model; and ε_i is the i-th realization of the error term. For details on this econometric approach, see Appendix 3.

4 EMPIRICAL RESULTS

Our empirical results are con

5 CONCLUSIONS

Credit unions are a growing part of the retail financial landscape in the United States. Credit-union expansion is a controversial issue, particularly among bank and thrift owners and managers. The strength of opposition by these interested parties alone provides some indirect evidence that credit unions are relevant competitors to banks in some markets segments of retail financial services. This article provides more direct evidence consistent with the notion that credit unions and banks compete directly.

Our dynamic theoretical model of competition between banks and credit unions makes two predictions. First, an increase in the concentration of the commercial-banking sector of a

county in a given year will lead to an increase in the participation rate at occupational credit unions in this county in the next year, all else being equal. In other words, some households respond to increased concentration among local banks by moving accounts to credit unions. Second, an increase in the rate of participation at credit unions in a given year will cause more concentration in the commercial-banking market of the respective county in the next year, all else held constant. Both theoretical predictions are supported by our empirical results, suggesting that commercial banks and credit unions are direct competitors in the local household deposit market.

[1] The (commercial-bank) Herfindahl indexes reported and employed in this article are based on the commercial-bank and thrift deposits only, that is, they exclude the credit unions.

[2] It is important to differentiate between fixed costs and sunk costs (Tirole, 1988, pp. 307-8). Fixed costs that are recoverable are not sunk and do not function as a barrier to entry. Only sunk costs confer market power.

[3] This shortcoming of the data means that evidence of interaction between commercial banks and other types of limited-purpose depository institutions such as credit unions may be obscured by the inclusion of markets in which they do not compete directly. The evidence reported in this article therefore understates the true extent of credit unions' effects on banks and may overstate the effects of banks on credit unions.

[4] Credit unions are exempt from federal income taxes, which allows them to operate with low costs of capital.

[5] Employers sponsor occupational credit unions for the benefit of their employees. There is good reason to believe that at least some employers use credit unions to deliver tax-favored fringe benefits to employees. Thus, occupational credit unions may be quite attractive to many households and may become formidable competitors for banks.

[6] See Emmons and Schmid (1999b) for a model of credit unions with multiple common bonds.

[7] See Hart and Moore (1996) for an analysis of the competitive differences between shareholder-owned for-profit firms and mutually owned firms.

[8] A credit union cannot attract members and, at the same time, break even if the marginal cost at the credit union exceeds the price charged by a bank, that is, if $p_{\mathrm{CB}} - v < 0$.

[9] If the square root is a complex number, that is, if the marginal travel cost, t, or the marginal or fixed cost of production at the credit union, f or v, respectively, is sufficiently high, a corner solution results in which there are no credit unions.

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Appendix 1: Data

We analyze a dataset comprising all federally chartered and federally insured credit unions during the years 1989-96. Before eliminating some counties for some years due to reasons mentioned below, the credit-union dataset comprised 41,329 observations. The dataset was obtained from the Report of Condition and Income for Credit Unions (NCUA 5300, 5300S), produced by the National Credit Union Administration (NCUA). These reports are issued semiannually in June and December. We used the December data from each year. The business years of the credit unions are on a calendar basis. The flows in the December income statements cover the entire year, whereas the stocks in the balance sheet are end-of-year values.

We concentrate on the following Types Of Membership (TOM) groups among occupationally based credit unions: educational; military; federal, state, and local government; manufacturing; and services. This means that we do not include community credit unions, associational credit unions, or corporate credit unions. Lists of TOM classification codes are from the NCUA (Instruction No. 6010.2, July 28, 1995).

We excluded observations for any of the following reasons:

- Missing TOM codes
- Activity codes other than "active"
- Number of members or of potential members not greater than one; applies to actual and to lagged values
- Nonpositive values for total assets or lagged total assets
- No banks operating in the respective county (or independent city) in the year in question or in the preceding year.

Total assets, number of members, and potential number of members are end-of-year values.

We calculated county-specific Herfindahl indexes as measures of concentration of the local banking market. A Herfindahl index is defined as the sum of squared market shares. We

measured market shares by the fraction of total bank deposits (as of June 30) within a county (or independent city) based on FDIC Summary of Deposits data. These data are available online at <http://www2.fdic.gov/sod/>.

We used population density to control for cross-sectional differences across counties. Population density was calculated by dividing the total county population by the total land area of the county (or independent city). Both the county population and land area data were obtained from the U.S. Census Bureau <http://www.census.gov>. The population data are Census Bureau estimates as of July 1 of the corresponding year. The land area measurements are from the 1990 census.

Appendix 2: Definitions of Variables

The county-specific credit-union participation rate was calculated as a weighted average over the participation rates of all credit unions in our dataset. We used the number of potential members to weight the participation rates.

The county-specific participation rates and Herfindahl indexes, which serve as the two endogenous variables, are bounded on the [0,1] and the (0,1] intervals, respectively. This conflicts with the assumption of normally distributed error terms. This is why we applied the logit transformation, $\ln(y/(1-y))$, where y is the participation rate and the Herfindahl index, respectively, and where $\ln$ is the natural logarithm. To keep the econometric results easy to interpret, we applied this transformation also to the lagged values of these two variables which served as explanatory variables.

The logit transformation requires the values of the variables to lie within the (0,1) interval. Whereas zero values for the Herfindahl index are not defined, zero values for the participation rate can occur. This happens when there are counties without occupational credit unions (of the TOM codes covered by this analysis). This poses the problem of data truncation, for which we did not control explicitly. In the period 1989-96, about 64 percent of the U.S.

counties (independent cities included) did not have credit unions of the type we analyzed. There was one observation of a county (FIPS 8047) that did not have a bank in the year 1988 only (and thus we could not calculate a lagged Herfindahl index for 1989).

When the participation rate or the Herfindahl index are used as dependent variables, unit values pose the problem of data censoring (the so-called Tobit problem). Observations of unit values for the Herfindahl index did not occur, but there were 34 cases of unit values for the participation rate. We did not control for this Tobit problem because the number of censored observations was low. Instead, we eliminated these observations from the dataset. We also eliminated two observations of unit values for the lagged Herfindahl index and 35 cases of unit values for the lagged participation rate because these observations represent corner solutions. Because there was some overlap in these 72 cases of unit values, we only needed to eliminate 62 observations (out of a total of 8,496 county-years).

There was a total of 3,141 counties (and independent cities) in the United States in 1996, including 43 independent cities (40 in Virginia) and the District of Columbia. The corresponding number for 1989 was 3,139 (*The World Almanac and Book of Facts*, 1989, 1996). Overall, our study covers 1,061 counties (and independent cities), which is about 34 percent of the total. There were 117 observations (out of a total of 8,434 county-years), for which there was either no bank in the county (one such observation) or no occupational credit union in a given year or in the preceding year.

Definitions of variables and underlying data sources are listed below. For data taken from the Report of Condition and Income for Credit Unions, produced by the National Credit Union Administration, the relevant item numbers are in brackets.

We employed two dependent variables in the regressions:

1) Participation Rate (PARTICIPATION): Number of actual credit-union members [CUSA6091] divided by the number of potential members [CUSA6092]. In the regressions, we use the logit transformation, $\ln(y/(1-y))$.

2) HERF: Sum of squared market shares of commercial banks within a county based on total bank deposits. By definition, the Herfindahl index is greater than zero; its maximum value is one.

In addition to lagged values of the dependent variables, we used three types of control variables:

1) POPDENS: Population Density, population per square mile in the respective county.

2) State indicator variables; one of the state-indicator variables was eliminated. We do not report parameter estimates for these variables because of their number and because we do not wish to place any particular interpretation on them.

3) Year indicator variables; the indicator variable for 1989 was eliminated.

Appendix 3: Definitions of Variables

We estimate a semiparametric model of the additive partially linear type:

(A1) $y_i = f(z_i) + x_i \cdot \beta + \varepsilon_i,\ i = 1,...,n$,

where

y_i: i-th observation of the dependent variable

z_i : vector of the i-th observation of the explanatory variable(s) in the nonparametric part x_i: row vector of the i-th observation of the explanatory variables of the parametric part, including the intercept

β: (column) vector of the parameters of the linear part

ε_i: i-th realization of the error term.

We estimate the model following Speckman (1988). In a first step, y is smoothed on the variables in the nonparametric part of the semiparametric model. The "smoother" matrix, S, establishes a linear relationship between y and the estimate $\hat{y}$:

(A2) $\tilde{y} = S \times y$.

We use the smoother LOESS (locally weighted regression) as developed by Cleveland and Devlin (1988) and Cleveland, Devlin and Grosse (1988). In contrast to univariate smoothers (e.g., kernel methods) that are used in conjunction with the backfitting algorithm, this so-called locally weighted running-line smoother does not impose the restriction that the influence of the explanatory variables within the nonparametric part is additive (Hastie and Tibshirani, 1990, pp. 29-31). We use locally quadratic fitting with a smoothing parameter of 0.3.

In a second step, the vector containing the dependent variable and the matrix of the explanatory variables of the parametric part are adjusted for the influence of the nonparametric part:

(A3a) $\tilde{y} = (I - S) \times y \;\; \hat{y} = (I - S) \times y$

(A3b) $\tilde{X}_p = (I - S) \times X_p$,

where I is the identity matrix.

Now, the vector β_p is estimated using ordinary least squares:

(A4) $\hat{\beta}_p = (\tilde{X}'_p \tilde{X}_p)^{-1} \times \tilde{X}'_p \tilde{y}$.

As Speckman (1988) has shown, the bias of the estimator $\hat{\beta}_p$ is asymptotically negligible.

The estimated impact of the explanatory variables in the partially linear model is

(A5) $\hat{f}_p = S \times (y - X_p \hat{\beta}_p)$.

Thus, we obtain as the estimated vector of the dependent variable the following:

(A6) $\hat{\hat{y}} = X_p \hat{\beta}_p + \hat{f}_p$.

It is then straightforward to show that $\hat{\hat{y}}$ is a linear function in *y*:

(A7a) $\hat{\hat{y}} = L_S \times y$

where

(A7b) $L_s = X_p(\tilde{X}'_p\tilde{X}_p)^{-1}\tilde{X}'_p(I-S)+S_F$

(A7c) $S_F = S[I - X_p(\tilde{X}'_p\tilde{X}_p)^{-1}\tilde{X}'_p(I-S)]$.

Based on the linearity of equation (A7a), we use results from Cleveland and Devlin (1988, p. 599) on the distribution of the residuals of LOESS regressions to estimate standard errors for $\hat{\beta}_p$ as proposed by Speckman (1988, p. 421). We correct these standard errors for heteroskedasticity following White (1980).

We present the impact of each of the variables of the nonparametric part (partial impact) in so-called conditioning plots (Cleveland and Devlin, 1988). While one of these variables is set equal to its median, the other one is varied over all observations. Since the intercept in the estimated semiparametric model is not identified, only the changes in the values on the ordinate, not the values themselves, should be interpreted. The graphs we present include bands representing 90 percent confidence intervals.

TABLE 1

Credit Union Type Of Membership (TOM) Codes

TOM Code [1]	Type of Membership
4	Educational
5	Military
6	Federal, state, local government
10-15	Manufacturing
20-23	Services
34	Multiple group – primarily educational
35	Multiple group – primarily military
36	Multiple group – primarily federal, state, local government
40-49	Multiple group – primarily manufacturing
50-53	Multiple group – primarily services

[1] National Credit Union Association (NCUA), Instruction No. 6010.2, July 28, 1995.

TABLE 2

Distribution of Credit Unions by TOM Code [1]

Year	4	5	6	10-15	20-23	34	35	36	40-49	50-53	Number of Observations (Credit Unions)
1989	326	40	410	481	126	601	948	603	848	740	5,123
1990	327	40	412	482	126	603	949	604	848	742	5,133
1991	329	39	426	484	127	620	942	614	848	745	5,174
1992	329	39	427	485	127	624	944	616	848	749	5,188
1993	331	40	429	484	128	627	952	624	851	753	5,219
1994	332	41	432	489	128	634	951	628	853	756	5,244
1995	332	41	432	489	129	637	936	621	857	757	5,231
1996	322	38	415	486	125	631	846	582	834	738	5,017

[1] Before eliminating 62 county-years for the reasons mentioned in Appendix 2.

TABLE 3

Descriptive Statistics for the Herfindahl Index [1]

Year	Minimum	Median	Mean	Maximum	Standard Deviation	Number of Observations (Counties)
1989	0.0344	0.2524	0.2707	0.9051	0.1280	1,035
1990	0.0358	0.2510	0.2699	0.8806	0.1279	1,039
1991	0.0360	0.2466	0.2661	0.8584	0.1259	1,040
1992	0.0341	0.2507	0.2654	0.8489	0.1221	1,042
1993	0.0444	0.2376	0.2611	0.8506	0.1218	1,037
1994	0.0519	0.2304	0.2572	0.8500	0.1205	1,039
1995	0.0512	0.2287	0.2532	0.8537	0.1178	1,047
1996	0.0535	0.2263	0.2519	0.8357	0.1150	1,038

[1] After eliminating 62 county-years for the reasons mentioned in Appendix 2.

TABLE 4

Descriptive Statistics for the County Participation Rate [1]

Year	Minimum	Median	Mean	Maximum	Standard Deviation
1989	0.0423	0.5600	0.5696	0.9997	0.1913
1990	0.0119	0.5567	0.5733	0.9959	0.1928
1991	0.0411	0.5623	0.5726	0.9974	0.1908
1992	0.0246	0.5787	0.5846	0.9964	0.1915
1993	0.0375	0.5893	0.5937	0.9985	0.1895
1994	0.0602	0.5897	0.5909	0.9998	0.1881
1995	0.0367	0.5833	0.5824	0.9983	0.1889
1996	0.0330	0.5776	0.5822	0.9987	0.1859

[1] After eliminating 62 county-years for the reasons mentioned in Appendix 2.